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Fifty-year study shows climate change is pushing UK wildlife "out of sync"

Climate change has advanced the breeding season of many species in the UK – but just how much varies markedly across the country, according to a major new study.

The first in-depth analysis into the seasonal timing of certain bird and insect behaviours has confirmed that spring is indeed getting earlier each year – but that exactly how much earlier these events now start depends on where in the UK and in which habitat they occur.

The authors of the report have warned these trends could have serious ramifications for ecosystems, as significant variation between groups of animals in the rates of advance means populations are becoming "out of sync" with the life cycles of their prey.

The fifty-year study into natural cycles of egg laying and migration has also dashed environmentalists' hopes that shaded habitats such as forests are shielding some populations from the destabilising effects of global warming.

Lead author Dr James Bell, who heads up the Rothamsted Insect Survey, said: "There was already good evidence that spring is coming earlier each year, but what we didn't expect to find was that it was advancing as much in forests as it is in open areas such as grassland.

"Equally, in areas where we'd expect to see much greater acceleration, such as urban parkland, the rates of advance appear to be the same.

"This all points to a complex picture emerging under climate change, which makes ecosystem responses hard to predict, and even harder for conservationists to prepare for."

An earlier study by the group looking at a 30-year period had shown the average rate of advance varied from about a week earlier for birds and a month earlier for aphids, but this new paper reveals an even more complex picture.

Dr Stephen Thackeray of the Centre for Ecology & Hydrology, leader of the NERC-funded project, said "Our previous research has shown that, in the UK, many signs of spring have been shifting earlier over the last few decades and that this is likely to be driven by climatic change.

"However, we have never before had such a detailed picture of how these changes vary across the UK and its major habitats."

Published in the journal *Global Change Biology*, the study charts the seasonal habits of more than 250 UK species of birds and insects, and shows clear evidence that aphids, moths and butterflies are now on the wing, and birds are laying their eggs, much earlier than they were in the mid twentieth century.

The researchers, which also included scientists from the Centre for Ecology & Hydrology (CEH), the British Trust for Ornithology (BTO), Butterfly Conservation, and Science and Advice for Scottish Agriculture (SASA), analysed data collected between 1960 and 2010 from three national monitoring networks – the Rothamsted Insect Survey, the UK Butterfly Monitoring Scheme, and the Nest Record Scheme

The long-term changes they uncovered broadly confirm similar effects being observed the world over – that as global temperatures rise, natural phenomena such as flowering, or emergence from hibernation, are occurring earlier each year.

But by looking in detail at this long-term data, the team have revealed the responses of some species to climate change are not straightforward, nor necessarily predictable.

Moths provide a good example of this; as those species that turn from caterpillars to adults earlier in the year are apparently much more sensitive to global warming than those emerging later in the summer.

Those moths that start flying before June have started doing so much earlier in the year.

Prof Tom Brereton of Butterfly Conservation said it was unclear what was behind these specific patterns, nor why butterflies didn't show something similar.

"Whatever the reasons, we should be concerned about how dramatically climate change is affecting butterfly and moth life cycles."

And bucking this trend towards earlier onset are those birds and butterflies that inhabit farmland, as well as birds who live in coastal habitats – providing possible evidence that other factors, such as declining food availability, are applying a different pressure on these populations and delaying the onset of breeding.

Dr James Pearce-Higgins, Director of Science at the BTO, said: "Birds are at the top of many food chains, and are sensitive to the impacts of climate change on the availability of their insect prey. This work shows how changing spring conditions may affect the ability of birds to find food, and that those impacts are likely to vary across the country."

A particularly worrying finding of the study is that the rate at which these seasonal behaviours are shifting is the same in open habitats, such as grasslands, as it is in shady ones, such as forests. It had been thought forests might offer some protection for species against rising temperatures.

"The work is important because it shows us that we cannot rely on habitat to slow down climate change impacts, even in woodlands and forests where the conditions are more stable, and which were expected to buffer against adverse changes," says Dr Bell.

As well as providing more evidence of the effects of climate change, the study also provides the most detailed assessment yet of how many species' life cycles are determined by geography and altitude.

It shows that rather than tracking the simple north-south trend of increasing temperatures and earlier onset of spring, the date of key behaviours of many species follow more complex patterns.

So, whilst aphid activity simply becomes progressively later the further north you go, the same was only true for birds and butterflies up to the likes of Derry, Gretna or Newcastle.

Beyond that point, butterflies become active earlier in the warmer, wetter west than the colder, drier east, whilst for birds laying eggs, the opposite is true.

Dr Jon Pickup, lead aphid researcher at SASA said: "As pests, it remains a concern that aphid migrations are getting earlier at a dramatic rate, and this piece of work shows us that signal across the UK very clearly".

The study is the result of many years work analysing and interpreting huge data sets, and now lays the ground work for some urgent new research into what is driving these impacts at habitat levels.

“There is unlikely to be a more comprehensive analysis that address both spatial and habitat variations in seasonal timings,” says Dr Bell.

Notes

1) James Bell, Marc Botham, Peter Henrys, David Leech, James Pearce-Higgins, Chris Shortall, Tom Brereton, Jon Pickup & Stephen Thackeray (In press) Spatial and habitat variation in aphid, butterfly, moth and bird phenologies over the last half century. *Global Change Biology* https://doi.org/10.1111/gcb.14592

2) This work was funded by Natural Environment Research Council (NERC) grant NE/J02080X/1 titled 'Quantifying links between human influences on climate, shifting seasons and widespread ecosystem consequences'.

3) Data from a total of 263 species were used in the analyses.

- 55 aphid species across 17 sites (1965-2010) using the the first individual to be caught in a site-year for a given species.
- 139 moth species across 40 sites (1965-2010), using the median day of flight phenological metric, a historical measure of flight phenology that is commonly used.
- 45 butterfly species across 169 sites (1973-2010), using the day of mean abundance; a widely-used UKBMS index to estimate the date of mean abundance during the adult flight period.
- 30 bird species across 11,664 sites (1960-2010) and for this analysis the first egg day; the appearance of the first egg to be recorded in a nest per species-nest-year.