Animal & Plant Health Agency

Review of the evidence base for inclusion of avian species on General Licences GL34, GL35 and GL36 in England

National Wildlife Management Centre

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Executive Summary

- Thirteen avian species were evaluated in respect to the strength of evidence of scientific literature for their inclusion under General Licences GL34-GL36 in England, which allow certain species to be killed or taken for various purposes.

- The review built on the existing reference database and methodology established by the British Trust for Ornithology (BTO) as part of their evaluation of the scientific evidence base for inclusion of bird species listed on General Licences in Scotland.

- The existing BTO database was expanded to encompass scientific literature from a number of other existing sources - previous reviews undertaken by Defra and Natural England and scientific literature cited by stakeholders in their responses to a stakeholder survey of General Licences.

- Each of the scientific documents was evaluated according to two criteria – *size of impact* (low, medium, high) and *scientific rigour* (low, medium, high) for the relevant General Licence species-purpose. Then, the body of documents for each species-purpose was synthesised into a final summary score. This involved an evaluation of the distribution of the scores across an impact/rigour matrix and allocation of this distribution to an overall Strength of Evidence.

- Final synthesised scores ranged, in order of increasing strength of evidence: Low < Low-Medium < Medium-Low < Medium < Medium-High < High-Medium < High. The categories with the greatest strength of evidence to support a species-purpose were High, High-Medium and Medium-High.

- For GL34 (conservation of wild birds) species scoring 'High-Medium' were: carrion/hooded crow, ring-necked parakeet and Indian house crow; species scoring 'Medium-High' were: jay, magpie, Egyptian goose and sacred ibis.

- In terms of the conservation status of wild bird prey, crow and jay showed the highest strength of evidence for a predation effect on sensitive species: *red-listed species* – crow (H-M), jay (H-M); *amber-listed* – crow (M-H); *green-listed* – jay (H-M). The effects of jay were focussed on songbirds that nest in woodland or woodland-edge habitat.

- For GL34 (conservation of fauna) ring-necked parakeet scored 'Medium-High' - due to competition with other species utilising tree-cavities, especially bats.

- For GL34 (conservation of wild flora): Canada goose scored 'Medium-High'.

- For GL35 (public health and safety) species scoring 'High-Medium': monk parakeet (nest building); and Medium-High: magpie and feral pigeon (carrying pathogens common to humans).

- For GL36 (serious damage) species with the greatest strength of evidence for an effect on the licensed sub-purposes were: *livestock* – feral pigeon (M-H, spread of disease), Indian house crow

(M-H, spread of disease); *foodstuff for livestock* – feral pigeon (M-H); *crops* – rook (M-H), feral pigeon (M-H), woodpigeon (M-H), Canada goose (H), Egyptian goose (M-H), monk parakeet (M-H), ring-necked parakeet (H-M), Indian house crow (M-H); *vegetables* – woodpigeon (M-H); *fruit* – monk parakeet (M-H), ring-necked parakeet (H-M).

- A note of caution is required, however, as an important finding in the review was a number of over-arching themes in the scientific literature that have implications in terms of mitigating the strength of evidence for the effect of a specific species on a licensed purpose. These are:

- *Predator removal* - studies generally measure the effect of a higher level group, such as 'corvids' or 'predators' (includes mammals) and do not differentiate the relative effects of individual predator species (e.g. carrion crow or magpie). High predator effects in such a study cannot, therefore, be solely attributed to one individual licensed species. *Simultaneous treatments* - simultaneous application of additional treatments alongside predator removal, e.g. habitat management. *Artificial nests* - the use of artificial nests to assess predation rates, which are not representative of real nests and, therefore, cannot be used to infer natural predation rates.

- Spread of disease (GL35 and GL34 livestock) - many of the species listed under General Licence have been shown to carry a variety of diseases that are common to livestock and/or humans. The strength of evidence in the present review almost exclusively relates to the focal species carrying such pathogens. Studies that show probable transmission from wild birds to livestock and/or humans are very few in number. This lack of information on the relative risks and rates of actual disease transmission represents an evidence gap.

- Changes in the species' population status were reviewed to assess whether there had been any changes in their distribution and/or abundance over the past approximate 25 year period or less; potentially affecting the risk or effects on licensed purposes. In terms of conservation status all native species are categorised as green-listed species, i.e. not of conservation concern.

- Three invasive non-native species (INNS) have increased both their breeding distribution (occupied tetrads) and breeding abundance: Canada goose, Egyptian goose and ring-necked parakeet.

- Amongst corvids, carrion crow and jackdaw significantly increased their national breeding abundance by 29% and 79% respectively over the 23-year period 1995-2018. Regionally, both jackdaw and carrion crow showed significant population increases (>25%) across most English regions. Magpie showed greater variation: increases (>25%) in three regions (significant in two) and downward trends (<25%) in five regions (significant in two). Rook showed downward trends (>25%) in four regions (significant in three) and a significant decrease nationally (-14%).

- Feral pigeon and woodpigeon showed opposite trends, with feral pigeon exhibiting a significant decrease nationally (-29%) and woodpigeon a significant increase (+37%). Feral pigeon exhibited downward trends (-15% to -50%) in eight of the nine regions (significant in three); woodpigeon showed upward trends (+21% to +91%) in all nine regions (significant in eight regions).

1. Introduction

There are 13 bird species listed under General Licences GL34-36 which allow certain species to be killed or taken for various purposes (Table 1):

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.
GL35: To kill or take certain species of wild birds to preserve public health or public safety.
GL36: To kill or take certain species of wild birds to prevent serious damage to livestock, foodstuffs for livestock, crops, vegetables, fruit, growing timber or inland waters.

The species fall into three groups: corvids, pigeons and doves, and invasive non-native species (INNS). All species were evaluated against all licensed purposes under GL34-36.

Table 1: Bird species listed on General Licences GL34-36 in England included in the review and other selected species. Ticks indicate current species-purpose listing.

Species	GL34	GL35	GL36
Carrion crow *Corvus corone*	✓	✓	✓
Jackdaw *Corvus monedula*	✓	✓	✓
Jay *Garrulus glandarius*	✓		
Magpie *Pica pica*	✓	✓	✓
Rook *Corvus frugilegus*	✓	✓	✓
Feral pigeon *Columba livia*		✓	✓
Woodpigeon *Columba palumbus*			✓
Canada goose *Branta canadensis*	✓	✓	✓
Egyptian goose *Alopochen aegyptiaca*	✓		✓
Monk parakeet *Myiopsitta monachus*	✓	✓	✓
Ring-necked parakeet *Psittacula krameri*	✓		✓
Sacred ibis *Threskiornis aethiopicus*	✓		
Indian house crow *Corvus splendens*	✓		

A systematic review was undertaken of the available scientific literature in order to evaluate the evidence to support inclusion of each species under General Licence.

2. Methods

2.1 Population Status

Changes in the abundance or distribution of any of the listed species may lead to changes (increase or decrease) in the prevalence and magnitude of impacts of the species on a resource covered under General Licence. Population changes may occur at national or regional level. It should be noted that changes in the extent and magnitude of impact may also be affected by changes in the availability or vulnerability of the resource in addition to any avian species population changes. For each species on General Licence, the current distribution and an overview of changes in distribution and abundance are presented. Species were assessed using national bird atlases, the BTO/JNCC/RSPB Breeding Bird Survey (BBS), the BTO/RSPB/JNCC/WWT Wetland Bird Survey and reviews of species population status. The BBS is the main scheme for monitoring the population changes of the UK's common and widespread breeding birds, producing population trends for 117 bird species. Changes in breeding abundance nationally are presented in the individual species accounts; and where available changes in regional abundance are presented in Appendix 1.

2.2 Datasets

The approach to evaluating the scientific evidence base for species/purpose combinations involved utilising, and building on, the existing reference database established by the British Trust for Ornithology (BTO) as part of their evaluation of the evidence base for inclusion of bird species listed on General Licences in Scotland (Newson *et al*. 2019). The existing BTO database was expanded to encompass scientific literature from a number of other existing sources - principally previous reviews undertaken by Defra, the Animal and Plant Health Agency (APHA) and Natural England. Further, scientific literature cited by stakeholders in their responses to the associated Defra stakeholder survey of General Licences was also incorporated in the expanded database:

The final database (GL_species_purpose database_FINAL_4 August 2020), therefore, encompassed the following sources of information:

1. BTO - General Licence evidence.xls
   The dataset used by the BTO in their report to Scottish Natural Heritage (SNH) – Newson SE, Calladine J & Wernham C. 2019. Literature review of the evidence base for the inclusion of bird species listed on General Licences 1, 2 and 3. Scottish Natural Heritage Research Report No. 1136.
2. Natural England Evidence Review documents (May 2019).
3. Defra Call for Evidence (May 2019)
4. Organisational responses to Defra stakeholder survey

2.3 Evaluation of Literature

Types of study
Correlational studies
In respect to predation, a number of studies have investigated relationships between the relative abundance of predators and the numbers of wild birds or wild bird breeding performance (e.g. nest predation rate). In such an approach, if the data indicates that numbers of predators are negatively correlated with prey numbers or breeding performance, it lends support to the hypothesis that predators have caused the trend. There are a number of problems with the interpretation of observations from correlational studies. A negative relationship between predator and prey densities may have an alternative explanation. For example, predators and prey may have different habitat requirements, so that they tend to be relatively more abundant in different parts of the study area. In Britain, differences in breeding densities and breeding success of black grouse *Tetrao tetrix* have been related to the intensity of grazing on moorland and not solely to predator management (Baines 1996). Within years, densities and breeding success were higher on lightly grazed moors, compared to those heavily grazed, irrespective of the presence of a gamekeeper. Where the mechanism underpinning any effect of a treatment is complex, for example where mesopredator release may lead to increases in smaller predators, then correlational studies will be limited in their ability to understand or interpret the effects of any treatment.

Predator removal experiments

Any effect of predators limiting their prey can be shown most convincingly by experiment, such that removal of predators should be followed by an increase in prey numbers (Newton 1998). Predator removal experiments fall into three design categories: (i) paired-site experiments, (ii) cross-over experiments and (iii) before-and-after experiments.

Simply documenting an increase in bird numbers or productivity associated with predator removal would be insufficient proof of its effectiveness, as it is also necessary to demonstrate that the changes would not have occurred in the absence of predator removal (due, for example, to natural variation). To achieve this, changes in numbers of birds at predator removal sites must be compared to: (i) changes in numbers at control sites (i.e. 'paired-sites'), and/or (ii) changes in numbers at the same site during a period without predator removal (i.e. 'before-and-after' experiment). In order to minimise the influence of other variables on changes in bird numbers it is necessary to match predator removal areas with control areas in respect to factors such as habitat and predator and prey densities. To avoid biases caused by site selection, the control and experimental treatments should be assigned randomly rather than determined by some pre-existing condition which could influence the results. Ideally, in a paired-site experiment, treatments (i.e. predator removal and no predator removal) should be switched between the pair of sites, so that each site receives each treatment over an equivalent time period (i.e. a 'cross-over' experiment). In respect to replication, the experiment needs to be repeated on a sufficient number of sites to eliminate the possibility that the result could have occurred by chance.

There are problems or limitations with both paired-site and before-and-after experimental approaches. In studies involving paired-sites, matching of sites may be difficult due to high natural variability between areas, logistic constraints may prevent cross-over of treatments or complete randomisation of treatments, and large sample sizes may be costly and difficult to obtain. Even where treatment and control sites are closely matched for ecological and environmental factors, there may be differences in other parameters, such as mowing or burning regimes, which can influence breeding success. In before-and-after studies, between-year differences (e.g. weather) can confound the results, so that increases in breeding success cannot be attributed solely to predator removal. In terms of replication, removal experiments should be replicated spatially and not only temporally, as is common to many studies. Spatial replication involves the use of more than one pair of treatment and control plots.

Interpretation of any changes in breeding density needs caution (Newton 1993). Any increase in breeding numbers might be obscured if the additional breeders disperse from the study area. Conversely, removal of predators might enhance the attractiveness of the study area so that additional breeders move in from adjacent areas. An increase in breeding density would, thus, have arisen from a redistribution of birds rather than from increased productivity. This is consistent with the idea that the mere presence of predators may limit the distribution of some prey species, which avoid areas of high risk (Newton 1979).

Evaluation

The scientific literature database was evaluated for the strength of evidence for an effect for each species-purpose combination across General Licences GL34, GL35, and GL36 in England to take or kill wild birds, using a modified approach to that by Newson *et al*. (2019).

A number of documents/studies reported data separately on more than one species-purpose combination. For example, under GL36 'serious damage' data may have been reported in respect to a licensed species (or multiple species) and more than one licensed sub-purpose (e.g. foodstuffs for livestock, crops, and livestock – disease). Whilst under GL34 sub-purpose 'conservation of wild birds', studies may have involved a suite of licensed species (i.e. corvids), hence the data is relevant to all licensed species individually. Consequently, the database contains more species-purpose combinations, or 'interactions', than the number of studies.

Each of the scientific studies (or species-purpose interactions if more than one per study) was evaluated according to two criteria – *Size of Impact* and *Scientific Rigour*. Definitions for these criteria were identical for GL34 and GL36; but modified for the purpose 'public health' (GL35) and the specific purpose 'spread of animal disease' under the sub-purpose 'livestock' (GL36).

Database literature

In the current general license species-purpose evaluation, for the majority of the literature, particularly for the conservation of wild birds sub-purpose (GL34) the interpretation of 'impact' has inherent uncertainties. In respect to predation, ultimately, an impact on the *conservation* of wild birds by a predator species would be manifest in a decrease in the breeding population of the prey species; following from a reduction in breeding success and/or recruitment of young into the population, or increased mortality of adults.

However, much of the literature reports associations between predator and prey in respect to relative abundance, predation events or predator diet. That is, much of the literature assesses, or infers, a proximate impact (predation) that may or may not translate into an ultimate impact on the breeding population or conservation status. In the evaluation of literature, three categories of proximate impact were used (in the absence of data on changes in breeding populations): 'High' - predation events of elevated magnitude on breeding success or abundance with the potential to affect local conservation status of the prey species; 'Medium' – predation events impacting at some level on the prey species (at least at the level of individual birds or breeding pairs) but likely at a level that does not have any subsequent effect on the breeding population or local conservation status; 'Low' – extremely low, or absence of, predation events.

Note: 'medium impact' encompasses a relatively wide range of impacts that indicate actual or potential predation events; i.e. *some* impact, most of which is highly unlikely to have an effect on the conservation status of the local population of the prey species.

Evaluation of GL34 and GL36

(i) The size of impact as presented in the literature

High Impact (score of 2) – *'Elevated' impact. For example, >25% predation rate of nests/eggs/chicks; or 25% increase in numbers or breeding success (successful nests/young) when licensed species removed; or >20% loss in crop yield.*

Medium Impact (score of 1) – *'Some' impact. For example, 5% predation rate of nests/eggs/chicks; or 10% increase in numbers or breeding success (successful nests/young) when licensed species removed; or dietary studies show prey species present in predator diet; or 10% loss in crop yield.*

Low or no Impact (score of 0) – *No demonstrated effect.*

Note: values are illustrative of the relative magnitude involved and do not represent defined categories or boundaries.

(ii) The scientific rigour of investigation

High Scientific Rigour (score of 2) – Experimental evidence or a causal relationship is unequivocally demonstrated.

Medium Scientific Rigour (score of 1) – Correlative evidence not supported by experiment or where causal relationships have not necessarily been demonstrated but where they are possible.

Low or no Scientific Rigour (score of 0) – Evidence is restricted to unsubstantiated claims or anecdotes.

An example of how scientific rigour was assessed:

High - Impact fully quantified (e.g. yield was reduced by 20%, as a consequence of feeding by the target species) or an experimental reversal of treatments (e.g. controlling the target species) showed a statistically significant effect on crop yields at repeated sites;

Medium - Impact partially quantified or evidence is purely correlative (e.g. fields with fewer woodpigeons had significantly higher crop yields but where the impact of other species was not measured, and no experimental reversal of treatments was reported);

Low - Impact reported anecdotally and is essentially unquantified (e.g. woodpigeon *Columba palumbus* is commonly recorded on crops and it is assumed to be an important economic pest).

Evaluation of the spread of human disease (GL35 - public health) and animal disease (GL36 – livestock)

The scoring of evaluations under the spread of animal disease (GL36 Livestock) and spread of human disease (GL35 Public Health) do not lend themselves to interpretation in the same manner as the 'conservation' (GL34) and other 'serious damage' (GL36) purposes. Whereas, the latter are 'single-stage' mechanisms (direct consumption of/damage to the resource), 'spread of disease' is at least a two-stage mechanism. First, a species has to be shown to carry a pathogen common to humans or livestock, with expression in the latter of associated health impacts. Second, the species has to interact with humans or livestock, such that a transmission route is possible. In addition, the species has to represent a host in which the pathogen can survive and/or concentrate to levels at which it is viable and transmissible, such as through expressed material like faeces or respiratory mucus.

Therefore, in the case of 'animal disease' and 'public health' the criteria 'size of impact' and 'scientific rigour' were evaluated using a modified scoring system:

(i) The size of impact as presented in the literature

High Impact – Concurrent incidences of disease in livestock and/or humans.
Medium Impact – Pathogen isolated from humans and/or livestock.
Low or no Impact – No disease exhibited.

(ii) The scientific rigour of investigation

High Scientific Rigour – Transmission route shown between target species and livestock and/or humans.
Medium Scientific Rigour – Target species tested for pathogen (could be positive or negative).
Low Scientific Rigour – Anecdotal reference to pathogen in target species.

2.4 Synthesis of the Evaluations

For each species-purpose interaction, the *size of impact* and *scientific rigour*, together, provided an evaluation of the *strength of evidence* for that species-purpose combination. In order to provide an evaluation of the overall body of scientific documents for any species-purpose, the scores from all the individual interactions were synthesised into a *final summary score for strength of evidence*. This synthesis involved an evaluation of the distribution of the scores across the impact/rigour matrix and allocation of this distribution to an overall strength of evidence. The synthesis involved three elements:

- Plotting the distribution of reference scores for strength of impact and scientific rigour.
- Allocation of this distribution to a level of confidence or overall strength of evidence score.
- A narrative of the associated synthesis and nature of key elements of the underlying evidence,

Species-purposes with <5 interactions had insufficient data to synthesise a final summary score.

Distribution of reference scores

For each species-purpose, the percentage of interactions scored in each impact-rigour pairwise category was calculated and presented in a 9-box matrix (Figure 2.1).

		% studies		
Size of Impact	2	0.0	16.0	10.0
	1	0.0	50.0	8.0
	0	0.0	14.0	2.0
		0	1	2
		Scientific Rigour		

Figure 2.1 Example of a 9-box matrix showing the distribution of scores for a species-purpose for the Size of Impact (0-2) and Scientific Rigour (0-2). In this example, of 50 interactions, 25 of these were scored Size of Impact 1 and Scientific Rigour 1; 8 studies were score Size of Impact 2 and Scientific Rigour 1, etc.

Allocation of strength of evidence

An overall Strength of Evidence for a species-purpose was allocated using a modified version of the Intergovernmental Panel on Climate Change (IPCC) model for evaluating and communicating the degree of uncertainty in the findings of an assessment process (Mastrandrea *et al*. 2010). Generally, evidence is most robust where there are multiple, consistent independent lines of high-quality evidence. In the present review, this is equivalent to the distribution of impact and rigour scores being weighted toward the top right hand corner of the 9-box matrix (Figure 2.2). That is, the greater the proportion of studies with relatively high impact and high scientific rigour the greater the strength of evidence for an effect of the focal species on the licensed purpose.

Impact ↑			
	High Impact Low Rigour	High Impact Medium Rigour	High Impact High Rigour
	Medium Impact Low Rigour	Medium Impact Medium Rigour	Medium Impact High Rigour
	Low Impact Low Rigour	Low Impact Medium Rigour	Low Impact High Rigour
	Scientific Rigour →		

Figure 2.2. A depiction of the size of impact and scientific rigour scores and their relationship to overall strength of evidence. Strength of evidence for a negative impact of a species on a General Licence purpose increases towards the top-right corner – broadly indicated by increasing strength of shading.

In practice, for any species purpose the majority of interactions fall into the central box of the impact-rigour matrix (i.e. medium impact/medium rigour = medium strength of evidence). This is a consequence of most studies involving a correlational approach (medium rigour) and mostly finding some level of association between species and resource (medium impact). The overall synthesised strength of evidence will, therefore, depend on the relative distribution of scores between the top right of the matrix (HIGH strength of evidence) and bottom of the matrix (LOW strength of evidence) (Fig. 2.3). The column associated with low scientific rigour can be largely ignored.

		% studies		
Size of Impact	2	0.0	16.0	10.0
	1	0.0	50.0	8.0
	0	0.0	14.0	2.0
		0	1	2
		Scientific Rigour		

Figure 2.3. A 9-box matrix showing the distribution of impact and rigour scores and the key portions of the matrix used to determine summary strength of evidence. Green (HIGH strength of evidence): medium impact/high rigour and high impact/medium to high rigour; Red (LOW strength of evidence): nil-low impact/medium to high rigour.

The synthesised overall scores for strength of evidence are presented in respect to the weight of evidence relative to the medium. For example in figure 2.3, the greatest proportion of the data (50%) falls in the medium cell, followed by the high cells (34%) (i.e. green cells). Therefore, in this example, the final synthesised score for the strength of evidence is Medium-High.

Final synthesised scores ranged, in order of increasing strength of evidence: Low < Low-Medium < Medium-Low < Medium < Medium-High < High-Medium < High. The type of data underlying these scores and their interpretation are presented in Table 2.1 (conservation and serious damage) and Table 2.2 (public health and livestock disease). Interpretation tables for individual species-purposes are presented in Appendix 2.

Table 2.1 Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a species on the licensed purpose – conservation and serious damage.

Strength of Evidence [1]	Type of evidence	Likelihood of a species-purpose effect
High	Correlational evidence of high impact and/or experimental evidence of medium to high impact	High likelihood that a high effect occurs
High-Medium	Predominantly correlational evidence of high impact and/or experimental evidence of medium to high impact with some correlational evidence of some impact	Moderate likelihood that a high effect occurs
Medium-High	Predominantly correlational evidence of some impact with some correlational evidence of high impact and/or experimental evidence of medium to high impact	Some likelihood that a high effect occurs
Medium	Correlational evidence of some impact	Likely that some effect occurs
Medium-Low	Predominantly correlational evidence of some impact with some correlational and/or experimental evidence of nil/low impact	Some likelihood that some effect occurs
Low-Medium	Predominantly correlational and/or experimental evidence of nil/low impact with some correlational evidence of some impact	Very unlikely that an effect occurs
Low	Correlational and/or experimental evidence of nil/low impact	Negligible likelihood of an effect

[1] Strength of evidence categories with greatest support for a species-purpose are High, High-Medium and Medium-High.

Table 2.2 Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a species on the licensed purpose – public health and livestock disease.

Strength of Evidence	Type of evidence	Likelihood of an effect on public or livestock health through the spread of human or livestock disease[1]
High	Predominantly tested positive as carrier of disease common to people or livestock, with frequent concurrent disease occurrence and/or transmission route identified	Very likely that individuals of the species carry disease common to people or livestock with high likelihood of transmission in some circumstances[2]
High-Medium	Predominantly tested positive as carrier of disease common to people or livestock, with moderate occurrence of concurrent disease and/or transmission route identified	Very likely that individuals of the species carry disease common to people or livestock with moderate likelihood of transmission in some circumstances
Medium-High	Predominantly tested positive as carrier of disease common to people or livestock, with some occurrence of concurrent disease and/or transmission route identified	Very likely that individuals of the species carry disease common to people or livestock with some likelihood of transmission in some circumstances
Medium	Predominantly tested positive as carrier of disease common to people or livestock	Very likely that individuals of the species carry disease common to people or livestock but transmission route not shown
Medium-Low	Predominantly tested positive as carrier of disease common to people or livestock, with some negative tests	Likely that individuals of the species carry disease common to people or livestock but transmission route not shown
Low-Medium	Predominantly tested negative as carrier of disease common to people or livestock, with some positive tests	Some likelihood that individuals of the species carry disease common to people or livestock but transmission route not shown
Low	Tested negative as carrier of disease common to people or livestock	Very unlikely that individuals of the species carry disease common to people

[1] Strength of evidence largely relates to the likelihood of a species carrying disease common to people or livestock; evidence for actual transmission of disease to people or livestock is rare, although possible in some circumstances.

[2] Transmission will depend on factors such as the level of exposure and immunocompetence of people exposed.

Narrative
For each species-purpose a narrative summary outlines the nature and distribution of the data, including any factors associated with references key to the distribution. Included in the narrative will be details of the nature of any confounding factors that will lower confidence in the synthesised strength of evidence relative to the specific target species. Confounding factors in a study include: evaluation of the effect of a larger predator group (e.g. mammals and birds, or corvids) rather than an individual species (e.g. carrion crow *Corvus corone*), such that the relative effects specifically of the licensed species cannot be evaluated; simultaneous application of additional treatments, such as habitat modification (natural or managed); or the use of artificial nests from which predation rates cannot be extrapolated to predation on real nests. *It is important to note that confounding factors have not contributed in the synthesis of strength of evidence scores, but should be borne in mind when applying the scores to decision-making.*

2.5 License Purpose and Sub-purpose

Each of the three general licenses has a number of sub-purposes. Summary scores for the strength of evidence for each licensed sub-purpose were determined. Where relevant, the strength of evidence for further levels of sub-purpose was also determined. For example, under GL36 ('prevention of serious damage') the sub-purpose 'livestock' can involve an effect due to either the spread of animal disease or predation/harm. Evaluations below sub-purpose are included in the individual species accounts.

GL34: To kill or take certain species of wild birds to:
- conserve wild birds
- conserve flora
- conserve fauna

GL35: To kill or take certain species of wild birds to:
- preserve public health (preventing spread of human disease)
- preserve public safety (prevention of slips, trips and falls; dealing with issues in relation to birds' nests; other)

GL36: To kill or take certain species of wild birds to prevent serious damage to:
- livestock (spread of animal disease; predation/harm)
- foodstuffs for livestock
- crops
- vegetables
- fruit
- growing timber
- inland waters

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3. Summary of Evidence

3.1 Population Status

The population status of the thirteen species (seven native species and six INNS) on General Licences GL34-36 were reviewed to assess whether their populations had changed in their distribution and/or abundance over the past approximate 25 year period (Tables 3.1-3.4).

Three of the thirteen species increased their breeding distribution by >25% over the period 1988/91-2008/11. All three were INNS: ring-necked parakeet *Psittacula krameri*, monk parakeet *Myiopsitta monachus* and Egyptian goose *Alopochen aegyptiaca*; a fourth INNS Canada goose *Branta* canadensis exhibited an increase just short of 25% (24.4%). In the case of monk parakeet, however, since 2011, the breeding range and abundance have decreased (see below). All native species have shown only modest increases (0.9-8.4%) in breeding distribution over the same period.

In terms of conservation status, all native species are categorised as green-listed species. Amongst corvids, carrion crow significantly increased its national breeding abundance by 29% and jackdaw *Corvus monedula* by 79%, over the 23-year period 1995-2018. Regionally, both jackdaw and carrion crow showed significant population increases. Carrion crow significantly increased its population by >25% in five of the nine BBS regions; jackdaw increased significantly in seven of the nine regions (>50% in six). Compared to carrion crow and jackdaw, magpie *Pica pica* showed greater variation in regional changes: increases (>25%) in three regions (significant in two) but with downward trends (although <25%) in five regions (significant in two). Rook *Corvus frugilegus* showed downward trends >25% in four regions (significant in three); and a significant decrease nationally, although <25% (-14%).

Feral pigeon *Columba livia* and woodpigeon showed opposite trends, with feral pigeon (-29%) exhibiting a significant decrease nationally and woodpigeon (+37%) a significant increase during the period 1995-2018. Feral pigeon exhibited downward trends (-15% to -50%) in all eight BBS regions, statistically significant in three regions. Woodpigeon showed upward trends in all nine BBS regions, statistically significant in eight regions (>25% in six regions). The marked increase in woodpigeon abundance, over this period, across most of England is likely to have presented an increased risk to crops; however these population increases have plateaued out over the more recent decade 2008-18.

Three of the four INNS present in England (Canada goose, Egyptian goose, ring-necked parakeet) have increased their breeding abundance. The most widespread and abundant species, Canada goose has increased significantly nationally (+65%) and in five of the nine BBS regions (+34% to +174%). Egyptian geese have increased in both distribution and abundance. Similarly, ring-necked parakeet have increased in their core range in the south-east and also have established a number of satellite colonies across England (APHA 2018). The monk parakeet, having established a number of colonies in London (and further transient colonies elsewhere) have more recently markedly decreased in number due to an ongoing removal programme. Sacred ibis *Threskiornis aethiopicus* and Indian house crow *Corvus splendens* are presently not established in England.

Table 3.1 Regional and all-England summary statistics describing changes in the breeding population abundance of corvid species listed on General Licences GL34-36 in England derived from the BBS[1] (Massimino *et al*. 2019, Harris *et al*. 2020). Statistics presented for 10 year (2008 – 2018) and 23 year (1995 – 2018) trends, and the 95% confidence intervals (CI) are shown for the 23 year trends[2]. Changes highlighted are those with recognised 'marked' changes, with >25 - <50% in light shading and >50% change in dark shading. Green shading represents a marked increase, red a marked decrease. Statistically significant[3] changes are marked with an asterisk (*).

Region	Magpie			Carrion crow			Jackdaw			Jay			Rook		
	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr
North West	-6%	-15%	-27% to +1%	0%	+54%*	+19% to +103%	+41%*	+123%*	+60% to +221%	0%	+24%	-7% to +88%	-4%	-38%*	-61% to 0%
North East	-3%	-18%	-52% to +15%	-11%	-9%	-28% to +29%	+21%*	+15%	-12% to +50%	ND	ND	ND	-27%*	-29%*	-50% to -2%
Yorkshire	-4%	-24%*	-40% to -6%	-10%	+35%*	+10% to +58%	+14%*	+61%*	+25 to +118%	+34%*	ND	ND	+5%	-32%	-57% to +8%
East Midlands	+24%	+36%	-14% to +102%	+6%	+31%*	+7% to +63%	+73%*	+181%*	+98% to +297%	+52%*	+24%	-36% to +133%	-6%	+11%	-24% to +59%
West Midlands	+9%*	-8%	-18% to +4%	+5%	+10%	-5% to +28%	+44%*	+111%*	+66% to +186%	-3%	-23%	-39% to +4%	+1%	+3%	-27% to +46%
East England	+6%	+27%*	+10% to +45%	-2%	+83%*	+56% to +115%	+16%*	+138%*	+105% to +185%	-12%*	+32%*	+10% to +59%	-7%	+15%	-14% to +45%
South East	+2%	+5%	-4% to +15%	-1%	+18%*	+2% to +34%	+25%*	+71%*	+46% to +100%	-6%	-13%*	-23% to 0%	-14%	-3%	-24% to +20%
South West	-10%*	-12%*	-20% to -1%	+10%	+11%	-10% to +40%	+17%*	+40%*	+18% to +68%	0%	2%	-17% to +27%	-15%*	-26%*	-44% to -6%
London	+9%	+37%*	+13% to +66%	+9%	+61%*	+24% to +107%	+143%*	ND	ND	-21%*	-16%	-36% to +14%	ND	ND	ND
England	+1%	-2%	-7% to +3%	+3%	+29%*	+18% to +41%	+28%*	+79%*	+63% to +95%	-1%	+3%	-4% to +12%	-10%*	-14%*	-24% to -4%

[1] Massimino, D., Woodward, I.D., Hammond, M.J., Harris, S.J., Leech, D.I., Noble, D.G., Walker, R.H., Barimore, C., Dadam, D., Eglington, S.M., Marchant, J.H., Sullivan, M.J.P., Baillie, S.R. & Robinson, R.A. (2019) *BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds*. Research Report 722. BTO, Thetford. www.bto.org/birdtrends
Harris SJ, Massimino D, Balmer DE, Eaton MA, Noble DG, Pearce-Higgins JW, Woodcock P & Gillings S. 2020. The Breeding Bird Survey 2019. BTO Research Report 726. British Trust for Ornithology, Thetford. https://www.bto.org/our-science/publications/breeding-bird-survey-report/breeding-bird-survey-2019

[2] Data available at https://www.bto.org/our-science/projects/bbs/latest-results/population-trends

[3] A statistically significant trend is where the 95% confidence limits do not overlap zero.

Table 3.2 Regional and all-England summary statistics describing changes in the breeding population abundance of dove and pigeon species listed on General Licences GL34-36 in England derived from the BBS[4](Massimino *et al*. 2019; Harris *et al*. 2020). Statistics presented for 10 year (2008 – 2018) and 23 year (1995 – 2018) trends, and the 95% confidence intervals (CI) are shown for the 23 year trends[5]. Changes highlighted are those with recognised 'marked' changes, with >25 - <50% in light shading and >50% change in dark shading. Green shading represents a marked increase, red a marked decrease. Statistically significant[6] changes are marked with an asterisk (*).

Region	Feral pigeon/Rock dove[7]			Woodpigeon		
	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr
North West	-1%	-41%*	-60% to -2%	+25%*	+65%*	+34% to +103%
North East	+27%	ND	ND	+1%	+22%	-10% to +67%
Yorkshire	-43%*	-50%*	-69% to -6%	+4%	+91%*	+54% to +127%
East Midlands	-10%	-36%	-63% to +13%	+4%	+40%*	+12% to +80%
West Midlands	-14%	-39%	-63% to +3%	-3%	+22%*	+4% to +40%
East England	-1%	-19%	-45% to +18%	-19%*	+27%*	+13% to +43%
South East	-12%	-15%	-41% to +23%	-9%*	+21%*	+6% to +36%
South West	-17%	-22%	-46% to +19%	+10%*	+51%*	+38% to +67%
London	-3%	-23%*	-37% to -1%	-11%*	+46%*	+17% to +81%
England	-12%*	-29%*	-38% to -18%	-4%*	+37%*	+28% to +45%

[4] Massimino, D., Woodward, I.D., Hammond, M.J., Harris, S.J., Leech, D.I., Noble, D.G., Walker, R.H., Barimore, C., Dadam, D., Eglington, S.M., Marchant, J.H., Sullivan, M.J.P., Baillie, S.R. & Robinson, R.A. (2019) *BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds*. Research Report 722. BTO, Thetford. www.bto.org/birdtrends
Harris SJ, Massimino D, Balmer DE, Eaton MA, Noble DG, Pearce-Higgins JW, Woodcock P & Gillings S. 2020. The Breeding Bird Survey 2019. BTO Research Report 726. British Trust for Ornithology, Thetford. https://www.bto.org/our-science/publications/breeding-bird-survey-report/breeding-bird-survey-2019

[5] Data available at https://www.bto.org/our-science/projects/bbs/latest-results/population-trends

[6] A statistically significant trend is where the 95% confidence limits do not overlap zero.

[7] Changes are reported for feral pigeon and rock dove combined as the two forms are widely integrated. In reality, the indices will be measures of change for the much more abundant and widespread feral pigeon 'form'.

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Table 3.3 Regional and all-England summary statistics describing changes in the breeding population abundance of non-native species listed on General Licences GL 34-36 in England derived from the BBS[8] (Massimino *et al*. 2018, Harris *et al*. 2020). Statistics presented for 10 year (2008 – 2018) and 23 year (1995 – 2018) trends, and the 95% confidence intervals (CI) are shown for the 23 year trends[9]. Changes highlighted are those with recognised 'marked' changes, with >25 - <50% in light shading and >50% change in dark shading. Green shading represents a marked increase, red a marked decrease. Statistically significant[10] changes are marked with an asterisk (*).

Region	Canada goose			Egyptian goose			Monk parakeet			Ring-necked parakeet			Sacred ibis			Indian house crow		
	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr	10-yr	23-yr	CI 23-yr
North West	+14%	+161%*	+38% to +317%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
North East	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Yorkshire	-7%	+174%*	+63% to +459%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
East Midlands	-15%	+16%	-32% to +118%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
West Midlands	+2%	+34%*	+6% to +92%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
East England	-22%	+22%	-19% to 60%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
South East	+15%	+45%*	+3% to +101%	ND	ND	ND	ND	ND	ND	+57%*	+604%*	+207% to +5048%	ND	ND	ND	ND	ND	ND
South West	-41%	+108%*	14% to +460%	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
London	-11%	ND	ND	ND	ND	ND	ND	ND	ND	+115%*	+25700%*	+6312% to +6864327997274870000%	ND	ND	ND	ND	ND	ND
England	-12%	+65%*	+39% to +97%	+60%*	ND	ND	ND	ND	ND	+114%*	+1777%*	+715% to +14354%	ND	ND	ND	ND	ND	ND

[8] Massimino, D., Woodward, I.D., Hammond, M.J., Harris, S.J., Leech, D.I., Noble, D.G., Walker, R.H., Barimore, C., Dadam, D., Eglington, S.M., Marchant, J.H., Sullivan, M.J.P., Baillie, S.R. & Robinson, R.A. (2019) *BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds*. Research Report 722. BTO, Thetford. www.bto.org/birdtrends
Harris SJ, Massimino D, Balmer DE, Eaton MA, Noble DG, Pearce-Higgins JW, Woodcock P & Gillings S. 2020. The Breeding Bird Survey 2019. BTO Research Report 726. British Trust for Ornithology, Thetford. https://www.bto.org/our-science/publications/breeding-bird-survey-report/breeding-bird-survey-2019

[9] Data available at https://www.bto.org/our-science/projects/bbs/latest-results/population-trends

[10] A statistically significant trend is where the 95% confidence limits do not overlap zero.

Table 3.4 Summary statistics describing changes in the spatial extent of the breeding populations of species listed on General Licences GL34-36 in England derived from the Bird Atlas (Balmer *et al*. 2013[11]). The number of hectads (10 by 10 km squares) in which the species was recorded during the breeding season in each of the three atlas periods and the percentage change from the 1968-72 to 1988-91 and 1988-91 to 2008-11 periods, and overall.

	Hectads occupied 1968-72	Hectads occupied 1988-91	Hectads occupied 2008-11	% Change in occupied hectads 68-72 to 88-91	% Change in occupied hectads 88-91 to 08-11	% Change in occupied hectads 68-72 to 08-11
Magpie	1425	1448	1472	1.61	1.66	3.30
Jackdaw	1477	1518	1548	2.78	1.98	4.81
Carrion crow	1484	1474	1495	-0.67	1.42	0.74
Jay	1352	1296	1372	-4.14	5.86	1.48
Rook	1446	1425	1492	-1.45	4.70	3.18
Feral pigeon	784	1268	1375	61.73	8.44	75.38
Woodpigeon	1488	1478	1491	-0.67	0.88	0.20
Canada goose	629	1060	1319	68.52	24.43	109.70
Egyptian goose	18	83	231	361.11	178.31	1183.33
Monk parakeet	0	2	3	-	50.00	-
Ring-necked parakeet	2	61	89	2950.00	45.90	4350.00

[11] Balmer, D., Gillings, S., Caffrey, B., Swann, B., Downie, I., Fuller, R. 2013. Bird Atlas 2007-11: The Breeding and Wintering Birds of Britain and Ireland. British Trust for Ornithology.

3.2 Species-purpose Evaluations

In total, 475 scientific papers, covering 744 species-purpose combinations (or interactions), were evaluated for strength of evidence. A further 116 papers (168 interactions) were considered to not be relevant.

A number of over-arching themes were apparent in the scientific literature that have implications for the evaluation of the strength of evidence for a species effect on certain licensed purposes.

Complexity of predation

The dynamics of predator-prey relationships and implications for conservation status of wild birds is complex. There is significant variation in predation between bird prey species influenced by their ecology and behaviour, the behaviour and ecology of the predator (including predator abundance before and after control to remove them) and by habitat. Some bird species are particularly vulnerable due to the interplay of these factors; others relatively unaffected by predation. Importantly, individual prey species may be impacted differently under different circumstances. This complexity may explain variation in the findings of different studies due to variation in the interplay of these factors between the studies. When considering conservation and management (including predator control), the understanding of the complexity and interaction of these factors is important.

Confounding factors

For a number of species-purpose combinations a significant number of the studies have factors that confound the findings of these studies. A confounding factor is something, other than the thing being studied, that could be causing or contributing to the results seen in a study. For example, for those groups of studies that presented the highest strength of evidence for an impact of carrion/hooded crow and magpie on wild birds, 68% and 90% of these had confounding variables respectively.

When evaluating studies for Size of Impact and Scientific Rigour, confounding factors were not considered in the scoring. For example, in a predator removal study that reported a high predation impact of carrion crow, but the effect was actually due to the removal of all predators, unless species-specific data was presented, there was no attempt to estimate the proportion of the overall effect that could be attributed to crow. Where relevant, the proportion of studies with confounding factors was reported for a species-purpose.

Predator removal

One of the recurring confounding factors in predator removal studies is that the study measured the impact of a higher level group, such as ‘corvids’ (crow, jackdaw, magpie, rook, jay *Garrulus glandarius*, raven *Corvus corax*) or ‘predators’ (includes birds and mammals) and did not differentiate the relative impacts of individual predator species. For example, if a predator removal study removed all corvids and fox *Vulpes vulpes* but did not measure the relative levels of predation by each individual species, before and after removal, then any change in the breeding success or abundance of prey species cannot be assigned solely to the removal of one individual species (e.g. crow). High predator impacts, in such a study therefore, cannot be solely attributed to one individual licensed species.

Simultaneous treatments
Another confounding variable within predation studies was the simultaneous application of additional treatments alongside predator removal. These factors can be natural or manipulated, such as variation in habitat between treatment (predator removal) and control (no predator removal) areas, either through natural variation between the different treatment areas or through applied habitat management. In before-and-after studies in the same area, different simultaneous treatments may be applied during predator removal and no predator removal periods.

Artificial nests
A further frequent confounding variable in predation studies is the use of artificial nests to assess predation rates. Most importantly, artificial nests are not representative of real nests and, therefore, cannot be used to infer natural predation rates. For example, artificial nests can be far less cryptic than real nests (sometimes deliberately placed to be conspicuous) and are not associated with cues of their presence, such as adult birds visiting the nest. Reviews of artificial nest studies have shown that predation of artificial nests is a weak indicator of predation of real nests (Major & Kendal 1996; Moore & Robinson 2004). Therefore, care must be taken in extrapolating findings to natural nest sites.

Spread of disease
Many of the species listed under General Licence have been shown to carry a variety of diseases that are common to livestock and/or humans. However, studies that show probable transmission from wild birds, in general, to livestock and/or humans are very few in number. This is a reflection of the relatively few studies that have attempted to directly map a transmission route, and the difficult and complex procedure required to achieve this. It is also the case that disease is widespread throughout wild birds in general and not just those listed under General Licence, including species in close association with livestock/humans such as house sparrows *Passer domesticus* and starlings *Sturnus vulgaris*. Many species of wild birds, for example, are implicated in the potential spread of Avian Influenza (AI), including numerous waterfowl (swans, geese, ducks) and passerines (songbirds). There are also examples of disease transmitted from humans to wild birds, such as via human waste water processing sites and landfills, where having picked up the pathogen the wild birds then act as a reservoir for the disease.

Presentation of findings
Results for species-purpose are summarised in Table 3.5 (GL34), Table 3.6 (GL35) and Table 3.7 (GL36).

The subsequent section (Section 4) contains accounts of individual species. For each species there is a brief description of the national population status. For species with available information, changes in regional populations are also included (graphs of regional population changes are included in Appendix 1). The 9-box matrices of Size of Impact/Scientific Rigour scores for each species-purpose are presented along with the summary conclusion for the Strength of Evidence. Any confounding factors considered to influence the summary score in respect to the specific target species, imposing a level of uncertainty on the conclusion, are detailed.

Table 3.5: Strength of evidence from the literature review for each species under GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna. Also, for corvids, the strength of evidence relative to conservation status of wild bird prey.

	GL34: Strength of Evidence		
Species	**Wild Birds**	**Fauna**	**Flora**
Carrion crow/Hooded crow *Corvus corone/Corvus cornix*	**High-Medium** [a]	No Data	No Data
Jackdaw *Corvus monedula*	**Medium-Low** [a]	No Data	No Data
Jay *Garrulus glandarius*	**Medium-High**	No Data	No Data
Magpie *Pica pica*	**Medium-High** [a]	No Data	No Data
Rook *Corvus frugilegus*	**Low-Medium**	No Data	No Data
Feral pigeon *Columba livia*	No Data	No Data	No Data
Woodpigeon *Columba palumbus*	No Data	No Data	No Data
Canada goose *Branta canadensis*	**Medium-Low**	No Data	**Medium-High**
Egyptian goose *Alopochen aegyptiaca*	**Medium-High**	No Data	No Data
Monk parakeet *Myiopsitta monachus*	**Medium**	No Data	No Data
Ring-necked parakeet *Psittacula krameri*	**High-Medium**	**Medium-High**	No Data
Sacred ibis *Threskiornis aethiopicus*	**Medium-High**	No Data	No Data
Indian house crow *Corvus splendens*	**High-Medium**	No Data	No Data

Conservation status of prey bird species [b]		
Red	**Amber**	**Green**
High-Medium	**Medium-High**	M-L
L-M	*(M)* [c]	*(L)* [c]
High-Medium	*(H)* [c]	**High-Medium**
M	L	L-M
M	*(M-H)* [b]	no data

[a] Significant number of studies have confounding factors which reduces confidence in the strength of evidence in respect to the focal species. Confounding factors are prevalent in respect to corvids and wild bird conservation; frequently due to studies not differentiating impacts between different predators, or through the application of a package of management measures of which predator control is but one aspect.

[b] Eaton M.A., Aebischer N.J., Brown A.F., Hearn R.D., Lock L., Musgrove A.J., Noble D.G., Stroud D.A. & Gregory R.D. 2015. Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man. British Birds 108: 708-746

[c] Sample size is too small (≤2) to be able to draw a meaningful conclusion.

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Table 3.6: Strength of evidence from the literature review for each species under GL35: To kill or take certain species of wild birds to preserve public health or public safety.

	GL35: Strength of Evidence	
Species	**Public Health [a]**	**Public Safety [b]**
Carrion crow/Hooded crow *Corvus corone/Corvus cornix*	**Medium-Low**	No Data
Jackdaw *Corvus monedula*	**Medium**	No Data
Jay *Garrulus glandarius*	No Data	No Data
Magpie *Pica pica*	**Medium-High**	No Data
Rook *Corvus frugilegus*	**Medium**	No Data
Feral pigeon *Columba livia*	**Medium-High**	No Data
Woodpigeon *Columba palumbus*	**Medium**	No Data
Canada goose *Branta canadensis*	**Medium-Low**	No Data
Egyptian goose *Alopochen aegyptiaca*	No Data	No Data
Monk parakeet *Myiopsitta monachus*	No Data	**High-Medium [c]**
Ring-necked parakeet *Psittacula krameri*	No Data	No Data
Sacred ibis *Threskiornis aethiopicus*	No Data	No Data
Indian house crow *Corvus splendens*	**Medium**	No Data

[a] Public Health is equivalent to the prevention of the spread of human disease. The strength of evidence for an impact on public health largely relates to the evidence for a species carrying pathogens common to humans; evidence for actual transmission of disease to humans is rare. The latter reflects an evidence gap as few studies have attempted to quantify either the risk or actual rates of transmission.

[b] Public Safety encompasses: prevention of trips, slips and falls; dealing with issues in relation to birds nesting, and any other impacts.

[c] In relation to birds nesting.

Table 3.7: Strength of evidence from the literature review for each species under GL36: To kill or take certain species of wild birds to prevent serious damage.

	GL36: Strength of Evidence							
Species	**Livestock [a]**	**Foodstuffs**	**Crops**	**Vegetables**	**Fruit**	**Timber**	**Fisheries**	**Inland waters**
Carrion/Hooded crow	**Medium-Low**	No Data	No data	No Data	No Data	No Data	No Data	No Data
Jackdaw	**Medium**	No Data	**Medium**	No Data	No Data	No Data	No Data	No Data
Jay	**Medium**	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Magpie	**Medium-Low**	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Rook	No Data	No Data	**Medium-High**	No Data	No Data	No Data	No Data	No Data
Pigeon	**Medium-High**	**Medium-High**	**Medium-High**	No Data	No Data	No Data	No Data	No Data
Woodpigeon	**Medium-Low**	No Data	**Medium-High**	**Medium-High**	No Data	No Data	No Data	No Data
Canada goose	**Medium-Low**	No Data	**High**	No Data	No Data	No Data	No Data	No data
Egyptian goose	**Medium**	No Data	**Medium-High**	No Data	No Data	No Data	No Data	No Data
Monk parakeet	No Data	No Data	**Medium-High**	No Data	**Medium-High**	No Data	No Data	No Data
Ring-necked parakeet	No Data	No Data	**High-Medium**	No Data	**High-Medium**	No Data	No Data	No Data
Sacred ibis	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
Indian house crow	**Medium-High**	No Data	**Medium-High**	No Data	No Data	No Data	No Data	No Data

Note:
[a] The strength of evidence for an effect on livestock largely relates to animal disease and the evidence for a species carrying pathogens common to livestock; evidence for actual transmission of disease between birds, in general, and livestock is rare. The latter reflects an evidence gap as few studies have attempted to quantify either the risk or actual rates of transmission.

4. Species Accounts

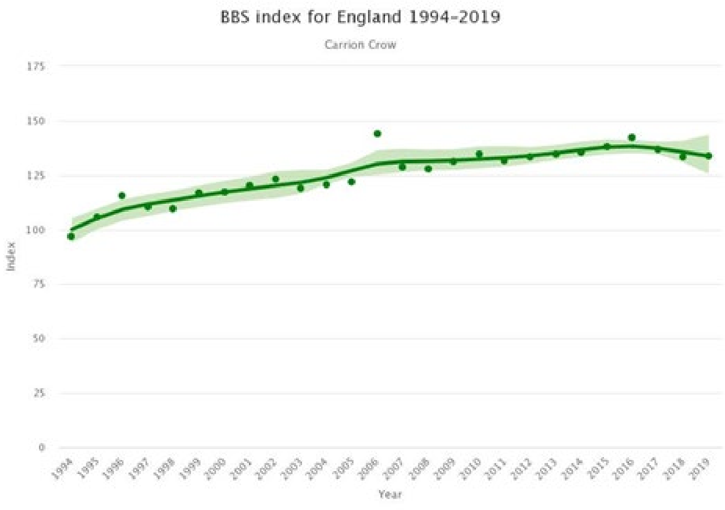
4.1 Corvids

Carrion Crow (*Corvus corone*)

Carrion crow occurs in the breeding season across all of England and is consistently one of the most widespread species in England, being found in almost all 10km squares in all three national atlases. Variations in range relate to occupation of individual 10km squares and show no regional patterns. Breeding range has remained the same since 1991; with London and the South East, West Midlands and the North West and North East (except uplands) being strongholds. The non-breeding distribution reflects that of the breeding season.

The Breeding Bird Survey (BBS) (1994-2019) has recorded a steady increase in carrion crow in England (Figure 4.1) in comparison to stability or minor decrease in Scotland and a fluctuating trend in Wales. All English regions except the North East have seen increases in populations, the largest occurring in the North West, Yorkshire & Humberside, East England and London, with more modest and patchy increases in the other English regions. The current GB population estimate is 1,050,000 territories (Woodward *et al*. 2020).

In the UK, the carrion crow has been treated as a separate species from the closely related hooded crow *Corvus cornix* since 2002, when they were split by the British Ornithologists' Union. The hooded crow replaces the carrion crow in large parts of Scotland, the Isle of Man, and in Northern Ireland. However, this split is not recognised by everyone, particularly in other parts of Europe. Consequently, it is often hard to deduce which species is being referred to in the literature. This review covers the literature for both species combined. As the two species are closely related, with similar ecologies and behaviour, there is no reason to suggest that their impacts should differ significantly.



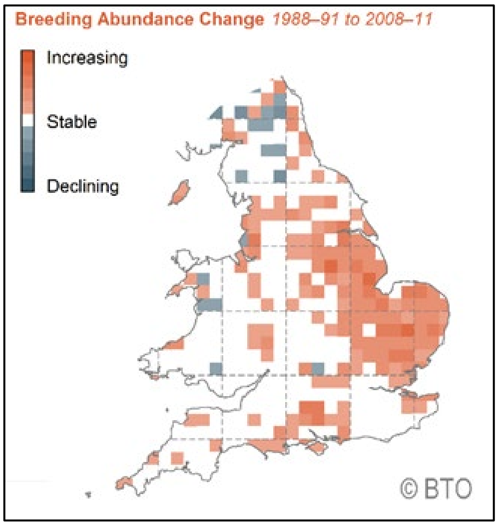


Figure 4.1 Carrion crow: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

All wild birds (n=98)

Size of Impact	2	0.0	16.3	9.2
	1	0.0	38.8	19.4
	0	3.0	8.2	5.1
		0	1	2
		Scientific Rigour		

44.9% of studies were of medium to high scientific rigour and presented medium to high impact.
13.3% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***high-medium*** *strength of evidence for an impact of carrion/hooded crow on the* ***conservation of wild birds*****.*

**68.2% of the studies (n=44) with high strength of evidence (green cells) had confounding variables, such that it is not possible to attribute the strength of evidence directly to crow.*

Over half of all studies showing at least some level of impact had confounding factors, including 68% of all studies with high strength of evidence. A high proportion of studies did not separate the effects of different predator species. A number of predator removal experiments involved the removal of all avian and mammalian predators, or of all or several corvid species. Several studies that reported a high impact on *ground-nesting birds* involved the removal of other avian and mammalian species, so that the impact cannot be attributed specifically to crow (Aebischer *et al*. 2018, Ainsworth *et al*. 2016, Baines *et al*. 2008, Baines & Richardson 2013, Douglas *et al*. 2014, Fletcher *et al*. 2010, Ludwig *et al*. 2017, 2020, Summers *et al*. 2004, Tapper *et al*. 1996). The same was true of several predator control studies that showed an impact on *songbirds* (Stoate & Szczur 2006, White *et al*. 2008, White *et al*. 2014) and one on a range of *farmland birds* (Aebischer *et al*. 2016). Control of carrion crow and magpie led to lower abundances of both and increased breeding success of a number of songbird species (Stoate & Szczur 2001). This study, however, also included changes to habitat management practices that may have influenced the results, as did many of the others (Aebischer *et al*. 2016, Aebischer *et al*. 2018, Ainsworth *et al*. 2016, Baines *et al*. 2008, Douglas *et al*. 2014, Ludwig *et al*. 2017, 2020, Summers *et al*. 2004, White *et al*. 2008, White *et al*. 2014). One also involved measuring rates of predation on artificial nests (Summers *et al*. 2004). Several predator control studies also recorded no impact on wild bird populations. Bodey *et al*. (2011) controlled hooded crow and feral ferrets and found this had no significant effect on lapwing *Vanellus vanellus* breeding success. Stoate and Szczur (2005) found that the cessation of predator control (that included carrion crow among other species) had no effect on the breeding abundance of blackbird *Turdus merula* or whitethroat *Sylvia communis*. Heather moorland game management, which included the removal of foxes and crows, was associated with increased abundance and breeding success of ground-nesting hen harriers and merlins *Falco columbarius*, whereas it did not influence abundance or breeding success of tree and crag-nesting buzzard peregrine falcon and raven (Ludwig *et al*. 2020).

Several studies linked higher levels of corvid density or abundance with higher predation rates or lower breeding success of other birds (Andren *et al*. 1985, Andren 1992, Bonnington *et al*. 2015, Dunn *et al*. 2010). However, because these studies group several corvid species together, the effects cannot be solely attributed to crows. Several other predation studies also attributed predation of real or artificial nests to corvids without distinguishing between corvid species (Arbeiter 2018, Bodey *et al*. 2009, Capstick 2018, Opermanis *et al*. 2001).

Several studies that attributed predation directly to carrion or hooded crow used artificial nests, which cannot be reliably assumed to be an accurate reflection of predation rates on real nests (Darinot 2014, Einarsen *et al*. 2008, Klausen *et al*. 2010, Kruger *et al*. 2018, Moller 1989, Pedersen *et al*. 2009, Roos 2002, Soderstrom *et al*. 1998).

There were a number of studies that linked higher abundance or density of crows with lower breeding success of a number of *gamebird and wader species*. Baines *et al*. (2011a) found that lower crow densities were associated with significantly higher breeding success in capercaillie *Tetrao urogallus*. However, Baines *et al*. (2011b) found that lower crow densities were only sometimes associated with higher capercaillie breeding success. Amar *et al*. (2011) showed a correlation between higher crow abundance and declines in populations of breeding lapwing, but there was no correlation with populations of curlew *Numenius arquata*, dunlin *Calidris alpina*, snipe *Gallinago gallinago*, or golden plover *Pluvialis apricaria*. Several studies showed a negative association between measures of crow density or abundance and breeding populations of red grouse *Lagopus lagopus scoticus* (Baines *et al*. 2008, Baines & Richardson 2013, Fletcher *et al*. 2010, Ludwig *et al*. 2017, Tharme *et al*. 2001). Some of these also noted negative associations with breeding populations of waders (Baines *et al*. 2008, Fletcher *et al*. 2010, Tharme *et al*. 2001) and hen harrier *Circus cyaneus* (Baines *et al*. 2008, Baines & Richardson 2013). Warren and Baines (2012) found that numbers of several wader and gamebird species decreased over a period of nearly twenty years, while numbers of carrion crow and raven had increased. Several of these studies may have been confounded by the effects of changes to habitat management practices.

Monitoring of nests and young, through camera traps, video or direct observation has recorded events of crow predation on the eggs or young of a range of species: waders, including lapwing (Bolton *et al*. 2007, Dadam *et al*. 2014, Elliot 1985, Teunissen *et al*. 2008, Wallender *et al*. 2006), redshank *Tringa totanus* (Ottvall 2005, Wallender *et al*. 2006), golden plover (Parr 1992), avocet (Hotker & Segebade 2000) and other ground-nesters, including gamebirds (Erikstad *et al*. 1982), gulls and waterbirds (Slacedek *et al*. 2014), and open-nesting songbirds (Weidinger 2009), including skylark and woodlark (Praus & Weidinger 2010; Praus *et al*. 2014) and blackcap (Schaefer 2004). One camera monitoring study did not record crow amongst the predators of spotted flycatcher (Bolton *et al*. 2007).

<u>Conservation status of prey</u>

Within the 98 studies involving carrion/hooded crow it was possible to score 136 predator-prey interactions for impact and rigour for individual UK prey species (some studies involved multiple prey species). These interactions involved a total of 40 different species for which there was some impact (i.e. scoring 1 or 2). Three of these (pheasant *Phasianus colchicus*, spur-winged lapwing *Vanellus spinosus*, and willow ptarmigan *Lagopus lagopus*) have not been ascribed a UK conservation status (Eaton *et al*. 2015), the former because it is a non-native, intensively managed species in the UK, and the latter two because they don't exist in the UK (the red grouse sub-species of willow ptarmigan is considered different enough to be treated separately). In respect to the conservation status of the other 37 species, there were 14 Red-listed, 14 Amber-listed and 9 Green-listed species.

There were also 35 interactions that recorded no impact. Two of these were on species with no UK conservation status (red-legged partridge *Alectoris rufa* and willow ptarmigan), the former because it is a non-native, intensively managed species in the UK, and the latter because it doesn't exist in the UK. The other 33 interactions that recorded no impact involved 9 Red-listed, 6 Amber-listed, and 7 Green-listed species.

Red-listed species (n=64)

Size of Impact	2	0.0	20.3	10.9
	1	0.0	34.4	14.1
	0	4.6	9.4	6.3
		0	1	2
		Scientific Rigour		

45.3% interactions were of medium to high scientific rigour and presented medium to high impact.
15.7% interactions were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for an impact of carrion/hooded crow on the **conservation of red-listed wild birds****.*

**65.5% interactions (n=29) with high strength of evidence (green cells) had confounding factors.*

The majority of Red-listed species impacted were ground-nesters, with the highest recorded impacts for grey partridge *Perdix perdix*, capercaillie, black grouse, curlew, lapwing, kittiwake, hen harrier, merlin *Falco columbarius*, skylark *Alauda arvensis* and spotted flycatcher *Muscicapa striata*. The majority of these high-impact studies involved the removal of a whole suite of predators, so that the impacts cannot be attributed solely to crows. However, three studies without confounding factors recorded high impacts on capercaillie, kittiwake, and lapwing (Baines *et al*. 2011a, Cadiou 1999, Elliot 1985). Medium impact included further species: pochard *Aythya ferina*, black-tailed godwit *Limosa limosa*, red-backed shrike *Lanius collurio* and yellowhammer *Emberiza citrinella*. Of these, studies on black-tailed godwit and red-backed shrike were without confounding factors (Teunissen *et al*. 2008, Roos & Part 2004).

There were also studies that recorded no impact of crows on curlew, lapwing, black-tailed godwit, black grouse, hen harrier, turtle dove *Streptopelia turtur*, spotted flycatcher, whinchat *Saxicola rubetra*, and skylark (Amar & Redpath 2002, Amar *et al*. 2011, Beja *et al*. 2009, Bodey *et al*. 2011, Bolton *et al*. 2007, Boschert 2005, O'Brien 2001, Tharme *et al*. 2001, Van Der Vliet *et al*. 2008).

Amber-listed species (n=34)

Size of Impact	2	0.0	8.8	5.9
	1	0.0	52.9	5.9
	0	9.4	11.8	5.9
		0	1	2
		Scientific Rigour		

20.6% interactions were of medium to high scientific rigour and presented medium to high impact. 17.6% interactions were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium-high*** *strength of evidence for an impact of carrion/hooded crow on the* ***conservation of amber-listed wild birds*** **.*

**85.7%* interactions *(n=7) with high strength of evidence (green cells) had confounding factors.*

The majority of Amber-listed species were ground-nesters, with the highest recorded impacts on black-throated diver *Gavia arctica*, red grouse, and meadow pipit *Anthus pratensis*. The study on black-throated diver, however, suspected that the majority of the high levels of predation recorded were due to mammalian predators, although hooded crows were seen predating eggs (Mudge & Talbot 1993). The other studies involved the removal of a whole suite of predators, so that the impacts cannot be attributed solely to crows (Baines *et al*. 2008, Fletcher *et al*. 2010, Ludwig *et al*. 2017). Medium impacts were also recorded on mallard *Anas platyrhynchos*, northern shoveler *Anas clypeata*, garganey *Anas querquedula*, gadwall *Mareca strepera*, common eider *Somateria mollissima*, black-necked grebe *Podiceps nigricollis*, black-headed gull *Chroicocephalus ridibundus*, and dunnock *Prunella modularis* in studies that did not clearly differentiate the effects of different predator species. However, studies without confounding factors found medium impact on red grouse, redshank, avocet *Recurvirostra avosetta*, and European nightjar *Caprimulgus europaeus* (Hotker & Segebade 2000, Langston *et al*. 2007, Parr 1993, Wallander *et al*. 2006, Warren & Baines 2012).

There were also studies that recorded no impact of crows on snipe, dunlin, oystercatcher *Haematopus ostralegus*, redshank, quail *Coturnix coturnix*, and meadow pipit (Amar *et al*. 2011, Beja *et al*. 2009, Parr 1993, Tharme *et al*. 2001, Van Der Vliet *et al*. 2008).

Green-listed species (n=30)

Size of Impact	2	0.0	10.0	3.3
	1	0.0	43.3	6.7
	0	0.0	36.7	0.0
		0	1	2
		Scientific Rigour		

20.0% interactions were of medium to high scientific rigour and presented medium to high impact.
36.7% interactions were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of carrion/hooded crow on the **conservation of green-listed wild birds***.

**50.0% interactions (n=6) with high strength of evidence (green cells) had confounding factors.*

The Green-listed species with the highest recorded impact were golden plover and blackcap *Sylvia atricapilla*. One of three high impact studies on golden plover was without confounding factors (Parr 1992). High impact was also recorded on blackcap *Sylvia atricapilla*, but this study (like the other two on golden plover) did not distinguish between different predators (Balaz *et al*. 2007). Another study without confounding factors showed a medium impact on woodlark *Lullula arborea* (Praus *et al*. 2014), while confounded studies also showed medium impacts on tufted duck *Aythya fuligula*, ptarmigan *Lagopus muta*, coot *Fulica atra*, blackbird, song thrush *Turdus philomelos*, wheatear *Oenanthe oenanthe*, chaffinch *Fringilla coelebs*, and whitethroat.

There were also studies that recorded no impact of crows on golden plover, blackbird, whitethroat, wheatear, peregrine, buzzard and raven (Amar *et al*. 2011, Degen 2008, Exo 2005, Ludwig *et al*. 2020, Stoate & Szczur 2005, Tharme *et al*. 2001, White *et al*. 2014).

Fauna

A review (Speakman 1991) lists carrion crow amongst 11 bird species recorded to have occasionally predated on bats.

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=9)

Size of Impact	2	0.0	11.1	0
	1	0.0	55.6	0.0
	0	0.0	22.2	0.0
		0	1	2
		Scientific Rigour		

11.1% of studies were of medium scientific rigour and presented high impact.
22.2% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of carrion/hooded crow on public health. However, this relates to the evidence for crows carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

All of the studies related to evidence of carrion or hooded crow carrying pathogens common to humans, but without showing transmission. These pathogens include West Nile Virus, Sindbis virus, *E. coli*, *Giardia lamblia, Campylobacter spp*., *Salmonella spp*., *Chlamydia spp*., *Cryptosporidium spp*., and *Yersinia spp*..

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease + predation) (n=16)

Size of Impact	2	0.0	6.3	0.0
	1	6.3	62.5	0.0
	0	0.0	18.8	6.3
		0	1	2
		Scientific Rigour		

6.3% of studies were of medium scientific rigour and presented high impact.
25.1% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of carrion/hooded crow on **livestock**.*

Livestock (animal disease) (n=10)

Size of Impact	2	0.0	10.0	0.0
	1	0.0	70.0	0.0
	0	0.0	10.0	10.0
		0	1	2
		Scientific Rigour		

10.0% of studies were of medium scientific rigour and presented high impact.
20.0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of carrion/hooded crow on livestock through the spread of disease. However, this relates to the evidence for crows carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

Most of the studies on animal disease that presented an impact related to evidence of carrion or hooded crow carrying pathogens common to livestock, but without proving transmission. The single study that presented high impact related to an outbreak of West Nile Virus in horses in Italy with several carrion crows (and a number of other species) from the surrounding area tested positive for the disease (Calistri *et al*. 2010). Zeeh *et al*. (2018) isolated *Brachyspira hyodysenteriae* (a causative agent of swine dysentery) from a carrion crow living in the vicinity of a pig farm, which belonged to the same strain as isolates from pigs on one of the farms. Other studies found evidence of crows carrying *Mycobacterium avium*, *E. coli*, *Campylobacter jejuni*, *Salmonella typhimurium*, *Chlamydophila abortus*, *Chlamydophila psittaci*, *Pasteurella multocida*, *Mycoplasma spp*. and *Yersinia spp*. but did not provide evidence of transmission to livestock (Beard *et al*. 2001, Ferrazzi *et al*. 2007, Daniels *et al*. 2003, Strugnell *et al*. 2011, Ziegler *et al*. 2017). After Kaden *et al*. (2003) artificially infected a hooded crow with Classical Swine Fever Virus, the crow failed to develop the disease, which suggests that hooded crows are not a vector for transmission on this disease.

Livestock (predation) (n=6)

Size of Impact	2	0.0	0.0	0.0
	1	16.7	50.0	0.0
	0	0.0	33.3	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact.
33.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of carrion/hooded crow on livestock through predation or damage.*

Several studies looked at the effects of damage or predation by carrion or hooded crows on sheep. Houston (1977) investigated damage to hill sheep by hooded crows in Scotland and concluded that the majority of lambs with crow damage were either dead before being attacked or unlikely to have survived anyway due to poor body condition. In addition, crow attacks on adult ewes were unlikely to have caused the deaths of these animals as they involved animals that were sick, trapped or rolled onto their backs, most of which would probably have died anyway without rapid human intervention. Another study in Scotland in the 1970s (Hewson 1984) found no evidence of predation by hooded crows on sheep. However, Burgess (1963) conducted surveys amongst farmers in northern England in the 1960s, many of whom reported attacks by carrion crow on adult ewes and apparently fit lambs. Edwards *et al*. (1994) conducted post-mortems on piglets and found that 6% of carcasses had suffered bird damage, although in some of the cases the damage was clearly inflicted after death. Hooded crows were observed attacking live piglets during the study. One study of predation in free-ranging poultry found that carrion crows were responsible for 4% of losses (Stahl *et al*. 2002). It should be noted that these studies on sheep and piglets are historic being conducted during the period 1963-1994. The carrion crow population has increased since this period and husbandry practices changed.

Crops (n=2)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	50.0	0.0
	0	50.0	0.0	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium-high scientific rigour and presented medium-high impact.
0% of studies were of medium-high scientific rigour and presented nil/low impact.

*There is **insufficient data** to evaluate the impact of carrion/hooded crow on crops.*

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Jackdaw (*Corvus monedula*)

Jackdaw is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases, with variations in range relating to occupation of individual 10km squares and showing no regional patterns. Breeding range has remained the same since 1991; with the Midlands and West and North being strongholds, and abundance is lowest in the uplands and the major conurbations. Changes in abundance (Figure 4.2) have been associated with improvements in breeding performance, probably due to increased food availability. The non-breeding distribution reflects that of the breeding season.

Jackdaw has increased in abundance since the 1960s (Gregory & Marchant 1996), and more recent BBS (1994-2019) data suggest that the increase is continuing in all UK countries apart from Wales where the BBS trend is stable. This increase has been fairly uniform across the English range, with greatest relative increases in breeding abundance in the East Midlands and East Anglia. The current GB population estimate is 1,450,000 pairs (Woodward *et al*. 2020).

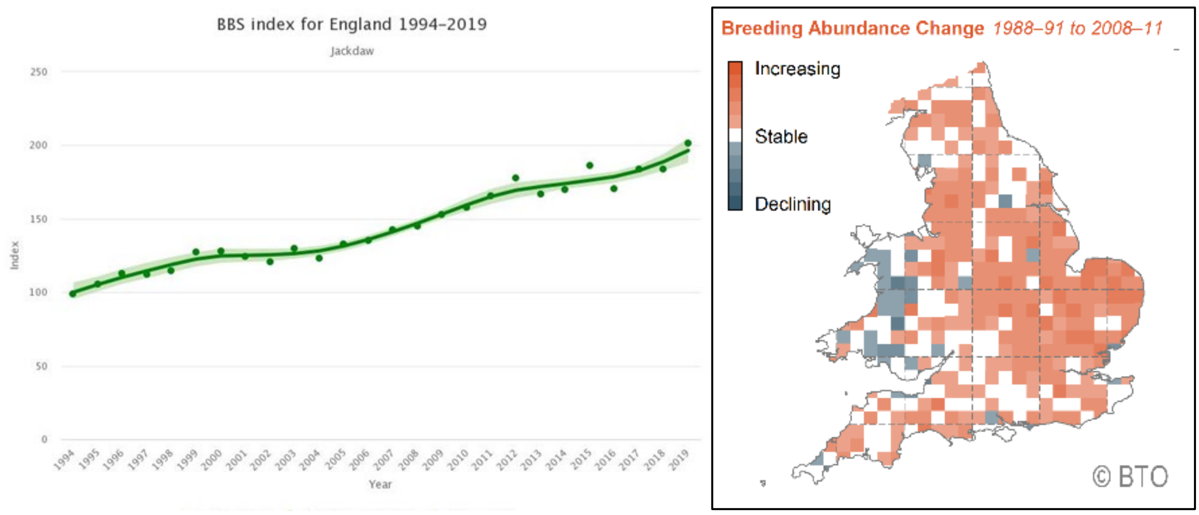

Figure 4.2 Jackdaw: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS [https://www.bto.org/our-science/projects/bbs/latest-results)](https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

<u>All wild birds (n=21)</u>

Size of Impact	2	0.0	0.0	4.8
	1	4.8	42.9	9.5
	0	0.0	33.3	4.8
		0	1	2
		Scientific Rigour		

14.3% of studies were of high scientific rigour and presented medium to high impact.
38.1% of studies were of medium to high scientific rigour and presented nil/low impact.

Animal & Plant Health Agency

*Overall, there is **medium-low** strength of evidence for an impact of jackdaw on the **conservation of wild birds**.*

**66.6% of the studies (n=3) with high strength of evidence (green cells) had confounding variables.*

Of these studies, the only one that reported a high impact (increased numbers and breeding success of grey partridge) was a predator removal experiment that removed a suite of predators (bird and mammal) and thus the impact cannot be attributed specifically to jackdaw (Tapper *et al*. 1996). Camera-monitoring at real nests confirmed predation by jackdaws but at low levels compared to other predators (Stevens *et al*. 2008, Praus &Weidinger 2010). The only other study scored as having high scientific rigour found a low level of jackdaw predation on artificial gamebird nests. Eight studies of medium or high scientific rigour showed no impact of jackdaw on wild birds. The remainder of the studies were of medium scientific rigour and showed medium impact. A high proportion of these had confounding factors (either did not separate the effects of different predator species or used artificial nests).

Conservation status of prey

Within the 21 studies involving jackdaw it was possible to score 13 predator-prey interactions for impact and rigour for individual prey species (some studies involved multiple prey species). These interactions involved a total of 7 different species for which there was some impact (i.e. scoring 1 or 2). One of these, pheasant, has not been ascribed a UK conservation status (Eaton *et al*. 2015), because it is a non-native, intensively managed species in the UK. In respect to the UK conservation status of the remaining 6 species, there were 4 Red-listed species and 2 Amber-listed. There were also 5 interactions that showed no impact - four involved Red-listed species and one involved a Green-listed species.

Red-listed species (n=8)

Size of Impact	2	0.0	0.0	12.5
	1	0.0	25.0	12.5
	0	0.0	25.0	25.0
		0	1	2
		Scientific Rigour		

25.0% interactions were of high scientific rigour and presented medium to high impact.
50.0% interactions were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **low-medium** strength of evidence for an impact of jackdaw on the **conservation of red-listed wild birds***.*

**50.0% interactions (n=2) with high strength of evidence (green cells) had confounding factors. Here the effect of different predators (including mammals) were not separated.*

The only study involving a Red-listed species that presented a high impact was a predator removal experiment involving grey partridge, where the effects of different predator species (bird and mammal) were not separated (Tapper *et al*. 1996). The remaining Red-listed species (medium impact) were spotted flycatcher, skylark, and yellowhammer. Camera monitoring revealed jackdaw predation on spotted flycatcher (Stevens *et al*. 2008) and skylark (Praus &Weidinger 2010) nests of 1.6% and 2.3% of nests, respectively. A study on yellowhammer that showed a negative correlation between brood size and chick growth and corvid abundance did not distinguish between the different corvid species (Dunn *et al*. 2010).

There were also studies that recorded no impact of jackdaw on lapwing, black-tailed godwit, and red-backed shrike (Roos 2002, Roos & Part 2004, Teunissen *et al*. 2008).

<u>Amber-listed species (n=2)</u>

The two interactions with amber-listed species each scored a strength of evidence of medium (1, 1) and involved razorbill *Alca torda* and redshank. Ottvall (2005) observed jackdaws occasionally taking redshank eggs, while Lloyd (1979) suspected that jackdaws were responsible for high levels of predation on razorbill eggs, although this was not actually observed. Sample size, however, is too small to be able to draw a meaningful conclusion.

<u>Green-listed species (n=1)</u>

There was one interaction that recorded no impact of jackdaw on the Green-listed species golden plover (Degen 2008). Sample size is too small to be able to draw a meaningful conclusion.

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

<u>Public health (n=5)</u>

Size of Impact	2	0.0	0.0	20.0
	1	0.0	60.0	0.0
	0	0.0	20.0	
		0	1	2
		Scientific Rigour		

20% of studies were of high scientific rigour and presented high impact.
20% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium** strength of evidence for an impact of jackdaw on public health. However, this relates to the evidence for jackdaw carrying pathogens common to humans; evidence for actual transmission of disease to humans is rare (one historical case for jackdaw). The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

There was only one study which showed transmission of pathogens from jackdaws to humans. Hudson *et al*. (1991) traced the source of human campylobacter infections in Gateshead to infected jackdaws (and magpies) pecking milk bottle tops. As delivery of milk bottles to household doorsteps is largely no longer in use, the likelihood of transmission via this route is significantly reduced. All of the other studies related to evidence of jackdaw carrying pathogens common to humans, but without showing transmission. These pathogens include Borna Virus, West Nile Virus, *Campylobacter spp., Giardia spp.,* and *Cryptosporidium spp.*.

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease + harm) (n=5)

Size of Impact	2	0.0	0.0	0.0
	1	20.0	80.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium*** *strength of evidence for an impact of jackdaw on livestock through the spread of disease. However, this relates to the evidence for jackdaw carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an* ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission.*

Several studies found evidence of jackdaws carrying pathogens common to livestock (*Mycobacterium avium*, *Cryptosporidium spp*. Borna virus), but without showing transmission (Beard *et al*. 2001, Berg *et al*. 2001, Daniels *et al*. 2003, Reboredo-Fernandez *et al*. 2015). In respect to harm, Campbell *et al*. (2016) reported that Jackdaws have been observed pulling wool off of the backs of sheep.

Crops (n=11)

Size of Impact	2	9.1	0.0	0.0
	1	18.2	72.7	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact.
72.7% of studies were of medium scientific rigour and presented medium impact.

Overall, there is ***medium*** *strength of evidence for an impact of jackdaws on* ***crops****.*

Lockie (1956) and Holyoak (1968) conducted dietary analyses of the gizzard contents of jackdaws and found they often contained grain (barley, wheat and oats) and occasionally contained some fruit. Hadjisterkotis (2003) also analysed gizzard contents and in addition to wheat and barley found legume seeds and fruit. These dietary analyses show that Jackdaws do feed on cereals, legumes, and fruit, although the extent of the damage to the crops is not quantified. O'Leary (1995) observed jackdaws (and crows and rooks) feeding on wheat and barley crops and states that they contributed to significant crop damage, although the damage is not quantified with respect to jackdaw specifically. He also states that jackdaw were often observed feeding on cut silage fields, stubble fields, and recently ploughed fields. These activities are not likely to contribute to crop damage, and in the case of cut silage and recently ploughed fields is likely to be due to foraging for invertebrates. The habitat types most frequently used by Jackdaws in this study were grassland and set-aside, again likely due to foraging for invertebrates. Seubert (1964) and Vappula (1965) state that jackdaws cause damage to cereal crops and occasionally to peas, beans, potatoes, onions, and fruit, but do not provide evidence of this or quantify the damage done. Jackdaw is not listed by Seubert (1964) as a significant crop pest in England. Govorushko (2014) states that in the early 1990s the most important avian pests in Germany were 'corvids such as crows, jackdaws, rooks, magpies, etc.', which caused 0.5 million DM of damage, but does not provide evidence or quantify the relative importance in respect to individual species or specific crops. Three studies related to damage to the plastic wrapping of silage bales rather than to standing crops (McNamara *et al*. 2001, McNamara *et al*. 2002, McNamara *et al*. 2004).

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Jay (*Garrulus glandarius*)

Jay is consistently one of the most widespread species in England, being widespread in all regions in all three national atlases. As it is a predominantly woodland species, variations in range are likely to reflect changes in woodland cover and the main areas of range change are associated with areas such as the North Pennines and the East coast from Flamborough to the Fens of Lincolnshire and Norfolk where woodland cover, and jay abundance, is low (Figure 4.3). The non-breeding distribution reflects that of the breeding season.

The UK jay population remained stable in the species' preferred woodland habitat until the late 1980s, after which the population began to decline. This decrease followed an earlier decline on farmland CBC plots (Gregory & Marchant 1996). With the losses since the 1980s now regained, long-term trends (including in England) are stable overall. The BBS (1994-2019) indicates that there have been population abundance increases in the East Midlands and East Anglia, relatively stable populations in the North West and South West, with declines elsewhere. The current GB population estimate is 165,000 territories (Woodward *et al*. 2020).

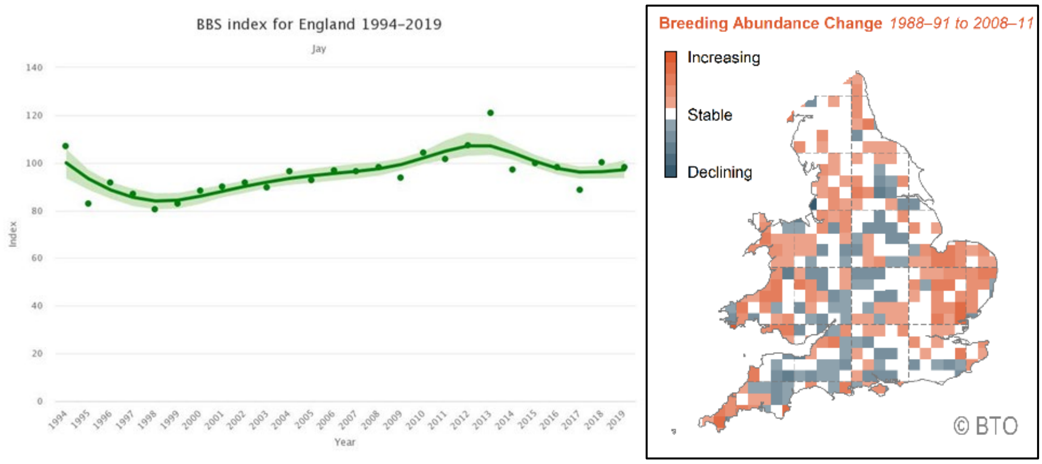

Figure 4.3 Jay: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS [https://www.bto.org/our-science/projects/bbs/latest-results)](https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

<u>All birds (n=33)</u>

Size of Impact	2	0.0	6.1	18.2
	1	3.0	45.5	9.1
	0	0.0	15.2	3.0
		0	1	2
		Scientific Rigour		

33.3% of studies were of medium to high scientific rigour and presented medium to high impact.
18.2% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of jay on the **conservation of wild birds**.*

36.4% of studies (n=11) with high strength of evidence (green cells) had confounding variables (artificial nests).

The majority of the studies reporting at least some impact (rigour and impact at least 1) involved predation occurring in woodland habitats or at woodland edges, and the majority of these involved the predation of woodland songbirds. Four out of the five studies on gamebirds referred to forest-nesting grouse (Andren *et al*. 1985, Andren *et al*. 1992, Angelstam 1986, Wegge *et al*. 2012). The other, Draycott *et al*. (2008), recorded predation by corvids on pheasants, but did not separate the effects of different corvid species, so this impact cannot be specifically attributed to jay. All of the four studies on woodland gamebirds used artificial nests, and only one (Angelstam 1986) was able to differentiate between predator species and reliably attribute some proportion of the recorded predation specifically to jay. One review (Parrott 2012) concluded that there was a lack of empirical evidence of jay predation on wild gamebirds, but there is evidence of jay predation on songbirds, mainly eggs and chicks, and particularly in woodland habitats. Another review (Roos *et al*. 2018) found that 5% of the reviewed studies showed jays had an effect on populations of wild bird species (without specifying which prey species.)

The use of cameras at real nests has identified the jay as a key nest predator for a number of woodland songbirds, including blackcap, spotted flycatcher and wood warbler *Phylloscopus sibilatrix*. Weidinger (2009) found that jays were less likely to predate the nests of larger bodied songbirds, such as thrushes, and all of the studies without confounding factors involved nest predation of relatively small songbirds that nest in woodland or semi-woodland habitats.

Conservation status of prey

Within the 33 studies involving jay it was possible to score 26 predator-prey interactions for impact and rigour for individual prey species (some studies involved multiple prey species). These interactions involved a total of 14 different species for which there was some impact (i.e. scoring 1 or 2). One of these, pheasant, has not been ascribed a UK conservation status (Eaton *et al*. 2015), because it is a non-native, intensively managed species in the UK. In respect to the UK conservation status of the remaining 13 species, there were 6 Red-listed, 1 Amber-listed and 6 Green-listed species. Four interactions also recorded no impact of jay on 3 Red-listed and 1 Green-listed species.

Red-listed species (n=13)

Size of Impact	2	0.0	7.7	23.1
	1	0.0	30.8	15.4
	0	0.0	15.4	7.7
		0	1	2
		Scientific Rigour		

46.2% interactions were of medium to high scientific rigour and presented medium to high impact.
23.1% interactions were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for an impact of jay on the **conservation of red-listed wild birds**.*

High impact was associated with two Red-listed species: spotted flycatcher (Bolton *et al*. 2007, Charman & Gruar 2009, Stevens *et al*. 2008) and wood warbler (Mallord *et al*. 2012), which also presented medium impact in another study (Maziarz *et al*. 2018). A study using artificial red-backed shrike nests in Sweden attributed 10% of predation to jay (Roos 2002). The other Red-listed species impacted were yellowhammer, marsh tit *Poecile palustris*, and willow tit *Poecile montanus* (Gibbons *et al*. 2007, Weidinger 2009). Of the six species associated with high or medium impact, four are woodland specialists (spotted flycatcher, wood warbler, marsh tit and willow tit); whilst the study involving yellowhammer (a farmland specialist in the UK) was undertaken in fragmented woodland in the Czech Republcic (Weidinger 2009). Three further studies showed no impact of jay on Red-listed lapwing, willow tit, and marsh tit (Bolton *et al*. 2007, Siriwardena 2004, Siriwardena 2006).

<u>Amber-listed species (n=1)</u>
The one Amber-listed species associated with some impact was dunnock (Weidinger 2009). Sample size, however, is too small to be able to draw a meaningful conclusion.

<u>Green-listed species (n=11)</u>

Size of Impact	2	0.0	0.0	18.2
	1	0.0	36.4	36.4
	0	0.0	9.1	0.0
		0	1	2
		Scientific Rigour		

54.5% interactions were of high scientific rigour and presented high impact.
9.1% interactions were of medium scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for an impact of jay on the **conservation of green-listed wild birds**.*

Green-listed species with at least some impact were blackcap, woodlark, chaffinch, chiffchaff *Phylloscopus collybita*, blackbird, and song thrush; two studies on blackcap with high impact (Schaefer 2004, Weidinger 2009) – all species being almost exclusively woodland specialists or generalists. One study showed no impact on the Green-listed golden plover (Degen 2008).

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

<u>Public health (n=4)</u>

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*However, as there are only 4 studies there is **insufficient data** to evaluate the impact of jay on public health.*

All of the studies related to evidence of jay carrying pathogens common to humans, including West Nile Virus, *Salmonella spp*., *Campylobacter spp., Giardia spp.,* and *Cryptosporidium spp*. but without showing transmission. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease + harm) (n=6)

Size of Impact	2	0.0	16.7	0.0
	1	0.0	66.7	0.0
	0	0.0	16.7	0.0
		0	1	2
		Scientific Rigour		

16.7% of studies were of medium scientific rigour and presented high impact.
16.7% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium** strength of evidence for an impact of jay on livestock through the spread of disease (one study found no evidence for predation on poultry). However, this relates to the evidence for jay carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

Several studies found evidence of jays carrying pathogens common to livestock but without showing transmission. The single study that presented high impact on livestock related to an outbreak of West Nile Virus in horses in Italy (Calistri *et al*. 2010), with several jays (and a number of other species) from the surrounding area tested positive for the disease. Other studies found evidence of jays carrying *Toxoplasma gondii*, *Giardia spp*., and several species of parasitic helminth, but did not provide evidence of transmission to livestock (Darwich *et al*. 2012, Luft 1960, Reboredo-Fernandez *et al*. 2015). A review (Parrott 2012) found no empirical evidence of jay predation on poultry.

Fruit (n=1)
In one study, jay was listed as having been known to damage Persimmon fruit (Moran 2003). There is ***insufficient evidence*** to evaluate the impact of jay on ***fruit***.

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Magpie (*Pica pica*)

Magpie occurs in the breeding season across all of England except North Pennines, and is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases. Breeding distribution has remained the same since 1991, with London and the South East, West Midlands and the North West and North East (except uplands) being strongholds. Variations in range since the first atlas have primarily arisen from infilling of individual 10km squares in Kielder Forest, Northumberland, the North-East coast, and the westernmost fringes of East (Figure 4.4). The non-breeding distribution reflects that of the breeding season.

Magpie increased steadily until the late 1980s (Gregory & Marchant 1996), after which abundance stabilised. BBS (1994-2019) indicates that abundance increases have occurred in London, East Midlands and East Anglia, with decreases in the other English regions. The current GB population estimate is 550,000 territories (Woodward *et al*. 2020).

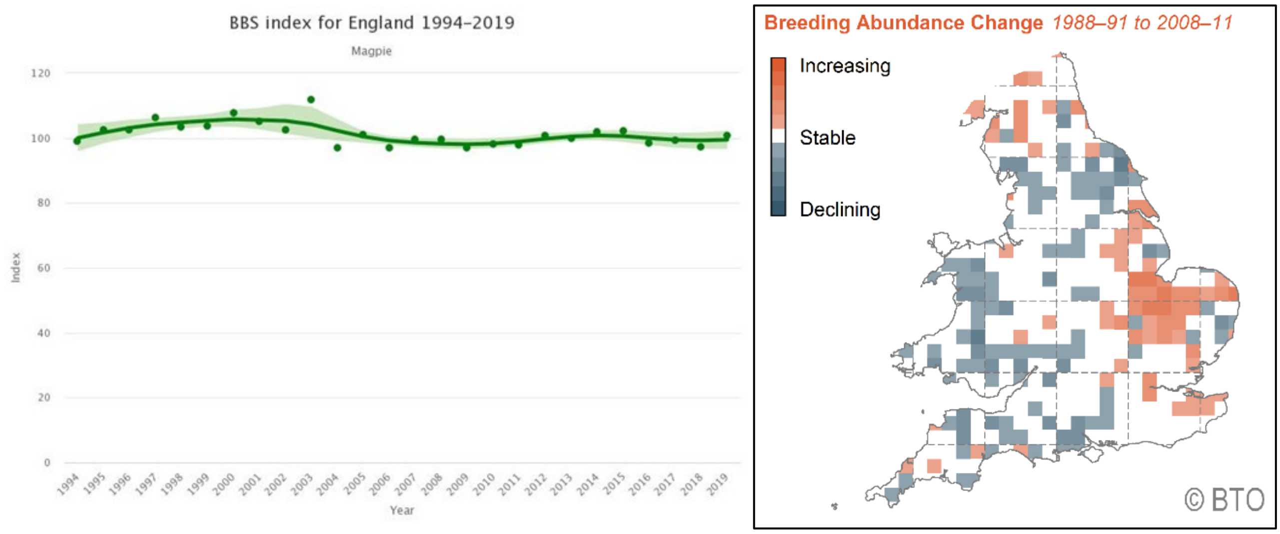

Figure 4.4 Magpie: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS [https://www.bto.org/our-science/projects/bbs/latest-results)](https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

<u>All birds (n=54)</u>

Size of Impact	2	0.0	9.3	13.0
	1	0.0	40.7	16.7
	0	0.0	16.7	3.7
		0	1	2
		Scientific Rigour		

38.9% of studies were of medium to high scientific rigour and presented medium to high impact.
20.4% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of magpie on the **conservation of wild birds***

**90.4% of the studies (n=21) with high strength of evidence (green cells) had confounding variables.*

A high proportion of the studies did not separate the effects of different predator species, instead looking at the effect of the removal of a suite of predators. Occasionally, these predator removal studies involved the removal of both avian and mammalian predators from an area, at other times they removed all or some corvid species.

Several studies reported a positive impact of predator removal on grey partridge populations – all of these included the removal of other avian predators as well as mammalian predators such as red fox and stoat *Mustela erminea* (Tapper *et al*. 1996, Aebischer *et al*. 2010, Farago *et al*. 2012). One study involved the removal of ravens, hooded crows, and magpies and noted a slight reduction in egg loss for willow ptarmigan and black grouse (Parker 1984). Several studies found a positive effect of predator removal on songbird breeding success (Gibbons *et al*. 2007, Sage *et al*. 2017, Stoate & Szczur 2001, Stoate & Szczur 2006, White *et al*. 2008, White *et al*. 2014). Aebischer *et al*. (2016) found that predator removal had the most impact on abundance of farmland birds when predator densities were initially high, while Draycott *et al*. (2008) found that areas with greater intensity of predator control had lower levels of pheasant nest predation. Because all of these studies involved the removal of several predator species, the impacts cannot be reliably attributed to magpie specifically. Several also included changes to habitat management practices, which could also have affected the results. One removal study targeted magpies specifically, and found that their removal in urban areas led to an increase in the number of juvenile blue tits *Cyanistes caeruleus*, but found no impact on several other songbird species (Chiron & Julliard 2007).

A number of studies found a negative relationship between natural abundance of corvids (including magpie) and songbird populations (Bonnington *et al*. 2015, Dunn *et al*. 2010, Paradis *et al*. 2000), while Andren (1992) found increased predation on artificial nests where corvid abundance was high. Again, because the effects of different predator species are not separated, the impact cannot be attributed specifically to magpie.

A significant proportion of studies also used artificial nests mimicking those of songbirds or gamebirds to study predation. Some of these showed a high level of predation by magpies (Capstick 2018, Capstick *et al*. 2019, Hanmer *et al*. 2017, Kruger *et al*. 2018, Salek 2004, Suvarov *et al*. 2012). However, predation on artificial nests cannot be reliably assumed to be an accurate reflection of predation rates on real nests (Major & Kendal 1996; Moore & Robinson 2004).

Of those studies without confounding factors all those showing at least some impact involved songbirds. One (Groom 1993) showed a high impact of magpie predation on blackbird nests in an urban area. A review (Madden *et al*. 2015) found that in 81% of cases, corvids are unlikely to limit wild bird populations, and that crows were more likely to have an effect than magpies.

Conservation status of prey

Within the 54 studies involving magpie it was possible to score 59 predator-prey interactions for impact and rigour for individual prey species (some studies involved multiple prey species). These interactions involved a total of 18 different species for which there was some impact (i.e. scoring 1 or 2). Two of these species, pheasant and willow ptarmigan, have not been ascribed a UK conservation status (Eaton *et al*. 2015) – the former because it is a non-native, intensively managed species in the UK, and the latter because it does not exist in the UK (although it is closely related to red grouse). In respect to the UK conservation status of the other 16 species, there were 8 Red-listed species, 1 Amber-listed, and 7 Green-listed species.

There were also 26 interactions that scored no impact. One of these was on red-legged partridge, which has not been ascribed a UK conservation status because it is a non-native, intensively managed species in the UK. Within the other interactions scoring no impact, there were 5 Red-listed, 5 Amber-listed, and 12 Green-listed species.

Red-listed species (n=18)

Size of Impact	2	0.0	5.6	16.7
	1	0.0	44.4	5.6
	0	0.0	16.7	11.1
		0	1	2
		Scientific Rigour		

27.9% interactions were of medium to high scientific rigour and presented medium to high impact.
27.8% interactions were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium** strength of evidence for an impact of magpie on the **conservation of red-listed wild birds***.

**100%* interactions *(n=5) with high strength of evidence (green cells) had confounding factors.*

The Red-listed species impacted were grey partridge, black grouse, black-tailed godwit, lapwing, red-backed shrike, spotted flycatcher, house sparrow *Passer domesticus*, and yellowhammer. The highest impacts were shown on grey partridge, spotted flycatcher and yellowhammer in predator removal experiments that removed a suite of avian and mammalian predators (Aebischer *et al*. 2010, Stoate & Szczur 2006, Tapper *et al*. 1996, White *et al*. 2014). Medium impact was also shown on grey partridge, yellowhammer, and black grouse in studies where several other predator species were also removed (Dunn *et al*. 2010, Farago *et al*. 2012, Parker 1984). These impacts cannot therefore be attributed specifically to magpie. Studies on lapwing and black-tailed godwit noted that magpie specifically were at least partly responsible for high predation levels (Groen & Yurlov 1999, Klimov 1998). House sparrow remains were found in magpie diets by Tatner (1983), although the majority of the diet was made up of invertebrates, and Fernandez-Juricic *et al*. (2004) observed two incidents of predation by magpies on adult house sparrows. Roos & Part (2004) found that predation rates on red-backed shrike nests were slightly lower when further away from magpie nests.

There were also studies that recorded no impact of magpie on lapwing, black-tailed godwit, skylark, yellowhammer, and house sparrow (Chiron & Julliard 2007, Van Der Vliet *et al*. 2008, Weidinger 2009).

Amber-listed species (n=6)

Size of Impact	2	0.0	16.7	0.0
	1	0.0	0.0	0.0
	0	0.0	50.0	33.3
		0	1	2
		Scientific Rigour		

16.7% interactions were of medium scientific rigour and presented high impact.
83.3% interactions were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***low*** *strength of evidence for an impact of magpie on the* ***conservation of amber-listed wild birds****.*

The only interaction with an Amber-listed species recording an impact involved dunnock. There were also studies that recorded no impact of magpie on oystercatcher, redshank, meadow pipit, dunnock, and willow warbler *Phylloscopus trochilus* (Chiron & Julliard 2007, Van Der Vliet *et al*. 2008).

Green-listed species (n=31)

Size of Impact	2	0.0	12.9	0.0
	1	0.0	29.0	9.7
	0	0.0	12.9	35.5
		0	1	2
		Scientific Rigour		

22.6% of studies were of medium to high scientific rigour and presented medium to high impact.
48.4% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***low-medium*** *strength of evidence for an impact of magpie on the* ***conservation of green-listed wild birds*****.*

**42.9% interactions (n=7) with high strength of evidence (green cells) had confounding factors.*

The Green-listed species impacted were woodpigeon, feral pigeon, blue tit, greenfinch *Chloris chloris*, chaffinch, blackbird and song thrush, with the highest impacts found for chaffinch, blackbird and song thrush. The majority of studies did not separate the effects of different predators, but Chiron and Julliard (2007) found some impact on blue tit when magpies were removed from urban areas, Groom (1993) attributed high levels of blackbird nest predation in an urban area to magpie, and Fernandez-Juricic *et al*. (2004) observed several instances of magpies attacking adult songbirds as well as feral pigeon and woodpigeon.

There were also studies that recorded no impact of magpie on golden plover, blackbird, song thrush, robin *Erithacus rubecula*, great tit *Parus major*, long-tailed tit *Aegithalos caudatus*, chaffinch, blackcap, whitethroat, garden warbler *Sylvia borin*, chiffchaff (Chiron & Julliard 2007, Degen 2008, Stoate & Szczur 2005, Weidinger 2009, White *et al*. 2014).

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=12)

Size of Impact	2	0.0	16.7	8.3
	1	0.0	66.7	0.0
	0	8.3	0.0	0.0
		0	1	2
		Scientific Rigour		

25.0% of studies were of medium to high scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium-high*** *strength of evidence for an impact of magpie on public health. However, this largely relates to the evidence for magpies carrying pathogens common to humans; evidence for actual transmission of disease to humans is rare (one historical case for magpie). The latter reflects an* ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission.*

There was only one study which showed transmission of pathogens from magpies to humans. Hudson *et al*. (1991) traced the source of human campylobacter infections in Gateshead to infected magpies (and jackdaws) pecking milk bottle tops. As delivery of milk bottles to household doorsteps are largely no longer in use, the likelihood of transmission via this route is significantly reduced. All of the other studies related to evidence of magpie carrying pathogens common to humans, but without showing transmission. These pathogens include West Nile Virus, *Campylobacter spp*., *Giardia spp.,* and *Cryptosporidium spp*..

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease) (n=7)

Size of Impact	2	0.0	14.3	0.0
	1	0.0	57.1	0.0
	0	0.0	28.6	0.0
		0	1	2
		Scientific Rigour		

14.3% of studies were of medium scientific rigour and presented high impact.
28.6% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of magpie on livestock through the spread of disease. However, this relates to the evidence for magpie carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

The single study that presented high impact on livestock related to an outbreak of West Nile Virus in horses in Italy (Calistri *et al*. 2010), with several magpies (and a number of other species) from the surrounding area tested positive for the disease. Jourdain *et al*. (2007) also isolated West Nile Virus from magpie in southern France. Other studies found evidence of magpies carrying *Toxoplasma gondii*, *Neospora caninum*, and several species of parasitic helminth, but without providing evidence of transmission to livestock (Darwich *et al*. 2012, Luft 1960). There were no studies on predation or damage to livestock caused by magpies.

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Rook (*Corvus frugilegus*)

Rook is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases, with variations in range relating to occupation of individual 10km squares and showing no regional patterns. The only range gaps are in London, and Kielder Forest in Northumberland both areas that include extensive areas of unsuitable habitat. The non-breeding distribution reflects that of the breeding season.

Relatively few rookeries fell within Common Bird Census (CBC) plots, but an index calculated from the available CBC nest counts showed a shallow, long-term increase to the mid-1990s (Wilson *et al*. 1998). This was confirmed by the results of the most recent BTO rookeries survey, which identified a 40% increase in abundance between 1975 and 1996 (Gregory & Marchant 1996). This probably reflected the species' considerable adaptability in the face of agricultural change (Woodward *et al*. 2018). Since then, BBS (1994-2019) indicates a decline in the English population (Figure 4.5), with declines at a regional scale in the North, South West and Yorkshire & Humberside. The current GB population estimate is approximately 885,000 breeding pairs (Woodward *et al*. 2020).

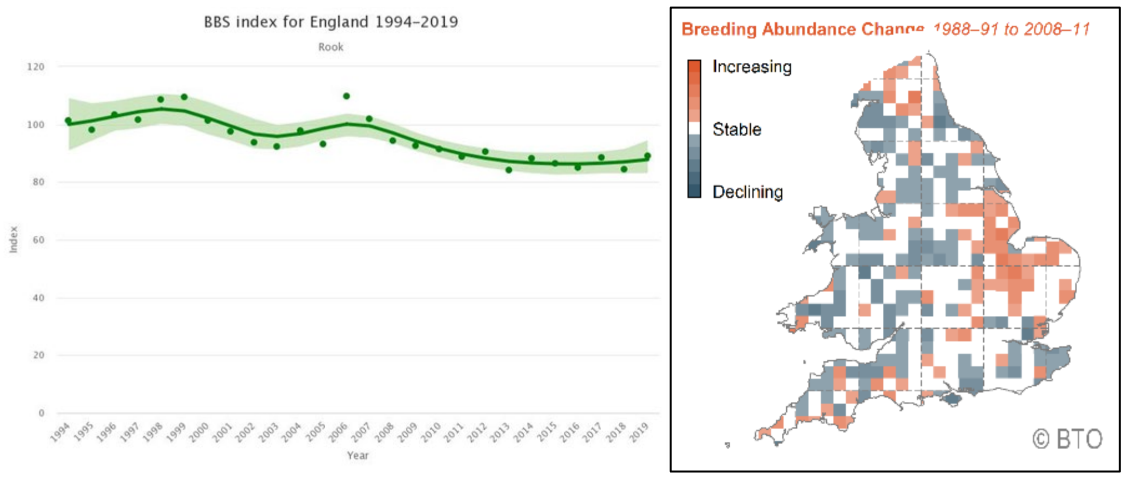

Figure 4.5 Rook: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS [https://www.bto.org/our-science/projects/bbs/latest-results)](https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

<u>All birds (n=16)</u>

Size of Impact	2	0.0	6.3	6.3
	1	0.0	25.0	0.0
	0	6.3	56.3	0.0
		0	1	2
		Scientific Rigour		

12.6% of studies were of medium-high scientific rigour and presented high impact.
56.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **low-medium** strength of evidence for an impact of rook on the **conservation of wild birds**.*

The majority of studies showed no or low impact on wild birds. Several studies that showed some level of impact did not separate the effects of different predator species, so the impact recorded cannot be attributed to rook specifically. The only studies that attributed predation specifically to rook were one on lapwing in which the authors list rook as a predator without quantifying their impact (Klimov 1998), and one which noted high levels of egg predation by rooks at a little tern *Sternula albifrons* colony (O'Connell *et al*. 2015).

Conservation status of prey

Within the 16 studies involving rook it was possible to score 8 predator-prey interactions for impact and rigour for individual species (some studies involved multiple prey species). These interactions involved a total of 5 different species for which there was some impact (i.e. scoring 1 or 2). One of these species, pheasant, has not been ascribed a UK conservation status (Eaton *et al*. 2015), because it is a non-native, intensively managed species in the UK. In respect to the UK conservation status of the other 4 species, there were 3 Red-listed species, and 1 Amber-listed species. There were also two interactions that scored no impact, both on lapwing (a Red-listed species).

Red-listed species (n=5)

Size of Impact	2	0.0	0.0	20.0
	1	0.0	40.0	0.0
	0	20.0	20.0	0.0
		0	1	2
		Scientific Rigour		

20.0% interactions were of high scientific rigour and presented high impact.
20.0% interactions were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium** strength of evidence for an impact of rook on the **conservation of red-listed wild birds****.*

**The single study with high strength of evidence (green cells) had confounding factors.*

The Red-listed species impacted were grey partridge, lapwing, and yellowhammer. One predator removal experiment that showed a high impact on grey partridge populations removed both avian and mammalian predators (Tapper *et al*. 1996), while another that found improved breeding success of yellowhammers where corvid abundance was lower did not distinguish between different corvid species (Dunn *et al*. 2010). However, Klimov (1998) lists rook specifically as a predator of lapwing without quantifying the impact.

There were also two studies that recorded no impact of rook on lapwing (Krolikowska *et al*. 2016, O'Brien 2001).

Amber-listed species (n=2)
O'Connell *et al*. (2015) cite high levels of predation by rooks at a little tern colony; whilst Keogh *et al*. (2011) do not specify damage due only to rook - corvids (including rooks) managed to predate some little tern nests. Sample size is too small to be able to draw a meaningful conclusion.

Fauna (n=1)
A review (Speakman 1991) lists rook amongst 11 bird species recorded to have occasionally predated on bats.

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=11)

Size of Impact	2	0.0	9.1	0.0
	1	0.0	81.8	0.0
	0	0.0	9.1	0.0
		0	1	2
		Scientific Rigour		

9.1% of studies were of medium scientific rigour and presented high impact.
9.1% of studies were of medium scientific rigour and presented nil/low impact.

Overall, there is ***medium*** *strength of evidence for an impact of rook on public health. However, this relates to the evidence for rooks carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an* ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission.*

All of the studies related to evidence of rook carrying pathogens common to humans, but without showing transmission. These pathogens include *Campylobacter spp*., *Listeria spp*., *Escherichia coli*, *Agrobacterium radiobacter*, *Enterocytozoon bieneus*, *Encephalitozoon hellem*, *Salmonella spp*., *Staphylococcus spp*., *Streptococcus spp*., *Acinetobacter spp*., *Cryptosporidium spp*., *Giardia spp*., *Mucor spp*., *Cladosporium spp*., *Rhodotorula rubra*, *Aspergillus spp*., and *Candida spp*.

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease) (n=3)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*However, as there are only 3 studies there is **insufficient data** to evaluate the impact of rook on livestock.*

These studies found evidence of rooks carrying pathogens common to livestock (*Mycobacterium avium*, *Pasteurella multocida*), but without showing transmission (Beard *et al*. 2001, Daniels *et al*. 2003, Strugnell *et al*. 2011). There were no studies on rooks predating or damaging livestock.

Crops (n=16)

Size of Impact	2	0.0	0.0	6.3
	1	12.5	56.3	6.3
	0	12.5	6.3	0.0
		0	1	2
		Scientific Rigour		

12.6% of studies were of high scientific rigour and presented medium to high impact.
6.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of rooks on crops.*

Crop damage attributed to rooks was almost always cereals. A number of dietary analysis studies found grain in the gizzards of rooks, including corn, barley, wheat and oats, but these cannot quantify the impact on crop losses (Gromadzka 1980, Holyoak 1972, Lockie 1956, Orlowski *et al*. 2015). Holyoak (1972) states that half of the grain eaten by rooks is from crops and half from stubble fields. Kasprzykowski (2003) states that rooks took young shoots of plants as well as grain. One study stated that rooks caused 88% yield loss in winter wheat and 59% yield loss for spring wheat in Ireland (Kennedy & Connery 2008). Another Irish study noted that rooks caused damage to wrapped silage bales (McNamara *et al*. 2004).

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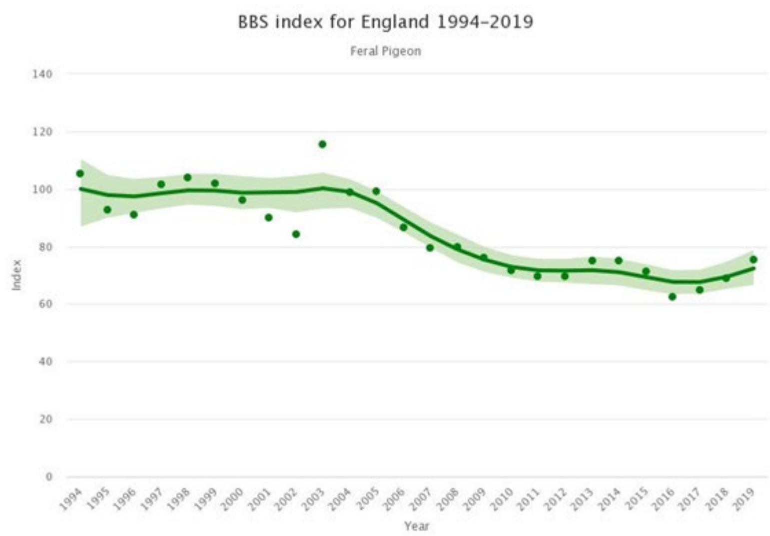
4.2 Pigeons

Feral Pigeon (*Columba livia*)

CBC samples for feral pigeon were consistently too small for annual monitoring, and there was no trend information before BBS began in 1994. Breeding atlas data have shown a 39% increase in occupied 10-km squares between 1968-72 and 1988-91 (Gibbons *et al*. 1993) and a further 5% or so by 2008-11 (Balmer *et al*. 2013). However, BBS indices (1994-2019) suggest that there has been a moderate decline in numbers across England in recent years (Figure 4.6). The current British population is estimated to be 460,000 pairs (Woodward *et al*. 2020).

At the time of the first atlas, however, feral pigeons were more commonly overlooked during bird surveys, and some of the reported range increase may have been due to greater observer awareness. It is now clear that feral pigeons are almost ubiquitous in the UK, nesting in rural as well as their more traditional urban habitats, and avoiding only the highest ground. The highest densities however remain associated with urban areas.

No distinction can realistically be drawn between feral birds of domestic origin and true wild-type rock doves, although birds of wild-type plumage still predominate on some more-remote Scottish islands. In field conditions, it is often not possible to distinguish between pure native rock doves, wild-nesting feral pigeons, semi-captive dovecote breeders, and passing racing pigeons, nor between adults and young of the year, and BBS counts are likely to include birds from all of these groups.



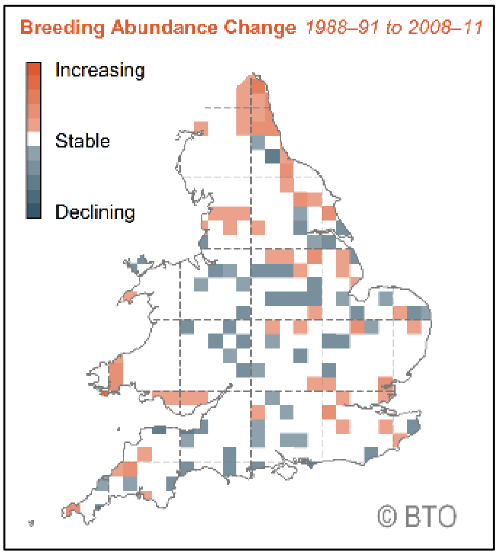


Figure 4.6 Feral pigeon: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

Animal & Plant Health Agency

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

*There is **insufficient data** to evaluate the strength of evidence for an impact of feral pigeons on the conservation of wild birds, flora and fauna.*

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=59)

Size of Impact	2	0.0	10.2	8.5
	1	0.0	76.3	0.0
	0	1.7	3.4	0.0
		0	1	2
		Scientific Rigour		

18.7% of studies were of medium to high scientific rigour and presented high impact.
3.4% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of feral pigeon on public health. However, this largely relates to the evidence for feral pigeons carrying pathogens common to humans; evidence for actual transmission of disease to humans is rare. The latter largely reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission. However, feral pigeon is one of the few species for which transmission has been shown.*

Several studies have shown transmission of pathogens or parasites from feral pigeons to humans. Three referred to transmission of *Chlamydia psittaci*, which causes respiratory psittacosis in humans (Dickx *et al*. 2010, Haag-Wackernackel & Moch 2004, Haag-Wackernackel 2006). One also referred to transmission of *Cryptococcus neoformans* (Haag-Wackernackel & Moch 2004). Two studies referred to transmission of ectoparasites, including pigeon fleas, to humans (Haag-Wackernackel & Spiewak 2004, Haag-Wackernackel & Bircher 2010). All of the other studies related to evidence of feral pigeon carrying pathogens common to humans, but without showing transmission. These pathogens include West Nile Virus, Borna Virus, *Escherichia coli*, *Campylobacter spp.*, *Cryptosporidium homini*, *Clostridium difficile*, *Enterocytozoon bieneusi*, *Encephalitozoon spp.*, *Salmonella spp*., *Cryptococcus spp., Enterococcus spp*., and *Candida spp*..

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease) (n=32)

Size of Impact	2	3.1	18.8	6.3
	1	3.1	62.5	0.0
	0	0.0	6.3	0.0
		0	1	2
		Scientific Rigour		

25.1% of studies were of medium to high scientific rigour and presented high impact.
6.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of feral pigeon on livestock through the spread of disease. However, this relates to the evidence for feral pigeon carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is rare. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

Two studies referred to outbreaks of Newcastle Disease (ND) in Britain in 1984 that were traced back to feral pigeons infecting food stores at Liverpool docks (Alexander *et al*. 1985, Wilson 1986). Another study detected similar strains of ND virus in wild pigeons and infected poultry in Europe (Alexander 2011). One study related to an outbreak of West Nile Virus in horses in Italy (Calistri *et al*. 2010); with several feral pigeons (and a number of other species) from the surrounding area tested positive for the disease. Another study isolated similar strains of *Salmonella enteritidis* from feral pigeons and poultry in Belgium (Haesendonk *et al*. 2016). Another identified the same strain of *Salmonella enterica indiana* from feral pigeons and ewes amongst which an outbreak had occurred (Luque *et al*. 2009).

Most of the studies on animal disease presented evidence of feral pigeon carrying pathogens common to livestock, but without evidence of transmission. These pathogens include *Chlamydia psittaci*, *Clostridium difficile*, Avian hepatitis E virus, and the causative agents of paratuberculosis, salmonellosis, cryptosporidiosis, aspergillosis, blastomycosis, cryptococcosis, histoplasmosis, listeriosis, salmonellosis, encephalitides, and toxoplasmosis. Two studies suggested that feral pigeons were unlikely to play a major role in the spread of avian influenza H5N1 (Boon *et al*. 2007, Brown *et al*. 2009).

Crops (n=9)

Size of Impact	2	0.0	22.2	0.0
	1	0.0	77.8	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

22.2% of studies were of medium scientific rigour and presented high impact.
0.0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for feral pigeons causing serious damage to crops.*

Several studies refer to feral pigeon taking newly sown seeds or seedling crops (Giunchi *et al*. 2012, Johnston & Janiga 1995, Saini & Toor 1991). Saini & Toor (1991) refer to high levels of damage on sprouting legume crops in India. Another study reported damage by feral pigeon to chickpea crops in Israel (Moran 2003), while Nakao (1984) recorded low levels of damage to soybean crops in Japan.

Foodstuffs for livestock (n=7)

Size of Impact	2	0.0	28.6	0.0
	1	0.0	57.1	0.0
	0	0.0	14.3	0.0
		0	1	2
		Scientific Rigour		

28.6% of studies were of medium scientific rigour and presented high impact.
14.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for feral pigeons causing serious damage to foodstuffs for livestock.*

All of the studies on foodstuffs for livestock refer to stored grain. Pimentel *et al*. (2000, 2001) state that feral pigeons cause large amounts of damage to stored grain in the U.S. Several studies refer to damage to stored grain without quantifying it (FERA 2009, Giunchi *et al*. 2012, Johnston & Janiga 1995, Saini & Toor 1991). Murton *et al*. (1972), however, found that feral pigeons at Salford docks only took spillage grain, therefore did not contribute to losses.

Infrastructure (n=4)

Size of Impact	2	0.0	50.0	0.0
	1	0.0	50.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

50% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*There is **insufficient data** to evaluate the impact of feral pigeons on infrastructure.*

All of the studies on infrastructure refer to damage to buildings caused by fouling. Pimentel *et al*. (2000, 2001) state that feral pigeons cause economically significant levels of damage to buildings in the U.S. Two other studies cite damage to buildings through fouling by feral pigeons without quantifying it (FERA 2009, Giunchi *et al*. 2012).

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Woodpigeon (*Columba palumbus*)

Bird Atlas data (Balmer *et al*. 2013) shows woodpigeon to be a widespread breeding species throughout England, occurring in almost all heptads in all three atlas periods. In the lowlands is it ubiquitous across both rural and urban landscapes, but is found at lower densities in the uplands of Northern England and the South West. Winter distribution reflects that of the breeding season.

With an estimated population 5,050,000 pairs the woodpigeon is one of the commonest breeding birds in Britain, with England holding the majority of the population (Woodward *et al*. 2020). The CBC/BBS trend for this species is of a steady, steep increase in population abundance since at least the mid-1970s. Since 1994, BBS has recorded significantly upward trends in the UK, and in England (Figure 4.7), Wales and Northern Ireland separately, but stability in Scotland. This has only recently started to level off, with BBS showing a very shallow but statistically significant decline in England over the most recent five year period. Most English regions have mirrored the national abundance trend for increase and then stability (or even some decrease), except for the North West, South West, and East Midlands where there has been continued increase.

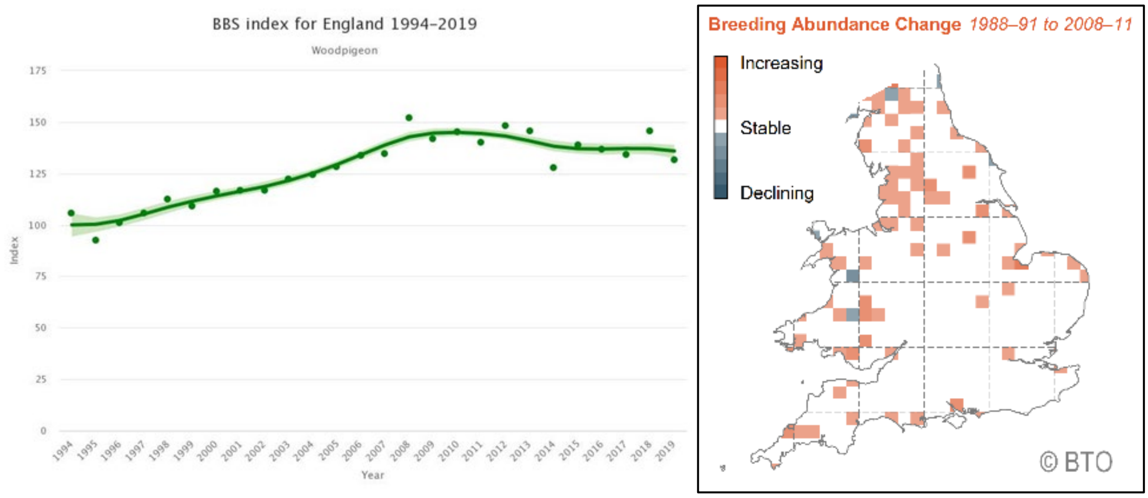

Figure 4.7 Woodpigeon: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

<u>Conservation of wild birds (n=3)</u>

Three studies were of medium scientific rigour and presented medium impact. All three studies related to the prevalence of the disease trichomoniasis in wild woodpigeons. Transmission of the disease to other wild birds via shared feeding and drinking places is suspected but not proven (Marx *et al*. 2017). In addition, Villanua *et al*. (2006) state that nestling raptors being fed on pigeon prey can contract the disease.

*There is **insufficient data** to evaluate the strength of evidence for an impact of woodpigeons on the conservation of wild birds, flora and fauna.*

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=5)

Size of Impact	2	0.0	20.0	0
	1	0.0	60.0	0.0
	0	0.0	20.0	0.0
		0	1	2
		Scientific Rigour		

20% of studies were of medium scientific rigour and presented high impact.
20% of studies were of medium scientific rigour and presented nil/low impact.

Overall, there is ***medium*** *strength of evidence for an impact of woodpigeon on public health. However, this relates to the evidence for woodpigeon carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an* ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission.*

All of the studies related to evidence of woodpigeon carrying pathogens common to humans, but without showing transmission. These pathogens include *Chlamydia psittaci*, *Enterococcus spp*., *Salmonella spp*., *Giardia spp*., and *Cryptosporidium spp*..

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease) (n=6)

Size of Impact	2	16.7	0.0	0.0
	1	0.0	50.0	0.0
	0	0.0	33.3	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact.
33.3% of studies were of medium scientific rigour and presented nil/low impact.

Overall, there is ***medium-low*** *strength of evidence for an impact of woodpigeons on livestock through the spread of disease. However, this relates to the evidence for woodpigeons carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an* ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission.*

All of the studies on animal disease related to evidence of woodpigeon carrying pathogens common to livestock, but without showing transmission. These pathogens include trichomoniasis, *Mycoplasma gallisepticum*, *Salmonella enterica*, and *Chlamydia spp*.

All crops (n=15)

Size of Impact	2	0.0	33.3	6.7
	1	0.0	60.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

40.0% of studies were of medium to high scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of woodpigeon on crops.*

Several studies reported serious damage to brassica crops (APHA 2014, 2018, Jones 1974, Murton & Jones 1973, Murton 1965). Several studies also recorded serious damage to oilseed rape (APHA 2014, Colquhoun 1951, Inglis *et al*. 1989, Inglis *et al*. 1997). A number of studies referred to damage to legumes, particularly peas (APHA 2014, Canale & Bue 2018, Colquhoun 1951, De Grazio 1978, Jimenez *et al*. 1994, Murton *et al*. 1964, Murton 1965); others to cereal crops, such as wheat and barley (Canale & Bue 2018, Colquhoun 1951, De Grazio 1978, Galan *et al*. 2017, Jimenez *et al*. 1994, Murton *et al*. 1964, Ó hUallachain & Dunne 2013); three to damage to fruit (Canale & Bue 2018, Galan *et al*. 2017, Murton 1965) and one to damage to sugar beet (Dunning 1974).

Separating the studies broadly into brassicas and other crops has similar outcomes:

Vegetables (brassicas) (n=5)

Size of Impact	2	0.0	20.0	20.0
	1	0.0	60.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

40.0% of studies were of medium to high scientific rigour and presented high impact.

*Overall, there is **medium-high strength** of evidence for an impact of woodpigeon on brassicas.*

Other: cereals/OSR/sugar beet (n=10)

Size of Impact	2	0.0	40.0	0.0
	1	0.0	60.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

40.0% of studies were of medium scientific rigour and presented high impact.

*Overall, there is **medium-high strength** of evidence for an impact of woodpigeon on other crops*.

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4.3 Non-native Species

It is widely accepted that one of the greatest threats to biodiversity across the globe is that posed by invasive non-native species (INNS). The huge ecological and economic impacts imposed by the minority of non-native species that become invasive are increasingly being understood. It has been estimated that damage caused by invasive species worldwide amounts to almost five percent of the world economy (GBNNSS 2008).

Defra is committed to combatting the serious risk posed by INNS and to this end the GB Invasive Non-native Species Strategy (GBNNSS 2008, 2015) follows the principals of the Convention on Biological Diversity (CBD) in prioritising prevention and rapid eradication over long-term management and control. It also follows the precautionary approach – the first of the guiding principles of the CBD. This states: 'The precautionary approach should also be applied when considering eradication' and 'Lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriate eradication, containment and control measures'. Measures to prevent the introduction of INNS will not always be successful. The sooner action is taken to address any threat, the greater the chance of success and the less costly it will be.

The responsibility for coordinating non-native species policy in GB lies with the GB Programme Board for non-native species, chaired by Defra. The Board has established a GB risk analysis mechanism which provides evidence of the risk posed by non-native species as well as the feasibility of management. Within the Non-native Risk Assessment (NNRA) scheme (Baker *et al* 2008, Mumford *et al* 2010) risk assessments on non-native species are carried out by independent experts, which are then reviewed by one peer reviewer and GB's independent panel of risk analysis experts (known as the NNRAP). Risk assessments are then made available, on the GBNNSS website, for three months for stakeholders to comment on the scientific evidence which underpins them before being finalised. Risk assessments may be re-evaluated in light of substantive new research or scientific evidence.

Although the main emphasis of the GB Invasive Non-native Species Strategy is directed towards prevention and rapid response, there is still a need to manage the impacts of the large number of INNS that are already established in GB. There are four main types of long-term management: large scale eradication, containment, control, and mitigation.

At the EU level, the Invasive Alien Species Regulation (EC 1143/2014) (1 January 2015) requires Member States to implement a range of measures for the prevention and management of the introduction and spread of INNS. Legal requirements are imposed on EU Member States relating to prevention (e.g. by prohibiting sale, etc. of listed species, and developing pathway action plans); early warning and rapid response, and management of established species. There is an EU list of prohibited species of union concern (or 'Union List) for which all EU Member States should aim to eradicate the species if possible, or if eradication is not deemed feasible or cost-effective, to apply appropriate containment or control measures.

There are currently six INNS on General Licences GL34-36: Canada goose, Egyptian goose, monk parakeet, ring-necked parakeet, sacred ibis and Indian house crow. Of these, Egyptian goose, sacred ibis and Indian house crow are INNS included on the Union List. Sacred ibis and Indian house crow are currently not present in GB and hence prevention, and in the event of introduction, rapid reaction and eradication are the appropriate management. Monk parakeet are present in small numbers in one location and are undergoing active management to remove this remaining population. Canada goose and ring-necked parakeet both have large, well-established populations. Egyptian geese are on that phase of the invasion pathway, where having established and remained at relatively low numbers and distribution over many years have more recently increased markedly in abundance and distribution. This is the typical invasion cycle of many INNS, where detrimental impacts only become manifest following marked population growth and expansion following a seemingly benign lag phase.

For all of these INNS, although removal under General Licence does not represent a strategic approach to their management, it does provide an additional mechanism through which the GB Invasive Non-native Species Strategy can be implemented. Any targeted strategic management of an INNS (e.g. as currently for ruddy duck and monk parakeet) would benefit from any additional control that may be taken under General Licence. As INNS have been present in GB for significantly less time and in fewer numbers compared to native species, evidence for detrimental impacts can often be less evident; hence the adoption of the precautionary principle.

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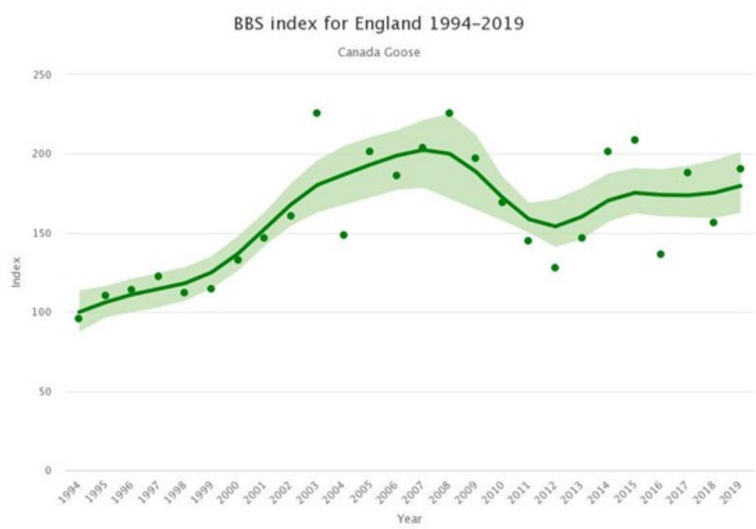
Canada Goose (*Branta canadensis*)

Canada geese were first introduced to English parkland around 1665 but have expanded hugely in range and numbers following translocations in the 1950s and 1960s. Population abundance has since increased rapidly, at a rate estimated at 9.3% per annum in Britain between the 1988-91 Atlas period and 2000; with no sign of any slowing in the rate of increase (Austin *et al*. 2007). The WeBS sample became large enough for annual monitoring in 1980, since when further, apparently exponential increase has occurred on linear waterways. Annual breeding-season monitoring in a wider range of habitats through BBS has shown similar strong increases in England (Figure 4.8) and in the UK as a whole but with significant reversals over the last ten years. Populations have increased in the North West, Yorkshire & Humber, South West and South East, and remain relatively stable over the longer term in other areas. The wintering distribution reflects that of the breeding season, with some dispersal from breeding grounds.

Since the translocations in the middle of the last century, Canada goose has rapidly expanded its range to the north and south west until it is now present over much of England except the uplands and Fens. It is one of the most widespread and abundant non-native birds in England, and the commonest non-gamebird. It has more than doubled its range from its core in the South-east and Midlands at the time of the first atlas and is now found in over 85% of 10km squares across the country with an overall population estimated to be around 54,000 pairs.



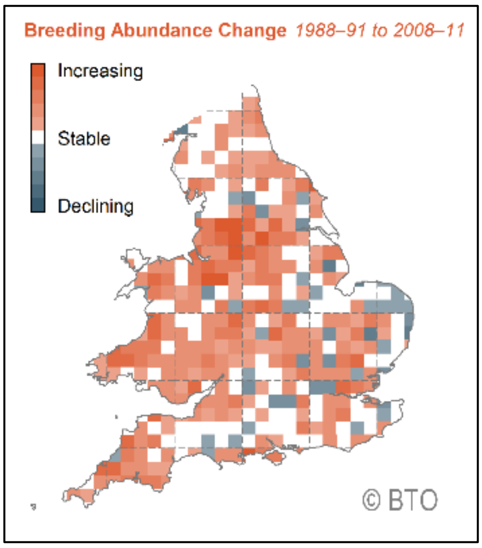


Figure 4.8 Canada goose: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=9)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	44.4	0.0
	0	22.2	11.1	22.2
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact.
33.3% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of Canada goose on the **conservation of wild birds**.*

Hybridisation with other goose species is becoming more frequent in GB, however, there are few native breeding geese in GB and most incidences have been with other feral species (Allan *et al.* 1995). There is concern that, if the population of Canada geese continues to expand into and through Scotland, this could create a risk *via* introgression to other native breeding goose species (Welch *et al.* 2001). There are differing results of research relating to the eutrophication of waterbodies caused by faecal deposits. These are summarised by Unckless & Makarewicz (2007), who suggest deposits are unlikely to alter water quality unless present in small ponds whose banks and bases can be disturbed by wave action. Seymour *et al.* 2002, confirm that Canada geese are associated with foraging on eel grass *Zostera spp*., a key food for other species such as Brent geese *Branta bernicla* around the UK coastline in winter. Expansion could, for example, reduce the availability of food for this species.

Conservation of flora (n=6)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	66.7	16.7
	0	16.7	0.0	0.0
		0	1	2
		Scientific Rigour		

16.7% of studies were of high scientific rigour and presented medium impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of Canada goose on the conservation of flora.*

High densities of Canada geese on waterbodies are likely to result in erosion of bankside vegetation and potential reductions in the sizes of reedbeds (Josefsson & Andersson 2001). These could therefore impact on other waterfowl or wading species that utilise this habitat. There is also evidence that high levels of faecal deposits could change the structure and diversity of plant life (Best 2008).

Animal & Plant Health Agency

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=39)

Size of Impact	2	0.0	0.0	0.0
	1	10.3	79.4	0.0
	0	0.0	10.3	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact. 10.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of Canada goose on **public health**. However, this relates to the evidence for Canada goose carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

In respect to Avian Influenza, a European-wide project (Veen *et al* 2007) categorised Canada goose as one of 29 Bridge Species i.e. species that pose a higher risk of spreading H5N1 from wild birds to humans, as identified on the basis of an assessment of the frequency of their contacts with humans. Canada Geese (amongst numerous other species) have been found dead in the wild carrying H5N1.

A review by Gorham and Lee (2016) revealed a wide-range of pathogens identified in Canada goose faeces, including: *Campylobacter jejuni*, *Salmonella* Typhimurium, *Listeria monocytogenes*, *Helicobacter canadensis*, *Arcobacter* spp., Enterohemorragic *Escherichia coli* pathogenic strains, *Chlamydia psitacci*, *Cryptosporidium parvum* and *Giardia lamblia*. The authors concluded that the association between increased numbers of Canada geese and outbreaks of recreational water-associated disease in the U.S. lent support for a potential transmission route for some of these pathogens to cause human illness in these freshwater setting; although it was also concluded that the any real health risk posed by Canada geese was uncertain.

However, although geese faeces have been shown to host several human pathogens, including a rare pathogenic fungus *Cryptococcus laurentii* (Filion *et al*. 2006) and the potential exists for transfer (Kassa *et al*. 2004; Brochier *et al*. 2010; Gorham & Lee 2016) there is little conclusive evidence for transmission to humans (Allan *et al.* 1995, Feare *et al.* 1999).

GL36: To kill or take certain species of wild birds to prevent serious damage.

Livestock (animal disease) (n=12)

Size of Impact	2	0.0	0.0	0.0
	1	16.7	75.0	0.0
	0	0.0	8.3	0.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact
8.3% of studies were of medium scientific rigour and presented nil/low impact.

*Overall, there is **medium-low** strength of evidence for an impact of Canada geese on livestock through the spread of disease. However, this relates to the evidence for Canada geese carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

In respect to Avian Influenza, a European-wide project (Veen *et al* 2007) categorised Canada goose as one of 15 Higher Risk Species (HRS), i.e. species posing a higher risk of spreading H5N1 further once it has been introduced into the EU, as identified on the basis of habitat use, gregariousness and degree of mixing with other species. In the same evaluation, Canada goose was also categorised as one of 29 Bridge Species i.e. HRS that also pose a higher risk of spreading H5N1 from wild birds to humans and/or poultry, as identified on the basis of an assessment of the frequency of their contacts with humans and/or poultry. Canada geese (amongst numerous other species) have been found dead in the wild carrying H5N1. Canada geese has tested positive for Campylobacter (Colles *et al*. 2008), avian bornavirus (Delnatte *et al*. 2013) and Canada goose eggs have carried antibodies for Newcastle Disease (Bonner *et al*. 2004). Jannson *et al.* (2007) suggested a possible cause of an outbreak of Parvovirus that resulted in almost complete mortality for farmed geese could have come from a clutch of infected wild Canada goose eggs.

Crops (n=25)

Size of Impact	2	0.0	8.0	16.0
	1	16.0	12.0	20.0
	0	4.0	8.0	16.0
		0	1	2
		Scientific Rigour		

44.0% of studies were of medium to high scientific rigour and presented medium to high impact.
24.0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **high** strength of evidence for an impact of Canada geese on **crops**.*

No national assessment of economic loss has been attempted in GB but some costs reported from grazing, fouling, trampling and bird strike have been reported. In GB, yield losses of 20% on winter cereals have been cited (Allan *et al.* 1995). Evidence from North America suggests that the timing of grazing, crop type and growing conditions influence the impact of Canada goose grazing on arable land. Yield losses as high as 70% have been recorded on sprouting winter wheat and in rye grass but no yield losses were recorded on dormant winter wheat. Borman *et al.* 2002, showed varied losses in grain yield of between 5% and 19% based on timing, intensity and extent of grazing by geese. Conversely improvements in yield were also reported on winter wheat grown on nutrient poor soils (due to improved fertilisation from the goose droppings) as well as rye grass seed in another investigation (Allan *et al.* 1995).

Inland waters (n=4)

Size of Impact	2	0.0	0.0	0.0
	1	25.0	50.0	0.0
	0	0.0	0.0	25.0
		0	1	2
		Scientific Rigour		

0% of studies were of medium to high scientific rigour and presented medium to high impact
25% of studies were of high scientific rigour and presented nil/low impact.

*However, as there are only four studies, there is insufficient data to evaluate the strength of evidence for an impact of Canada geese on **inland waters**.*

Amenity grassland n=3
Two studies were of low scientific rigour and presented medium impact; one study was of medium scientific rigour and presented high impact.

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Egyptian Goose (*Alopochen aegyptiaca*)

The species established a self-sustaining breeding population in Norfolk, which grew and spread to other parts of eastern and southern England (Lensink 1999, Reeber 2015). These populations have likely been enhanced by further escapes from waterfowl collections (Reeber 2015). The population was estimated to be 300-400 birds in the early 1960s, around 500 birds in the early 1980s, 750-800 birds between 1988 and 1991, and 1000 birds during 1991-1999. A study in 2000 of introduced geese in Great Britain estimated that there were between 1260 and 1580 full-grown birds. Taylor and Marchant (2011) estimated that there were 1500-2000 birds in Norfolk alone between 1999 and 2007, while Wright (2011) estimated that the population in Great Britain was in excess of 2520-3160 birds in 2011. Musgrove *et al*. (2011, 2013) estimated a total British population of 3400 birds as an average between the years 2004 and 2008. Data from the BTO's Wetland Bird Survey (WeBS) shows a steady increase in numbers of Egyptian Geese since they were first included in the survey in 1988, with the population in 2011 having more than doubled since 2000. In 2018, using the, as then, latest available WeBS data (2015-16), modelling estimated a GB population of 6,095 for 2011-12 and projected estimates of 8,361 (+37%) for 2017-18 and 9,661 (+59%) at the end of December 2018 (APHA 2018).

The size of the breeding range of the Egyptian goose in Great Britain as shown by the 1968-72, 1988-91 and 2007-11 bird atlases show a steady increase from an initial stronghold in East Anglia, with new populations forming in the Thames basin and now scattered records across England (Figure 4.9) as well as Wales and Scotland. The higher numbers of Egyptian geese in the southern half of England may be due to climatic factors, as well as the higher amount of urban habitats, which Egyptian geese seem to favour (Roy *et al*. 2015). There appears to be little difference between the summer and winter distributions of the species (Parrott 2013).

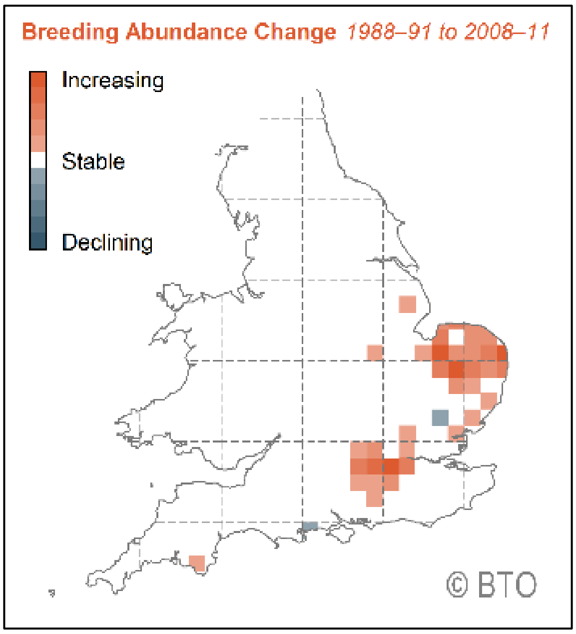

Figure 4.9 Egyptian goose: (Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=8)

Size of Impact	2	0.0	25.0	12.5
	1	0.0	62.5	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

37.5% of studies were of medium to high scientific rigour and presented medium to high impact. 0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of Egyptian geese on the conservation of wild birds.*

Egyptian geese are fiercely territorial and aggressive towards other birds, and there is some evidence that they may negatively affect populations of other waterbirds (Gyimesi & Lensink 2010, Baccetti 2017). Aggressive interactions have been recorded between Egyptian Geese and a wide range of other species of waterfowl, raptors, owls and passerines (Pieterse & Tamis 2005, Sarat *et al*. 2015, Baccetti 2017). Competitive exclusion of other waterbirds, particularly smaller species, could have locally important negative impacts on species of duck, grebe, coots, and moorhens (Wright 2011).

Egyptian geese may also utilise nesting habitat of other waterbirds, including common shelduck *Tadorna tadorna* and mallard (Baccetti 2017). The propensity of Egyptian geese to nest in holes in trees puts it in competition with native hole-nesting bird species, which it is likely to out-compete due to its large size, aggressive nature, and early nesting habits (Wright 2011). Suitable sites for hole-nesting bird species are limited and a shortage of suitable nest sites is known to have an effect on many such species (Newton 1994). The presence of one dominant hole-nesting species can have detrimental effects on the populations of other hole-nesting species (Newton 1994). The effects of competition for nest-holes is not known but could affect native owls, common kestrel *Falco tinnunculus*, some duck species, and species such as stock dove *Columba oenas* and western Jackdaw (Wright 2011).

Egyptian geese have also been known to displace some species of bird of prey from their existing nests, including northern goshawks *Accipiter gentilis* and common buzzards *Buteo buteo*, possibly affecting their breeding success (Van Dijk 2000, Baccetti 2017). They have also been reported as displacing common kestrels from nest-boxes and using nest-boxes meant for peregrine falcons *Falco peregrinus* (Van Dijk 2000). In their native range, Egyptian geese have been reported negatively affecting the breeding success of black sparrowhawks *Accipiter melanoleucus* through nest usurpation (Curtis *et al*. 2007).

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

There is ***insufficient data*** (one study) to evaluate the strength of evidence for an impact of Egyptian geese on public health or public safety.

GL36: To kill or take certain species of wild birds to prevent serious damage.

Crops (n=7)

Size of Impact	2	0.0	42.9	0.0
	1	0.0	57.1	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

42.9% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for Egyptian geese causing serious damage to crops.*

In its native range in South Africa, Egyptian goose populations are growing, and the species is considered an agricultural pest, particularly in areas close to moult sites (Mangnall & Crowe 2001, Gyimesi & Lensink 2012, Bastiaansen 2013, Baccetti 2017). Egyptian geese in South Africa have caused significant damage to agricultural yields through eating young cereal shoots and seed crops and through the effects of trampling (Mangnall & Crowe 2001, Gyimesi & Lensink 2012). Barley and wheat appear to be the preferred crops, in that order, and crop yields have been reduced by up to 60% in places (Magnall & Crowe 2001). The winter foraging areas of non-native Egyptian geese in Europe include agricultural fields, but there is no information available on crop damage (Gyimesi & Lensink 2012, Baccetti 2017).

Livestock (animal disease) (n=5)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*Overall, there is **medium** strength of evidence for Egyptian geese causing serious damage to livestock through animal disease. However, this relates to the evidence for Egyptian geese carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

The Egyptian goose is a potential vector for Avian Influenza (AI) (Baccetti 2017). Experimentally infected Egyptian geese shed avian influenza viruses, suggesting they may play a role in transmission (Burger *et al*. 2012). There is some suggestion that Egyptian geese may have spread AI to Ostrich farms in their native South Africa, where, amongst other factors, increased risk of seropositivity in ostriches was associated with increasing frequency of contact of ostriches with certain wild bird species: white storks *Ciconia ciconia*, gulls *Larus* spp., and Egyptian geese (Thompson *et al*. 2008).

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Monk Parakeet (*Myiopsitta monachus)*

First recorded breeding in the UK in 1993, it was recorded in four hectads in the most recent Atlas (Figure 4.10), though breeding has only been confirmed in two. In 2008, the feral population in England was estimated at *c*.100 birds in three areas of London - having been present in the wild since at least 1992 (Parrott 2013). Further transient colonies have previously existed in locations elsewhere in England (outside of London). In January 2010 Natural England (NE) added the monk parakeet to three General Licenses enabling landowners/occupiers to carry out control activities that would otherwise be unlawful under the Wildlife and Countryside Act 1981. This measure may have helped address individual local issues but did not amount to a strategic approach and therefore did not address potential further establishment and expansion of the population. In February 2011, a ministerial approved eradication was initiated, following which the species has been reduced to one known remaining breeding population of around 25 birds.

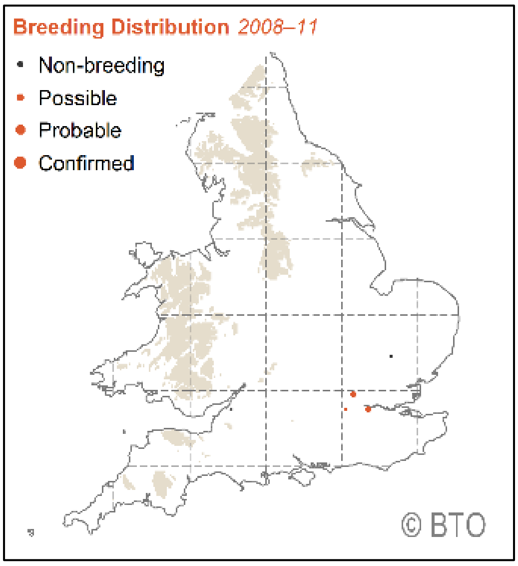

Figure 4.10: Monk parakeet breeding distribution 2008-11 (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=5)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*Overall, there is **medium** strength of evidence for an impact of monk parakeet on the **conservation of wild birds**.*

Reviews (Menchetti & Mori 2014) and risk assessments (GBNNSS, Stafford 2003) have reported that monk parakeets may have negative effects on native birds due to competition for food, and can carry Newcastle disease, which could potentially be passed on to native birds.

Conservation of wild flora (n=3)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.
These studies all referred to tree damage.

*However, as there were only three studies, there is **insufficient data** to evaluate the strength of evidence for the impact of monk parakeets on wild flora.*

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (spread of disease) (n=2)

Size of Impact	2	0.0	0.0	0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*As there were only two studies, however, there is **insufficient data** to evaluate the strength of evidence for the impact of monk parakeets on human health.*

Public safety (nest building) (n=6)

Size of Impact	2	0.0	66.7	0.0
	1	0.0	33.3	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

66.7% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium-high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for an impact of monk parakeet on infrastructure and public safety through **nest building** activities.*

All studies referred to damage to electrical infrastructure (short circuits and power cuts) in the USA and associated repair and maintenance costs caused through the monk parakeet's nest-building behaviour (Avery *et al*. 2002, 2006). An economic analysis of damage to electric utility structures in south Florida estimated nest removal costs of $415 to $1,500 per nest (Hodges & Newman 2002 cited in Avery *et al*. 2008). Electrical transmission structures are not the same design in England.

GL36: To kill or take certain species of wild birds to prevent serious damage.

Fruit (n=9)

Size of Impact	2	0.0	44.4	0.0
	1	0.0	55.6	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

44.4% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium-high*** *strength of evidence for an impact of monk parakeet causing serious damage to fruit.*

Crops (n=7)

Size of Impact	2	0.0	42.9	0.0
	1	0.0	57.1	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

42.9% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium-high*** *strength of evidence for an impact of monk parakeet causing serious damage to crops.*

Mott (1973) reports that the monk parakeet is regarded as a serious agricultural pest in South America. In Uruguay, in the Paysandu-Mercedes area, they are reported to do extensive damage to sunflowers, and also to damage corn. Although they sometimes feed in wheat, barley and sorghum, most damage to these crops is caused by other species. Monk parakeets also damage apples and other fruit (pears, peaches and grapes) in areas near Montevideo. In Argentina, monk parakeets have been blamed for 2-15% of crop losses, mostly corn and sunflower, with the occasional reporting of a 45% loss (Niedermyer & Hickey 1977 cited in Stafford 2003). In Europe, crop losses of up to 37% have been recorded, mostly from the outskirts of Barcelona, Spain (Senar *et al*. 2016). In the United States, although feral monk parakeets have been widely established since the early 1970s, there have been relatively few reports of damage to crops. Where damage occurs, however, it can be locally significant, such as in commercial, high-value tropical fruit orchards in south Florida (Tillman *et al*. 2000). In Connecticut, there have been reports of parakeet damage to sweetcorn (Avery *et al*. 2006).

Livestock (animal disease) (n=4)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*However, this relates to the evidence for monk parakeets carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission. As there were only four studies, however, there is **insufficient data** to evaluate the strength of evidence for an impact of monk parakeets on livestock.*

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Ring-necked Parakeet (*Psittacula krameri*)

Following escapes and releases over many decades, this parrot, native to Africa and southern Asia, began breeding annually in the UK in 1969. Its population slowly increased to an estimated 500 birds in 1983, 1500 birds by 1996 and an estimated 5800 birds by 2001. BBS (1994-2018) data indicate more than a tenfold increase since 1995 (Figure 4.11). With England supporting almost the entirety of the British population the latest population estimate identifies a further quadrupling of the 2001 population to 12,000 pairs (Woodward *et al*. 2020).

Population modelling in the early 2000s revealed that while populations in Greater London initially increased by approximately 30% per year, and those in Thanet by 15% per year, the range initially only expanded by 0.4 km per year in the Greater London area and hardly at all in Thanet (Butler, 2003). Ring-necked parakeet (RNP) remains a relatively localised species in England with the bulk of the population located in the Greater London area and the Isle of Thanet, Kent (Butler *et al*. 2013). Within London, the breeding distribution has expanded from two hectads in the first atlas period to now occupy every hectad within the M25 and is consolidating its range in the surrounding areas. The population on the Isle of Thanet is now well established. By the third atlas it was recorded in 89 hectads including a wide scatter of areas away from its two established cores, and in some colonisation appears to be occurring (Balmer *et al*. 2013). The current population is estimated to be around 30,000 birds (Peck 2013) in the South-east of England.

The current national population estimate, however, does not take into account satellite populations which have been emerging across the UK. With the expansion in numbers of the greater London population that has been observed over the last 40 years, it seems likely that established satellite populations could follow the same trend, especially as it has been shown that the UK has ample suitable habitat for the RNP (Strubbe *et al*. 2015). A least thirteen English counties hold probable breeding populations, from Plymouth in the south to Newcastle in the North; with numbers in different colonies ranging from <5 birds to >150 birds(APHA 2018).

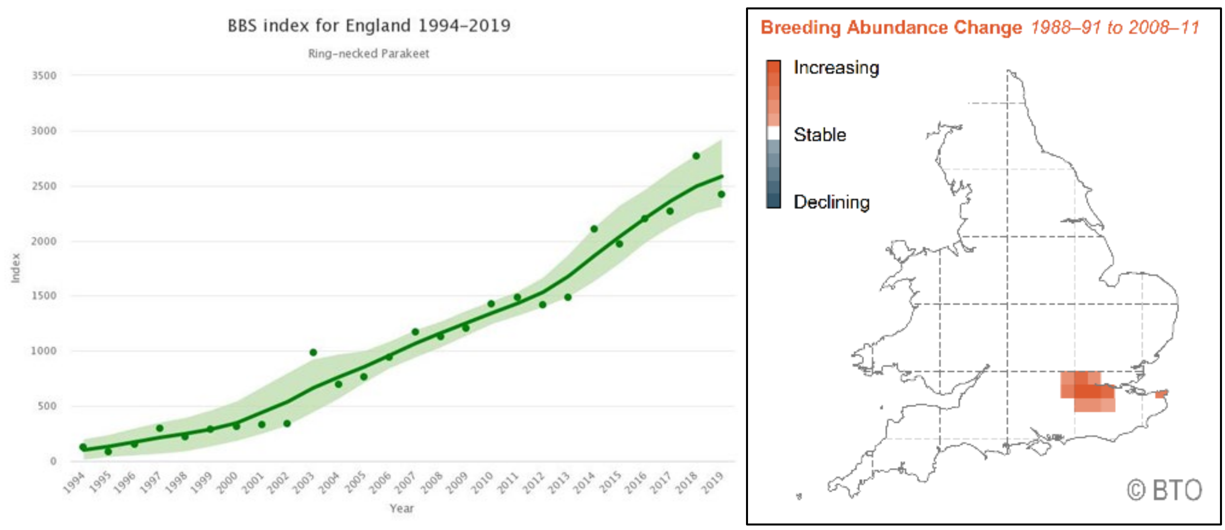

Figure 4.11 Ring-necked parakeet: (Left) Smoothed trend and 85% confidence interval (with annual indices also plotted) for breeding abundance in England 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS https://www.bto.org/our-science/projects/bbs/latest-results); (Right) Summary of relative changes in breeding abundance 1988-91 to 2008-11 (Bird Atlas) (*after Balmer et al. 2013*).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=15)

Size of Impact	2	0.0	6.7	6.7
	1	0.0	40.0	33.3
	0	0.0	6.7	6.7
		0	1	2
		Scientific Rigour		

46.7% of studies were of medium-high scientific rigour and presented medium-high impact.
13.3% of studies were of medium-high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for an impact of ring-necked parakeet on the **conservation of wild birds**. This is largely due to competition for nest sites with native cavity-nesting birds.*

The ring-necked parakeet is a secondary cavity nester, occupying cavities that are either naturally formed or have been excavated by other species. It is also able to modify smaller cavities meaning that it has the potential to be in direct competition with a variety of smaller bird species, not just larger birds which require similar sized cavities (Hernández-Brito *et al*. 2014). In a recent 10-year study, the species was shown to have seriously detrimental impacts on the native Eurasian hoopoe, *Upupa epops* (Yosef *et al*. 2016). Studies in Belgium found a negative correlation between the abundance of ring-necked parakeets and nuthatches *Sitta europaea* (Strubbe & Matthysen 2007, 2009). Nest cavities are a declining resource in the UK, with the removal of older trees and buildings which can be a limiting factor in the populations of species which utilise these places to breed (Newton 1994, Strubbe & Matthysen 2007). Parakeets commence breeding earlier than native species, sometimes as early as January, and in addition have a relatively long incubation period (c.2.5 months from laying to fledging, Cramp 1985). On top of their aggressive nature, this gives them an advantage over native species; a 13-year study showed them outcompeting the Eurasian scops owl *Otus scops* for nest cavities for this reason (Mori *et al*. 2017).

In the UK, studies have provided no current evidence for a significant impact through competition on a range of cavity-nesting species within the RNP's current range. A study in London parklands demonstrated the potential for nest site competition as RNPs favour similar types of cavity to some native species but occupy them significantly earlier (Central Science Laboratory 2010). Actual competition, however, was mitigated due to the super-abundance of nest cavities. Also, the possibility cannot be excluded that competitive exclusion could be occurring at alternative sites at which the availability of nest cavities is limiting (Newson *et al*. 2011). A recent study has shown that RNP do have an effect on the foraging behaviour of native birds at bird feeders. Feeding rates were reduced significantly while RNP were present, and vigilance was increased. This effect was more pronounced than that caused by another dominant native bird, the great spotted woodpecker *Dendrocopus major* (Peck *et al*. 2014).

Conservation of wild fauna (n=5)

Size of Impact	2	0.0	0.0	20.0
	1	0.0	80.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

20.0% of studies were of high scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***medium-high*** *strength of evidence for an impact of ring-necked parakeet on the* ***conservation of wild fauna****. This is largely due to competition for cavities and aggressive attacks on bats.*

In Spain, RNPs are having negative impacts on the greater noctule bat *Nyctalus lasiopterus* with which it directly competes for nest cavities (Hernández-Brito *et al*. 2014). In Italy, there has also been an observed fatal attack by RNP on a Leisler's bat *Nyctalus leisleri* (Menchetti *et al*. 2014). RNPs also compete with a range of other cavity-nesting mammals, such as dormice, squirrels, as well as honey bees *Apis mellifera* (Menchetti *et al*. 2016). In Spain, numerous observations of RNPs attacking black rats *Rattus rattus* (killing them 9.5% of the time) (Hernandez-Brito *et al*. 2014) suggest potential impacts on native small mammals.

Flora (n=1)
There was one study on the conservation of wild flora which referred to tree damage. However, there is ***insufficient data*** to evaluate the strength of evidence for an impact of ring-necked parakeets on wild flora.

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=3)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

This relates to the evidence for ring-necked parakeets carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an ***evidence gap*** *as few studies have attempted to quantify either the risk or actual rates of transmission. As there were only three studies, however, there is* ***insufficient data*** *to evaluate the strength of evidence for an impact of ring-necked parakeets on humans.*

GL36: To kill or take certain species of wild birds to prevent serious damage.

Crops (n=11)

Size of Impact				
Size of Impact	2	0.0	63.6	0.0
	1	0.0	36.4	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

63.6% of studies were of medium scientific rigour and presented high impact.
0.0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for ring-necked parakeets causing serious damage to crops.*

Fruit (n=8)

Size of Impact	2	0.0	75.0	0.0
	1	0.0	25.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

75.0% of studies were of medium scientific rigour and presented high impact.
0.0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **high-medium** strength of evidence for ring-necked parakeets causing serious damage to fruit.*

RNPs are considered a serious crop pest in their native range (Dhindsa & Saini 1994, Patel 2011, Ahmad *et al*. 2011). Research in its native range in Asia showed that 12% of maize crop was lost (Ramzan & Toor 1973) and 22% of sunflower seeds were taken (Toor & Ramzan 1974) from experimental plots. In Italy, ring-necked parakeets caused significant damage to almond orchards with about 30% of fruits damaged (Mentil *et al.* 2018). Menchetti and Mori (2016) report damage to crops and fruit in its native India, with losses of up to 81% for corn and up to 74% for sorghum. There is some evidence of detrimental impacts in England with increasing reports of crop damage, most notably from fruit growers and vineyards in SE England (FERA 2009).

Livestock (animal disease) (n=3)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100.0% of studies were of medium scientific rigour and presented high impact.

This relates to the evidence for ring-necked parakeets carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an evidence gap as few studies have attempted to quantify either the risk or actual rates of transmission. As there were only three studies, however, there is ***insufficient data*** *to evaluate the strength of evidence for an impact of ring-necked parakeets on livestock.*

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Sacred Ibis (*Threskiornis aethiopicus*)

The sacred ibis is not established in the UK. There are, however, occasional sightings, largely in southern and eastern England. Records are probably a mixture of escapes from zoos (known incidents) or private collections in the UK, and vagrants from the naturalized populations in western France and the Netherlands, however vagrancy from the naturalized populations in continental Europe has not been proven (Dudley 2005). The species has established breeding populations in Spain, Italy and France, as a result of escapes from captivity (Wright 2011). In France, birds are dispersing to northern Brittany and Normandy.

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=6)

Size of Impact	2	0.0	33.3	16.7
	1	0.0	50.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

50.0% of studies were of medium to high scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of sacred ibis on the **conservation of wild birds**.*

Sacred ibises are omnivorous, but largely predatory, feeding on a range of prey including the eggs and chicks of other bird species (Cramp and Simmons 1977, Kopij *et al*. 1996, Clergeau & Yésou 2006). In South Africa, where they are native, sacred ibis predation of eggs and chicks has been shown to be one of the most serious causes of mortality in seabird colonies (Williams & Ward 2006). Furthermore, in France, where there is an established population of introduced sacred ibises, they have been recorded to predate the eggs or chicks of a wide range of bird species including terns, egrets, ducks, seabirds and waders (Clergeau & Yésou 2006). In one incident, two sacred ibises were recorded to take all the eggs from a 30-nest sandwich tern *Sterna sandvicensis* colony in a few hours, causing the terns to desert the colony for the rest of the season, and similar incidents have been recorded with other tern species (Yésou & Clergeau 2005). They may outcompete native cattle egrets *Bubulcus ibis* and little egrets *Egretta garzetta* for nest sites (Yésou & Clergeau 2005).

Fauna n=2

Two studies reported the predation of frogs, crabs and newts, but there is ***insufficient data*** to evaluate the strength of evidence for an impact of sacred ibis on wild fauna.

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

There is ***insufficient data*** (1 study) to evaluate the strength of evidence for an impact of sacred ibis on public health or safety.

GL36: To kill or take certain species of wild birds to prevent serious damage.

There is ***insufficient data*** (1 study) to evaluate the strength of evidence for sacred ibis causing serious damage.

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Indian House Crow (*Corvus splendens*)

The Indian house crow is currently absent from the UK, but has established breeding colonies in c.20 tropical and sub-tropical countries outside its native range; sightings of solitary birds have been reported from a further 12 countries (Ottens & Ryall 2003).There is one record of successful captive breeding for Great Britain and Ireland (Cleeton 2001) - this is the only known reference to house crows in captivity in GB. Global spread has occurred through natural expansion, and by deliberate and accidental introductions. Deliberate introduction to a number of countries occurred for a variety of reasons, including for instance biocontrol and clean-up of refuse, while accidental introductions have been ship-assisted. There are also records of individual house crows from European countries – Netherlands, Denmark, France, Hungary, Ireland, Poland and Spain (Ryall 2002, Ottens & Ryall 2003). In some cases birds are known to have survived for a number of years, e.g. 5 years for the bird recorded in Ireland (Mullarney *et al*. 2000).

GL34: To kill or take certain species of wild birds to conserve wild birds and to conserve flora and fauna.

Conservation of wild birds (n=5)

Size of Impact	2	0.0	60.0	0.0
	1	0.0	40.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

60% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

Overall, there is ***high-medium*** *strength of evidence for an impact of Indian house crow on the* ***conservation of wild birds****.*

The Indian house crow is regarded as having a serious impact on other bird species through predation and harassment. It is a predator of eggs, chicks and adults of other bird species (Balasubramanian 1988, Cramp 1994, Ryall 1992, Puttoo & Archer 2003, Yap & Sodhi 2004). Ryall (1992) listed 13 species, in Mombassa, Kenya, which had been observed to be preyed upon. Colonial nesters, such as weavers, appear to be particularly vulnerable, although solitary nesters are also predated (Ryall 1992). Dramatic declines in the populations of further species have been associated with an increasing house crow population, although no direct reports of predation (Ryall 1992, Puttoo & Archer 2003, Daniels 2004). The house crow also displaces indigenous bird species through competition and aggression - Ryall (1992) listed 22 species that were harassed and mobbed. House crows are reported to have displaced other scavenger species from urban areas in a number of introduced countries, including the pied crow *Corvus albas* in Mombassa, Malindi and Zanzibar, the hooded crow *Corvus corone sardonius* in Suez, and black kites *Milvus migrans* in Mombassa, Dar es Salaam and Aden (reviewed in Ryall 1992).

GL35: To kill or take certain species of wild birds to preserve public health or public safety.

Public health (n=6)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*Overall, there is **medium** strength of evidence for an impact of Indian house crow on **public health**. However, this relates to the evidence for Indian house crow carrying pathogens common to humans; evidence for actual transmission of disease to humans is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission.*

Indian house crows are regarded as a public nuisance in a number of countries. The birds roost communally and can involve thousands of individuals (Cramp 1994). Such large roosts in urban areas create high levels of noise pollution and faecal contamination (Jennings 1992, Brook *et al*. 2003). Together with scavenging from refuse tips, streets and from human residences these behaviours present risks to public health. House crows have been shown to carry organisms detrimental to human health, including *Salmonella* and *Escherichia coli* (Jennings 1992), and that of livestock, including Newcastle Disease (Roy *et al.* 1998). The species is also a potential reservoir for West Nile Virus and avian influenza (Nyari *et al.* 2006). The house crow's scavenging habits and close association with man would facilitate disease transmission and poses potential health risks to humans and livestock via disease transmission (Roy *et al*. 1998, Puttoo & Archer 2003).

GL36: To kill or take certain species of wild birds to prevent serious damage.

Crops (n=6)

Size of Impact	2	0.0	33.3	0.0
	1	0.0	66.7	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

33.3% of studies were of high scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of Indian house crow on **crops**.*

The Indian house crow is regarded as a serious crop pest. It is reported to raid crops such as wheat and maize, and to cause severe damage to fruit in orchards (Long 1981), and to fields of oats and maize (Cramp 1994). Other crops damaged in India are ripening sunflower (Dhindsa *et al*. 1991) and almonds (Bhardwaj 1991). Also, in Pakistan, the house crow is regarded as a serious pest, consuming maize, sunflower and harvested wheat (Khan 2003). Similarly, in its introduced range it is reported to damage a variety of crops. In Egypt, it has been reported damaging a wide range of fruit and cereal crops (Kamel 2014).

Fruit (n=3)

Size of Impact	2	0.0	33.3	0.0
	1	0.0	66.7	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

33.3% of studies were of high scientific rigour and presented high impact.

However, as there are only three studies, there is ***insufficient data*** to evaluate the strength of evidence for an impact of Indian house crow on fruit.

Livestock (animal disease + predation) (n=7)

Size of Impact	2	0.0	14.3	0.0
	1	0.0	85.7	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

14.3% of studies were of medium scientific rigour and presented high impact.
0% of studies were of medium to high scientific rigour and presented nil/low impact.

*Overall, there is **medium-high** strength of evidence for an impact of Indian house crow on **livestock through animal disease and through predation**.*

In Mauritius, production of free range poultry was affected by predation on eggs and chicks (Puttoo & Archer 2003). House crows have been shown to carry organisms detrimental to human health, including *Salmonella* and *Escherichia coli* (Jennings 1992), and that of livestock, including Newcastle Disease (Roy *et al.* 1998, Fraser *et al*. 2015). The species is also a potential reservoir for West Nile Virus and avian influenza (Nyari *et al.* 2006, Kamel 2014).

Livestock (predation) (n=4)

Size of Impact	2	0.0	25.0	0.0
	1	0.0	75.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

25% of studies were of medium scientific rigour and presented high impact.

*However, there were only 4 studies, so there is **insufficient data** to evaluate the strength of evidence for an impact of Indian house crow on livestock through predation.*

Livestock (animal disease) (n=3)

Size of Impact	2	0.0	0.0	0.0
	1	0.0	100.0	0.0
	0	0.0	0.0	0.0
		0	1	2
		Scientific Rigour		

100% of studies were of medium scientific rigour and presented medium impact.

*This relates to the evidence for Indian house crow carrying pathogens common to livestock; evidence for actual transmission of disease to livestock is not shown. The latter reflects an **evidence gap** as few studies have attempted to quantify either the risk or actual rates of transmission. However, as there were only 3 studies, there is **insufficient data** to evaluate the strength of evidence for an impact of Indian house crow on livestock through animal disease.*

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5. Overview

Thirteen avian species were evaluated in respect to the strength of evidence of scientific literature for their inclusion under General Licences GL34-GL36 in England, which allow certain species to be killed or taken for various purposes.

The review of the scientific evidence for the inclusion of species on General Licence built on the existing reference database and methodology established by the British Trust for Ornithology (BTO) as part of their evaluation of the evidence base for inclusion of bird species listed on General Licences in Scotland.

Each of the scientific documents was evaluated according to two criteria – *size of impact* (low, medium, high) and *scientific rigour* (low, medium, high) for the relevant General Licence species-purpose.

In the current General License species-purpose evaluation, the majority of the literature, particularly for conservation purposes (GL34) the interpretation of 'impact' has inherent uncertainties. In respect to predation, ultimately, an impact on the *conservation* of wild birds by a predator species would be manifest in a decrease in the breeding population of the prey species; following from a reduction in breeding success and/or recruitment of young into the population, or increased mortality of adults.

However, much of the literature reports associations between predator and prey in respect to relative abundance, predation events or predator diet. That is, much of the literature assesses, or infers, a proximate impact (predation) that may or may not translate into an ultimate impact on the breeding population or conservation status. In the evaluation of literature, three categories of proximate impact were used: 'High' - predation events of elevated magnitude on breeding success or abundance with the potential to affect local conservation status of the prey species; 'Medium' – predation events impacting at some level on the prey species (at least at the level of individual birds or breeding pairs) but likely at a level that does not have any subsequent effect on the breeding population or local conservation status; 'Low' – extremely low, or absence of, predation events.

Following the scoring of each study for impact and rigour, all the scores from all the individual documents for each species-purpose were synthesised into a *final summary score for strength of evidence*. Final synthesised scores ranged, in order of increasing strength of evidence: Low (L) < Low-Medium (L-M) < Medium-Low (M-L) < Medium (M) < Medium-High (M-H) < High-Medium (H-M) < High (H). The categories with the greatest strength of evidence to support a species-purpose were High, High-Medium and Medium-High.

Interpretation of the final summary scores for strength of evidence are detailed in Tables 2.1 and 2.2 (page 10). For example, in respect to predation and wild bird conservation, for the latter three categories above (H, H-M, M-H) the strength of evidence is interpreted as, respectively, 'high likelihood', 'moderate likelihood' and 'some likelihood' that high predation occurs in some circumstances with an effect on breeding success and/or breeding numbers that has the potential to affect the local conservation status of the prey species. Whilst for M and M-L there is 'likely' and 'some likelihood' that some predation occurs in some circumstances with the level of predation having an effect on individual breeding pairs but unlikely at a level that has a subsequent effect on breeding numbers or the local conservation status of the breeding population. Categories L-M and L represent 'very unlikely' and 'negligible likelihood' that predation occurs.

For ***GL34 (conservation – wild birds)*** species with the greatest strength of evidence were:
– High-Medium: carrion/hooded crow, ring-necked parakeet (competition), Indian house crow.
– Medium-High: jay, magpie, Egyptian goose (competition), sacred ibis.

In respect to the ***UK conservation status of prey species***, the greatest strength of evidence for an effect by native corvid species is summarised in Table 5.1:

– Red-listed species: crow (High-Medium) and jay (High-Medium).
– Amber-listed: crow (Medium-High), *rook (M-H)* and *jay (H)*.
– Green-listed: jay (High-Medium).

Of these, it should be noted that all of the species impacted by jay were songbirds that nest in woodland or semi-woodland habitat (apart from yellowhammer - a farmland specialist in the UK but which occupied fragmented woodland in the Czech Republic in the relevant study in this review). The sample size for amber-listed species involved only one interaction and is, therefore, too low to be meaningful on its own. However, in the larger sample of red-listed species, studies showed high strength of evidence for an effect on blackcap, spotted-flycatcher and wood warbler.

For rook, the sample size involved only two interactions with amber-listed species and was too low to be meaningful. The Medium-High strength of evidence is solely influenced by an incident of predation at a little tern colony.

Table 5.1: The number of different prey species, the number of predatory interactions between those prey species and native corvid species and the strength of evidence to support the species-purpose relative to the prey species conservation status.

	Red			Amber			Green		
Species	**No. Spp**	**No. interact.**	**Strength of evidence**	**No. Spp**	**No. interact.**	**Strength of evidence**	**No. Spp**	**No. interact.**	**Strength of evidence**
Crow	15	62	H-M	18	34	M-H	11	27	M-L
Jackdaw	7	8	L-M	2	2	M	1	1	*(L)* [a]
Jay	7	13	H-M	1	1	*(H)* [a]	7	11	H-M
Magpie	9	18	M	5	6	L	15	31	L-M
Rook	3	5	M	1	2	*(M-H)* [a]	0	0	no data

[a] Sample size is too small (≤2) to be able to draw a meaningful

For ***GL34 (conservation – fauna)*** species with the greatest strength of evidence were:
– Medium-High: ring-necked parakeet (competition with other cavity-nesting species, especially bats).

For ***GL34 (conservation – flora)*** species with the greatest strength of evidence were:

– Medium-High: Canada goose (damage to bankside vegetation, such as reedbeds).

For ***GL35 (public health and safety)*** species with the greatest strength of evidence were:
– High-Medium: monk parakeet (public safety - nesting behaviour)
– Medium-High: magpie and feral pigeon (public health – spread of disease).
– Medium: jackdaw (public health – spread of disease)

Scientific studies relating to GL35 (public health) very largely relate to avian species listed on General Licence carrying pathogens common to humans. However, evidence of actual transmission to humans is rare (a few cases for feral pigeon, and a single historical case involving jackdaw and magpie). This is also the case for GL36 (serious damage), where one of the potential impacts on livestock is through the transmission of disease. Similarly, the large majority of studies relate to avian species carrying pathogens common to livestock, but evidence of actual transmission to livestock is rare (historical cases of feral pigeon and Newcastle Disease). The issue of actual transmission of disease to humans or livestock represents and evidence gap as few studies have attempted to quantify either the risk or actual rates of transmission.

For ***GL36 (serious damage)*** species with the greatest strength of evidence were:
– High: Canada goose (crops)
– High-Medium: ring-necked parakeet (crops and fruit)
– Medium-High: rook (crops), feral pigeon (livestock, livestock foodstuffs and crops), woodpigeon (crops and vegetables), Egyptian goose (crops), monk parakeet (crops and fruit), Indian house crow (livestock and crops).

Five of the species on General Licence increased their national breeding abundance by >25% over the period 1995-2018: two invasive non-native species (INNS) – Canada goose (+65%) and ring-necked parakeet (+1777%); and three native species – woodpigeon (+37%), carrion crow (+29%) and jackdaw (+79%). Egyptian goose (an INNS) increased by 60% over the more recent 2008-18 period.

Amongst corvids, carrion crow and jackdaw significantly increased their national breeding abundance by 29% and 79% respectively over the 23-year period 1995-2018. Regionally, both jackdaw and carrion crow showed significant population increases of >25%: carrion crow in five of the nine BBS regions; jackdaw increased in seven of the nine regions (>50% in six). Magpie showed greater variation in regional changes: increases (>25%) in three regions (significant in two) but downward trends (although <25%) in five regions (significant in two). Rook showed downward trends >25% in four regions (significant in three); and a significant decrease nationally of -14%.

Feral pigeon and woodpigeon showed opposite trends, with feral pigeon exhibiting a significant decrease (-29%) nationally and woodpigeon a significant increase (+37%). Feral pigeon exhibited downward trends in eight of the nine BBS regions (-15% to -50%); statistically significant in three regions. Woodpigeon showed upward trends in all nine BBS regions (+21% to +91%); statistically significant in eight regions (>25% in six regions).

In terms of conservation status, all native species are categorised as green-listed species.

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Appendix 1: National and Regional Population Status

All data reproduced from the BTO/JNCC/RSPB Breeding Bird Survey (BBS)
https://www.bto.org/our-science/projects/bbs/latest-results

Harris SJ, Massimino D, Balmer DE, Eaton MA, Noble DG, Pearce-Higgins JW, Woodcock P & Gillings S. 2020. The Breeding Bird Survey 2019. BTO Research Report 726. British Trust for Ornithology, Thetford. https://www.bto.org/our-science/publications/breeding-bird-survey-report/breeding-bird-survey-2019

Massimino, D., Woodward, I.D., Hammond, M.J., Harris, S.J., Leech, D.I., Noble, D.G., Walker, R.H., Barimore, C., Dadam, D., Eglington, S.M., Marchant, J.H., Sullivan, M.J.P., Baillie, S.R. & Robinson, R.A. (2019) *BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds*. Research Report 722. BTO, Thetford. www.bto.org/birdtrends

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Table 1. Key for English regions used in graphs.

Region	**Counties**
North West England	Cheshire, Cumbria, Lancashire, Greater Manchester, Merseyside
North East England	Cleveland, County Durham, Northumberland
Yorkshire and Humber	East Yorkshire, North Lincolnshire, North Yorkshire, South Yorkshire, West Yorkshire
East Midlands	Derbyshire, Northamptonshire, Leicestershire & Rutland, Lincolnshire, Nottinghamshire
East England	Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk, Suffolk
West Midlands	Birmingham, Herefordshire, Shropshire, Staffordshire, Warwickshire, Worcestershire
South East England	Berkshire, Buckinghamshire, Hampshire, Isle of Wight, Kent, Oxfordshire, Surrey, Sussex
South West England	Avon, Cornwall, Devon, Dorset, Gloucestershire, Somerset, Wiltshire
London	Greater London

Carrion Crow

Carrion crow occurs in the breeding season across all of England and is consistently one of the most widespread species in England, being found in almost all 10km squares in all three national atlases. Variations in range relate to occupation of individual 10km squares and show no regional patterns (Fig. 1, Left). Breeding range has remained the same since 1991; with London and the South East, West Midlands and the North West and North East (except uplands) being strongholds (Fig. 1, Middle). The non-breeding distribution reflects that of the breeding season.

Carrion crows increased in population consistently since the 1960s (Gregory & Marchant 1996) and reached a plateau around the turn of the century. Since then the BBS (1994-2019) has recorded ongoing steady increase in England (Fig. 2, Top) in comparison to stability or minor decrease in Scotland and a fluctuating trend in Wales. All English regions except the North East have seen increases in populations, the largest occurring in the North West, Yorkshire & Humberside, East England and London, with more modest and patchy increases in the other English regions (Fig. 1 Right and Fig. 2). The current GB population estimate is 1,050,000 territories (Woodward *et al*. 2020).

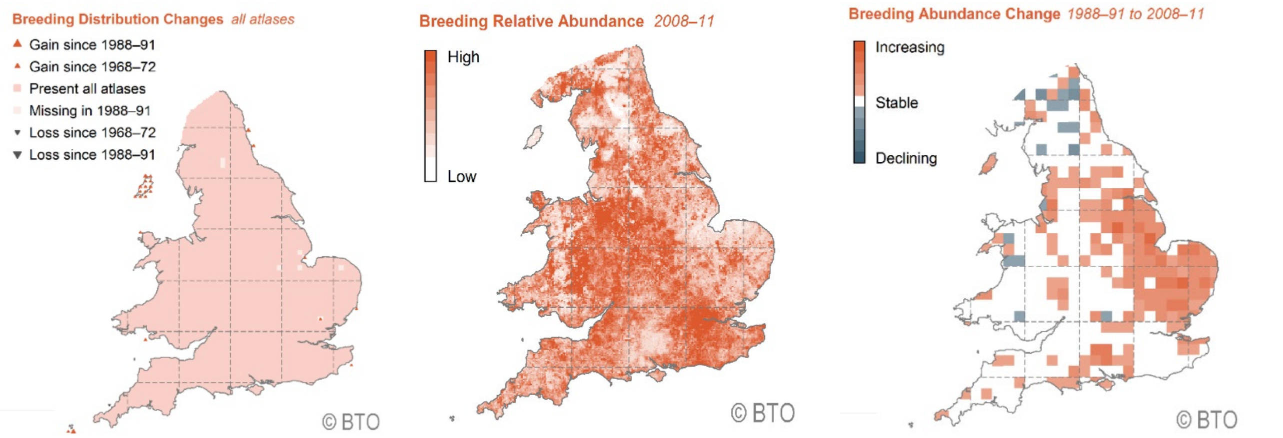

Figure 1. Carrion crow: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

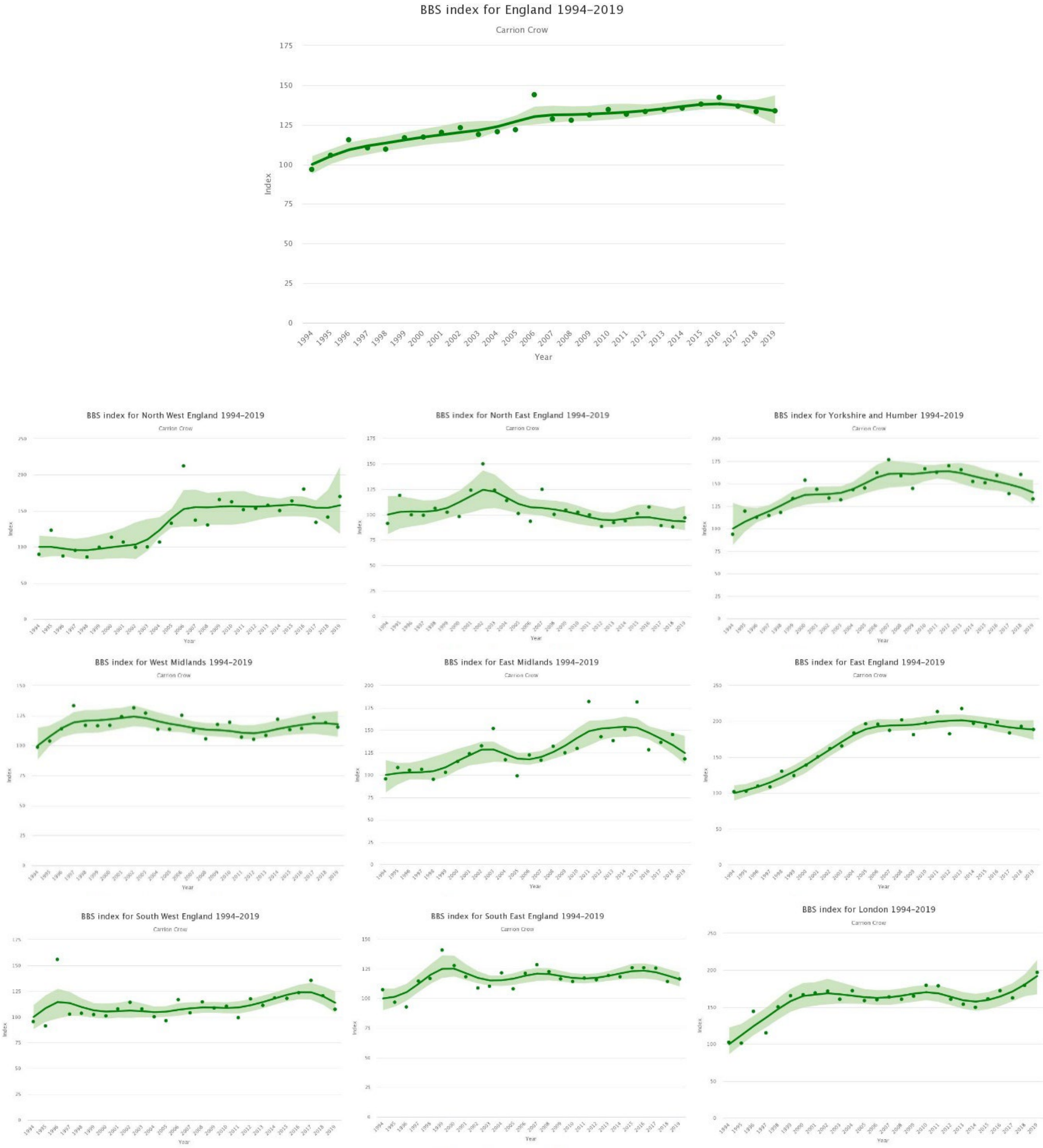

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for carrion crow breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Jackdaw

Jackdaw is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases, with variations in range relating to occupation of individual 10km squares and showing no regional patterns (Fig. 1, Left). Breeding range has remained the same since 1991; with the Midlands and West and North being strongholds, and abundance is lowest in the uplands and the major conurbations (Fig. 1, Middle). Changes in abundance have been associated with improvements in breeding performance, probably due to increased food availability. The non-breeding distribution reflects that of the breeding season.

Jackdaw has increased in abundance since the 1960s (Gregory & Marchant 1996), and more recent BBS (1994-2019) data suggest that the increase is continuing in all UK countries apart from Wales where the BBS trend is stable. This increase has been fairly uniform across the English range (Fig. 2, Top), with greatest relative increases in breeding abundance in the East Midlands and East Anglia (Fig. 1 Right and Fig. 2). The current GB population estimate is 1,450,000 pairs (Woodward *et al*. 2020).

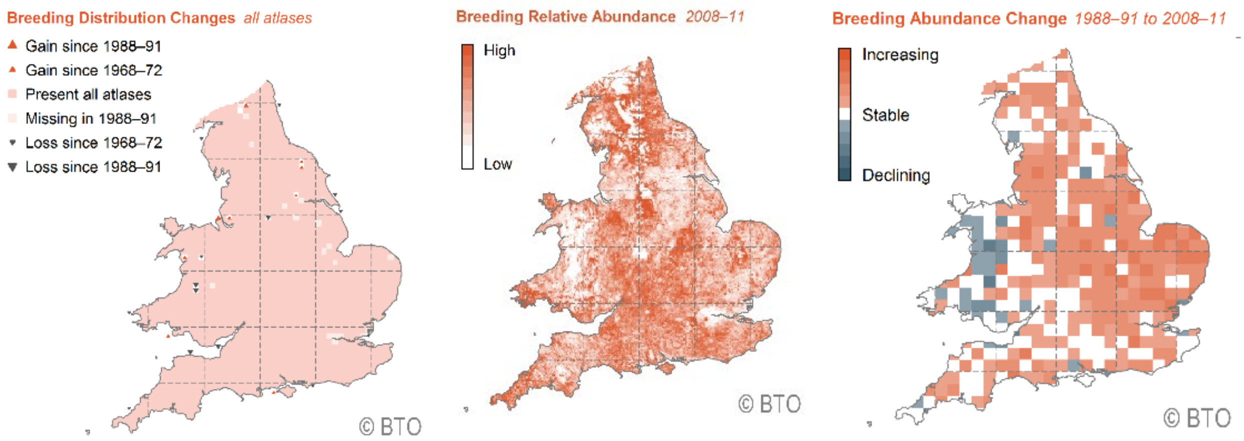

Figure 1. Jackdaw: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

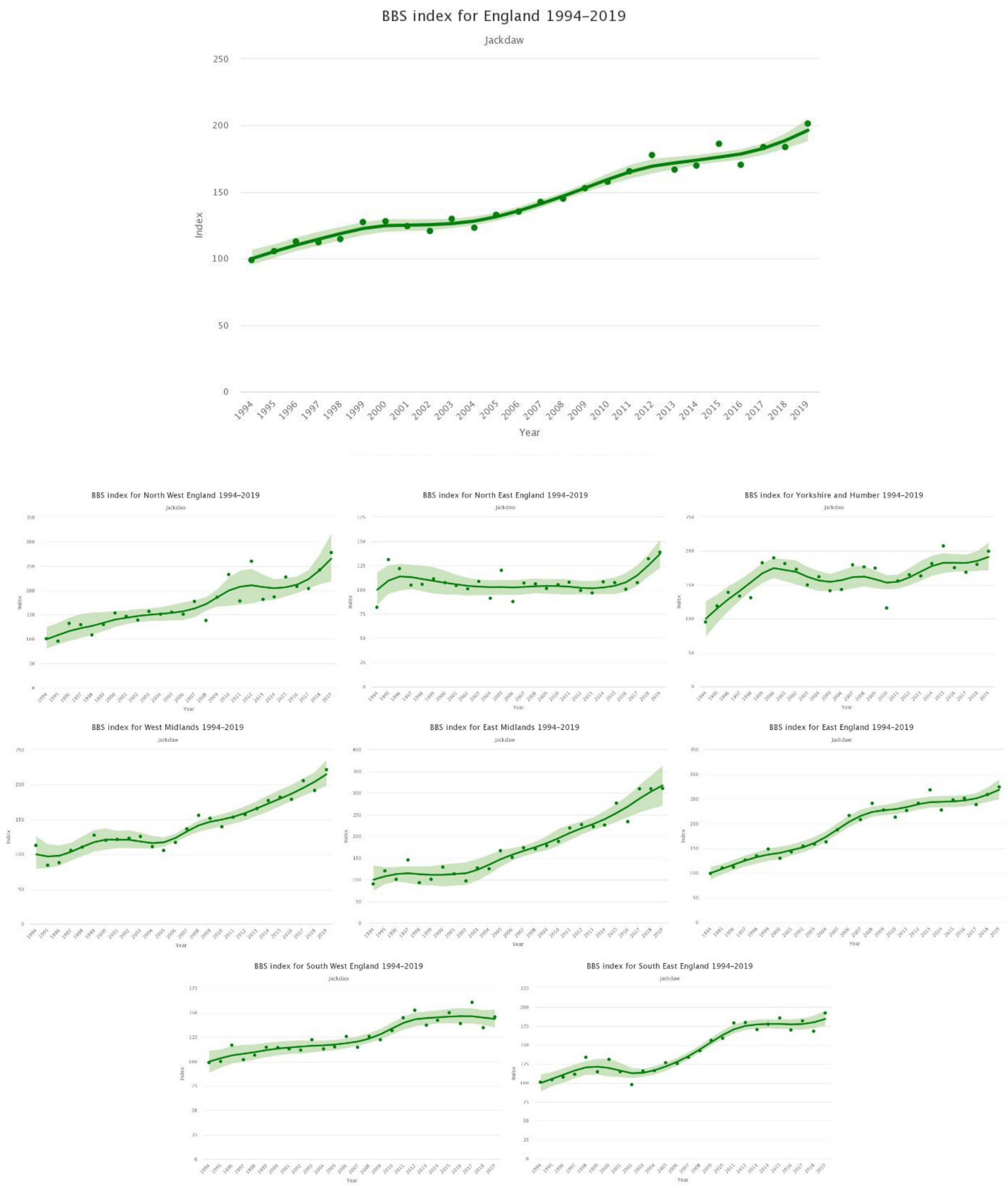

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 for 1994) for jackdaw breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Jay

Jay is consistently one of the most widespread species in England being widespread in all regions in all three national atlases (Fig. 1, Left). As a predominantly woodland species variations in range are likely to reflect changes in woodland cover and the main areas of range change are associated with areas such as the North Pennines and the East coast from Flamborough to the Fens of Lincolnshire and Norfolk where woodland cover, and jay abundance, is low (Fig. 1, Left and Middle). The non-breeding distribution reflects that of the breeding season.

The UK jay population remained stable in the species' preferred woodland habitat until the late 1980s, after which the population began to decline. This decrease followed an earlier decline on farmland CBC plots (Gregory & Marchant 1996). With the losses since the 1980s now regained, long-term trends (including in England) are stable overall (Fig. 2, Top). The BBS (1994-2019) indicates that there have been population abundance increases in the East Midlands and East Anglia, relatively stable populations in the North West and South West, with declines elsewhere (Fig. 1 Right and Fig. 2). The current GB population estimate is 165,000 territories (Woodward *et al*. 2020).

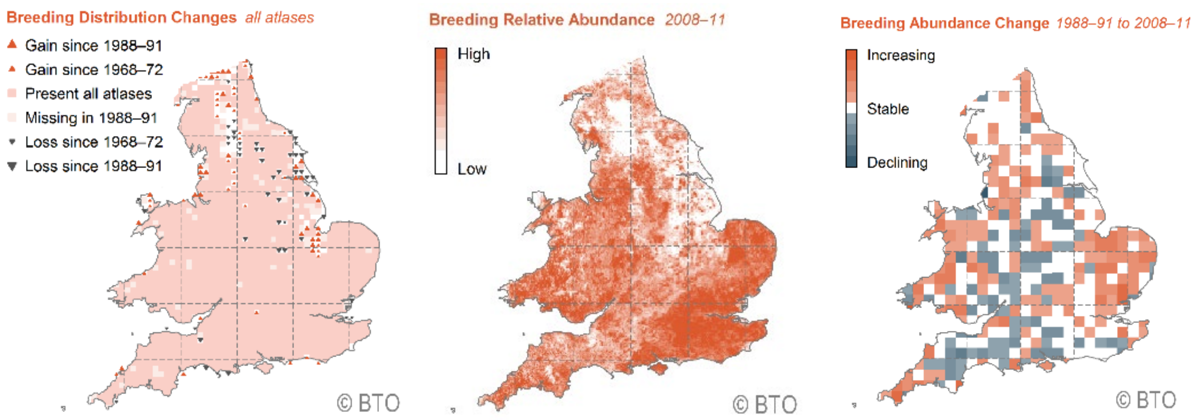

Figure 1. Jay: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for jay breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Magpie

Magpie occurs in the breeding season across all of England except North Pennines, and is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases (Fig. 1, Left). Breeding distribution has remained the same since 1991, with London and the South East, West Midlands and the North West and North East (except uplands) being strongholds (Fig. 1, Middle). Variations in range since the first atlas have primarily arisen from infilling of individual 10km squares in Kielder Forest, Northumberland, the North-East coast, and the westernmost fringes of East Anglia (Fig. 1, Left). The non-breeding distribution reflects that of the breeding season.

Magpie increased steadily until the late 1980s (Gregory & Marchant 1996), after which abundance stabilised (Fig. 2, Top). BBS (1994-2019) indicates that abundance increases have occurred in London, East Midlands and East Anglia, with decreases the other English regions (Fig. 1 Right and Fig. 2). The current GB population estimate is 550,000 territories (Woodward *et al*. 2020).

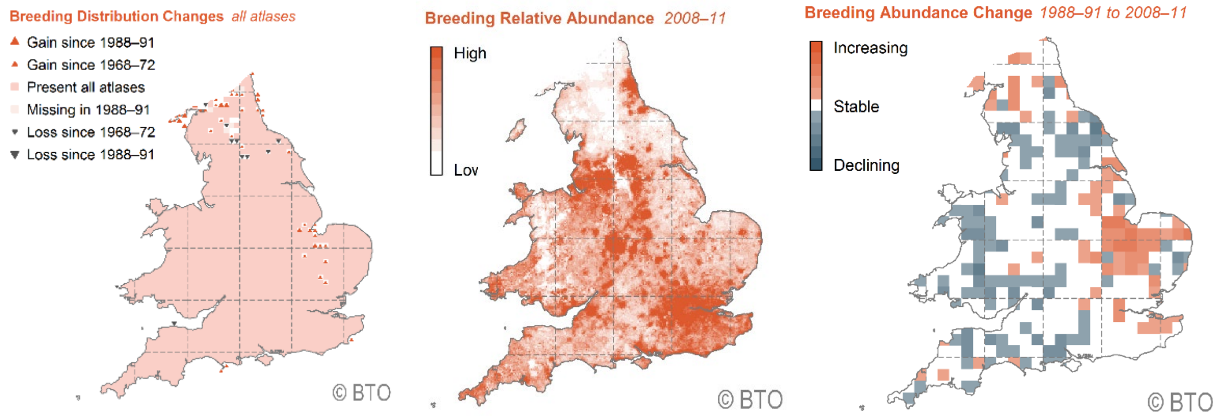

Figure 1. Magpie: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

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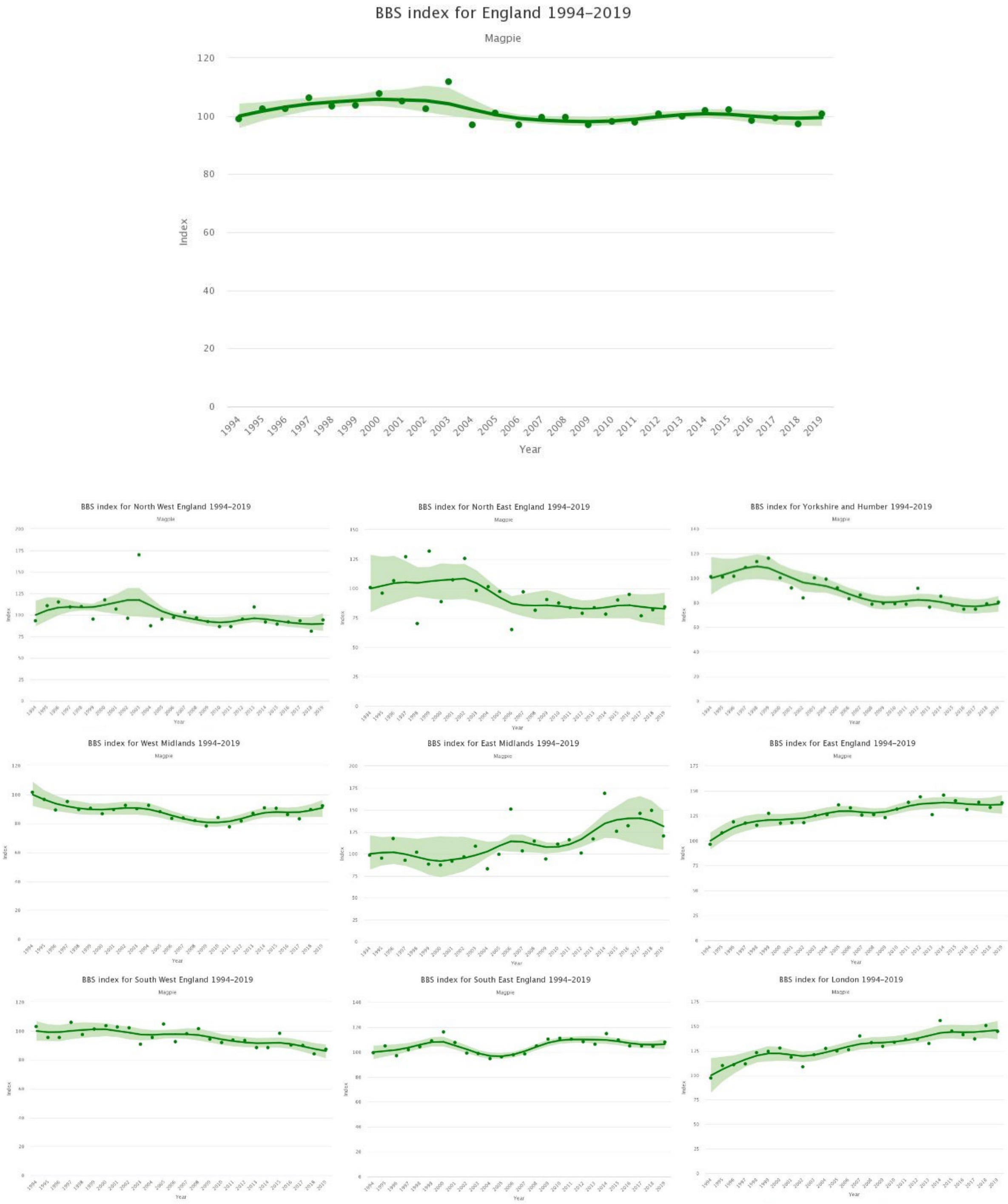

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for magpie breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Rook

Rook is consistently one of the most widespread species in England being found in almost all 10km squares in all three national atlases, with variations in range relating to occupation of individual 10km squares and showing no regional patterns. The only range gaps are in London, and Kielder Forest in Northumberland both areas that include extensive areas of unsuitable habitat (Fig. 1, Left and Middle). The non-breeding distribution reflects that of the breeding season.

Relatively few rookeries fell within Common Bird Census (CBC) plots, but an index calculated from the available CBC nest counts showed a shallow, long-term increase to the mid-1990s (Wilson *et al*. 1998). This was confirmed by the results of the most recent BTO rookeries survey, which identified a 40% increase in abundance between 1975 and 1996 (Gregory & Marchant 1996). This probably reflected the species' considerable adaptability in the face of agricultural change (Woodward *et al*. 2018). Since then, BBS (1994-2019) indicates there has been a decline in the English population, with declines at a regional scale in the North, South West and Yorkshire & Humberside. The current GB population estimate is approximately 885,000 breeding pairs (Woodward *et al*. 2020).

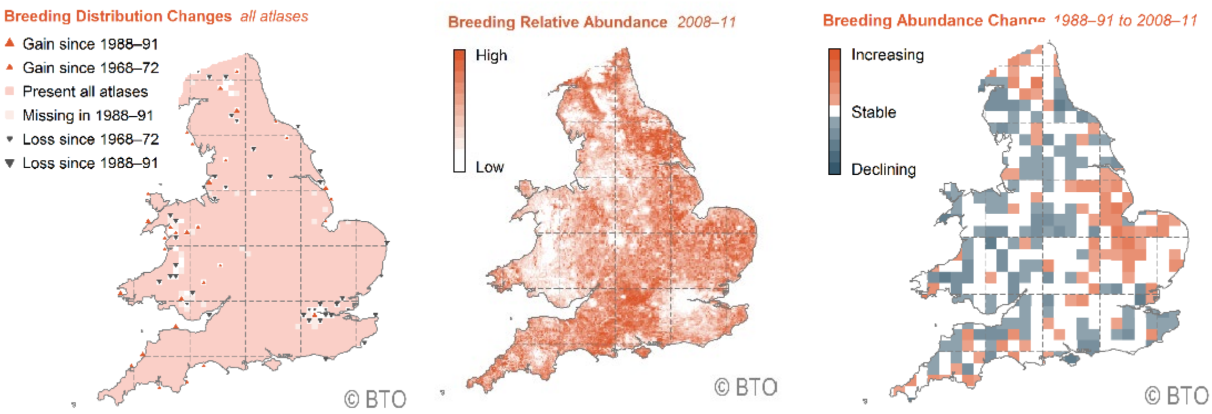

Figure 1. Rook: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. (2013).

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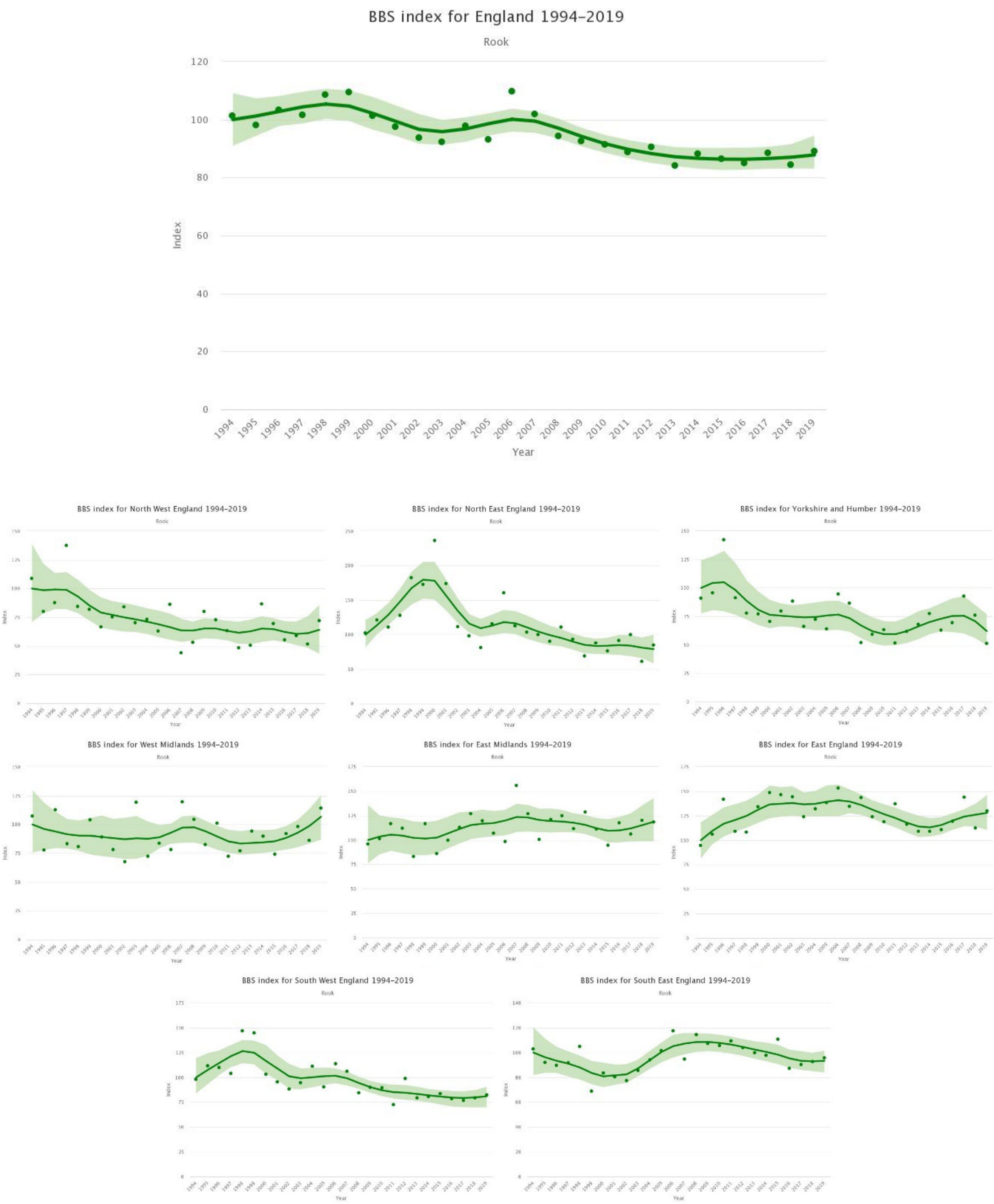

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for rook breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

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Feral Pigeon

At the time of the first atlas feral pigeons were more commonly overlooked during bird surveys, and some of the reported range increase may have been due to greater observer awareness. It is now clear that feral pigeons are almost ubiquitous in the UK, nesting in rural as well as their more traditional urban habitats, and avoiding only the highest ground (Fig. 1, Left). The highest densities however remain associated with urban areas.

CBC samples for feral pigeon were consistently too small for annual monitoring, and there was no trend information before BBS began in 1994. Breeding atlas data have shown a 39% increase in occupied 10-km squares between 1968-72 and 1988-91 (Gibbons *et al*. 1993) and a further 5% or so by 2008-11 (Balmer *et al*. 2013). However, BBS indices (1994-2019) suggest that there has been a moderate decline in numbers across England in recent years (Fig. 2). The current British population is estimated to be 460,000 pairs (Woodward *et al*. 2020).

No distinction can realistically be drawn between feral birds of domestic origin and true wild-type rock doves, although birds of wild-type plumage still predominate on some more-remote Scottish islands. In field conditions, it is often not possible to distinguish between pure native rock doves, wild-nesting feral pigeons, semi-captive dovecote breeders, and passing racing pigeons, nor between adults and young of the year, and BBS counts are likely to include birds from all of these groups.

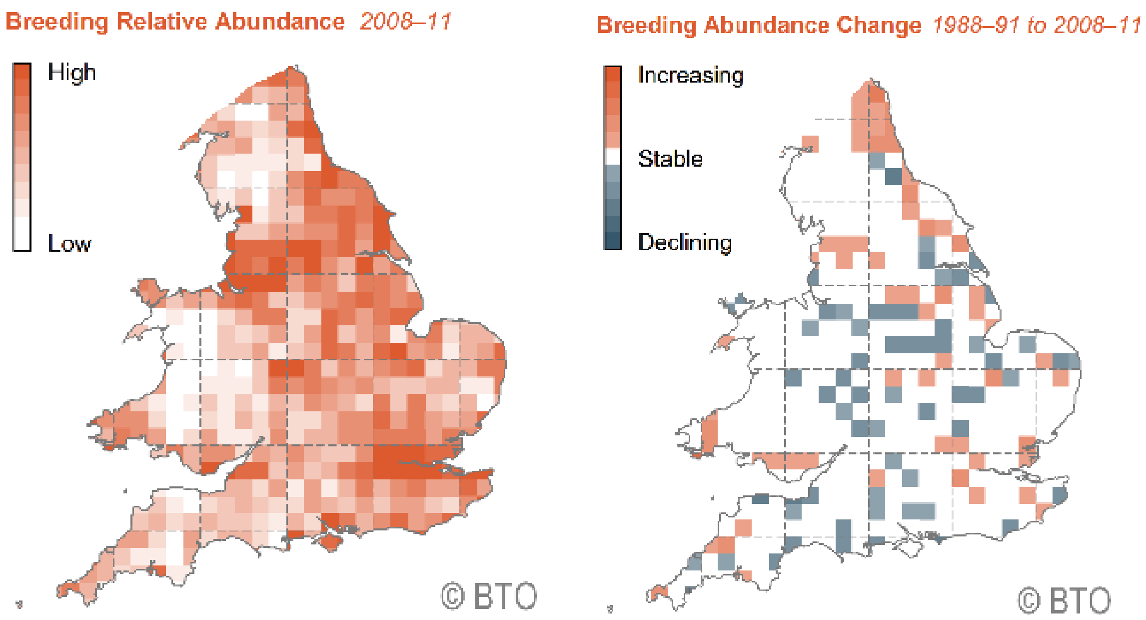

Figure 1. Feral pigeon: (Left) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for feral pigeon breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Woodpigeon

Bird Atlas data (Balmer *et al*. 2013) shows woodpigeon to be a widespread breeding species throughout England, occurring in almost all heptads in all three atlas periods (Fig. 1, Left). In the lowlands is it ubiquitous across both rural and urban landscapes, but is found at lower densities in the uplands of Northern England and the South West (Fig. 1, Middle). Winter distribution reflects that of the breeding season.

With an estimated population 5,050,000 pairs the woodpigeon is one of the commonest breeding birds in Britain, with England holding the majority of the population (Woodward *et al*. 2020). The CBC/BBS trend for this species is of a steady, steep increase in population abundance since at least the mid-1970s. Since 1994, BBS has recorded significantly upward trends in the UK, and in England, Wales and Northern Ireland separately, but stability in Scotland. This has only recently started to level off, with BBS showing a very shallow but statistically significant decline in England over the most recent five year period (Fig. 2, Top). Most English regions have mirrored the national abundance trend for increase and then stability (or even some decrease), except for the North West, South West, and East Midlands where there has been continued increase (Fig. 1 Right and Fig 2).

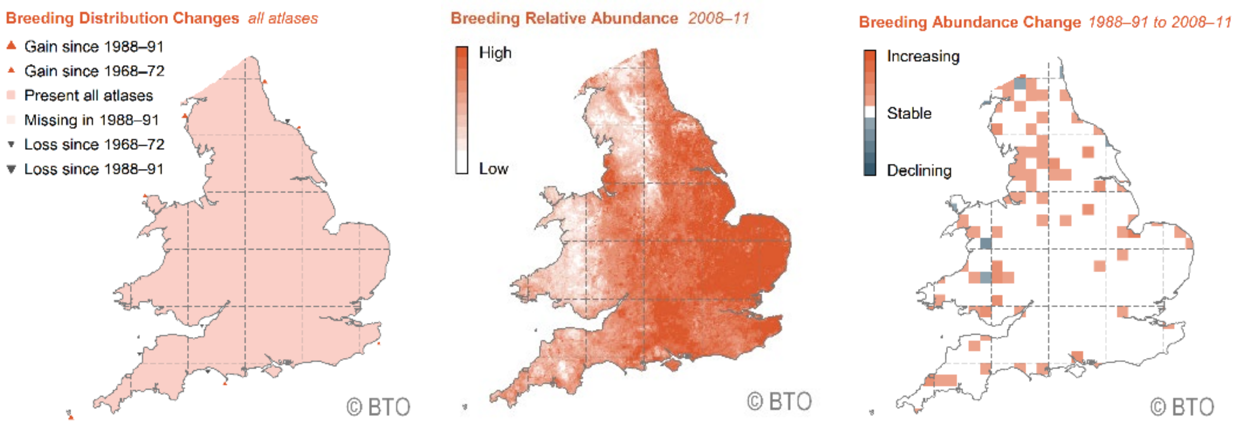

Figure 1. Woodpigeon: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

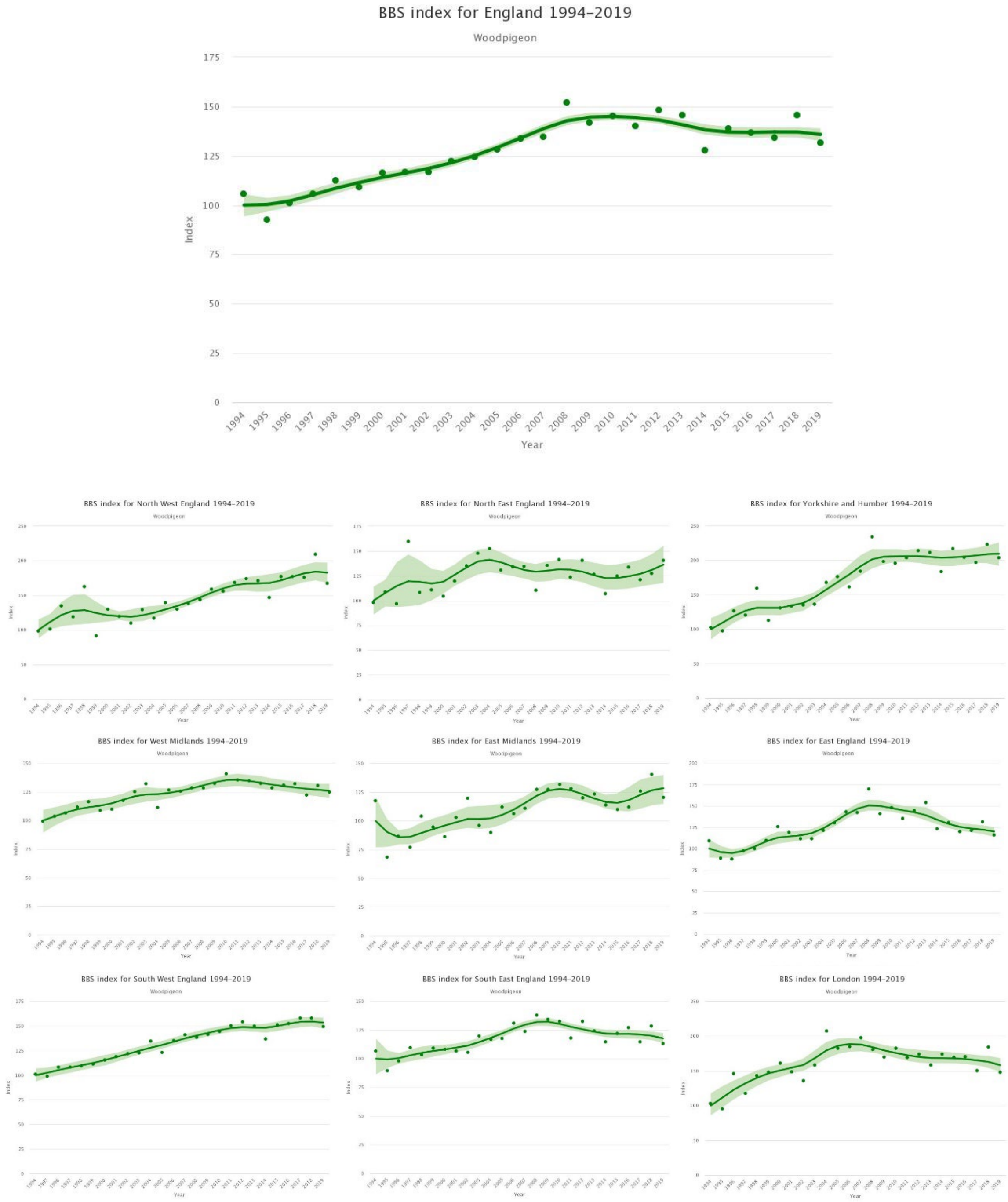

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for woodpigeon breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

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Canada Goose

Since the translocations in the middle of the last century, Canada goose has rapidly expanded in its range to the north and south west (Fig. 1, Left) until it is now present over much of England except the uplands and Fens (Fig. 1, Middle). It is one of the most widespread and abundant non-native bird species in England, and the commonest non-gamebird. It has more than doubled its range from its core in the South-east and Midlands at the time of the first atlas and is now found in over 85% of 10km squares across the country with an overall population estimated to be around 54,000 pairs.

Canada geese were first introduced to English parkland around 1665 but have expanded hugely in range and numbers following translocations in the 1950s and 1960s. Population abundance has since increased rapidly, at a rate estimated at 9.3% per annum in Britain between the 1988-91 Atlas period and 2000; with no sign of any slowing in the rate of increase (Austin *et al*. 2007). The WBS sample became large enough for annual monitoring in 1980, since when further, apparently exponential increase has occurred on linear waterways. Annual breeding-season monitoring in a wider range of habitats through BBS has shown similar strong increases in England and in the UK as a whole but with significant reversals over the last ten years (Fig 2, Top). Populations have increased in the North West, Yorkshire & Humber, South West and and South East, and remain relatively stable over the longer term in other areas (Fig. 1 Right and Fig. 2). The wintering distribution reflects that of the breeding season, with some dispersal from breeding grounds.

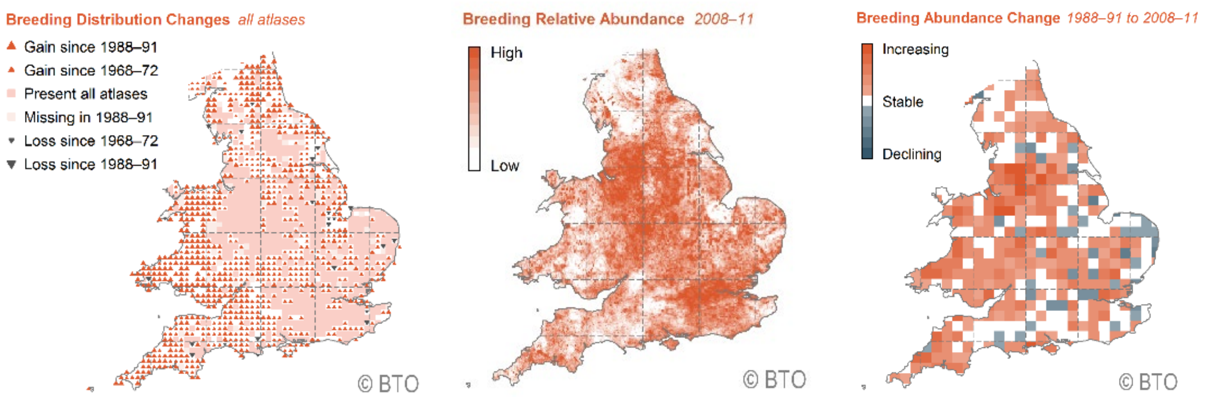

Figure 1. Canada goose: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for Canada goose breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) https://www.bto.org/our-science/projects/bbs/latest-results

Egyptian Goose

Egyptian goose was introduced to Britain from Africa in the seventeenth century and were widely distributed by the eighteenth and nineteenth century. By the 1990s, their range was however restricted to Norfolk (Sutherland & Allport, 1991). Since that period, the range of this species has again increased, with some colonisation of the East Midlands and a notable expansion in London and along the Thames valley (Fig. 1). In recent years it has become abundant enough for a national trend to be calculated, with a BBS increase of 73% in the most recent 10 year period. In 2018, using the latest available WeBS data (2015-16), modelling estimated a GB population of 6,095 for 2011-12 and projected estimates of 8,361 (+37%) for 2017-18 and 9,661 (+59%) at the end of December 2018 (APHA 2018).

At the time of the first atlas the Egyptian goose was found in just 18 hectads in England, but by the third atlas this had grown more than ten-fold to 231 hectads (Figure 1). The current population is estimated to be around 1850 pairs in Britain, which almost entirely accounted for by England. Range expansion since the first atlas has focused on the consolidation and expansion of the East Anglian core range twinned with the colonisation of the Thames Valley and subsequent expansion in this area. The range continues to expand steadily from these two centers, but away from these cores it currently remains a localized species.

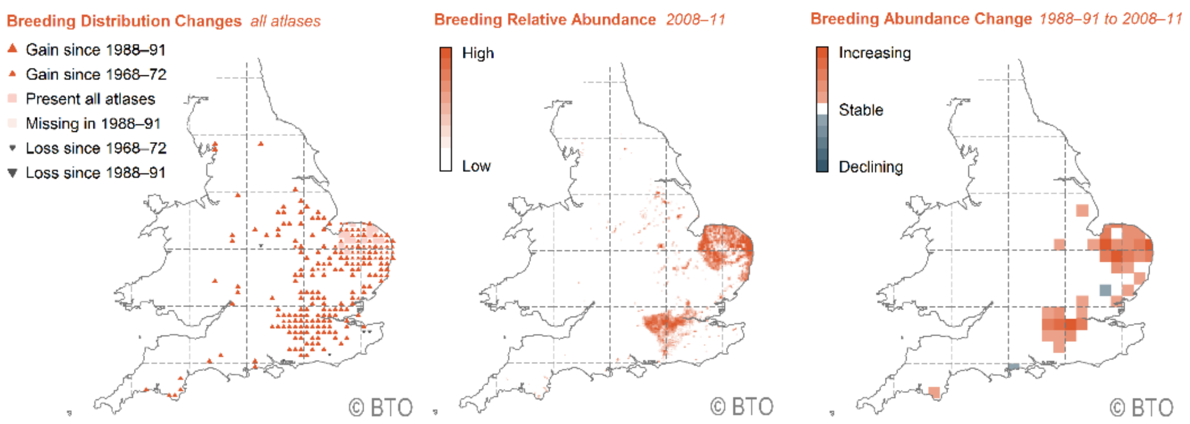

Figure 1. Egyptian goose: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

Monk Parakeet

Monk parakeet has been identified as a potential threat to economic interests and biodiversity and its English population, established from aviary escapes, has been managed to prevent its further spread. First recorded breeding in the UK in 1993 it was recorded in four hectads in the most recent Atlas (Fig. 1), though breeding has only been confirmed in two. At its peak the population was thought to number around 100 birds but the most recent figures (2012-14) suggested an estimated population of 24 breeding pairs (Holling & RSPB 2017).

This reduction in population reflects management undertaken to remove monk parakeets from the wild. In 2008, the feral population in England was estimated at *c*.100 birds in three areas of London - having been present in the wild since at least 1992 (Parrott 2013). Further transient colonies have previously existed in locations elsewhere in England (outside of London). In January 2010 Natural England (NE) added the monk parakeet to three General Licences enabling landowners/occupiers to carry out control activities that would otherwise be unlawful under the Wildlife and Countryside Act 1981. This measure may have helped address individual local issues but did not amount to a strategic approach and therefore did not address potential further establishment and expansion of the population. In February 2011, a ministerial approved eradication was initiated, following which the species has been reduced to one known remaining breeding population of around 25 birds.

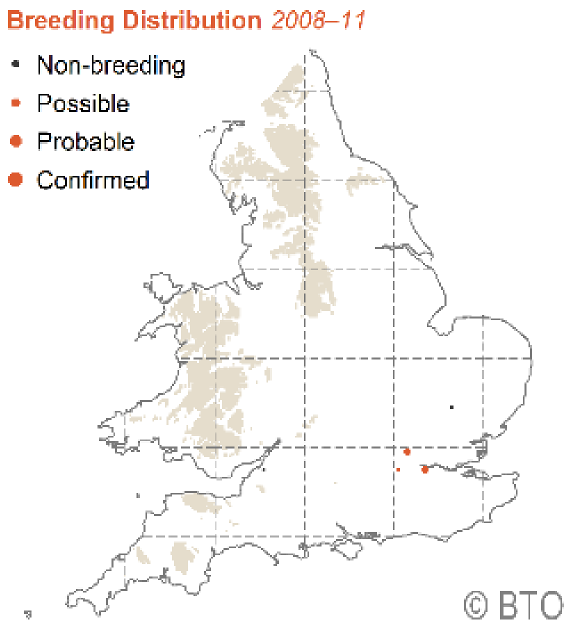

Figure 1. Monk parakeet breeding distribution 2008-11. After Balmer *et al*. 2013.

Ring-necked parakeet

Following escapes and releases over many decades, this parrot, native to Africa and southern Asia, began breeding annually in the UK in 1969. Its population slowly increased to an estimated 500 birds in 1983, 1500 birds by 1996 and an estimated 5800 birds by 2001.

Population modelling in the early 2000s revealed that while populations in Greater London initially increased by approximately 30% per year, and those in Thanet by 15% per year, the range initially only expanded by 0.4 km per year in the Greater London area and hardly at all in Thanet (Butler 2003). Ring-necked parakeet remains a relatively localised species in England with the bulk of the population located in the Greater London area and the Isle of Thanet, Kent (Fig. 1, Middle) (Butler *et al.* 2013). Within London, the breeding distribution has expanded from two hectads in the first atlas period to now occupy every hectad within the M25 and is consolidating its range in the surrounding areas (Fig. 1, Right). The population on the Isle of Thanet is now well established. By the third atlas it was recorded in 89 hectads including a wide scatter of areas away from its two established cores, and in some colonisation is occurring (Fig. 1, Left) (Balmer *et al*. 2013).

BBS (1994-2019) data indicate more than a tenfold increase since 1995 (Fig. 2). With England supporting almost the entirety of the British population the latest population estimate identifies a further quadrupling of the 2001 population to 12,000 pairs (Woodward *et al*. 2020).

The current population is estimated to be around 30,000 birds (Peck 2013) in the South-east of England. However, at least thirteen English counties hold probable breeding populations, from Plymouth in the south to Newcastle in the North (APHA 2018).

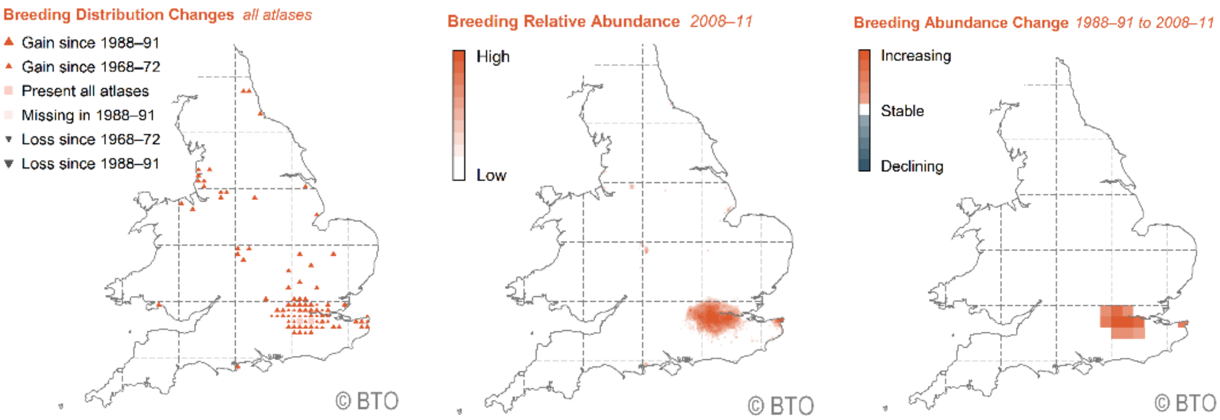

Figure 1. Ring-necked parakeet: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11; (Middle) summary of relative breeding abundance 2008-11, (Right) summary of relative changes in breeding abundance 1988 – 91 to 2008 – 11. After Balmer *et al*. 2013.

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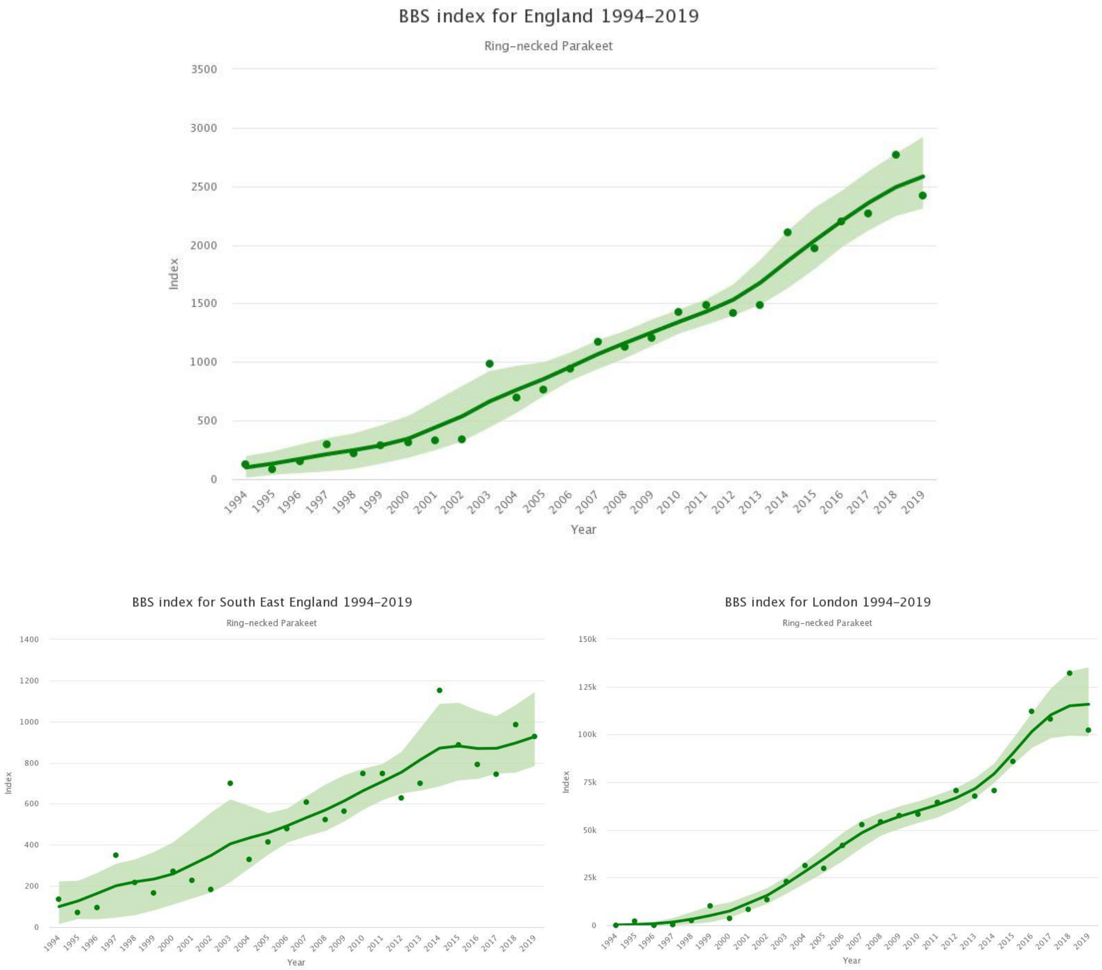

Figure 2: Smoothed trend and 85% confidence interval (with annual indices also plotted, starting at 100 in 1994) for ring-necked parakeet breeding abundance in England and English Regions 1994 to 2019 (BTO/JNCC/RSPB Breeding Bird Survey BBS) **https://www.bto.org/our-science/projects/bbs/latest-results**

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Appendix 2: Interpretation Tables

The following tables (1-7) give interpretations of the summary synthesised strength of evidence scores for each of the avian species-general license sub-purposes, in respect to the likelihood of there being an effect of the species on that sub-purpose.

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GL34 Conservation – wild birds

Table 1: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on the conservation of wild birds.

Strength of Evidence[1]	Likelihood of an effect on the conservation of wild birds[2]
High	High likelihood that a high effect occurs in some circumstances, and that this effect (e.g. predation[3] or competition for breeding sites or other resources) has the potential to affect the local conservation status of the target species
High-Medium	Moderate likelihood that a high effect occurs in some circumstances, and that this effect (e.g. predation or competition for breeding sites or other resources) has the potential to affect the local conservation status of the target species
Medium-High	Some likelihood that a high effect occurs in some circumstances, and that this effect (e.g. predation or competition for breeding sites or other resources) has the potential to affect the local conservation status of the target species
Medium	Likely that some effect occurs in some circumstances, and that this effect (e.g. predation or competition for breeding sites or other resources) is on individual animals but unlikely having a subsequent effect on breeding numbers or the local conservation status of the breeding population
Medium-Low	Some likelihood that some effect occurs in some circumstances, and that this effect (e.g. predation or competition for breeding sites or other resources) is on individual animals but unlikely having a subsequent effect on breeding numbers or the local conservation status of the breeding population
Low-Medium	Very unlikely that an effect (e.g. predation or competition for breeding sites or other resources) occurs as predominantly nil/low strength of evidence for an effect.
Low	Negligible likelihood that an effect (e.g. predation or competition for breeding sites or other resources) occurs as nil/low strength of evidence for an effect.

[1] Strength of evidence categories with greatest support for an effect of a licensed species on the conservation of wild fauna are High > High-Medium > Medium-High.

[2] The evidence evaluates the likelihood of effects such as predation or competition for breeding sites or other resources (proximate effects).

[3] In the majority of studies the strength of evidence evaluates the likelihood of an effect of predation. In only infrequent cases do studies evaluate changes in the breeding numbers of a prey species. For this reason a judgement has had to be made of how likely it is that the level of predation could affect the conservation status.

GL34 Conservation – fauna

Table 2: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on the conservation of wild fauna.

Strength of Evidence[1]	Likelihood of an effect on the conservation of wild fauna[2]
High	High likelihood that a high effect occurs in some circumstances, and that this effect (e.g. competition for breeding sites or refuges, predation or harm) has the potential to affect the local conservation status of the prey species
High-Medium	Moderate likelihood that a high effect occurs in some circumstances, and that this effect (e.g. competition for breeding sites or refuges, predation or harm) has the potential to affect the local conservation status of the prey species
Medium-High	Some likelihood that a high effect occurs in some circumstances, and that this effect (e.g. competition for breeding sites or refuges, predation or harm) has the potential to affect the local conservation status of the prey species
Medium	Likely that some effect occurs in some circumstances, and that this effect (e.g. competition for breeding sites or refuges, predation or harm) is on individual animals but unlikely having a subsequent effect on breeding numbers or the local conservation status of the breeding population
Medium-Low	Some likelihood that some effect occurs in some circumstances, and that this effect (e.g. competition for breeding sites or refuges, predation or harm) is on individual animals but unlikely having a subsequent effect on breeding numbers or the local conservation status of the breeding population
Low-Medium	Very unlikely that an effect (e.g. competition for breeding sites or refuges, predation or harm) occurs as predominantly nil/low strength of evidence for an effect.
Low	Negligible likelihood that an effect (e.g. competition for breeding sites or refuges, predation or harm) occurs as nil/low strength of evidence for an effect.

[1] Strength of evidence categories with greatest support for an effect of a licensed species on the conservation of wild fauna are High > High-Medium > Medium-High.

[2] The evidence evaluates the likelihood of effects such as competition for breeding sites or refuges, predation or harm (proximate effects) because there is no data on the ultimate effect of whether breeding numbers are affected.

GL34 Conservation – flora

Table 3: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on the conservation of wild flora.

Strength of Evidence[1]	**Likelihood of an effect on the conservation of wild flora**[2]
High	High likelihood that a high effect occurs in some circumstances, and that this effect (e.g. grazing, trampling, faecal deposition) has the potential to affect the local conservation status of the flora species
High-Medium	Moderate likelihood that a high effect occurs in some circumstances, and that this effect (e.g. grazing, trampling, faecal deposition) has the potential to affect the local conservation status of the flora species
Medium-High	Some likelihood that a high effect occurs in some circumstances, and that this effect (e.g. grazing, trampling, faecal deposition) has the potential to affect the local conservation status of the flora species
Medium	Likely that some effect occurs in some circumstances, and that this effect (e.g. grazing, trampling, faecal deposition) is restricted in area and unlikely to have a subsequent effect on the local conservation status of the flora species
Medium-Low	Some likelihood that some effect occurs in some circumstances, but this effect (e.g. grazing, trampling, faecal deposition) is restricted in area and unlikely to have a subsequent effect on the local conservation status of the flora species
Low-Medium	Very unlikely that an effect (e.g. grazing, trampling, faecal deposition) occurs as predominantly nil/low strength of evidence for an effect.
Low	Negligible likelihood that an effect (e.g. grazing, trampling, faecal deposition) occurs as nil/low strength of evidence for an effect.

[1] Strength of evidence categories with greatest support for an effect of a licensed species on the conservation of wild flora are High > High-Medium > Medium-High.
[2] The evidence evaluates the likelihood of effects such as grazing, trampling, faecal deposition (proximate effects) because there is little data on the ultimate effect of whether abundance is significantly reduced.

GL35 Public Health and Safety

Public Health (spread of human disease)

Table 4: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on public health (the spread of human disease).

Strength of Evidence[1]	**Likelihood of an effect on public health through the spread of human disease**[2]
High	Very likely that individuals of the species carry disease common to people with high likelihood of transmission in some circumstances[3]
High-Medium	Very likely that individuals of the species carry disease common to people with moderate likelihood of transmission in some circumstances
Medium-High	Very likely that individuals of the species carry disease common to people with some likelihood of transmission in some circumstances
Medium	Very likely that individuals of the species carry disease common to people but transmission route not shown
Medium-Low	Likely that individuals of the species carry disease common to people but transmission route not shown
Low-Medium	Some likelihood that individuals of the species carry disease common to people but transmission route not shown
Low	Very unlikely that individuals of the species carry disease common to people

[1] Strength of evidence categories with some support for transmission of disease between avian species and people or livestock are High > High-Medium > Medium-High.
[2] Strength of evidence largely relates to the likelihood of a species carrying disease common to people; evidence for actual transmission of disease to people is rare, although possible in some circumstances.
[3] Transmission will depend on factors such as the level of exposure and immunocompetence of people exposed.

GL35 Public Health and Safety

Public Safety (trips, slips and falls; issues in relation to birds nesting, any other impacts)

Table 5: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on public safety caused by trips, slips and falls; issues in relation to birds nesting, any other impacts.

Strength of Evidence[1]	**Likelihood of an effect on public safety**[2]
High	High likelihood that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs in some circumstances and has the potential to affect public safety
High-Medium	Likely that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs in some circumstances and has the potential to affect public safety
Medium-High	Moderate likelihood that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs in some circumstances and has the potential to affect public safety
Medium	Some likelihood that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs in some circumstances and has the potential to affect public safety
Medium-Low	Minor likelihood that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs in some circumstances and has the potential to affect public safety
Low-Medium	Very unlikely that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs as predominantly nil/low strength of evidence for an effect.
Low	Negligible likelihood that an effect (trips, slips and falls; issues in relation to birds nesting; or any other impacts) occurs as nil/low strength of evidence for an effect.

[1] Strength of evidence categories with greatest support for an effect of a licensed species on public safety are High > High-Medium > Medium-High.

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GL36 Significant Damage

Livestock (harm), foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water

Table 6: Interpretation of synthesised strength of evidence scores in respect to the likelihood of significant damage by a licensed species on livestock (predation or harm), foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water.

Strength of Evidence[1]	Likelihood of an effect causing serious damage[2]
High	High likelihood that a high effect occurs in some circumstances, and this effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) results in significant damage
High-Medium	Moderate likelihood that a high effect occurs in some circumstances, and this effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) results in significant damage
Medium-High	Some likelihood that a high effect occurs in some circumstances, and this effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) results in significant damage
Medium	Likely that some effect occurs in some circumstances and this effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) does not result in significant damage
Medium-Low	Some likelihood of an effect in some circumstances and this effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) does not result in significant damage
Low-Medium	Very unlikely that an effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) occurs as predominantly nil/low strength of evidence for an effect.
Low	Negligible likelihood that an effect on (e.g. livestock [predation or harm], foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water) occurs as nil/low strength of evidence for an effect.

[1] Strength of evidence categories with greatest support for an effect of a licensed species causing significant damage are High > High-Medium > Medium-High.
[2] Strength of evidence relates the likelihood of significant damage to livestock (i.e. predation or harm), foodstuffs for livestock, crops, vegetables, fruit, growing timber, inland water.

Animal & Plant Health Agency

GL36 Significant Damage

Livestock (spread of animal disease)

Table 7: Interpretation of synthesised strength of evidence scores in respect to the likelihood of an effect of a licensed species on livestock health (through the spread of animal disease).

Strength of Evidence[1]	**Likelihood of an effect on livestock health through the spread of animal disease**[2]
High	Very likely that individuals of the species carry disease common to livestock with high likelihood of transmission in some circumstances[3]
High-Medium	Very likely that individuals of the species carry disease common to livestock with moderate likelihood of transmission in some circumstances
Medium-High	Very likely that individuals of the species carry disease common to livestock with some likelihood of transmission in some circumstances
Medium	Very likely that individuals of the species carry disease common to livestock but transmission route not shown
Medium-Low	Likely that individuals of the species carry disease common to livestock but transmission route not shown
Low-Medium	Some likelihood that individuals of the species carry disease common to livestock but transmission route not shown
Low	Very unlikely that individuals of the species carry disease common to livestock

[1] Strength of evidence categories with some support for transmission of disease between avian species and livestock are High > High-Medium > Medium-High.

[2] Strength of evidence largely relates to the likelihood of a species carrying disease common to livestock; evidence for actual transmission of disease to livestock is rare, although possible in some circumstances.