Timing is everything

Birds find it difficult to change their breeding seasons in response to climate change, reports **Alistair Dawson.**

Unlike people, birds have distinct breeding seasons which are timed so that their young are growing up when their food is most abundant. For most songbirds, this means raising their chicks in the spring, when the caterpillars or other invertebrates that they eat are in plentiful supply.

Each species of bird has adapted to use a particular food. So the timing and duration of each species' breeding season have evolved to suit the food requirements of their young. For example, great tits time their breeding so that the chicks are in the nest during May when leaf-eating caterpillars are most abundant. Starlings feed their young largely on leatherjackets, the larvae of craneflies. Their nestlings are growing when leatherjackets are most abundant, which also happens to be in May.

Another important factor is the need to moult. Feathers wear out, so birds have to replace their plumage each year. Both moulting and breeding demand a lot of energy, so they rarely occur at the same time of year. Normally moulting starts as soon as breeding ends.

For young to hatch at the right time of year, a long sequence of events has to happen first: maturation of the sex organs, courtship, nest-building, egg-laying and incubation. Obviously these changes have to start well before hatching, and therefore before food becomes abundant. So the food supply is not a useful cue to trigger these changes.

Instead, birds, like many other animals, use the annual change in day length to get ready for breeding. Day length changes in an exactly predictable fashion every year. It is therefore a reliable indicator of calendar time. Day length is used to time the start and rate of maturation of the testes and ovaries so that they are fully mature at the time the eggs need to be laid. It also controls inactivation of the sex organs at the end of the breeding season, and the start and rate of moult after breeding.

Climate change therefore presents a problem for songbirds which rely on insects or other invertebrates to feed their nestlings. Invertebrates develop faster when the temperature is higher, so their peak comes sooner when spring is warmer. But if birds rely entirely on day length to time breeding, their breeding seasons will stay the same and the young will hatch after the best food is over.

Can birds compensate for climate change? For example, is the day-length-controlled rate of sexual maturation increased at higher temperatures? To test this, we used the controlled environment facility at the Centre for Ecology & Hydrology (CEH), Monks Wood. In this facility, birds can be kept in large indoor aviaries where both day length and temperature can be controlled. In this particular study, starlings were kept in two aviaries. In both aviaries, the time that the lights came on each morning and went off each evening was controlled by outdoor photocells, so day length for both groups was identical and followed the natural cycle. Only the temperature was different: in one aviary, temperature was kept at a constant average mid winter temperature (5°C) and in the other it was a constant mid summer temperature (20°C).

We found that the time and rate of sexual maturation in the two groups were identical. But, completely unexpectedly, the birds became sexually inactive (ie, their breeding season ended) earlier at the higher temperature. And these birds also started their annual moult sooner. This was such an unexpected result that we repeated the study the following year, but the outcome remained the same. We are now looking at magpies and greenfinches to see whether they show the same effects as starlings.

This result means that climate change gives birds two potential problems. First, they may lay their eggs too late, since eggs can only be fertilised and laid during full sexual maturity. So in warmer springs the beginning of the breeding season will remain the same and young will be in the nest after the food supply has peaked. A long-term study on seabirds at CEH Banchory (*Planet Earth*, Autumn 2004) has shown that laying dates are no earlier (in fact two species are actually laying later). The second problem is that breeding seasons may end sooner. Species that normally raise more than one brood will therefore have fewer young each year.

Many ongoing studies are monitoring the timing of events in spring and relating these to temperature and climate change, for example, the BBC's Springwatch, which is run in collaboration with the UK phenology network based at CEH Monks Wood. For birds in particular, the British Trust for Ornithology (BTO) records the dates that eggs are laid. These studies have shown that for plants and insects, spring is advancing by three to four days per decade, but egg-laying in birds has advanced by only one day on average. A recent study in the Netherlands has shown that pied flycatcher populations are decreasing fastest in parts of the country where their food supply peaks earliest, a change which birds seem unable to adapt to.

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