Further, faster, higher: Wildlife responds increasingly rapidly to climate change

August 18 2011

New research by scientists in the Department of Biology at the University of York shows that species have responded to climate change up to three times faster than previously appreciated. These results are published in the latest issue of the leading scientific journal *Science*.

Faster distribution changes. Species have moved towards the poles (further north in the northern hemisphere, to locations where conditions are cooler) at three times the rate previously accepted in the scientific literature, and they have moved to cooler, higher altitudes at twice the rate previously realised.

Analysing data for over 2000 responses by animal and plant species, the research team estimated that, on average, species have moved to higher elevations at 12.2 metres per decade and, more dramatically, to higher latitudes at 17.6 kilometres per decade.

Project leader Chris Thomas, Professor of Conservation Biology at York, said: "These changes are equivalent to animals and plants shifting away from the Equator at around 20 cm per hour, for every hour of the day, for every day of the year. This has been going on for the last 40 years and is set to continue for at least the rest of this century. "

The link to climate change. This study for the first time showed that species have moved furthest in regions where the climate has warmed the most, unambiguously linking the changes in where species survive to climate warming over the last 40 years.

First author Dr I-Ching Chen, previously a PhD student at York and now a researcher at the Academia Sinica in Taiwan, said: "This research shows that it is global warming that is causing species to move towards the poles and to higher elevations. We have for the first time shown that the amount by which the distributions of species have changed is correlated with the amount the climate has changed in that region."

Co-author Dr Ralf Ohlemüller, from Durham University, said: "We were able to calculate how far species might have been expected to move so that the temperatures they experience today are the same as the ones they used to experience, before global warming kicked in. Remarkably, species have on average moved towards the poles as rapidly as expected."

A diversity of changes. These conclusions hold for the average responses of species, but individual species showed much greater variation. Some species have moved much more slowly than expected, others have not moved, and some have even retreated where they are expected to expand. In contrast, other species have raced ahead, perhaps because they are sensitive to a particular component of climate change (rather than to average warming), or because other changes to the environment have also been driving their responses.

Co-author Dr David Roy, from the Centre for Ecology & Hydrology, illustrates this variation among species: "In Britain, the high brown fritillary butterfly might have been expected to expand northwards into Scotland if climate warming was the only thing affecting it, but it has in fact declined because its habitats have been lost. Meanwhile, the comma butterfly has moved 220 kilometres northwards from central England to Edinburgh, in only two decades."

Similar variation has taken place in other animal groups. Cetti's warbler, a small brown bird with a loud voice, moved northwards in Britain by

150 kilometres during the same period when the Cirl bunting retreated southward by 120 kilometres, the latter experiencing a major decline associated with the intensification of agriculture.

How they did the research. The researchers brought together all of the known studies of how species have changed their distributions, and analysed them together in a "meta-analysis". The changes that were studied include species retreating where conditions are getting too hot (at low altitudes and latitudes), species expanding where conditions are no longer too cold (at high altitude and latitudes), and species staying where they are but with numbers declining in hotter parts and increasing in cooler parts of the range.

They considered studies of latitudinal and elevational range shifts from throughout the world, but most of the available data were from Europe and North America.

Birds, mammals, reptiles, insects, spiders, other invertebrates, and plants featured in the evidence. For example, I-Ching Chen and her colleagues discovered that moths had on average moved 67 metres uphill on Mount Kinabalu in Borneo.

Co-author Jane Hill, Professor of Ecology at York, said: "We have taken the published literature and analysed it to detect what the overall pattern of change is, something that is not possible from an individual study. It's a summary of the state of world knowledge about how the ranges of species are responding to climate change. Our analysis shows that rates of response to climate change are two or three times faster than previously realised."

Implications. The current research does not explicitly consider the risks posed to species from climate change, but previous studies suggest that climate change represents a serious extinction risk to at least 10 per cent

of the world's species. Professor Thomas says: "Realisation of how fast species are moving because of climate change indicates that many species may indeed be heading rapidly towards extinction, where climatic conditions are deteriorating. On the other hand, other species are moving to new areas where the climate has become suitable; so there will be some winners as well as many losers."

More information: 'Rapid range shift of species associated with high levels of climate warming' by I-Ching Chen, Jane K. Hill, Ralf Ohlemüller, David B. Roy and Chris D. Thomas is published in *Science*, on Friday 19 August, 2011.

Provided by University of York