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## **Long- and short-distance migrants: differing impacts and changes in migration strategy as a means of adapting to climate change**

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Migration is a means for species to make use of locations when food is plentiful but where harsh conditions occur at other times of the year. However, the trade-off is that migration is energy demanding and carries increased risk. Climate change has the potential either to exacerbate this risk by increasing migration distance or reducing food abundance, or to improve conditions if, for example, areas closer to the breeding ground become suitable in the non-breeding season.

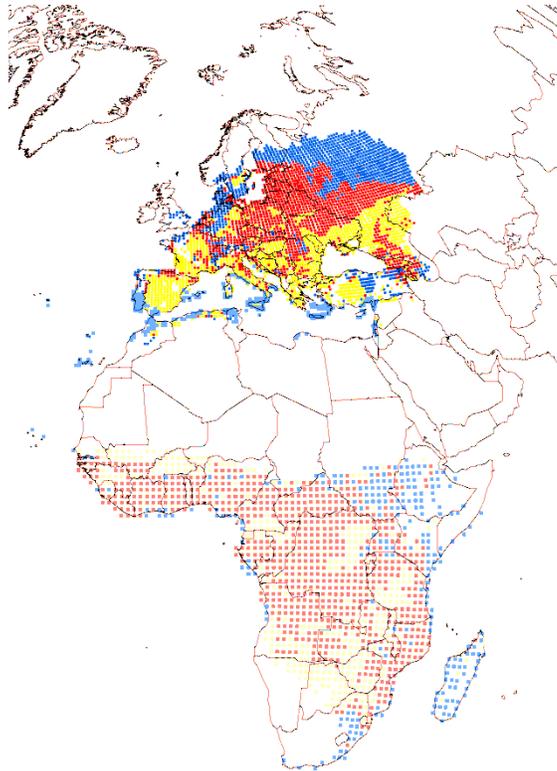
Migration is largely genetically controlled and individuals within one species can show varying degrees of migratory behaviour (obligate, partial, long-distance, short-distance). Climate change may impact differently on these migratory groups. It is thought that obligate long-distance migrants may suffer more than other groups of species, which may be able to adapt their behaviour. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as ‘the adjustment in natural systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’ (IPCC, 2001). In response to climate change birds have been seen to adapt in three main ways. (1) Phenotypic adjustment: there are many examples of bird species adjusting their phenology in response to climate change. (2) Species can evolve to cope with new conditions. The arrival date of Barn Swallows *Hirundo rustica* is hereditary, and changes in arrival time may be due to micro evolution. This has also been suggested for the Sand Martin *Riparia riparia* (Sparks & Tryjanowski 2007). (3) Finally, species can shift their ranges in response to climate change. Chiffchaffs *Phylloscopus collybita* and the Great Reed Warbler *Acrocephalus arundinaceus* have shifted their breeding range poleward at the northern edge of their range (Brommer 2004). Birds have also shown shifts in non-breeding range, for example the Curlew *Numenius arquata* (Maclean *et al.* 2008). It has also been shown that novel migratory habits can evolve rapidly under strong selective pressure; climate change could be such a pressure. Indeed, there is evidence of reduced migratory tendencies in many bird species, as well as evidence of species shortening or lengthening their migration. Climate niche models of future breeding and non-breeding bird distributions could be used to provide an indication of potential changes required by migratory species, by simulating changes in breeding and non-breeding ranges and resultant migratory distance.

In the present study, the breeding and non-breeding ranges of 229 Afro-Palaearctic migratory birds were modelled using Generalized Additive Models and Climate Response Surfaces and projected into three future time periods (2025, 2055, 2085) using three general circulation models and the A1B scenario. The multi-model mean was used to determine change in distribution with a full and no dispersal scenario, and migratory distance (geodesic distance between the centroid of breeding and non-breeding areas). Species were categorized into three groups: short-distance European migrants, long-distance trans-Saharan migrants and split-strategy migrants (those species with populations that migrate above and below the Sahara). Differences between groups were examined. Changes in migratory behaviour were established by examining gains and losses of non-breeding area above and below the Sahara desert. The change in proportion of resident areas (overlapping breeding and non-breeding areas) was also examined.

There were differences between groups in terms of how their distribution changed between present and future time periods. On average on the breeding grounds, with a full dispersal scenario, range sizes of short-distance migrants were projected to stay stable, those of trans-Saharan migrants to increase (more suitable climate in Europe) and to decrease for split-strategy migrants as a whole (climate was projected to be less suitable in Europe). Under a no-dispersal scenario, the range size of all groups decreased. On the non-breeding grounds all groups were projected to gain suitable climatic space under a full-dispersal scenario but to lose range under a no-dispersal scenario, with trans-Saharan migrants losing the most range as a group.

Changes to average, minimum and maximum migration distance calculated as the geodesic distance between goal areas were calculated. All groups were projected to face similarly increased average migration distance. Trans-Saharan migrants were predicted, however, to have greater maximum distances and smaller minimum distances.

In terms of changes of migratory strategy, 14–17 species were consistently projected to shorten their migratory distance with new non-breeding range becoming suitable in the Mediterranean region (Fig. 1). Changes in the proportion of resident cells for different migratory groups revealed that about 61% of short-distance migrants are predicted to become more resident, with an average of 24% increase in resident areas.



**Figure 1.** Future range change for the Great Reed Warbler under the GFDL 2085 A1B scenario: Blue = future range only, Yellow = current range only, Red = overlapping ranges. Light blue on Mediterranean coast is newly suitable non-breeding range.

Climate change is predicted to affect different migratory groups in different ways as well as to show different effects on the breeding and non-breeding grounds. The projected distribution change on breeding and non-breeding grounds of long-distance trans-Saharan migrants indicates that these species may suffer most from climate change. Some of these species are currently declining and climate change has been suggested as a driver (Sanderson *et al.* 2006). If future projections are part of an ongoing trend, then this may indicate that climate has a role in the decline in some species.

Furthermore, the future changes in non-breeding range suggest mechanisms whereby species may change their migratory behaviour. There is evidence that climate change is having an effect on species and that species are adapting to climate change. Visser *et al.* (2009) have shown that some migratory birds have decreased their migratory distance over the last 70 years due to shifts in non-breeding range, which could be a result of temperature change.

Predicting which species are more likely to adapt to climate change will require a better understanding of the physiological limits and adaptive capacity (a function of genetic, history and ecology) of species. This understanding would enable analyses of species' vulnerability and resilience to climate change so that appropriate conservation responses can be put in place.

### **Related website**

<http://www.chinabird.org/news/Potential%20impacts%20of%20climatic%20change.pdf>

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