# Assessing the impacts of climate change on upland birds

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## Introduction

Global climate change is arguably the most pressing environmental issue of our time and there is an increasing body of literature examining the impacts of climate change on birds. It is considered that climate change in northern and upland areas in particular may reduce the area of suitable habitat to the extent that many species will be committed to extinction by 2050, and yet there are few studies of the impacts of climate change in the British uplands. To address this, we used long-term data sets to examine variation in breeding phenology, demographic parameters and population size in relation to climate variables for a number of bird species, illustrating the ways in which future climate change may impact upon upland birds.

## Golden plover

Golden plovers (*Pluvialis apricaria*) are a characteristic wader of upland and boreal regions. Although not currently of conservation concern in the UK, population declines have occurred in some areas. Laying date is strongly correlated with spring temperature, with warming suggesting that a 9-day advancement of first-laying dates may have occurred through the 1990's. As the hatching of first-clutches is timed to coincide with the synchronised emergence of adult tipulids, we also investigated the phenology of tipulid prey emergence, which is negatively correlated with May temperature. Recent trends in climate suggest that golden plover first-laying dates may have advanced more rapidly than the timing of tipulid emergence, which demographic modelling suggests may have a small negative impact on overall breeding success in some areas (Pearce-Higgins *et al.* 2005). Positive correlations between daily temperature and chick growth rates may, however, offset such changes in breeding success, whilst milder winters are also likely to improve adult survival rates. Future work on this species should further investigate the role of climate in driving tipulid populations, as tipulid emergence may be suppressed following summer drought. Thus, there is likely to be an optimum temperature that maximises productivity.

## Dunlin

We illustrated this principle using data on dunlin (*Calidris alpinal)* productivity, a widespread upland bird that occupies similar habitats to the golden plover within the UK. We obtained a long-term index of breeding productivity from the ratio of juvenile to adult dunlin captured during the winter in North Wales; individuals which breed in north-west Siberia. Annual variation in productivity was significantly correlated with June / July temperature on the breeding grounds, and its quadratic term. Thus, productivity increased with temperature from 8 to 11 °C, but declined between 11 and 13 °C (Beale *et al.* 2006b). This may be because warmer summers increase invertebrate activity and reduce the risk of chilling, but too high a temperature may reduce populations of the wetland invertebrates that Dunlin feed on.

## Common sandpiper

In addition to affecting productivity, climate change may impact upon upland bird populations by altered adult mortality rates. Such effects may be most marked on migrants, because there are more locations for climate change to disrupt their life-cycles. Indeed, trans-Saharan Afro-Palaearctic migrants are some of the most rapidly declining bird species in Europe at present, potentially as a result of such disruption (Sanderson *et al.* 2006). We used long-term data from a marked population of common sandpipers (*Actitis hypoleucos*) breeding in the Peak District, England, to examine the potential for climate variation to drive annual variation in mortality. This is a population which has declined by 59 % from 1977 to 2004, and for which population fluctuations have previously been related to variation in North Atlantic Oscillation (NAO) (Forchhammer *et al.* 1998). As expected, annual fluctuations in NAO were significantly negatively correlated with annual survival rates, although the effects were relatively weak. There were no other significant climate effects. Annual variation in adult mortality did not describe the observed decline in the common sandpiper population, and thus, it appears that climate change cannot explain the observed decline in common sandpipers.

## Ring ouzel

Finally, we combined these themes of climate impacts on both productivity and adult survival, to examine the likely impact of climate change upon another migratory species, the ring ouzel (*Turdus torquatus*), which is one of the UK's fastest declining upland birds. Analysis of detailed nest survival data showed that fledging rates were unrelated to weather variables, with predation the main cause of nest failure and losses strongly density dependent. However, annual variation in territory occupancy was strongly correlated with climate variables. Thus, fluctuations in population size were linked to summer rainfall and temperature in the preceding year, and to rainfall in the Moroccan wintering grounds 24 months previously, coincident with the period of juniper (*Juniperus* sp.) flowering, the main food of wintering ring ouzels. High summer temperature, intermediate levels of summer rainfall, and high spring rainfall in Morocco all had negative impacts on territory occupancy the following year. Although there has been no long-term trend in Moroccan spring rainfall, significant increases in UK summer temperature and declines in rainfall since 1952 are sufficient to describe the observed population decline (Beale *et al.* 2006a). An improved understanding of the post-breeding ecology of ring ouzels is required to elucidate any mechanisms that may cause this relationship, but it may relate to food availability after breeding, and prior to migration.

## Conclusion

Climate change may therefore impact upon upland bird populations through altered phenologies, productivity or survival rates. The analysis presented indicates that different species will have differing sensitivities to climate change at different stages of their life-histories. Long-term monitoring and detailed research is required to fully assess these likely sensitivities, and guide conservation management to allow for adaptive management.

## References


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