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The Changing Status of the Glossy Ibis *Plegadis falcinellus* in Britain

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ABSTRACT

Numbers of Glossy Ibis recorded in Britain have increased dramatically since the mid-2000s, mirroring the increase in their breeding population in southwest Europe, especially in Doñana (south Spain). Despite the increasing number of records in Britain, there are still only small numbers of Glossy Ibis present in spring and, so far, only two nesting attempts. The majority of Glossy Ibises recorded in Britain arrive in autumn, with re-sightings of colour-ringed birds indicating that most arrive during their first year. Our results indicate that, regardless of any common trend, larger numbers of Glossy Ibis tend to be recorded in Britain in years when smaller numbers have bred in Doñana. A higher proportion of Glossy Ibises then tend to be present in Britain in spring compared to the previous autumn, when temperatures are higher during the winter in between. In short, our results suggest that Glossy Ibis is more likely to breed in Britain when poor conditions for breeding in Doñana are followed by mild winters in Britain. Although we expect Glossy Ibis to begin breeding regularly in Britain eventually, there are probably very few wetlands in Britain large enough to support breeding colonies of significant size.

Introduction

Until the early decades of the twentieth century, Glossy Ibis *Plegadis falcinellus* was a fairly regular visitor to Britain, with 340 accepted records prior to 1950 (<http://www.rbbp.org.uk/>). The number of records then declined, probably mirroring the decline in their breeding population in southeast Europe (e.g. Doroşencu *et al.* 2019; Puzović *et al.* 2019), their main breeding population in the region at that time. Glossy Ibis became a very rare visitor to Britain until the early 2000s, albeit with two long-staying individuals present in Kent during the period between 1975 and 1992 (Brown and Grice 2005). Major arrivals of Glossy Ibises into Britain took place in the autumns of 1986 and 2002 (<http://www.rbbp.org.uk/>),

after which numbers recorded in Britain have shown an upward trend, which we quantify and report on in the Results.

The 1986 arrival took place before the re-establishment of regular breeding by Glossy Ibis in southwest Europe in 1993 (Santoro *et al.* 2010; Vera *et al.* 2019), but the subsequent increase in numbers of sightings in Britain has coincided with a period of growth in their breeding population in the Iberian Peninsula and south France. In these areas, the breeding populations have shown a remarkable increase, especially in Doñana (south Spain) which nowadays hosts the main breeding and wintering populations of Glossy Ibis in Europe (e.g. Santoro *et*

al. 2016; Mañez *et al.* 2019; Champagnon *et al.* 2019).

It remains to be seen whether Glossy Ibis might start breeding regularly in Britain. Two breeding attempts have already occurred. The first took place in 2014, and involved a pair of birds displaying at RSPB Frampton Marsh in Lincolnshire in eastern England, one of which then built a nest platform (Holling *et al.* 2016). Then in 2016 a pair summered at RSPB Ham Wall in Somerset in southwest England, and built a nest platform in the old nest of a Eurasian Coot *Fulica atra*. Ham Wall forms part of a large (ca 1,200 ha) complex of wetlands in Somerset known as the Avalon Marshes. A limiting factor for the breeding of the Glossy Ibis in Britain could be the ability of juveniles to survive the winter and remain in the area until they can breed. We are not aware of any information regarding the effect of winter conditions on the probability of ibises remaining in Britain from autumn to spring.

In this study we aim to (i) describe the changing status of Glossy Ibis in Britain by reporting the variation in the yearly and monthly frequency of sightings and their spatial distribution; (ii) test whether numbers of Glossy Ibis recorded in Britain are explained by the dynamics of their breeding population in Doñana; and (iii) evaluate whether numbers of Glossy Ibis in Britain in spring relative to autumn might be negatively affected by winter conditions.

Methods

Description and comparison of numbers in Britain and Doñana

First, we summarised long-term (1950–2016) changes in the status of Glossy Ibis in Britain using numbers of accepted records of Glossy Ibis in Britain each year. Before 1 January 2013 records of Glossy Ibis were collated by the British Birds Rarities Committee (BBRC) (<https://www.bbrc.org.uk/>), the official adjudicator of rare bird records in Britain. After this date, Glossy Ibis ceased to be classified as a rare bird, which meant that records of them ceased to be assessed by the BBRC. Subsequent records have instead been assessed by county record committees,

and collated to produce an annual report on scarce migrant birds in Britain (e.g. White and Kehoe 2017). Both systems of assessing and collating records list the location, and first and last dates, of each record. This information is used to estimate the numbers of newly arrived Glossy Ibises each year. Most apparently recently arrived flocks of Glossy Ibises in Britain have broken into smaller groups and dispersed within a few days. Based on this, and on observations of colour-ringed Glossy Ibises in Britain, the BBRC and scarce migrants reports presume that most subsequent records are of individuals from these dispersed flocks (e.g. Hudson *et al.* 2010, 2011). Hence the figures produced by the BBRC and scarce migrants reports will tend to under-estimate numbers of Glossy Ibis arriving in Britain, rather than double-count birds.

The numbers of Glossy Ibis pairs in Doñana, their most important breeding site in western Europe, have been collected since 1996 by the Monitoring Team of Natural Processes of the Biological Station of Doñana (see Mañez *et al.* 2019 for details on visual count methodology). For each population (Doñana breeding pairs and British records), we performed a Poisson GLM (glm function in R, R Core Team 2017) to assess the linear trend of their annual numbers in the period 1996–2016. Given that we were interested in estimating the two populations' trends if both of them had started in 1996, we added a zero to each data set for 1995, and for each series we ran a model without intercept to make the two coefficients comparable.

Then we investigated whether variation in the number of records of Glossy Ibis recorded in Britain each year was explained by variation in the breeding population in Doñana (see Mañez *et al.* 2019). The analysis of the two time-series cross-correlation was performed using Autobox (Version 6.0, Automatic Forecasting Systems Inc., Hatboro, Pennsylvania, USA). This software implements an automatic algorithm capable of detecting, estimating and adjusting for the presence of (i) outliers (shift-levels or pulses), (ii) autocorrelation and (iii) non-stationarity in the auto-regressive integrated moving-average (ARIMA) model. The number of annual records in Britain was set up as the dependent variable, and the annual number of breeding pairs in Doñana as the independent variable. Since most

apparently recently arrived ibises in Britain are first year birds, we defined the model as to allow only immediate (no lagged) effects. The results of this analysis indicate whether variation in numbers of ibises breeding in Doñana explains variation in numbers recorded in Britain during the same year, net of any common trend between the two series.

Monthly frequency and spatial distribution

We investigated changes in the monthly abundance and spatial distribution of Glossy Ibis in Britain since the start of recent influxes in 2002. To do this, we calculated the number of Glossy Ibis ‘bird-site-days’ per month. For each accepted record, we multiplied the number of ibises recorded at a site by the number of days between the first and last date they were recorded there. To investigate changes in the abundance of ibises, we then summed the number of ibis ‘bird-site-days’ in each month, and divided this by the total number of days in the month. This provided an estimate of the mean number of Glossy Ibises present in Britain per day during each month. We investigated the geographical distribution of ibises by summing the number of ibis ‘bird-site-days’ in each bird recording area in Britain.

Winter conditions and numbers of ibises present in spring compared to the previous autumn

We also investigated the relationship between the abundance of Glossy Ibises in Britain in spring compared to in the previous autumn, and the mean temperature of the winter in between. We ran a Spearman correlation test (`cor.test` function in R) between the (i) ratio of ‘bird-site-days’ in April and May and ‘bird-site-days’ during the previous September and October and the (ii) mean UK temperature anomaly during December to February inclusive. Temperature data were from the UK Met Office

(<https://www.metoffice.gov.uk/climate/uk/summaries/anomalygraphs>). For this analysis we only used data collated in the period 2009–2015, since very few ibises were present in Britain in autumn and/or spring before then.

Results and Discussion

Description and comparison of numbers in Britain and Doñana

After the long period between 1950 and 1986 when the species was almost absent in Britain, numbers of Glossy Ibis recorded in Britain have increased dramatically, particularly since 1996 when the Doñana colony became established (Figures 1 and 2). The Doñana yearly rate of increase has been 1.92 times greater than that in Britain (on the log-scale, Doñana: $\beta = 0.427$, $SE = 0.00027$, $p < 0.001$; Britain: $\beta = 0.222$, $SE = 0.00209$, $p < 0.001$). This is not surprising, given that the growth rate in Doñana is determined by the population’s high breeding productivity (Santoro *et al.* 2016), whereas the population in Britain comprises birds that have dispersed from other areas.

Figure 1. Numbers of accepted records of Glossy ibis in Britain between 1950 and 2016

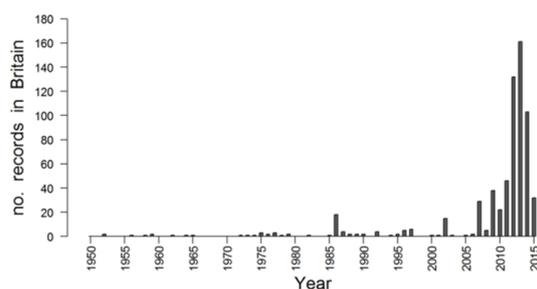
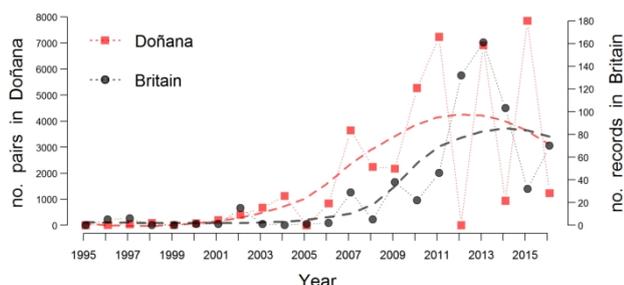


Figure 2. – Numbers of breeding pairs of Glossy Ibis in Doñana and numbers of accepted records of Glossy Ibis in Britain during the period 1996 – 2016. Red squares and dashed line indicate, respectively, the number of breeding pairs in Doñana and the relative smoothed trend. Black circles and dashed line the number of accepted records in Britain and the relative smoothed trend



According to the final model selected by Autobox, which accounted for the statistically significant causes of non-stationarity (autoregressive factor AR1, coeff. = 0.9, E = 0.103, $p < 0.001$; pulse at time 17, coeff. = 37.5, SE = 17.3, $p = 0.044$; pulse at time 18, coeff. = 99.9, SE = 16.4, $p < 0.001$), the number of ibises recorded in Britain was negatively affected by the dynamics of the population in Doñana (Intercept = 0.709, SE = 5.36, $p = 0.203$; slope = - 0.00581, SE = 0.00163, $p = 0.002$). This indicates that, regardless of any common trend, in years when there are smaller numbers of breeding pairs in Doñana, larger numbers tend to be recorded in Britain. This might be because poor conditions for breeding in Doñana also tend to result in higher rates of dispersal of birds towards other areas such as Britain after the breeding season. A previous study (Santoro *et al.* 2013) demonstrated that when breeding in Doñana was prevented by dry years, the probability of dispersal towards other regions increased between 2.5 and 4 times depending on the individual’s previous fidelity in the area. Furthermore, the immediate effect (in the same year) of the Doñana dynamics on numbers of ibises recorded in Britain, is supported by the evidence that most ibises arrive in Britain during their first year. Of the 135 Glossy Ibises thought to have arrived in Britain in autumn during 2009-16 (i.e. since the large increase in numbers of records), 62 were juveniles, four were adults, with the age of the remaining 69 not reported. Evidence that the majority of Glossy Ibises

arriving in Britain are first year birds is further supported by the results of colour ringing. There have, so far, been sightings of 33 colour-ringed Glossy Ibises in Britain, of which 30 were ringed as nestlings in Doñana in southwest Spain, and three as nestlings in the Petite Camargue in the south of France. The majority of these individuals have been recorded in Britain during their first year (21 out of 30 birds ringed in Doñana; all three of the birds ringed in the Petite Camargue). Many of these birds have dispersed quickly from their breeding areas, with eight of the colour-ringed Glossy Ibises having been recorded in Britain within three months of being ringed as nestlings in Doñana.

Monthly frequency and spatial distribution

The peak of records of the species in Britain tends to be in autumn, but this pattern has not been consistent over time (see Figure 3). The majority of assumed arrivals of Glossy Ibises in Britain have been in coastal counties of southwest and southeast England. Both of these regions are also favoured by Glossy Ibises during the rest of the year (Figure 4).

Figure 3. Mean numbers of Glossy Ibises recorded in Britain since the start of recent influxes in 2002

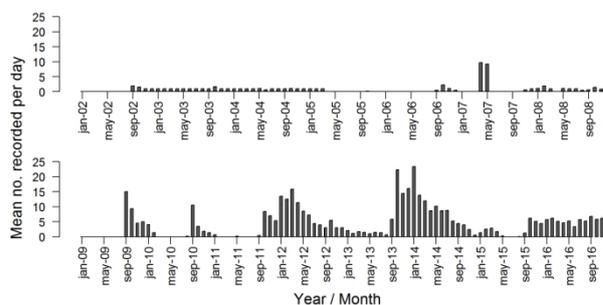
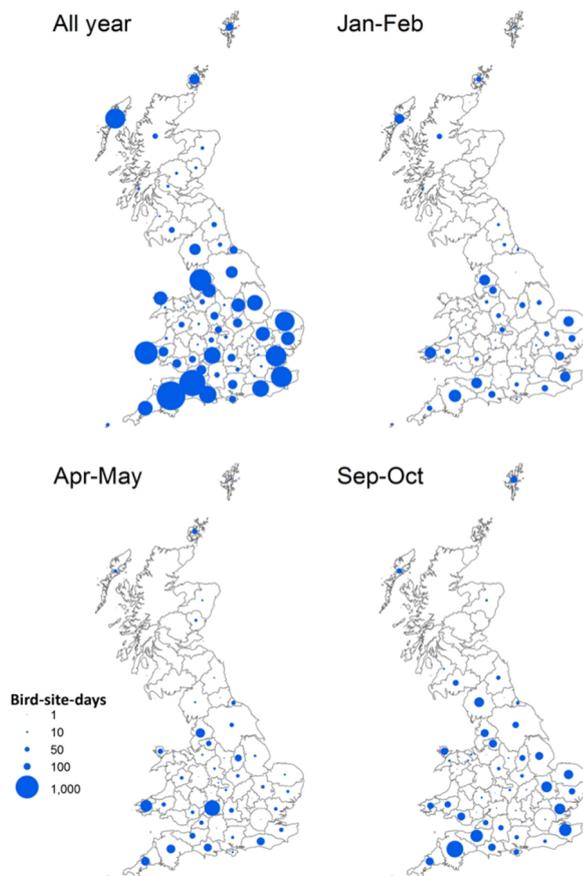


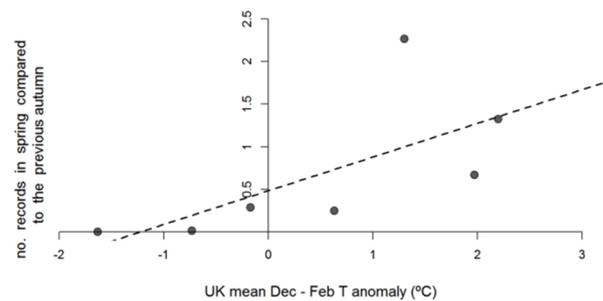
Figure 4. The abundance of Glossy Ibis in different bird recording areas in Britain between 2002 and 2016



Winter conditions and numbers of ibises present in spring compared to the previous autumn

Because the majority of Glossy Ibises arriving in Britain are first year birds, most would have to survive at least one winter in Britain before breeding. There has been considerable variation in the abundance of Glossy Ibises in Britain in spring, compared to in the previous autumn (Figure 5).

Figure 5. The relationship between the abundance of Glossy Ibises in Britain in spring compared to the previous autumn, and the mean UK temperature anomaly during the winter in between. Temperature is expressed as the mean difference from the 1961-90 average, with negative values in the x-axis indicating that the winter was colder than the 1961-90 average. The dashed line indicates the regression line of the ratio between spring and previous autumn records on the temperature anomaly



This variation appears to be largely related to the severity of the winter, with a higher proportion of birds being present in spring compared to in the previous autumn, when temperatures are higher during the winter in between (Spearman correlation coeff. = 0.86, $p = 0.024$). There is no evidence that Glossy Ibises show a more southerly, or south-westerly, distribution in Britain in winter than during the rest of the year (Figure 4). This is perhaps surprising, given the milder winter temperatures in southwest England compared to further north and east in Britain.

Our results therefore suggest that Glossy Ibises are more likely to breed in Britain when poor conditions for breeding in Doñana result in birds dispersing north in autumn, and these are followed by mild conditions in Britain that enable birds to remain there through the winter. However, it is unclear whether Britain could support significant-sized breeding colonies of Glossy Ibis, even as the climate continues to warm. In particular, there are probably very few wetlands in Britain large enough to support significant-sized breeding colonies of colonial waterbirds (Ausden *et al.* 2014). The most likely area in Britain for Glossy Ibis to begin regularly breeding is probably the Avalon Marshes. This large complex of wetlands is in southwest England, a region with a

large number of records of Glossy Ibis, and there has already been one nesting attempt in the Avalon Marshes, as described earlier. The Avalon Marshes is playing an important role in the colonisation of Britain by several other southerly-distributed waterbird species (Ausden *et al.* 2014; Hughes 2018).

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