BTO RESEARCH NOTE

# Modelled abundance and change in abundance of Red Deer and Roe Deer in Scotland from Breeding Bird Survey data

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Looking out for birds

## INTRODUCTION

Responding to a request for information on the status of deer in Scotland, we aimed to assess spatiotemporal change in deer abundance from the late 1990s to the present day using data from a volunteer survey, the BTO/JNCC/RSPB Breeding Bird Survey (BBS; Harris *et al.* 2016). This short note describes the derivation of maps of abundance and abundance change for Red Deer *Cervus elaphus* and Roe Deer *Capreolus capreolus*, to illustrate recent changes and discussing their interpretation.

## METHODS

The maps we present here have been produced by modelling deer count data from the BBS to obtain estimates of abundance and change in abundance across Scotland. Because not every 1-km square is surveyed, statistical modelling was needed to fill in the gaps between surveyed squares using information on their location and habitat, the latter derived from land cover data.

In practice, the model relates deer number in each BBS squares to the habitat in that square, and to its location, because squares that are close together and have similar habitat are more likely to have similar deer abundance than squares that are far apart. We did this by using a Generalised Additive Model (GAM) with a three-dimensional (easting, northing and elevation) smoothing function. Covariates were the percentage cover in the 1-km square of seven land cover classes (broadleaved/mixed woodland, coniferous woodland, mountain/heath/bog, improved grassland, semi-natural grassland, arable land, and built-up area) and a categorical variable for islands, which was needed to account for large differences in density between island groups and between islands and the mainland.

For each species, two separate models were run, one for each of the following 5-year time frames: 1995–1999, which represents the start of the mammal recording within the BBS project, and 2012–2015, the most recent years for which data were available at the time of analysis.

## RESULTS

For each species, the first map shows predicted abundance in the later years (2012–2015) across Scotland. As shown in the legend, darker colours correspond to higher abundance (expressed as the number of deer we would expect to count in a 1-km square if the square was surveyed following the BBS procedure). The resolution of this map is 1-km. The second map shows information about changes in abundance from 1995–1999 and 2012–2015 at a 10-km resolution.

The map presents two different pieces of information using combinations of dot colour and size. Colour shows the relative change in abundance with blue colours showing increase and red colours showing decline. Grey colours indicate little or no change. The relative change is simply the proportional change in abundance between the two time frames. Dot size indicates the mean abundance of that species across both periods, so that locations with large dots were estimated to contain more deer than those with small dots.

## REFERENCES

Harris, S.J., Massimino, D., Newson, S.E., Eaton, M.A., Marchant, J.H., Balmer, D.E., Noble, D.G., Gillings, S., Procter, D. & Pearce-Higgins, J.W. (2016). *The Breeding Bird Survey 2015.* BTO Research Report 687. British Trust for Ornithology, Thetford.

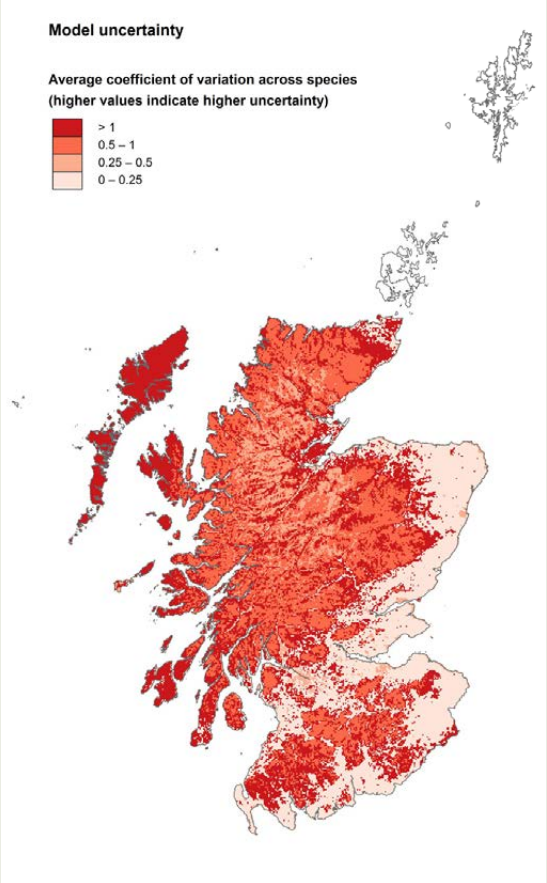
Massimino, D. & Calladine, J. (2017). Modelled abundance and change in abundance of Red Deer and Roe Deer in Scotland from Breeding Bird Survey data. BTO, Thetford.

## LIMITATIONS OF THE ABUNDANCE MODELS

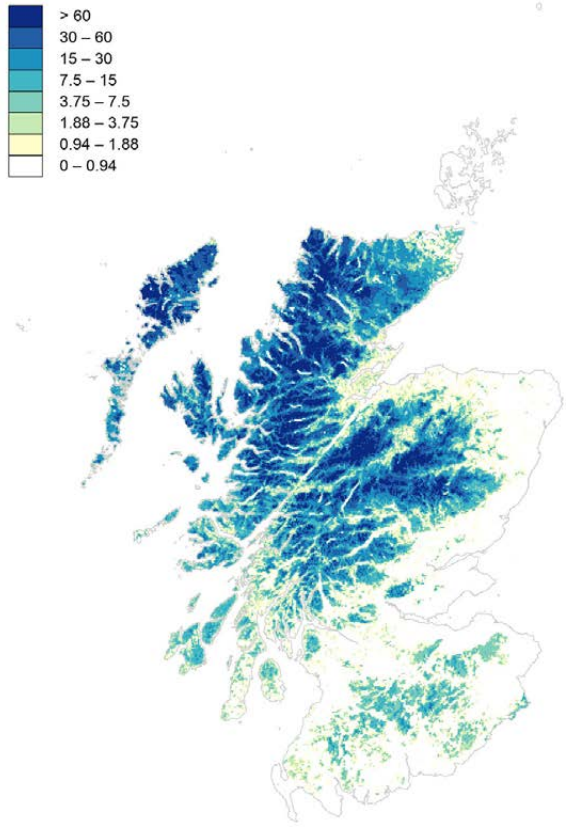
Modelling always involves some degree of approximation; therefore the figures that you see on the maps are not always exactly what you can find in reality. The accuracy of a species distribution model depends on many factors, for example the density of survey squares in the region or the extent to which the density of a certain species is influenced by factors not accounted for in the model. These maps are likely to be more accurate where there is a high concentration of BBS squares, whilst in areas with fewer survey squares, the model estimates the species abundance based on the nearest available data and the relationship between the species and similar habitats in better sampled areas.

Particularly critical areas are the islands, which do not have neighbouring areas for interpolation and often have only a small number of sample squares or none at all. For this reason a categorical variable was used to model together the islands belonging to three broad archipelagos: Shetland, Orkney, and Western Isles. The Inner Hebrides were lumped with the mainland. In this way the model uses counts from nearby islands or the mainland to estimate abundance. A specific case where the models may be prone to error is where occupancy of Inner Hebridean islands is not determined by the factors in the models (space and habitat), for example where island occupancy by deer is related to colonisation ability or artificial management factors.

The map to the right shows the average coefficient of variation (a measure of the uncertainty associated with each estimate) of the modelled abundance across the two deer species. The darker the colour, the higher is the uncertainty. Uncertainty appears particularly high for islands and in upland areas. The coefficient of variation is not shown in Orkney and Shetland where the estimated abundance was virtually zero, as no deer are present on those islands. To reduce the uncertainty, more BBS squares should be surveyed on islands and in upland areas.

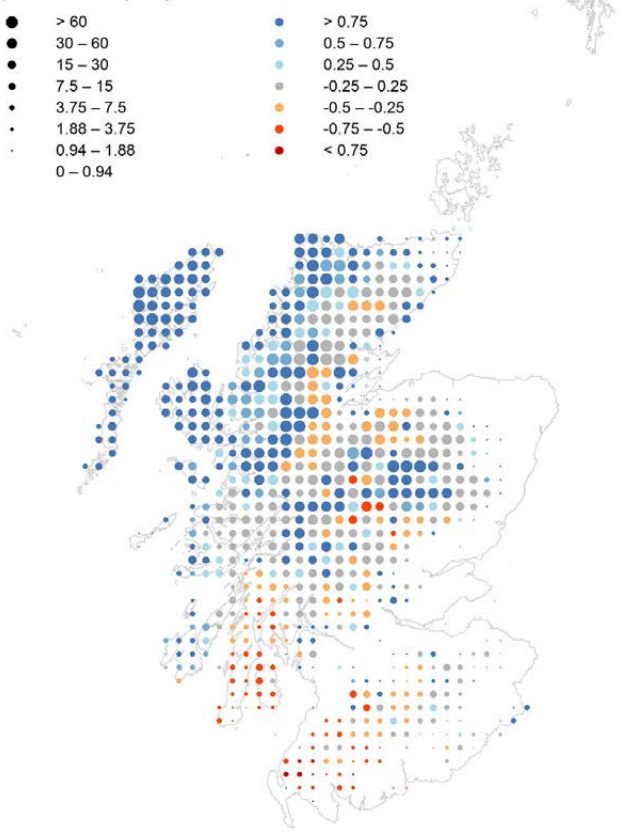


**Red Deer**
***Cervus elaphus***



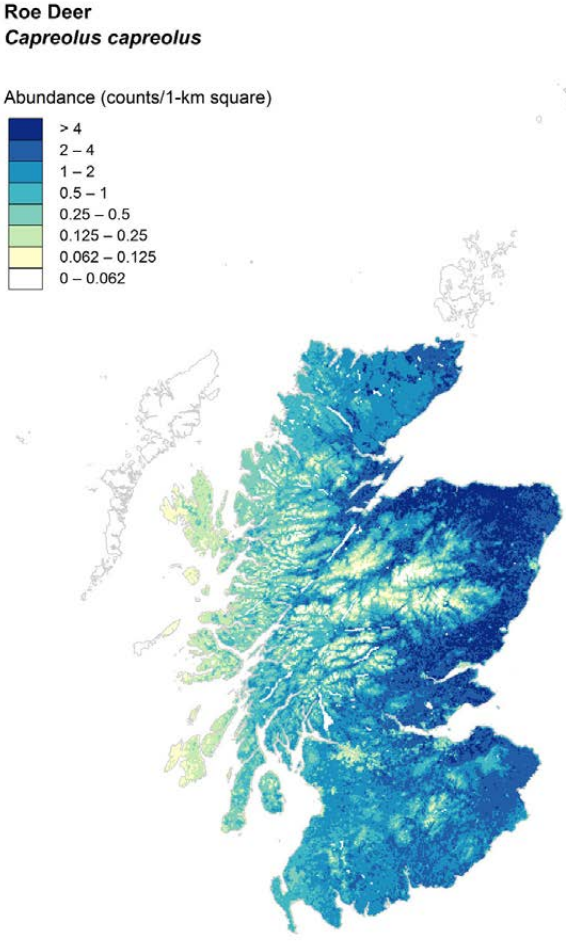

Years: 2012-2015

**Red Deer**
***Cervus elaphus***



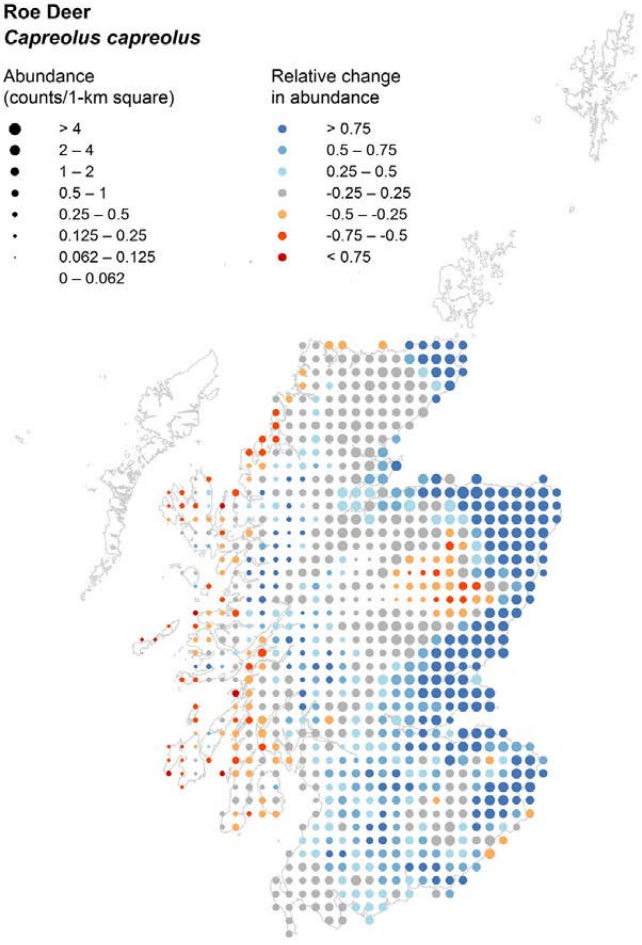

Change between 1995-1999 and 2012-2015

**Roe Deer**
***Capreolus capreolus***




Years: 2012-2015

**Roe Deer**
***Capreolus capreolus***




Change between 1995-1999 and 2012-2015



## Massimino, D. & Calladine, J. 2016. Modelled abundance and change in abundance of Red Deer and Roe Deer in Scotland from Breeding Bird Survey data. BTO, Thetford.

Responding to a request for information on the status of deer in Scotland, BTO researchers Dario Massimino and John Calladine analysed data on Red Deer and Roe Deer distribution and abundance, collected through the BTO/JNCC/RSPB Breeding Bird Survey. This short note describes the derivation of maps of abundance and change in abundance for the two species, from the late 1990s to the present day. This short BTO Research Note illustrates recent changes in distribution and abundance and discusses interpretation of the data presented.

The BTO/JNCC/RSPB Breeding Bird Survey (BBS) is the main scheme for monitoring the population changes of the UK's common breeding birds. It is a national volunteer project aimed at keeping track of changes in the breeding populations of widespread bird species in the UK. Wild bird populations are an important indicator of the health of the countryside, and knowing to what extent bird populations are increasing or decreasing is fundamental to bird conservation.

Mammal recording was introduced to the BBS in 1995 with a view to help improve our knowledge of the distribution and population trends of some of our commoner mammals. Compared with birds, the population trends of mammals are relatively poorly known. Even though mammal recording has always been a voluntary addition to the scheme, 90% of BBS observers now actively look for them during their BBS visits. To find out more about the Breeding Bird Survey, and how you can help, please visit www.bto.org/bbs

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