Literature review of the evidence base for inclusion of bird species listed on General Licences 1, 2 and 3 in Scotland

RESEARCH REPORT

Research Report No. 1136

Literature review of the evidence base for inclusion of bird species listed on General Licences 1, 2 and 3 in Scotland

This report should be quoted as:

Newson, S.E., 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.*

RESEARCH REPORT
Summary

Literature review of the evidence base for the inclusion of bird species listed on General Licences 1, 2 and 3

Keywords

Background

General Licences 1-3 are a light-touch form of regulation, which allow landowners or land managers to control certain species of wild bird, by shooting or trapping. These cover common situations where there is unlikely to be a significant conservation impact for the controlled species. Since taking over the responsibility for general licensing in Scotland from the Scottish Government in 2011, Scottish Natural Heritage (SNH) has consulted key licence users and the public on the content of licences and made some significant improvements. Despite this, some queries remain over the evidence base for the current listing of target species. In this report we carry out an independent evaluation of the target species on General Licences 1-3 based on a review of the scientific literature.

Main findings

- A formal systematic review was carried out. Searches were divided into three main groups, each focusing on identifying literature relevant to one of General Licences (GL) 1-3. Search terms were constructed to balance volume of literature returned with scope and comprehensiveness of the search.
- Searches of the World Wide Web, specifically using the same search terms above and Google Scholar were also carried out. This was done to identify relevant 'grey literature', or more obscure papers that may have been missed through the systematic literature. In addition, we looked through the responses to three previous general licensing consultations carried out in 2012, 2013 and 2016.
- Literature deemed to be within the scope of the review was scored according to the evidence of impact. This was considered at two levels: (a) the strength of evidence as presented by the reviewed literature (score 0-2); and (b) the quality or scientific rigour of that evidence as presented (score 0-2) and documented in an excel spreadsheet. These results were then synthesised across the literature, to calculate the maximum score for the strength of evidence and scientific rigour underlying the evidence for each species and General Licence.

- In relation to General Licence 1, which is issued to reduce impacts on wild bird conservation, there was no evidence that rooks are an important nest predator, or that they are likely to impact otherwise on the conservation of wild birds to support its inclusion on GL1.
- In relation to General Licence 2, which is issued to prevent serious damage to livestock, foodstuffs for livestock, crops, vegetables or fruit, depending on species there was little or no evidence that magpie, carrion crow / hooded crow, jackdaw, great black-backed gull or collared dove are likely to result in serious damage to livestock or agriculture to support their inclusion on GL2. However, this is an evidence gap, where conversely there is no robust evidence to demonstrate little or no impact.
- In relation to General Licence 3, which is issued to preserve public health, public safety or preventing the spread of disease, there was little evidence to support the inclusion of the current species listed on General Licence 3. This is on the basis that these species host several pathogens of humans and domestic livestock and poultry. However, this is an evidence gap, where there is no or very little quantitative information on the likelihood or risk of disease transmission.
- The status of 14 species listed on General Licences 1, 2 and 3 in Scotland is reviewed to assess whether their distribution and/or abundance has changed in the past 25 years, or thereabouts, sufficiently for any threat or impact posed by them to have potentially changed. Six of the focal species increased 'markedly' overall (indices of abundance had had changed by 25% or more) during the period considered (magpie, jay, Canada goose, lesser black-backed gull, feral pigeon and collared dove). Four species decreased markedly overall (ruddy duck, rook, great black-backed gull and herring gull). Five species changed in their distribution to make it possible that threats or impacts could have increased locally or regionally despite their overall status in Scotland either having changed little (carrion crow, jackdaw and woodpigeon) or decreased (great black-backed gull and herring gull).

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Acknowledgements

1. INTRODUCTION

Scottish Natural Heritage (SNH) General Licences (GL) 1-3 for birds allow certain species to be killed or taken for various purposes, namely: the conservation of wild birds (GL1); for the prevention of serious damage to livestock, foodstuffs for livestock, crops, vegetables and fruit (GL2); and for the preservation of public health, public safety and preventing the spread of disease (GL3). A summary of the bird species listed under General Licences 1-3 is provided in Table 1.

Table 1. Bird species listed on SNH General Licences 1-3 for inclusion in the review.

Target species	GL1 – conservation of wild birds	GL2 – prevention of serious damage	GL3 – preservation of public health, safety or spread of disease
Magpie			
Carrion Crow			
Hooded Crow			
Jackdaw			
Jay		Not listed	Not listed
Rook			
Ruddy Duck		Not listed	Not listed
Canada Goose			
Great Black-backed Gull			
Lesser Black-backed Gull	Not listed	Not listed	
Herring Gull	Not listed	Not listed	
Collared Dove	Not listed		
Feral Pigeon	Not listed		
Woodpigeon	Not listed		
Native Greylag Goose*	Not listed		Not listed

*Reviewing not required by SNH for this species

Since taking over the responsibility for general licensing from the Scottish Government in 2011, SNH has consulted key licence users and the general public on the content of licences, and made significant improvements. Despite this, some queries remain over the evidence base for the current listing of target species. Hence SNH require an independent evaluation of each target species (except native greylag goose) based on information ascertained from a review of scientific literature. This will be used to inform decisions on whether to include or otherwise these target species on the current licences. We note that anecdotal records of relevance may be missed through a literature review. Such records are difficult to collate and interpret in a meaningful way, and have not been considered here.

Through this report, we aim to identify the level of evidence available to support the current list of target species on SNH General Licences 1-3. Specifically, this study aims to assess:

(i) What level of evidence is there that each target species on General Licence 1 poses a threat to the conservation of wild birds?
(ii) What level of evidence is there that each target species on General Licence 2 causes serious damage (to livestock, foodstuffs for livestock, crops, vegetables and fruit)?
(iii) What level of evidence is there that each target species on General Licence 3 poses a threat to public health or safety, or a risk to the spread of disease?
(iv) Is there any evidence that populations of each target species have shown recent national/regional changes that could influence the threats/damage that they pose?

Following the systematic reviewing of all available literature, each species is assigned an objective evidence level category for each General Licence on which it is currently listed and a summary of the reasons for this categorisation is provided.

2. METHODS

2.1 Changes in distribution or abundance of target species

2.1.1 Sources and limitations of information

The extent and magnitude of any threat or impact caused by any species has the potential to change if their distribution or abundance changes. Relevant changes will not necessarily be restricted to gross changes, for example a species becoming more abundant or more widespread; more subtle changes in seasonal distribution or else in the habitats that a species occupies should also be considered. We describe changes in distribution and abundance for the 14 focal species based principally on national and regional *bird atlases* and avifaunas (Balmer *et al*. 2013, Elkins *et al*. 2016, Rheinallt *et al*. 2007, Francis & Cook 2011, Pennington *et al*. 2004, Forrester *et al*. 2007), the BTO/JNCC/RSPB *Breeding Bird Survey* (BBS: Harris *et al*. 2018), the BTO/RSPB/JNCC/WWT *Wetland Bird Survey* (Frost *et al*. 2018), surveys of breeding seabirds (Mitchell *et al*. 2004) and the *Seabird Monitoring Programme* (JNCC 2016). Other sources of information are cited where used within the individual species accounts.

The changes that can be described are necessarily limited in scale to the sources of data readily available. National *bird atlases* generally summarise the distribution of birds at a 10-km square resolution (hectad scale), while regional atlases tend to be at finer resolution, typically at tetrad scale (2 by 2 km squares). Although coverage by atlases tends to be near-complete, atlases sample fixed periods only. For example, national atlases have covered the periods 1968-72, 1988-91 and 2007-11. The *Breeding Bird Survey* has sampled randomly selected 1-km squares annually since 1994. This permits an annual assessment of changes in abundance for many widespread and common breeding species, including a Scotland-specific trend for most of the breeding species considered by this review. Although the number of sampled squares is generally increasing (over 500 were surveyed in Scotland in 2017), this still remains insufficient for routine assessment of trends for sub-regions within Scotland; regional assessments may be feasible for a limited range of species, but these would require additional and bespoke analyses that were not within the remit of the current study.

The *Wetland Bird Survey* collates counts of waterbirds at coastal and freshwater bodies at up to monthly intervals, though many sites are counted typically between September and March inclusive and so best provide an index of change for waterbirds outside of the breeding season.

Near-comprehensive surveys of *breeding seabirds* have been undertaken at periodic intervals (1969-70, 1985-88 and 1998-2002) but coverage of inland sites (particularly relevant for gulls) was either not attempted (1969-70) or was incomplete. The *Seabird Monitoring Programme* provides annual counts of breeding seabirds for some colonies since 1986 but reports changes in addition to those covered by the periodic surveys for Great Black-backed Gull only amongst the species included in this review.

2.1.2 Species accounts

For each species, the current distribution is described briefly at the start of each species account, followed by an overview of changes in distribution and abundance. This review focuses on the most recent 20-30 years of change that are available. Where contextually important, some longer term changes are also described. We have used a threshold of 25% change in any of the abundance or distribution metrics across the whole of Scotland to define a 'marked' change. This follows criteria to define 'birds of conservation concern' (Eaton *et al*. 2015) which adopts a decline of 25% over a 25 year period as a principal criterion to identify bird species that should be conservation priorities. Distributions of birds

change and declines or increases maybe experienced in some but not all parts of Scotland. Therefore and more subjectively, we have also indicated if similarly 'marked' changes are likely to have occurred regionally but not generally across all of Scotland.

2.2   Systematic literature review

The principles of a formal systematic review were adopted. We used the online literature database Web of Science (WoS) database constrained to the Scientific Citation Index Expanded (SCI-EXPANDED index) for years 1980-2019 (present). These searches were divided into three main groups, each focusing on identifying literature relevant to one of General Licences (GL) 1-3. Search terms were constructed to balance volume of literature returned with scope and comprehensiveness of the search. The search terms used for each search are explained below.

2.2.1   The conservation of wild birds (General Licence 1)

Ten separate searches (searches 1 to 10) were carried out, the first nine of which requiring the topic word included either the common name or scientific name of one of the nine species for which this licence applies (Table 1). We exclude native greylag goose from all literature searches carried out, as reviewing for this species was not required by SNH. A tenth search was carried using the terms CORVID or GULL or CORVUS or LARUS or BRANTA and considering records including a European country or "Europe" in the topic. This was done to ensure that additional studies which may be relevant to General Licence 1 were not missed. Each search required that the results included the terms BIRD* and one of the following terms: PREDAT* (to increase the chance that it would include information on the effects of predation on wild bird populations) or PRODUCTIVITY or REPRODUC* or CONFLICT* or CONSERVATION or IMPACT*.

Table 2. Search terms for literature relating General Licence 1: the impacts of target species on the conservation of wild birds. All searches included the common terms in TITLE, ABSTRACT and KEYWORDS. Search settings covered the period 1980 to 2019. Each search also contained one specific term, relating to a focal bird species, that was searched for in the TITLE, ABSTRACT and KEYWORDS.

Criterion	Common term
AND	BIRD*
AND	PREDAT* or PRODUCTIVITY or PREY or REPRODUC* or CONFLICT or CONSERVATION or IMPACT* or CONTROL or
AND	CULL or HYBRID*

Search	Specific term	Hits
1	MAGPIE or "COMMON MAGPIE" or "PICA PICA"	399
2	"CARRION CROW" or "CORVUS CORONE" or "CORVUS CORONE CORONE"	120
3	"HOODED CROW" or "CORVUS CORONE" or "CORVUS CORONE CORNIX"	136
4	JACKDAW or "WESTERN JACKDAW" or "CORVUS MONEDULA"	58
5	"JAY" or "EURASIAN JAY" or "GARRULUS GLANDARIUS"	370
6	ROOK or "CORVUS FRUGILEGUS"	50
7	"RUDDY DUCK" or "OXYURA JAMAICENSIS"	21
8	"CANADA GOOSE" or "BRANTA CANADENSIS"	117
9	"GREAT BLACK-BACKED GULL" or "LARUS MARINUS"	26
10	CORVID or GULL or GOOSE or CORVUS or LARUS or BRANTA and EUROPE or ESTONIA or CROATIA or GERMANY or SLOVAKIA or SPAIN or IRELAND or FRANCE or GREECE or ENGLAND or LATVIA	585

or "UNITED KINGDOM" or UKRAINE or POLAND or SLOVENIA or "UK" or BULGARIA or ITALY or NETHERLANDS or WALES or SWEDEN or FINLAND or ROMANIA or SWITZERLAND or ICELAND or NORWAY or DENMARK or IRELAND or BELGIUM or CZECH* or PORTUGAL or SCOTLAND or HUNGARY or AUSTRIA or BOSNIA or YUGOSLAVIA or ALBANIA or MACEDONIA or KOSOVO or SERBIA or MONTENEGRO or LUXEMBOURG or ANDORRA or MONACO or RUSSIA

2.2.2 Prevention of serious damage (General Licence 2)

Eleven separate searches (searches 11 to 21) were carried out to identify the literature relating to the prevention of serious damage to livestock, foodstuffs for livestock, crops, vegetables or fruit. Each search required that the topic words included either the common name or scientific name of one of the ten species for which this licence applies, excluding resident greylag goose as before (Table 2). An additional search was carried using the terms CORVID or GULL or PIGEON or CORVUS or LARUS or BRANTA or COLUMBA to ensure that studies relevant to General Licence 2 were not missed. Each search required that the results included one of the following terms: IMPACT or CONFLICT or THREAT or DAMAGE and one of LIVESTOCK or CROPS or AGRICUL* or FRUIT or VEGETABLE*.

Table 3. Search terms for literature relating to General Licence 2: the prevention of serious damage to livestock, crops, vegetables and fruit. All searches included the common terms in TITLE, ABSTRACT and KEYWORDS. Search settings covered the period 1980 to 2019. Each search also contained one specific term, relating to a focal bird species, that was searched for in the TITLE, ABSTRACT and KEYWORDS.

Criterion	Common term
AND	IMPACT or CONFLICT or THREAT or DAMAGE or CONTROL
AND	LIVESTOCK or CROP* or AGRICUL* or FRUIT or VEGETABLE* or FOOD

Search	Specific term	Hits
11	MAGPIE or "COMMON MAGPIE" or "PICA PICA"	106
12	"CARRION CROW" or "CORVUS CORONE" or "CORVUS CORONE CORONE"	29
13	"HOODED CROW" or "CORVUS CORONE" or "CORVUS CORONE CORNIX"	29
14	JACKDAW or "WESTERN JACKDAW" or "CORVUS MONEDULA"	18
15	ROOK or "CORVUS FRUGILEGUS"	21
16	"CANADA GOOSE" or "BRANTA CANADENSIS"	42
17	"GREAT BLACK-BACKED GULL" or "LARUS MARINUS"	8
18	"COLLARED DOVE" or "STREPTOPELIA DECAOCTO"	
19	"FERAL PIGEON" or "COLUMBA LIVIA"	
20	"WOOD PIGEON" or WOODPIGEON or "COLUMBA PALUMBUS"	15
21	CORVID or GULL or GOOSE or PIGEON or CORVUS or LARUS or BRANTA or COLUMBA and EUROPE or ESTONIA or CROATIA or GERMANY or SLOVAKIA or SPAIN or IRELAND or FRANCE or GREECE or ENGLAND or LATVIA or "UNITED KINGDOM" or UKRAINE or POLAND or SLOVENIA or "UK" or BULGARIA or ITALY or NETHERLANDS or WALES or SWEDEN or FINLAND or ROMANIA or SWITZERLAND or ICELAND or NORWAY or DENMARK or IRELAND or BELGIUM or CZECH* or PORTUGAL or SCOTLAND or HUNGARY or AUSTRIA or BOSNIA or YUGOSLAVIA or ALBANIA or MACEDONIA or KOSOVO or SERBIA or MONTENEGRO or LUXEMBOURG or ANDORRA or MONACO or RUSSIA	290

2.2.3 Preservation of public health, safety or spread of disease (General Licence 3)

Thirteen separate searches (searches 22 to 34) were carried out to identify literature relating to each of eleven target species included on General Licence 3, relating to the preservation of public health, public safety and preventing the spread of disease. For each search the topic word included either the common name or scientific name of one of the eleven species for which this licence applies (Table 1). An additional search was carried using the terms CORVID or GULL or PIGEON or CORVUS or LARUS or BRANTA or COLUMBA to ensure that studies relevant to General Licence 3 were not missed. Each search required that the results included one of the following terms: HUMAN or PUBLIC or HEALTH or SAFETY or DISEASE. For an initial search we focused on the period 1980-present.

Table 4. Search terms for literature relating to the preservation of public health, safety or spread of disease. All searches included the common terms in TITLE, ABSTRACT and KEYWORDS. Search settings covered the period 1980 to 2019. Each search also contained one specific term, relating to a focal bird species, that was searched for in the TITLE, ABSTRACT and KEYWORDS.

Criterion	**Common term**
AND	HUMAN or PUBLIC or HEALTH or SAFETY or DISEASE or or VECTOR or TRANSMI* or BACTERI* or VIRUS

Search	**Specific term**	**Hits**
22	MAGPIE or "COMMON MAGPIE" or "PICA PICA"	246
23	"CARRION CROW" or "CORVUS CORONE" or "CORVUS CORONE CORONE"	68
24	"HOODED CROW" or "CORVUS CORONE" or "CORVUS CORONE CORNIX"	74
25	JACKDAW or "WESTERN JACKDAW" or "CORVUS MONEDULA"	49
26	ROOK or "CORVUS FRUGILEGUS"	113
27	"CANADA GOOSE" or "BRANTA CANADENSIS"	238
28	"GREAT BLACK-BACKED GULL" or "LARUS MARINUS"	36
29	"LESSER BLACK-BACKED GULL" or "LARUS FUSCUS"	44
30	"HERRING GULL" or "LARUS ARGENTATUS"	247
31	"COLLARED DOVE" or "STREPTOPELIA DECAOCTO"	32
32	"FERAL PIGEON" or "COLUMBA LIVIA"	852
33	"WOODPIGEON" or "WOOD PIGEON" or "COLUMBA PALUMBUS"	69
34	CORVID or GULL or GOOSE or PIGEON or CORVUS or LARUS or BRANTA or COLUMBA and EUROPE or ESTONIA or CROATIA or GERMANY or SLOVAKIA or SPAIN or IRELAND or FRANCE or GREECE or ENGLAND or LATVIA or "UNITED KINGDOM" or UKRAINE or POLAND or SLOVENIA or "UK" or BULGARIA or ITALY or NETHERLANDS or WALES or SWEDEN or FINLAND or ROMANIA or SWITZERLAND or ICELAND or NORWAY or DENMARK or IRELAND or BELGIUM or CZECH* or PORTUGAL or SCOTLAND or HUNGARY or AUSTRIA or BOSNIA or YUGOSLAVIA or ALBANIA or MACEDONIA or KOSOVO or SERBIA or MONTENEGRO or LUXEMBOURG or ANDORRA or MONACO or RUSSIA	1069

The results of each search were saved as records in a separate collection in the reference manager software Zotero (www.zotero.org). The records in each search included (where relevant) title, authors, keywords, source, date and abstract of each item returned by the search.

Summaries of publications were captured under standardised headings in an MS Excel spreadsheet, so that the evidence underpinning species categorisations is documented in a form that is easy for others to view and synthesise efficiently.

2.2.4   Other sources of information for the review

In addition to the systematic literature searches, we drew on information from a number of other reviews, including Madden *et al*. 2015 and Roos *et al*. 2018. Primary studies referred to in these reviews, as well as in other literature that we encountered, were also included in the current review where they provided a clearer or more direct link to information or a line of reasoning relevant to this review. We also carried out searches of the World Wide Web, specifically using the same search terms above and *Google Scholar*. This was done to identify relevant 'grey literature', or more obscure papers that may have been missed through the systematic literature. We were not budgeted to carry out a comprehensive review of the 'grey literature' that has not been peer-reviewed, or to collect relevant information through consultation with stakeholders. To ensure that we were not missing any relevant literature highlighted previously by stakeholders, we looked through the responses to three previous general licensing consultations. Specifically, these related to consultations carried in 2012 for development of the 2013 licences; 2013 for the 2014 licences and 2016 for the 2017 licences. The latter consultation was carried out online and results made available to us via SNH in a spreadsheet. The two documents and one spreadsheet had previously been published on the SNH website. Summaries of any relevant publications identified were captured under standardised headings and added to the systematic review MS Excel spreadsheet above.

2.2.5   Formal systematic evaluation of literature

The systematic searches of WoS described above generated a total of 5,606 records. However, many records were duplicated between searches. After elimination of duplicate records, the number of unique records was reduced to 4,036. These records were screened for potential relevance to the project, with records being excluded from further consideration on the basis of title, and then abstract.

Records deemed to be potentially relevant on the basis of both title and abstract were initially categorised on a three-point scale:
  - Relevance level 1: deals with a process or relationship of direct relevance to the review;
  - Relevance level 2: the topic falls within the remit of the review, but it is unclear whether the subject matter of the literature is directly relevant;
  - Relevance level 3: unlikely to contain relevant information.

All literature classified as either relevance level 1 or relevance level 2 (493 references) was, where possible, examined in greater detail.

2.2.6   Categories for evidence of impact

Literature deemed to be within the scope of the review was then scored according to the evidence of impact. This was considered at two levels: (a) the strength of evidence as presented by the reviewed literature; and (b) the quality or scientific rigour of that evidence as presented.

a) *The strength of evidence as presented in literature*

Strong evidence (score of 2) – Clear effects in at least some situations;
Some evidence (score of 1) – Potential effects in at least some situations;
Little or no evidence (score of 0) – No demonstrated effect.

b) *Scientific rigour of the evidence as presented*

Strong evidence (score of 2) – Experimental evidence or a causal relationship is unequivocally demonstrated;
Some evidence (score of 1) – Correlative evidence not supported by experiment or where causal relationships have not necessarily been demonstrated but where they are possible;
Little or no evidence (score of 0) – Evidence is restricted to unsubstantiated claims or anecdotes.

An example of how scientific rigour has been assessed is given below:

Strong evidence - Impact fully quantified (e.g. yield for the farm was reduced by 20%, as a consequence of crop trampling 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;
Some evidence - Impact partially quantified or evidence is purely correlative (e.g. fields with scarecrows recorded fewer woodpigeons and had significantly higher crop yields but where the impact of other species was not measured, and no experimental reversal of treatments was reported);
Little or no evidence - Impact reported anecdotally and is essentially unquantified (e.g. woodpigeon is commonly recorded on crops and it is assumed to be an important economic pest).

In this review we consider only species that are currently listed on General Licences 1, 2 or 3, and the Licence/s against which they are listed.

During the review process, a spreadsheet (General_licence_evidence.xls) was prepared which contains for each reference, a score as detailed above for (a) the strength of the evidence, and (b) the scientific rigour for each item of literature. When a reference relates to more than one species or general licence, it may appear more than once in the spreadsheet. Please refer to Annex 1 for more details about this spreadsheet.

To summarise the results across the literature, we use the maximum score for the strength of evidence and scientific rigour underlying the evidence, for each species and general licence.

3. SYNTHESIS

3.1 Changes in distribution or abundance of target species

The status of 14 species listed on General Licences 1, 2 and 3 in Scotland is reviewed to assess whether their distribution and/or abundance has changed in the past 25 years, or thereabouts, sufficiently for any threat or impact posed by them to have potentially changed. Six of the focal species increased markedly overall (indices of abundance had changed by 25% or more) during the period considered (magpie, jay, Canada goose, lesser black-backed gull, feral pigeon and collared dove). Four species decreased markedly overall (ruddy duck, rook, great black-backed gull and herring gull). Five species changed in their distribution to make it possible that threats or impacts could have increased locally or regionally despite their overall status in Scotland either having changed little (carrion crow, jackdaw and woodpigeon) or decreased (great black-backed gull and herring gull). Quantitative summaries of change in distribution and abundance where available for the target species are presented in Table 5.

Table 5. Summary statistics describing changes in the status of species listed on General Licences 1, 2 and 3 in Scotland and included in the current review. Changes highlighted in bold are those that have been used to recognise 'marked' changes in distribution and abundance.

Species	Breeding Bird Atlas [a]			Breeding Bird Survey trend [b]			Other sources [c]
	Hectads occupied 1988-91	Hectads occupied 2008-11	Change in occupied hectads	10-year (2006-16)	21-year (1995-2016)	CI of 21-year trend	
Magpie	168	286	**+60%**	**+26%***	**+48%***	+6% to +121%	
Carrion Crow	513	550	+7%	-16%*	-7%	-29% to +22%	
Hooded Crow	513	522	+2%	-11%	-31%	-55% to +5%	
Jackdaw	565	576	+2%	+18%	+24%	-9% to +61%	
Jay	121	275	**+127%**	**+51%***			
Rook	565	576	-2%	-24%	**-35%***	-49% to -6%	
Ruddy Duck	18	7	**-61%**				*WeBS*: **-99.99% 98/99 to 16/17**
Canada Goose	50	236	**+372%**				*WeBS*: **+1011% 94/95 to 16/17**
Great Black-backed Gull	371	332	-11%				*WeBS*: **-48% 93/94 to 16/17** *Seabird census*: -4% 85-88 to 98-02 *Seabird Colony Register*: -11% 98 to 02
Lesser Black-backed Gull	289	270	-7%				*WeBS*: -1% 93/95 to 16/17 **+52% 08/09 to 16/17** *Seabird census*: +10% 85-88 to 98-02
Herring Gull	449	470	+5%				*WeBS*: **-51% 93/94 to 16/17** *Seabird census*: -23% 85-88 to 98-02
Collared Dove	404	595	**+47%**	-2%	+10%	-33% to +58%	
Feral Pigeon / Rock Dove [d]	464	588	**+27%**	-9%	-3%	-40% to +58%	
Woodpigeon	655	724	+11%	+1%	+10%	-12% to +34%	

Notes for Table 5:

[a] The number of hectads (10 by 10 km squares) in which the species was recorded during the breeding season in each of the two atlas periods and the percentage change from the 1988-91 to the 2008-11 periods;

[b] Changes in indices of abundance derived from the BBS between 2006 – 2016 and 1995 – 2016. Statistically significant changes are marked with an asterix. The 95% confidence intervals (CI) are shown for the 1995-2016 trends. Not including zero within the CI indicates a statistically significant trend. The closeness of a confidence limit to zero is an indication of how close to statistical significance is the trend. For Jay, the 10-year trend is reported only as the species has been too scarce over much of the period since 1994 for the longer-term trend to be derived;

[c] Other sources of data include the Wetland Bird Survey (WeBS: the change in index of abundance of non-breeding waterbirds between the winter seasons shown), the Seabird Census (changes in the counts of apparently occupied territories for coastal breeding seabirds between the periods 1985-88 and 1998-2002) and the Seabird Colony Register (the change reported by annual monitoring of sample colonies between 1998 and 2002);

[d] 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'.

3.2 Systematic literature review

During the review process, a spreadsheet (General_licence_evidence.xls) was prepared which contains for each reference, a score for (a) the strength of the evidence, and (b) the scientific rigour. Where a reference relates to more than one species or general licence, it may appear more than once in the spreadsheet.

To synthesise the results, we then determined the maximum score for the strength of evidence and scientific rigour underlying the evidence for each species and General Licence (Table 6). Scores for each published paper are presented in the spreadsheet. While there is some variation in scores with the associated literature, we present the maximum score in the summary (Table 6) to reflect the difficulty and uncertainty in identifying definitive causal relationships between the target species and impacts investigated. Therefore it would be anticipated that relative few studies would score highly in the strength of evidence they present in favour of a direct causal relationship. The use of alternative metrics such as mean or median would likely be biased towards a lower score as a result of lack of power to detect an effect in at least some of the relevant studies.

Table 6. Strength of evidence and scientific rigour of evidence from the literature review for each species and applicable General Licence. We present the maximum score from the literature. Situations where the strength of the reported evidence to support a species on a general licence is weak are highlighted in orange.

Target species	GL1 – conservation of wild birds		GL2 – prevention of serious damage		GL3 – preservation of public health, safety or spread of disease	
	Strength	Rigour	Strength	Rigour	Strength	Rigour
Magpie	2	2	0	0	2	2
Carrion / hooded crow	2	2	0	0	1	1
Jackdaw	1	2	0	0	1	2
Jay	2	2	Not listed		Not listed	
Rook	0	2	1	2	1	1
Ruddy duck	2	2	Not listed		Not listed	
Canada goose	1	1	2	2	2	1
Great black-backed gull	2	2	0	0	2	1
Lesser black-backed gull	Not listed		Not listed		1	1
Herring gull	Not listed		Not listed		2	1
Collared dove	Not listed		0	0	1	1
Feral pigeon	Not listed		2	1	2	2
Woodpigeon	Not listed		2	2	1	1
resident greylag goose*	Not listed		-		Not listed	

* Reviewing not required by SNH for this species

In the following sections we highlight the species and general licences where there is weak or no evidence to support inclusion on a General Licence.

3.2.1 Impact on the conservation of wild birds (GL1)

Rook: There was no evidence that rooks are an important nest predator, or that they are likely to impact otherwise on the conservation of wild birds to support its inclusion on General Licence 1. The scientific rigour underlying the absence of impact is largely

correlative, that is the absence of impact is based on studies looking at the diet of rooks rather than studies which recorded direct impact.

3.2.2 Prevention of serious damage to livestock, foodstuffs for livestock, crops, vegetables and fruit (GL2)

Magpie, carrion / hooded crow and jackdaw: There was little evidence in the literature that magpies, carrion / hooded crow or jackdaw are likely to impact on livestock or agriculture to support their inclusion on General Licence 2. In a questionnaire to corvid trap users in Scotland (Reynolds 2016), respondents identified that the main issues with corvids concerned sheep, with lambs and ewes stuck on their back and unable to rise, and to a lesser degree damage to crops. Importantly, this represents an evidence gap, rather than there being robust evidence that demonstrates little or no impact.

Great black-backed gull: There was no evidence in the literature that great black-backed gulls are likely to result in serious damage to livestock, foodstuffs for livestock, crops, vegetables or fruit. As with the corvids, this represents an evidence gap, rather than there being robust evidence that this species does not cause serious damage.

Collared dove: There was no published evidence of serious damage to crops, livestock, foodstuffs for livestock, vegetables or fruit. Again, this represents an evidence gap, rather than there being robust evidence that demonstrates absence of damage.

3.2.3 Preservation of public health, public safety or preventing the spread of disease (GL3)

No species-specific points can be made. As a general point in relation to disease and health risk to humans, livestock or poultry, most of the literature reviewed considers whether pathogens are present in the target species. Few studies have tried to quantify the risk of transmission, which is most important.

4. SPECIES ACCOUNTS

4.1 Canada Goose

4.1.1 Status and change in distribution / abundance

A non-native species originally introduced to Britain in the 18th and 19th centuries, **Canada geese** are now widespread breeders across southern Scotland and north to the central Highlands. The range has expanded markedly over recent decades and they are now quite abundant even in some areas where they are relatively recent colonists, for example the southern Highlands and Argyll. In winter, the distribution and increases match those recorded for the breeding season. **Canada geese** from England developed a moult migration to the Beauly Firth in the mid-20th century (Dennis 1964). This continues and **Canada geese** on their migrations occur more widely during migration periods, especially in eastern Scotland, though their presence may become less apparent as the breeding populations increase.

Canada goose is on the list of species that have increased markedly on account of the 372% increase in occupied hectads in the breeding season (and similar increase during winter) and a 1011% increase in winter abundance since 1994/95.
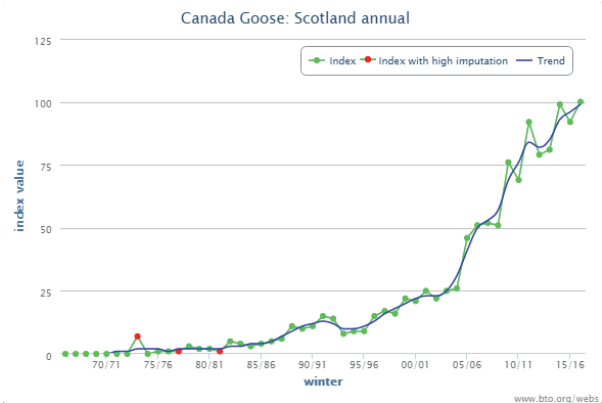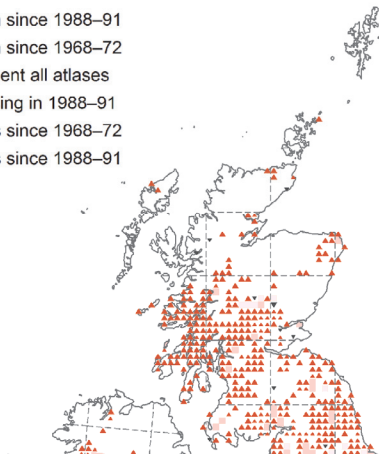
*Figure 4.1.1 **Canada Goose**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trends (with annual indices also plotted) for winter abundance in Scotland 1993-4 to 2016-17 (WeBS).*

4.1.2 Systematic review findings

4.1.2.1 Impact on the conservation of wild birds (GL1)

- **There was only weak evidence that Canada geese could compete with native waterfowl for resources or by a threat to native geese through hybridisation. They are also reported as trampling nests of other species but any impact appears unquantified. Other indirect impacts on wild birds may occur, for example through erosion of bankside vegetation and impacts on reedbeds.**

It has been suggested that **Canada geese** may compete with native waterfowl and other species for nest-sites, feeding and roosting areas. Palmer (1976) commented on their intolerance to other species during the breeding season. Anecdotal reports suggest that **Canada geese** may drive away ducks *Anas* species and mute swans *Cygnus olor* (Giles 1992) and may compete with wigeon *Anas penelope* for grazing (Hughes & Watson 1986).

There is perhaps better evidence for impacts in the Arctic, where impacts on breeding waders have been recorded, due to increasing numbers of **Canada geese** creating areas of bare mud (Swift *et al*. 2017).

Hybridisation with other geese (Welch *et al*. 2001), has also been suggested as a possible route of impact on species such as native greylag geese, if **Canada geese** were to expand their range in Scotland where native greylag geese are present. **Canada geese** have been recorded hybridising with at least 16 other species of *anatidae* (Rehfisch *et al*. 2006). However, Fabricius *et al*. (1974), suggest that such impact will be small, and that **Canada goose** and native greylag goose are likely to reside successfully alongside each other.

It is also possible that high densities of **Canada geese** on waterbodies may result in erosion of bankside vegetation and potentially reduce the sizes of reedbeds (Josefsson & Andersson 2001). These could conceivably impact on other waterfowl or wading species that use this habitat. They are also reported trampling the nests of other species (e.g. Allan *et al*. 1995) but quantification of any impact was not reported.

4.1.2.2   Prevention of serious damage (GL2)

- **Crop damage by goose trampling and indirectly through puddling resulting in soil compaction has not been demonstrated convincingly, nor do faeces deter grazing stock, but where consumption of crops evidently reduces yields this causes conflict with farmers.**

- **Studies show that it is difficult and expensive to assess the precise impacts of feeding on yield loss because of other sources of variation. Damage by Canada geese has rarely been quantified, or financially evaluated, and no national assessment has been attempted in the UK. However, there is some evidence to suggest that localised damage could be severe and incur significant costs to the farmer or landowner.**

(a) Trampling and puddling effects

Foraging geese have the potential to cause direct structural damage to plants through the removal of foliage, stolons, roots and other plant parts. In addition, their webbed feet could cause further damage to plant structures, especially young green growth by 'trampling' and through the indirect effects on soil compaction, especially to crop plants often grown on damp substrates. Puddling may cause surface soil compaction, resulting in changes in the properties of the soil, which may affect plant growth.

Few studies have measured impacts of trampling and puddling damage to crops for any species of waterfowl; existing studies mainly refer to potential but undetermined adverse effects of trampling (e.g. Kahl & Samson 1984, Owen 1990). Trampling and puddling effects are challenging to investigate by artificially replicating them in controlled experiments, making it difficult to quantify any consequences for crop production. An exception is Summers (1990) who carried out experimental clipping of plants with additional trampling by humans to determine the relative importance of defoliation verses trampling.

The potential for soil puddling by **Canada geese** on farmland is considered highest under wet conditions. Reed (1974) reported that the combination of wet conditions and **Canada goose** and lesser snow goose trampling may have a puddling effect on the soil, causing tillers of winter cereals to be more exposed to extraction by geese. In contrast, Groot Bruinderink (1989) found no significant effects of trampling or puddling regardless of soil type or moisture.

In an experimental study on other geese species (greylag and pink-footed geese) in Scotland (Abdul Jalil & Patterson 1989), experimentally clipped plots of autumn-sown Barley were compared with plots grazed and trampled by geese. No significant difference in the yield at harvest was found. In addition, studies designed to measure the direct consequences of goose trampling have not found significant effects on final yield (Groot Bruiderink 1989, Summers 1990). These findings suggest that trampling on grass and cereals in winter and early spring probably has no significant effects on final yield (Kear 1970, Groot Bruinderink 1989, Teunissen 1991).

(b) Direct crop damage

There is little information concerning the direct impact on yield and the associated financial cost of crop damage by **Canada geese** in the UK. **Canada geese** have been recorded feeding in stubble fields, on root crops and grazing newly-sprouted winter cereals (White-Robinson 1984, Owen 1991). Despite this there have been few studies of the effects of grazing by **Canada Geese** on crop yields. Kear (1970) reported no significant grain losses attributable to winter or spring grazing by **Canada geese**, although White-Robinson (1984) concluded that significant damage can occur in certain situations. Simpson (1991) cited instances of crop damage in the UK costing £15,000 and yield losses of 20% on winter cereals continuously grazed by **Canada geese**, although no details are given. **Canada geese** in the UK were reported as being largely sedentary and mainly occur in parks and other areas with water-based human activities (Blair *et al*. 2000), in which case, incidents of agricultural crop damage may not have been widespread as a consequence. However, their behaviour is changing with the development of regular migratory movements (Dennis 1964, Forrester *et al*. 2007) and their range spreading including into more semi-natural habitats (e.g. moorland; Garnett 1980, Forrester *et al*. 2007, Section 4.1) and so the potential for damage to crops and other habitats could increase.

In North America, Borman *et al*. (2002), estimated that **Canada goose** grazing reduced grain yields by 19, 7 and 5%, depending on timing, intensity and extent of grazing. In south Dekota, the Department of Game, Fish and Parks spent >$500,000 a year managing issues relating to crop damage caused by grazing **Canada geese** (Dieter *et al*. 2014). Yield losses of 15-70% following grazing of sprouting winter wheat have been recorded (Bell & Klimstra 1970, Kahl & Samson 1984, Flegler *et al*. 1987), and a 40-80% biomass loss in rye grass (Conover & Kania 1991). When **Canada geese** grazed dormant winter wheat no significant yield losses was measured by Pirnie (1954).

In areas with low nutrient levels, the presence of **Canada geese** is thought to have resulted in improved yields of winter wheat due to fertilisation of the soil with their droppings (Bell & Klimstra 1970). Grazing by migrant **Canada geese** in the St Lawrence Valley, Canada did little damage to crops (Reed *et al*. 1977), whilst grazing is thought that have improved the yield of rye grass seed in another study (Clark & Jarvis 1978).

(c) Direct effects of droppings

Canada geese produce about 175 g of faeces a day^{-1} (Kear 1963), so areas subject to heavy grazing can receive an application of 0.3 droppings m^{-2} day^{-1} (Groot Bruinderink 1989). Complaints that stock are dissuaded from foraging on pasture fouled by geese have been made (Kear 1963). Choice tests on penned sheep showed that grass was avoided in the presence of very fresh goose faeces, but that fouled pasture would still be grazed, and avoidance was short-lived and unlikely to cause losses to farmers (Rochard & Kear 1968).

(d) Water quality

Where resident goose populations are sizeable (>100 birds), there is evidence that the continuous influx of nutrients contained in **Canada goose** faeces can contribute to the eutrophication of small water bodies, especially those that have restricted circulation and flow-through, which in turn may stimulate algae and weed growth (Conover & Chasko 1985, Manny *et al*. 1994). Blue-green algal toxins are hazardous to fish, domestic animals and humans (National Rivers Authority 1990). **Canada geese** have also been reported to damage reed beds by trampling and consuming young shoots and rhizomes of *Phragmites australis* (Wall 1984), and vegetation such as willows *Salix* species resulting in bank erosion. A study at Brown Moss, an SSSI in Shropshire and a site designated in part for its macrophyte interest, identified that restoration of the site would be very difficult because of a high nitrogen budget (Chaichana *et al*. 2010, 2011). This is dominated by run-off from agricultural nitrogen inputs, though for a short period, **Canada geese** made a major contribution.

4.1.2.3   Public health, public safety and spread of disease (GL3)

- **The presence of slippery droppings can be a nuisance, especially on paths, playing fields or golf courses, as can possible aggression from nesting adults.**

- **There is concern that the presence of large numbers of Canada geese in close association with people, for example in urban parks, could be a natural reservoir for zoonotic pathogens. Introduced resident Canada geese in urban and suburban North America can potentially transmit *Campylobacter* and Avian Influenza through human contact with faecal deposits and contaminated water. Canada geese are also suspected of transmitting *Salmonella* to cattle.**

(a) Public health and safety concern

Beaches and other public areas littered with accumulated goose faeces have been closed due to the contamination or the threat of personal injury resulting from falls as people lose footing on the slippery material. During nesting and brood-rearing, aggressive geese have bitten and chased people and injuries have occurred due to people falling or being struck by wings (Conover & Chasko 1985).

(b) Disease concern

Canada goose faeces host several human pathogens, but there is little conclusive evidence for transmission to humans (Allan *et al*. 1995, Feare *et al*. 1999). Kassa *et al*. (2004) suggest that direct contact with contaminated animals, faeces or surfaces could lead to parasitic infection with *cryptosporidium*, a cause of diarrhoea. Jansson *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. **Canada geese** are also one of many potential host species for avian influenza (Kuiken *et al*. 2006). Public beaches in the US have been closed by local health departments due to excessive faecal coliform levels that in some cases have been traced back to geese and other waterfowl (Allan *et al*. 1995).

4.2 Ruddy Duck

4.2.1 Status and change in distribution / abundance

Ruddy duck is a non-native species that was accidentally released in England in the 1950s. Their recent occurrence is localised in the central belt, Fife and Tayside, and the species has declined markedly as a result of targeted culls (Smith *et al.* 2005). Between the two most recent Atlas periods (1988-91 and 2007-11), **ruddy ducks** also bred in the Borders, the North-east and Orkney but had been removed from those areas by the latest atlas period.

Ruddy duck is on the list of species that have decreased markedly on account of its 61% decrease in occupied hectads during the breeding season and >99% decrease in winter abundance since 1998/99.
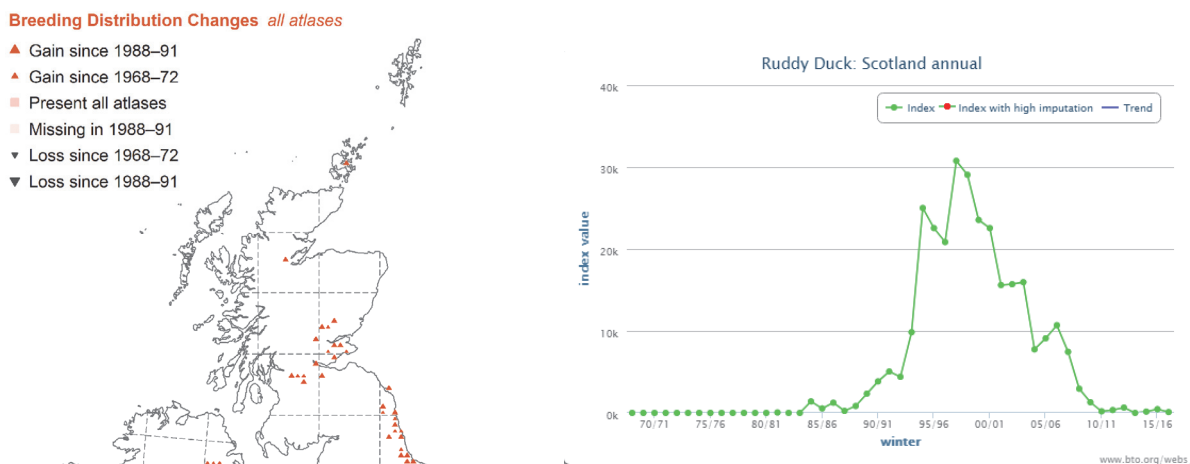

Figure 4.2.1 ***Ruddy Duck****: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trends (with annual indices also plotted) for winter abundance in Scotland 1993-4 to 2016-17 (WeBS).*

4.2.2 Systematic review findings

4.2.2.1 Impact on the conservation of wild birds (GL1)

(a) Impact on white-headed duck

- **Hybridisation with Western Europe's most important breeding population of white-headed duck may lead to genetic introgression and extinction of white-headed duck.**

The **ruddy duck** *Oxyura jamaicensis*, a stifftail native to the Americas, was introduced to the UK in the 1950s and has since been recorded in over 22 western Palearctic countries and by 2000, the UK population peaked at nearly 6,000 individuals (Muñoz-Fuentes *et al*. 2005). At this time, around 95% of the feral European population of **ruddy duck** occurred in the UK. In 1991, hybridisation with the native and globally threatened (IUCN Endangered) white-headed duck *Oxyura leucocephala*, a stifftail restricted to the Mediterranean and Asia, was recorded in Spain and culling of hybrids and **ruddy ducks** began. There were suggestions, principally in the popular media that **ruddy ducks** and white-headed ducks hybridised because they were not distinct species and also that **ruddy ducks** could have been natural colonists. However, a series of genetic studies described below provided evidence that they were distinctive species, their origin from captive sources and supported management decisions to control **ruddy ducks**.

Substantial divergence in mitochondrial DNA control region sequences and fixed differences between white-headed ducks and **ruddy ducks** across multiple nuclear introns, indicate that they are distinct species (McCracken & Sorenson 2005, Muñoz-Fuentes *et al*. 2007). In fact, the two species are not each other's closest relatives (McCracken & Sorenson 2005). To determine the origin of **ruddy ducks** in Europe, mitochondrial DNA and microsatellite data (Muñoz-Fuentes *et al*. 2005) were used to study the genetic structure and variability in **ruddy ducks** from North America, Europe and from the contemporary European captive population, descending from seven North American birds imported to Great Britain in 1948. Muñoz-Fuentes *et al*. (2003, 2006) found that wild **ruddy ducks** in European (sampled populations included Iceland, France, Spain and the UK) were more similar to the captive UK population than to wild birds in North America. These analyses also found that seven birds from North America would suffice to provide the genetic diversity seen today in the European population. This ruled out the possibility that natural arrivals of **ruddy ducks** from North America to Europe led the establishment of a European population (Muñoz-Fuentes *et al*. 2006).

4.3 Magpie

4.3.1 Status and change in distribution/ abundance

Occurs across southern, central and north-eastern Scotland and is generally most abundant across the lowland central belt. It is generally absent from large parts of the Highlands and islands but has recently started to colonise some areas (e.g. breeding in Caithness and present on Mull). Between 1990 and 2010, **Magpies** became more abundant within the central belt and in the north-east and expanded their range within the Borders, Galloway, Fife, Angus and more locally in Argyll. Range expansion is reported to have often been into more upland areas via valleys. Over the same period, a few localised losses in range were recorded, for example in Easter Ross. The distribution and changes in relative abundances of **Magpies** in the breeding season and in winter are broadly similar.

Magpie is included on the list of species that have increased markedly on account of its 60% increase in occupied hectads during the breeding season (noting also a similar change in winter distribution) and a 48% increase from the BBS trend since 1995.
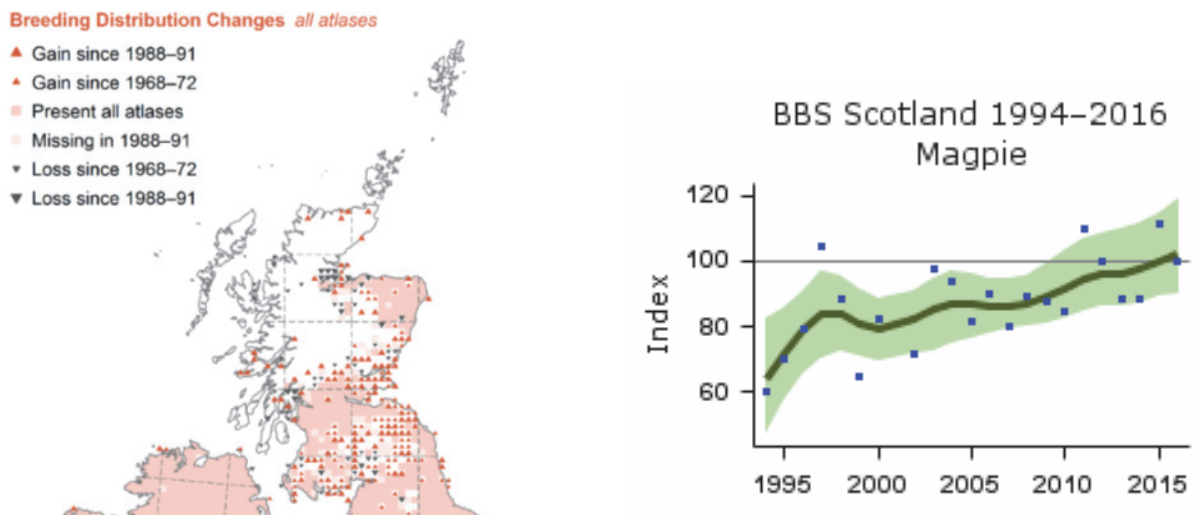
*Figure 4.3.1 **Magpie**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.3.2 Systematic review findings

4.3.2.1 Impact on the conservation of wild birds (GL1)

- **An opportunistic species, for which the eggs and young of wild birds form part of its diet**

- **There is some evidence that magpies can reduce the local productivity and abundance of prey species, where they occur at high density**

- **Analyses of large-scale and extensive national monitoring data provide little evidence for national-scale impacts of magpies on avian prey populations but most studies do not assess the impact of magpies alone**

For interpreting the impact of **magpies** and other corvids considered in this review on the conservation of wild birds, it is important to consider whether predation is likely to reduce the number of breeding individuals of the prey species, at either a large-scale or local level to levels below those that would occur in the absence of that predation, i.e. whether predation is having a limiting effect on that species. This is not necessarily a straightforward question to address, because where predator management takes places, the overall predation rate may not change, because of compensatory predation by other predator species (e.g. Bodey *et al*. 2011). This is further supported by a review on the impacts of corvids on bird productivity and abundance, where removing corvids was significantly less effective than removing corvids and other predators (Madden *et al*. 2015). In addition, many studies involve the management of multiple predator species simultaneously, so in many cases it is not possible to determine the impact of a single predator species on a single prey species.

(a) Impact on wader productivity

The use of temperature loggers in nests to determine timing of predation events and, in some cases, video cameras has indicated that predation of lapwing *Vanellus vanellus* eggs is attributable largely to mammals, whilst chicks are taken by both mammals and birds (e.g. Bolton *et al*. 2007a, Eglington *et al*. 2008, Teunissen *et al*. 2008). Identification of predatory species, particularly for chicks, can be problematic but for mammals the key predators of lapwing clutches are foxes, and at some sites, small mustelids such as stoat *Mustela erminea* (e.g. Bellebaum & Bock 2009). Potential impacts of avian predators appear to vary greatly between sites but include **magpie**, hooded crow, carrion crow, rook, grey heron *Ardea cinera*, buzzard *buteo buteo* and common gull *Larus canus* (Bolton *et al*. 2007b, Hudson *et al*. 1994, Klimov 1998, Teunissen *et al*. 2008).

In central Sweden, Berg *et al*. (1994) found that nest losses to predation were higher in areas overlooked by trees suitable for use as perches by avian predators, implying that birds were among the more important predators. Amar *et al*. (2011) report a negative relationship between lapwing population change and corvid abundance, while Amar *et al*. (2010) found that lapwing numbers were negatively (though not significantly) correlated with abundance of ravens *Corvus corax*. Changes in the breeding abundance of lapwing and other waders at Langholm (southern Scotland) between 1992 and 2006 were likely due to predation by generalist predators, but it is not possible to distinguish effects of corvids, red fox *Vulpes vulpes*, and other predators whose populations are controlled by gamekeepers (see below). The relative importance of different predator types may vary from one year to another (e.g. Dadam *et al*. 2014).

(b) Impact on gamebird productivity

A replicated, controlled study at two farmland and woodland sites in southern England between 1985 and 1990 (Tapper *et al*. 1996) found that Grey Partridge *Perdix perdix* breeding success and brood sizes were significantly higher when predators were controlled, compared to years without removal. This led to August partridge numbers being 75% higher and breeding numbers the next year being 36% higher. Over three years this led to breeding densities that were 2.6 times greater when predators were removed. Predators removed through trapping and shooting were predominantly red foxes, carrion crows and **magpies**. It is not, however, possible to disentangle the effects of the different predator species controlled during this study.

A controlled study in 2002-9 on mixed farmland in Hertfordshire, England (Aebischer & Ewald 2010), found that the number of grey partridges *Perdix perdix* increased significantly on an experimental site, where predators were controlled (along with several other interventions), but only slightly on a control site without predator control. This increase was apparent in spring (from fewer than 3 pairs/km^2 in 2002 to 12 pairs/km^2 in 2009, with a high

of 18 pairs/km^2 vs. approximately 1 pair/km^2 on the control site in 2002, increasing to approximately 4 pairs/km^2 in 2009) and autumn (from fewer than 10 birds/km^2 in 2002 to approximately 65 birds/km^2 in 2009, with a high of 85 birds/km^2 vs. approximately 4 birds/km^2 on the control site in 2002, increasing to approximately 15 birds/km^2 in 2009). Predators controlled were red fox, stoats *Mustela erminea*, brown rats *Rattus norvegicus*, carrion crows and **magpies**.

(c) Impact on songbirds

An experimental study at two demonstration farms, Game & Wildlife Conservation Trust's Loddington Farm in Leicestershire and Royal Society for the Protection of Birds's Hope Farm in Cambridgeshire, found that targeted management of predators including **magpie**, led to much faster increases in avian abundance than in the surrounding regions (Aebischer *et al*. 2016). More specifically the data from Hope Farm suggest that where predator densities are relatively low (<3 carrion crow and **magpie** pairs / km^2 locally, <0.2 foxes / km^2 in spring regionally), recovery of farmland birds can be achieved through habitat management alone. Where predator densities are high (>5 corvid pairs / km^2 and >1.1 foxes / km^2), as at Loddington Farm, species recovery, particularly of open-nesting species, may require predator control as well as habitat management.

In a randomised-pair study carried out in southern England in 2011-2014 at 32 paired sites of about 4 km^2 in size, Sage & Aebischer (2017) measured how nest success of hedgerow nesting passerines responded to the experimental removal of carrion crows and **magpies**. Corvids were counted using songbird territory mapping and fledged brood counts. Nest success was estimated as a brood / territory ratio for the community of songbirds in 4 km of hedgerow at each site. Carrion crows and **magpies** were still present at most removal sites, but numbers were half as high as at paired non-removal sites. Nest success was down 16% in the non-removal sites on average relative to removal sites. For open-nesting species there was no difference in nest success between site types.

A study in central Spain during the breeding season analysed the gizzard contents from 118 culled **magpies** (Diaz-Ruiz *et al*. 2015). The diet was described as the frequency of occurrence (FO) and the percentage of volume (VOL) of a certain food item and for each gizzard. The result showed that **magpies** had a generalist diet, which included a wide range of foods. Arthropods and cereal seeds were the most frequently consumed food groups (FO > 60%). Eggs and birds were consumed only occasionally (FO <6% and 17%, respectively; percentage of volume, VOL< 4%). The study concluded that birds and their eggs did not represent an important food for **magpies** in the Mediterranean agricultural environments considered in that particular study

A three-year experimental study using artificial ground nests was carried out in a highly fragmented agricultural landscape in Southern Bohemia, Czech Republic, to examine whether population density or spatial distribution of **magpie** nests contributes to the pattern of predation of dummy songbird nests (Salek 2004). Out of the total of 335 dummy nests with a known fate, predators robbed 126 (37.6%). The population density of **magpies** did not affect nest predation significantly, while nests placed closer to active **magpie** nests were predated significantly more than distant nests. The study suggested that the spatial distribution of **magpies** explained the predation pattern on experimentally treated nests.

A study in Sweden examined whether breeding habitat selection and reproduction of a tropical migrant, the red-backed shrike *Lanius collurio*, was related to the presence of breeding pairs of its potential nest predators, **magpie**, hooded crow, and jackdaw (Roos & Part 2004). Only **magpie** and hooded crow territories were associated with an elevated risk of predation based on an artificial nest experiment with nests mimicking red-backed shrike

nests. Predation risk on real red-backed shrike nests was also higher close to nests of hooded crow and **magpie** than elsewhere in the landscape.

White *et al*. (2014) analysed 11 years of nest data from 6 songbird species on three lowland farms in the UK. The different game management regimes on each farm enabled the authors to test whether systematic predator reduction (mammals and corvids including **magpie**) and sporadic corvid reduction improve nest success in songbirds. A positive effect of systematic predator reduction was recorded for 5 of the 6 songbird species. Sporadic corvid reduction had a positive effect on nest survival only for common blackbird at the nestling stage.

A study in central Spain looked at the predation rates by **magpies** of artificial bird nests located on the ground within young tree plantations and in open farmland adjacent to tree plantations (Sanchez-Oliver *et al*. 2014). Predation rates were very high at both tree plantations (95.6%) and open farmland habitat (94.2%) over a two-week period but declined with increasing area of plantation and development of the tree canopy. It was concluded that predation by **magpies** may be important in some situations, and that landscape planning should not favour tree plantations with a large edge to area ratio.

The abundance and distribution of a suite of corvids, including raven, hooded crow, jackdaw, **magpie** and jay, and predation of artificial nests were studied across a gradient from a landscape dominated by agricultural land to a landscape dominated by forest in south-central Sweden (Andren 1992). The total density of corvids and the predation rate on dummy nests increased as the proportion of agricultural land increased. However, different species of corvid responded differently to the proportion of woodland in the landscape. Jay and raven *Corvus corax* were absent from small forest fragments in a matrix of agricultural land and mainly preyed upon dummy nests inside the large forest fragments. **Magpie** and jackdaw showed a strong preference for agricultural land and they mainly preyed upon dummy nests in agricultural land. Hooded crow occurred in equally in both agricultural land and forest, and regularly preyed upon nests in both forest habitat and agricultural land. It was concluded that the hooded crow was the most important nest predator in the corvid family, although dummy nests were preyed upon by all corvid species.

An experimental study using artificial nests and wildlife cameras (n=104) was carried out in agricultural landscapes during 2015-2016 in South Finland (Kruger *et al*. 2018). During an 8-day period, 39.4% of the artificial nests were predated. Fifty percent of the predators were birds, 40% mammals, and 10% remained unknown. The three dominant predators of these artificial nests were the raccoon dog *Nyctereutes procyonoides* with 11 nests, and hooded crow and **magpie**, with 10 depredated nests each. The analyses indicated that avian predators preyed upon nests in open fields further away from the forest edge, whereas mammalian predation concentrated closer to the forest edge.

The effect of mowing on next-year nest predation was studied using artificial nests in grassland areas on the outskirts of Cracow, south Poland in 2004 and 2005 (Ejsmond 2008). Birds destroyed 29% (17) of 60 dummy eggs, where the size of the beak marks indicated **magpie**. Locations with greater vegetation cover had a lower predation pressure.

An experimental study in urban parkland in Manchester, UK, using plasticine eggs added to active blackbird *Turdus merula* clutches was carried out to estimate the rates of **magpie** predation on blackbird nests (Groom 1993). In this area, the breeding densities of **magpie** were higher than those previously recorded in other urban sites. Fewer than 5% of blackbird nests fledged young. Where a cause could be identified, predation was responsible for most nest failures, although most nests failed for unknown reasons. Of identified predation, the majority was attributable to **magpies**.

An experimental study using artificial ground and shrub nests was carried out in 38 grassland plots in south-central Sweden to examine whether predation risk was influenced by nest site, proximity to forest edge, and habitat structure (Söderstrom 1998). There was a clear separation of predator faunas between shrub and ground nests as identified from marks in plasticine eggs. Corvids accounted for almost all predation on shrub nests whereas mammals mainly depredated ground nests. Nest predation risk was significantly greater for shrub than for ground nests at all distances (i.e. 0, 15 and 30 m) from the forest edge. However, nest predation risk was not significantly related to distance to forest edge, but increased significantly with decreasing distance to the nearest tree. Different corvid species robbed nests at different distances from the forest edge, with jays robbing nests closest to edges and **magpies** in more open areas.

A comparison of productivity and relative densities of songbirds was carried out according to a before-after, control treatment experimental **magpie** removal in the suburbs of Paris, France over a three-year period (Chiron & Juilliard 2007). Despite very high densities of **magpies** in urban parks, this study found no detectable change in productivity or density of songbirds, with the removal of **magpies**.

Analyses of large-scale and extensive national monitoring data provides little evidence that **magpies** have driven UK-scale declines in songbird populations (Gooch *et al*. 1991, Thomson *et al*. 1998, Newson *et al*. 2010). However, these studies cannot exclude the possibility that impacts can be significant at a local scale.

BTO Nest Record Scheme data were used to examine the large-scale spatial variation in reproductive output of the song thrush *Turdus philomelos* and the blackbird in Great Britain (Paradis *et al*. 2000). Brood size and nest failure rates during the incubation and nestling periods were related to environmental factors using generalized linear models. Nest failure rate during incubation increased significantly where the combined frequency of occurrence of **magpie** and jay from the 1988-91 BTO Atlas (Gibbons *et al*. 1993) was higher, suggesting a role for avian nest predators in determining spatial variation in reproductive output. The authors did not look at the relative importance of the two corvids.

4.3.2.2   Prevention of serious damage (GL2)

- **There was little evidence that magpies impact on livestock or crops.**

In a before and after experiment in Ireland, McNamera *et al*. (2002) examined the incidence of bird damage to silage bales left spread out on grass-stubble fields. Damage was at least partly attributed to corvids, but there was no specific mention of the likely species involved.

A questionnaire survey of corvid trap users in Scotland, commission by SNH (Reynolds 2016), found that livestock issues mainly concerning sheep, with lambs and ewes stuck on their back and unable to rise and being susceptible to attack from corvids were most frequently mentioned by respondents (62%). Damage to cereal crops, were also mentioned by 25% of respondents, in relation to both newly-drilled and mature crops. More rarely, other issues mentioned included damage to animal feed, poultry, eggs, fruit and vegetables. With close to nothing published on the impacts of magpies on livestock and crops, we cannot exclude the possibility that this represents an evidence gap, rather than providing evidence for no impact.

4.3.2.3   Public health, public safety and spread of disease (GL3)

- **Magpie faeces host several pathogens of humans and domestic livestock.**

Following an outbreak of human Campylobacter infection in the Gateshead area of Northern England in 1990, an extended study of Campylobacter infections was carried out (Hudson *et al*. 1991). Interviews with 52 people infected, found a very strong association between the consumption of pecked milk bottle tops and human campylobacter infection. Isolates of Campylobacter were made from the bill and cloaca of **magpies** and jackdaws. In addition, Campylobacter was isolated from 12 of 123 pecked milk bottles. It was concluded, that milk bottles pecked by **magpie** and jackdaws were probably the source of human Campylobacter infection in the Gateshead area. A further study on the molecular epidemiology of Campylobacter in Northern England, which included samples from 71 **magpies,** concluded that the absence of unique wild bird strains of *Campylobacter* suggested that the direction of infection was predominantly from livestock to wild birds (Hughes *et al*. 2009).

4.4 Carrion and Hooded Crow

4.4.1 Status and change in distribution / abundance

4.4.1.1 Carrion crow

Occurs in the breeding season across most of Scotland but is generally absent from many areas in the westernmost Highlands and islands, where it is replaced by the **hooded crow**. A zone occupied by hybrids between the two species (or races, depending on the taxonomic classification being followed) has shifted westwards in recent decades, with the most marked shift being in the north but relatively little changed in the south (where physical boundaries such as the Firth of Clyde perhaps restrict its movement). **Carrion crows** are most abundant in the southern, eastern and central lowlands and have expanded their range into the west Highlands and also Orkney, mostly into areas that were occupied by **hooded crows**. There have been some decreases in the central and eastern Highlands with any increases mostly within lowland landscapes. Despite an expansion in range, overall the abundance of **carrion crows** has changed relatively little in recent decades but a modest decline was apparent since 2006. During winter, **carrion crows** are more widespread occurring outside of their current breeding range in the west and north, including Shetland. **Carrion crow** is included on the list of species that have increased locally.

*Figure 4.4.1.1 **Carrion Crow**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.4.1.2 Hooded crow

Occurs in the breeding season throughout much of the Highlands and islands and also in some parts of north-east Scotland. Some apparent recent increase in the north-east could potentially be an artefact of changing recording criteria for hybrids with **carrion crows**. Otherwise, **hooded crows** have generally contracted westwards, often replaced by, and hybridising with, **carrion crows** (see above). In winter, the range (and changes) are similar to that in the breeding season but also includes dispersing and migrant individuals in the southern and eastern lowlands but numbers are typically small.
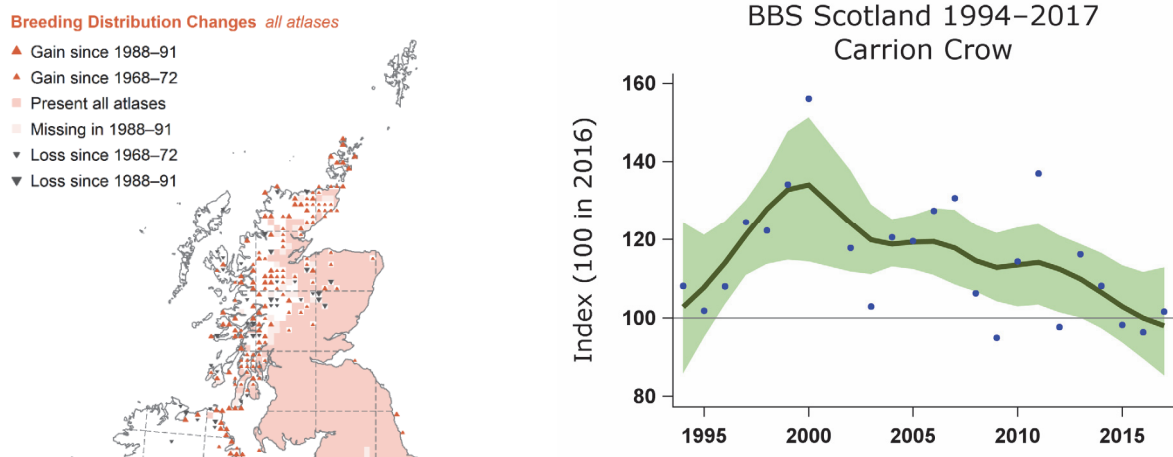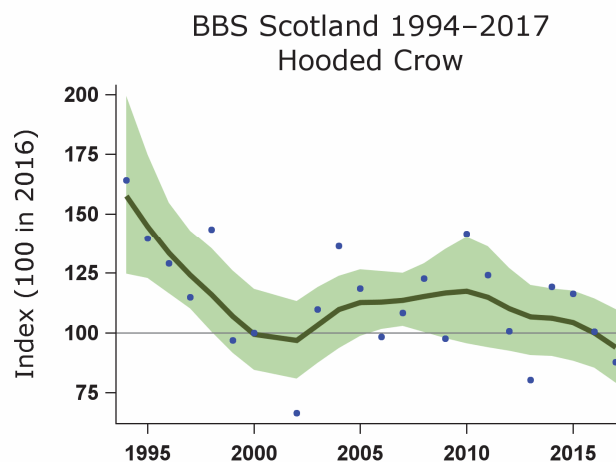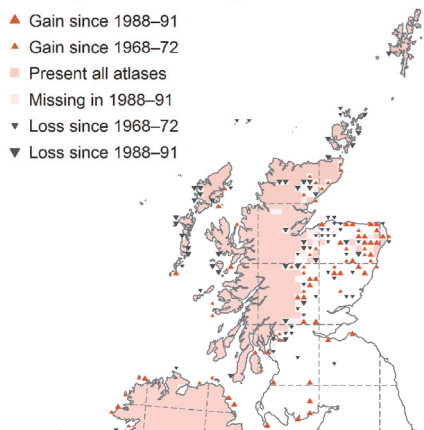
*Figure 4.4.1.2 **Hooded Crow**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.4.2   Systematic review findings

In the following section, we have considered the literature for **carrion** and **hooded crow** together. There is no reason to expect the impact of these two very closely related species would be different, but it is also difficult to determine which of the two species is being considered in some studies.

4.4.2.1   Impact on the conservation of wild birds (GL1)

- **The eggs and young of wild birds form a substantial part of the mixed diet of these two ecological similar opportunistic predators and scavengers, which are frequently specialist egg finders.**

- **There is evidence that carrion and hooded crows can reduce the local productivity and abundance of prey species where carrion or hooded crow occur at high density, particularly of waders and gamebirds.**

- **Analyses of large-scale and extensive national monitoring data provide little evidence for national-scale impacts of carrion / hooded crows on songbird populations.**

(a) Impact on breeding waders

There is considerable evidence to demonstrate an effect of predators on ground nesting waders and positive effect resulting from the control of predators, notably **carrion crows** and foxes (e.g. Bolton *et al*. 2007b; Baines *et al*. 2008; Fletcher *et al*, 2010), however the relative influences of just one predator species (or the effects of it being controlled) are difficult to separate. Two major studies in the British uplands, one in northern England (a paired site study where control of predators was switched experimentally; Fletcher *et al*. 2010) and one in southern Scotland (where waders were monitored during successive periods with and without control of predation) demonstrated positive effects in both breeding success and numbers of waders in response to the control of predators.

In Northumberland, a replicated, randomised, paired site study from March-July in 2000–2008 in two pairs of plots (9.3 – 14.4 km^2) found that plots where predators were controlled displayed increased density and fledgling success of breeding birds (Fletcher *et al*. 2010). Reductions in red fox and **carrion crows** led to an average threefold increase in the percentage of pairs fledging young of lapwing, golden plover and curlew (also red grouse *Lagopus lagopus scoticus* and meadow pipit); and subsequently led to increases in breeding numbers (≥ 14%/year) of lapwing, curlew, golden plover and red grouse, all of which declined in the absence of predator control (≥ 17%/year). Predator culling reduced the abundance of fox by 43% and **carrion crow** by 78% but had little effect on mustelids which were already scarce.

In southern Scotland, numbers of breeding lapwing in a study area near Langholm declined from 0.38 pars per km^2 between 1992-99 (when predators were actively controlled) to 0.01 per km^2 when control was very much reduced (Baines *et al*. 2008). Golden plover *Pluvialis apricaria* also declined from 0.38 to 0.21 individuals per km^2 after cessation of predator control. These reductions were largely attributed to predation by **carrion crows** and red foxes; **carrion crow** abundance increased to approximately four times than was present under active management for gamebirds. Although red fox abundance was not monitored prior to 2000, the number of scats (used as a relative measure of abundance) increased approximately three-fold between 2002 and 2005. No information on mustelid abundance or population trends during this time is available. Correlational evidence suggests that populations of curlew and other species of wader breeding on moorland, unlike populations of meadow pipit *Anthus pratensis* and skylark *Alauda arvensis*, were not adversely affected by raptor predation (some of which increased during periods of generalist predator control; Amar *et al*. 2008), but in the subsequent period, when the intensity of predator management was reduced, the density of curlew and other waders declined abruptly (Baines *et al*. 2008). Determining the cause of these declines is complicated by the fact that control of fox, stoat, weasel *Mustela nivalis* and **carrion crow** as well as heather burning, all stopped at the same time, and the response of most of these predators to relaxation of control was not well monitored. Other correlational studies in Scotland have suggested a likely negative impact of predation (by **hooded crows** and foxes) on breeding waders but it has proven difficult to separate the effects of land management (Calladine *et al*. 2014) or to account for compensational responses by other predators and at different stages of the breeding season or longer life-cycle (Calladine *et al*. 2017).

In lowland wet grasslands, a replicated 8-year cross-over experiment examined the effect of fox and **carrion crow** control on nests, breeding success and population trends in Lapwing at 11 sites (Bolton *et al*. 2007b). Predator control was carried out over four years at each site and compared with four years without predator control. The effect of predator removal on nest survival was dependent on the background densities of foxes and **carrion crows**, with the greatest improvement in nest survival at those sites with the highest (before control) predator densities. There was no consistent effect of predator control on chick mortality but the authors noted that the subset of sites chosen for chick monitoring tended to have lower densities of predators. However, at the remaining sites, the proportion of adults with young (another measure of breeding success), doubled in years of predator control indicating that predator removal in areas with high predator densities can positively impact on breeding success. There was some evidence for improved population trends following predator removal, but it was not possible to distinguish between effects of productivity and mortality, and those of movement in and out of sites, making it hard to circumscribe the population-level effects of the experiment.

A study of breeding curlew in two areas in Northern Ireland, where productivity was too low to sustain populations in some (Lough Erne, in the south-west) or all years (Antrim, in the north-east), identified predation as the main cause of breeding failure (Grant *et al*. 1999). The importance of predator type varied between different areas, being dominated by large

gulls and corvids in Lough Erne, with mammals (particularly red fox) being more important in Antrim (Grant *et al*. 1999). Control of **carrion crow** and common gull increased the hatching success of moorland breeding Curlew in Scotland (Parr 1993).

(b) Impact on gamebirds

A controlled before-and-after study in northern Scotland between 1989 and 1999 (Summers *et al*. 2004) found that the breeding productivity of capercaillie and 'survival' rates of 48 artificial nests were higher during the last three years (1994-6) of predator removal, compared to nine sites without predator removal. However, in the previous two years of predator removal (1992-3) and years without removal (1989-91, 1997-9), productivity was lower on the experimental site. In non-removal years, productivity averaged 0.1 chicks per female, compared with 1.4 chicks per female in removal years. Predator removal involved trapping **carrion crows** (a total of 368) and shooting red foxes (a total of 22 adults and 52 cubs).

Summers *et al*. (2004) assessed black grouse *Tetrao tetrix* productivity in relation to weather, vegetation, deer numbers and predator control over a period of 11 years in Abernethy Forest in Scotland. They found that there was a negative association between the number of breeding pairs of **carrion crows** and a measure of breeding success by black grouse. The same study also found that predations rate on artificial nests was higher where there were more **carrion crows**.

A replicated, controlled study at two lowland mixed farmland and woodland sites in southern England between 1985 and 1990 (Tapper *et al*. 1996) found that grey partridge breeding success and brood sizes were significantly higher when predators were controlled, compared to years without removal. This led to August partridge numbers being 75% higher and breeding numbers the next year being 36% higher. Over three years this led to breeding densities that were 2.6 times greater when predators were removed. Predators removed through trapping and shooting were predominantly red foxes, **carrion crows** and magpies. It is not, however, possible to disentangle the effects of the different predator species controlled during this study.

A study on the predation rates of willow grouse *Lagopus lagopus* and black grouse in northern Norway (Einarsen *et al*. 2008) found that predation rates were attributable mainly to two generalist species: red fox (19.2%) and **hooded crow** (7.5%). Predation appeared dependent on the successional stage of spruce plantations, with areas near clearings (63.5%) and open spruce plantations (59.8%) experiencing higher predation pressures than closed spruce plantations (45.3%).

A controlled study on Karlsøy Island (7.7 km^2), Norway, in 1978-81 (Parker 1984), found that removing **hooded crows** and ravens from an experimental area did not decrease predation of black grouse nests, compared to control areas (49 nests studied). Predation of willow grouse nests was lower in the first year of the experiment (21 nests studied) but not in the next three (total of 214 nests). The author suggests that compensatory predation by stoats may have prevented corvid removal from having an effect.

Spatial variation in productivity of capercaillie *Tetao urogllus* has been related to **hooded crow** and red fox (though not pine marten *Martes martes*) abundance (Baines *et al*. 2004, 2011a). However, Baines *et al*. (2011b) reported a negative correlation between capercaillie productivity and abundance of corvids and pine marten, and several studies in Scandinavia have shown that pine marten can reduce capercaillie breeding success (e.g. Kastdalen & Wegge 1989, Kurki *et al*. 1997).

A nine-year experimental study of red grouse *Lagopus l. lagopus* predation (Fletcher *et al*. 2013) included an assessment of predator abundance at each of the four study sites (and, hence, a measure of the effectiveness of predator control). Breeding success was most strongly affected by the abundance of corvids (which were the group of predators most effectively targeted by control), but mammals also affected numbers, with abundance of red fox impacting negatively on breeding success, and small mustelid abundance impacting negatively on over-summer adult survival.

(c) Impact on productivity of Hen Harrier

A randomised, replicated and controlled study in 1999-2000 on Orkney Mainland, Scotland (Amar & Redpath 2002) found that the breeding success of hen harriers *Circus cyaneus* was no different in nine territories where **hooded crows** were removed, compared to territories without crow removal. The number of clutches per male, clutch size, hatching success and laying date were not affected, although experiments with artificial nests containing chicken eggs showed that predation could be reduced by **hooded crow** removal (12 of 18 clutches surviving vs. two of 18). A total of 113 **hooded crows** were removed from the nine territories. As islands, the Orkney study areas had a very limited suite of ground predators with no foxes or stoats (at the time of the study) and therefore was not necessarily as confounded by cumulative effects of multiple predators or by compensatory responses by non-controlled predators as with many studies on mainland Britain.

(d) Impact on songbirds

An experimental study at two demonstration farms, Game & Wildlife Conservation Trust's Loddington Farm in Leicestershire and Royal Society for the Protection of Birds's Hope Farm in Cambridgeshire, found that targeted management of predators including **carrion crows**, led to much faster increases in avian abundance than in the surrounding regions (Aebischer *et al*. 2016). More specifically the data from Hope Farm suggest that where predator densities are relatively low (<3 **carrion crow** and magpie pairs per km^2 locally, <0.2 foxes per km^2 in spring regionally), recovery of farmland birds can be achieved through habitat management alone. Where predator densities are high (>5 corvid pairs per km^2 and >1.1 foxes per km^2), as at Loddington Farm, species recovery, particularly of open-nesting species, may require predator control as well as habitat management.

In a randomised-pair study carried out in southern England in 2011-2014 at 32 paired sites of about 4 km^2 in size, Sage & Aebischer (2017) measured how nest success of hedgerow nesting passerines responded to the experimental removal of **carrion crows** and magpies. Corvids were counted using songbird territory mapping and fledged brood counts. Nest success was estimated as a brood/territory ratio for the community of songbirds in 4 km of hedgerow at each site. **Carrion crows** and magpies were still present at most removal sites, but numbers were half as high as at paired non-removal sites. Nest success was on average 16% lower in the non-removal sites relative to removal sites. For open-cup nesting species as a group, there was no difference in nest success between site types.

A study in Sweden examined whether breeding habitat selection and reproduction of a tropical migrant, the red-backed shrike, was related to the presence of breeding pairs of its potential nest predators, magpie, **hooded crow**, and jackdaw (Roos & Part 2004). Only magpie and **hooded crow** territories were associated with an elevated risk of predation based on an artificial nest experiment with nests mimicking red-backed shrike nests. Predation risk on real red-backed shrike nests was also higher close to nests of **hooded crow** and magpie than elsewhere in the landscape.

White *et al*. (2014) analysed 11 years of nest data from 6 songbird species on three lowland farms in the UK. The different game management regimes on each farm enabled the authors

to test whether systematic predator reduction (mammals and corvids) and sporadic corvid reduction improve nesting success in songbirds. A positive effect of systematic predator reduction was recorded for 5 of the 6 songbird species. Sporadic corvid reduction had a positive effect on nest survival only for common blackbird at the nestling stage only.

The abundance and distribution of a suite of corvids, including raven, **hooded crow**, jackdaw, magpie and jay, and predation of artificial nests were studied across a gradient from a landscape dominated by agricultural land to a landscape dominated by forest in south-central Sweden (Andren 1992). The total density of corvids and the predation rate on dummy nests increased as the proportion of agricultural land increased. However, different species of corvid responded differently to the proportion of woodland in the landscape. Jay and raven were absent from small forest fragments in a matrix of agricultural land and mainly preyed upon dummy nests inside the large forest fragments. Magpie and jackdaw showed a strong preference for agricultural land and they mainly preyed upon dummy nests in agricultural land. **Hooded crow** occurred in equally in both agricultural land and forest, and regularly prey upon nests in both forest habitat and agricultural land. It was concluded that the **hooded crow** was the most important nest predator in the corvid family, although dummy nests were preyed upon by all corvid species.

An experimental study using artificial nests and wildlife cameras (n=104) was carried out in agricultural landscapes during 2015-2016 in South Finland (Kruger *et al*. 2018). During an 8-day period, 39.4% of the artificial nests were predated. Fifty percent of the predators were birds, 40% mammals, and 10% remained unknown. The three dominant predators of our artificial nests were the raccoon dog *Nyctereutes procyonoides* with 11 nests, **hooded crow** and magpie with 10 depredated nests each. The analyses indicated that avian predators preyed upon nests in open fields further away from the forest edge, whereas mammalian predation concentrated closer to the forest edge.

Analyses of large-scale and extensive national monitoring data provides little evidence that **hooded** or **carrion crows** have driven UK-scale declines in songbird populations (Thomson *et al*. 1998, Newson *et al*. 2010). However, these studies cannot exclude the possibility that impacts can be significant at a local scale.

(e) Impact on other species

The breeding biology and causes of nest failure were examined for black-throated divers *Gavia arctica* in core areas of their Scottish breeding range in 1983-1987 (Mudge & Talbot 1993). Hatching success was consistently low with, on average, only 43% of territorial pairs managing to hatch a clutch each year; 64% of recorded nest failures occurred during the first week of the 4-week incubation period. Causes of nest failure were assessed with the aid of surveillance cameras. Approximately 30% of losses were due to water level changes (mostly floods), 48% to predators (primarily nocturnal mammals, but also **hooded crows**), 13% to human egg collectors and 5% to desertion following human disturbance.

A study of nesting success of common eiders *Somateria mollissima* was carried out at two adjacent colonies on the islands of Grindøya and Hakøya in northern Norway between 2006 and 2011 (Stien & Ims 2016). Over the study period, nesting success was consistently higher on Hakøya (69-82%) than on Grindøya (35-60%). Between 2009 and 2011 camera monitoring of individual nests was used to identify determinants of nest survival and predation. Under high levels of human disturbance only, camera monitoring indicated that the main cause of breeding failure was predation, primarily by **hooded crows**, but also to some extent great black-backed gulls.

4.4.2.2 Prevention of serious damage (GL2)

- **There was little evidence that carrion or hooded crows impact on livestock or crops.**

In a before-after experiment in Ireland, McNamera *et al*. (2002) examined the incidence of bird damage to silage bales left spread out on grass-stubble fields. Damage was at least partly attributed to corvids, but there was no specific mention of the likely species involved.

A questionnaire survey of corvid trap users in Scotland, commissioned by SNH (Reynolds 2016), found that livestock issues mainly concerning sheep, with lambs and ewes stuck on their back and unable to rise and being susceptible to attack from corvids were most frequently mentioned by respondents (62%). Damage to cereal crops, were also mentioned by 25% of respondents, in relation to both newly-drilled and mature crops. More rarely, other issues mentioned included damage to animal feed, poultry, eggs, fruit and vegetables. With close to nothing published on the impacts of **carrion** and **hooded crows** on livestock and crops, we cannot exclude the possibility that this represents an evidence gap, rather than providing evidence for no impact.

4.4.2.3 Public health, public safety and spread of disease (GL3)

- **Carrion and hooded crow faeces host several pathogens of humans and domestic livestock.**

The possible cause of disease and mortality in corvids on an outdoor pig unit in the north of England between August 2007 and March 2008 was investigated (Strugnell *et al*. 2011). Nine **carrion crows** and nine rooks, comprising five live-caught birds with clinical signs of respiratory disease, one live-caught bird without respiratory disease, and 12 birds submitted dead were examined. Clinical signs, gross and histopathological examination, microbiology and toxicology indicated that *Pasteurella multocida* infection was the cause of disease. This work suggested that corvids are potential vectors of *P. multocida* and could pose a risk to domestic poultry.

Human enteropathogens, *Cryptosporidium parvum* and *Giardia lamblia* were tested from a total of 499 faecal droppings from 308 wild, 90 captive, and 101 domestic birds using conventional, immunological, and molecular techniques (Majewska *et al*. 2009). A total of 23 (7.5%) wild birds, comprising **carrion crow** and rook tested positive for cysts, whereas 18 (5.8%) wild birds again including corvids tested positive for oocysts. Whilst *G. lamblia* cysts and *C. parvum* oocysts were found in corvids, they were significantly more frequently found in faecal droppings of free-ranging aquatic birds than in birds not normally associated with water.

Brachyspira hyodysenteriae, the cause of swine dysentery, was isolated from one **carrion crow** in close proximity to two pig farms in Switzerland (Zeeh *et al*. 2018). Further studies would be needed to determine the role of the epidemiology of this organism.

4.5 Jackdaw

4.5.1 Status and change in distribution / abundance

Jackdaws are most abundant in the eastern, central and southern lowlands but their range also extends into neighbouring upland areas and includes some islands (e.g. Islay, Colonsay, Skye and Orkney). The species has contracted from some areas in the west and central Highlands within the past 30 years (and from some other areas in the longer term e.g. Shetland), but has increased in abundance across much of its lowland range in the east. The winter distribution and changes thereof, are broadly similar to those in the breeding season.

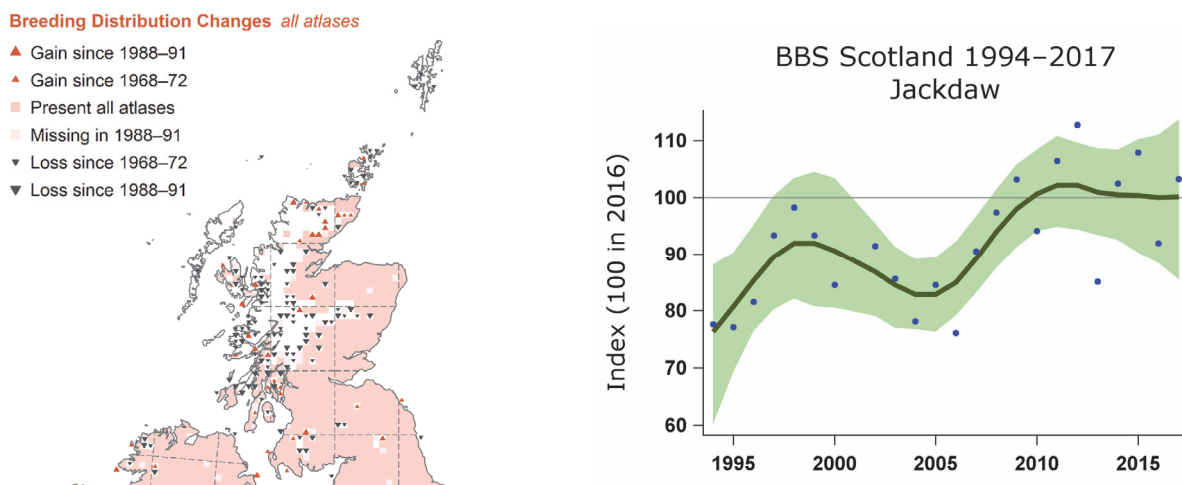**Jackdaw** is included on the list of species that have increased locally.

*Figure 4.5.1 **Jackdaw**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.5.2 Systematic review findings

4.5.2.1   Impact on the conservation of wild birds (GL1)

- **Jackdaws mainly feed on invertebrates, fruit, seeds and carrion, with eggs and young of wild birds forming a small part of a mixed diet (Lockie 1955, Robinson 2018).**

- **Jackdaws have the potential to out-compete red squirrels for artificial nest boxes where provided.**

(a) Impact on wader productivity

In a southern Swedish population of redshank *Tringa totanus*, where predation was the most common cause of breeding failure, the most commonly observed predator of redshank eggs and chicks was hooded crow, with raven, herring gull, common gull, **jackdaw**, and red fox all also observed taking eggs or chicks (Ottvall 2005).

A study on black-tailed godwit *Limosa limosa* and lapwing using temperature loggers and continuous video recording of 792 clutches was carried out in farmland in the Netherlands, to identify which species were responsible for egg predation (Teunissen *et al*. 2008). Chick

predators were identified by radio-tagging 662 chicks of the two species. In total, 22 species were identified as predators of wader eggs or chicks, of which red fox, common buzzard, grey Heron and stoat were the most frequent. Of 382 predations events, of which 242 could be assigned to species, only one event, predation at the chick stages was attributed to **jackdaw**.

(b) Impact on songbirds

An intensive territory mapping study in south-central Sweden, and experiment using artificial nests looked at whether the reproductive success of the red-backed shrike was related to the presence of breeding pairs of its potential nest predators, magpie, hooded crow and **jackdaw** (Roos & Part 2004). Only magpie and hooded crow territories were associated with an elevated risk of predation based on the artificial nest experiment.

The abundance and distribution of a suite of corvids, including raven, hooded crow, **jackdaw**, magpie and jay, and predation of artificial nests were studied across a gradient from a landscape dominated by agricultural land to a landscape dominated by forest in south-central Sweden (Andren 1992). The total density of corvids and the predation rate on dummy nests increased as the proportion of agricultural land increased. However, different species of corvid responded differently to the proportion of woodland in the landscape. Jay and raven were absent from small forest fragments in a matrix of agricultural land and mainly preyed upon dummy nests inside the large forest fragments. Magpie and **jackdaw** showed a strong preference for agricultural land and they mainly preyed upon dummy nests in agricultural land. Hooded crow occurred equally in both agricultural land and forest, and regularly preyed upon nests in both forest habitat and agricultural land. It was concluded that the hooded crow was the most important nest predator in the corvid family, although dummy nests were preyed upon by all corvid species.

Continuous video surveillance to monitor the nest fates of 42 active skylark nests in the Czech Republic, found that 22 nests were depredated by 12 species (Praus & Weidinger 2010). Of these, one nest was depredated by a **jackdaw**.

(c) Impact on other species

A study on the use of nest boxes provided for red squirrels *Sciurus vulgaris* in a coniferous woodland in Wales found that following the establishment of a **jackdaw** colony, which resulted in 86% of red squirrel nest boxes being used **jackdaws**, the use of boxes by red squirrels declined from 45% to 7% (Shuttleworth 2001).

4.5.2.2   Prevention of serious damage (GL2)

- **There was little evidence that jackdaws impact on livestock or crops.**

In a before-after experiment in Ireland, McNamera *et al*. (2002) examined the incidence of bird damage to silage bales left spread out on grass-stubble fields. Damage was at least partly attributed to corvids, but there was no specific mention of the likely species involved.

4.5.2.3   Public health, public safety and spread of disease (GL3)

- **Jackdaw faeces may host several pathogens of humans and domestic livestock.**

Following an outbreak of human *Campylobacter* infection in the Gateshead area of Northern England in 1990, an extended study of Campylobacter infections was carried out (Hudson *et al*. 1991). Interviews with 52 people infected, found a very strong association between the consumption of pecked milk bottle tops and human campylobacter infection. Isolates of

Campylobacter were made from the bill and cloaca of magpies and **jackdaws**. In addition, *Campylobacter* was isolated from 12 of 123 pecked milk bottles. It was concluded, that milk bottles pecked by magpie and **jackdaws** were probably the source of human *Campylobacter* infection in the Gateshead area.

Borna virus, a disease of sheep and horses and potentially responsible for certain psychiatric disorders in humans has been isolated from **jackdaws** and they are therefore a potential carrier (Berg *et al*. 2001).

4.6 Jay

4.6.1 Status and change in distribution / abundance

Now found across most of Scotland south and east of the Great Glen, **jays** are most abundant in the more wooded parts of the east, central and southern lowlands and also in some other more heavily wooded areas, such as Perthshire and Argyll. There has been a marked increase in range including the Southern Uplands, Central Belt, the North-east, Strathspey and the Great Glen including Morvern and Mull. There has also been a marked increase in abundance across much of its established range. Changes in the species' range in winter match those of the breeding season.

Jay is included on the list of species that have increased markedly on account of its 127% increase in occupied hectads during the breeding season (noting also a similar change in winter distribution) and a 51% increase in the BBS trend since 2006.

Breeding Distribution Changes *all atlases*
▲ Gain since 1988–91
▲ Gain since 1968–72
■ Present all atlases
□ Missing in 1988–91
▼ Loss since 1968–72
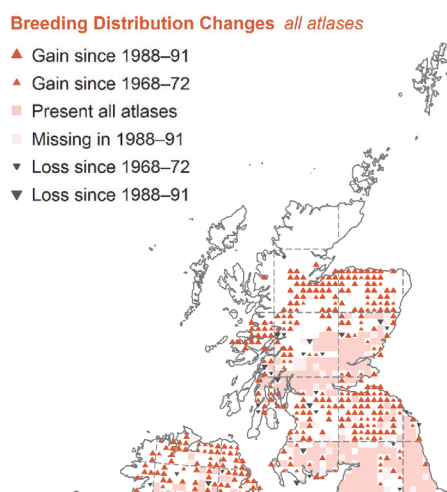▼ Loss since 1988–91

*Figure 4.6.1 **Jay**: Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas). Note that Jay has not been sufficiently abundant for a longer term Scottish trends to be plotted using BBS data.*

4.6.2 Systematic review findings

4.6.2.1 Impact on the conservation of wild birds (GL1)

- **An opportunistic species, for which the eggs and young of wild birds form part of a mixed diet. Nest predation is perhaps likely to be greatest for open-nesting birds in scrub or woodland habitats.**

(a) Impact on songbirds

Evidence for population level impacts of predation by **jays** on breeding songbirds is weak and declines are generally linked to habitat factors (Newson *et al*. 2010, Roos *et al*. 2018). However, there is evidence that the **jay** may be an important nest predator of some species of open-nesting birds. Looking at the importance of different predator species for woodland songbirds in Europe, Weidinger (2009) found that birds and mammals took roughly equal numbers of prey, with pine marten being the most important mammal predator, and **jay** being the most important bird. In England, nest predators of spotted flycatchers *Muscicapa striata*, identified with nest cameras, were mainly avian and mostly **jay**, but also commonly cat *Felis catus* (Stevens *et al*. 2008). There was evidence that this nest predation was

sufficient to contribute to the long-term population decline of woodland and farmland nesting spotted flycatchers (Stevens *et al*. 2007, 2008), although other factors such as climate change on wintering grounds have also been implicated (Ockendon *et al*. 2012). Control of a wide suite of predators was successful in increasing spotted flycatcher populations (Stoate & Szczur, 2006), although this was not attributed specifically to **jay**.

Remote cameras deployed at wood warbler *Phylloscopus sibilatrix* nests within 13 deciduous woodlands in Dartmoor, England found **jay** to be the most important nest predator. Of 66 nests, 34 were predated, of which **jay** was responsible for 21% (7 nests: Maziarz *et al*. 2018). In Wales, a comparable study on wood warbler recorded 28 predation events for which the **jay** was again the most important predator, responsible for 64% (18) of nests predated (Mallord *et al*. 2012). A study in forest edge habitat at Lake Constance in Germany used video cameras to monitor the outcome of 132 blackcap *Sylvia atricapilla* nests over four years (Schaefer 2004). Eight predators were responsible for 45 nest losses, of which the **jay** was responsible for 53% (24) of predation events in this species.

An experimental study using artificial ground and shrub nests looked at whether nest predation risk from different predators was influenced by nest site, proximity to forest edge and habitat structure in 38 grassland plots in Sweden (Söderström *et al*. 1998). Corvids including **jays** accounted for almost all predation of shrub nests, whereas mammals mainly depredated ground nests. A similar study using artificial nests in agricultural land in Sweden (Andren 1992) found that predation events by different species of corvid reflected their habitat associations and distribution, with more predation events by **jays** in woodland, more predation events by magpies and jackdaws in more open agricultural habitat, and a similar number of predation events by hooded crows in agricultural and woodland areas. This finding is supported with time-lapse videotaping at nests of 13 species of birds across nine plots of fragmented woodland in the Czech Republic. Twenty-two species of predators were recorded, of which the pine marten (37% of 178 predation events) and **jay** (29%), were the most important predators. In spite of their local abundance, hooded crows contributed to less than 1% of total predation (Weidinger 2009). Continuous video surveillance of 58 skylark and 40 woodlark *Lullula arborea* nests was used to determine survival times and predators in a semi-natural area in the Netherlands (Praus *et al*. 2014). The main predators of skylark nests were red fox (5), carrion crow (1) and European Adder (1). Woodlark nests were depredated by carrion crow (2), **jay** (1) and red fox (1). Although based on a small sample of predation events, it is of interest that the only recorded nest predation by **jay**, was of woodlark, which generally nests closer to trees.

BTO Nest Record Scheme data were used to examine the large-scale spatial variation in reproductive output of song thrush and the blackbird in Great Britain (Paradis *et al*. 2000). Brood size and nest failure rates during the incubation and nestling periods were related to environmental factors using generalized linear models. Nest failure rate during incubation increased significantly where the combined frequency of occurrence of magpie and **jay** from the 1988-91 BTO Atlas (Gibbons *et al*. 1993) was higher, suggesting a role for avian nest predators in determining spatial variation in reproductive output. The authors did not look at the relative importance of the two corvids.

Siriwardena (2004) analysed 30 years of Common Bird Census data for willow tit *Poecile montanus* in relation to habitat and local abundance of key potential nest predators (woodpeckers and **jay**) and key potential competitors (other tit species and nuthatch *Sitta europaea*). Nesting in holes in soft, dead wood, willow tits are probably protected from many nest predators, but are potentially more vulnerable to those with some excavation ability than are other hole-nesting species, such as other *Poecile* species, especially when the tits are only able to excavate shallow holes. This study found no indication of any role for predation by **jays**. A comparable analysis by Siriwardena (2006) on marsh tit *Poecile palustris* found no evidence that **jays** were depressing marsh tit productivity.

4.7 Rook

4.7.1 Status and change in distribution / abundance

Rooks are most abundant in the eastern, central and southern lowlands and their range extends into neighbouring upland areas. North-east Scotland is reputed to have some of the highest densities and largest colonies of **rooks** in the world. Although largely absent from the west Highlands, there are clusters of occurrence, for example on Kintyre, Islay, Skye and also in Caithness and on Orkney, with some more isolated colonies on Shetland and Lewis. The have been minor losses of range around the periphery of their more upland range and some more extensive declines in abundance in the lowlands. Winter distribution closely matches that during the breeding season.

Rook is included on the list species that have decreased markedly on account of a 35% decrease in the BBS trend since 1995.
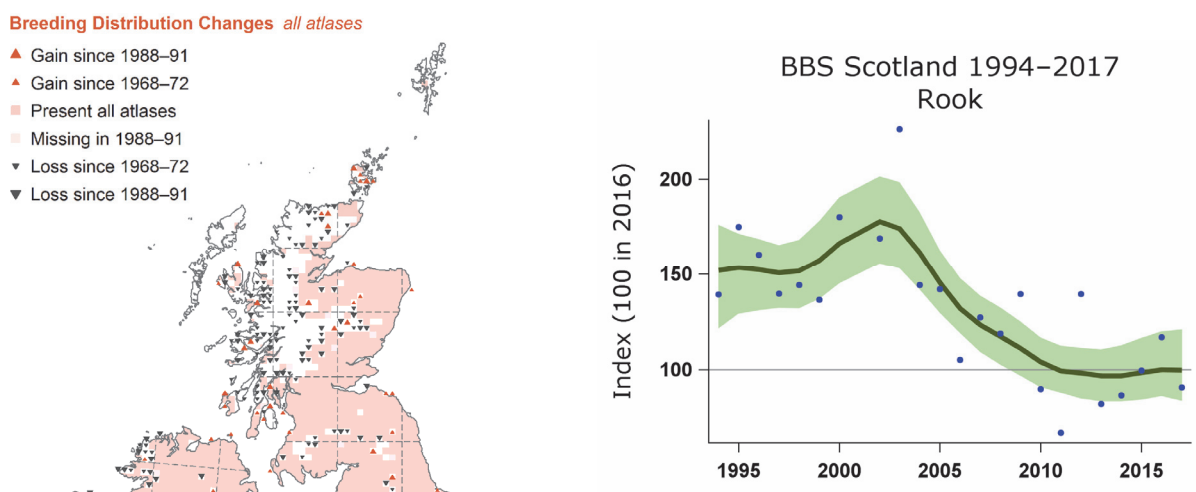

*Figure 4.7.1 **Rook**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.7.2 Systematic review findings

4.7.2.1 Impact on the conservation of wild birds (GL1)

- **There was no evidence that rooks are an important nest predator or that they are likely to impact otherwise on the conservation of wild birds.**

4.7.2.2 Prevention of serious damage (GL2)

- **Rooks feed on a wide variety of foods, including insects, seeds, vegetable and carrion. Several studies provide evidence that agricultural crops may form an important part of the diet.**

A study looking at the content of 933 **rook** gizzards from birds on farmland in England and Wales under Ministry of Agriculture Licence between 1943 and 1946 provided evidence that soft larvae and earthworms formed a large part of the diet of **rooks**, but depending on season, acorns, root crops and legumes, wheat, barley, and oats, also formed an important part of the diet of this species (Holyoak 1972). A comparable study on **rooks** from Poland, where 1,651 gizzards were examined, found that **rooks** took vegetable and animal food in

roughly equal proportions (Gromadzka 1980). Vegetable food mainly consisted of grains, and animal food of insects.

An unreplicated study, carried out between 2000-2002 in farmland around six rookeries in Poland, found that spring corn was the favoured foraging area for the **rooks** in the study area (Kasprzykowski 2003). Depending on the length of the growing season, these areas were thought to have provided a wide diversity of food items. At the start of the breeding season (early April), the birds foraged on arable land on which crops such as spring corn were to be grown, usually while the soil was being ploughed and harrowed. Later, they ate grains of corn and grazed the high-energy shoots.

In an unreplicated study from Poland carried out in 1975, the author found a clear preference for oats and wheat rather than rye (Luniak 1977), despite this being the main type of winter corn planted.

In an unreplicated study of **rooks** in the Ythan Valley in Aberdeenshire, Scotland (Feare 1974), the daily food intake of an average **rook** was calculated from measurements of the time spent feeding on each field type and the feeding rates of birds on these field types. During summer **rooks** obtained less food per day than at any other time of year, despite spending more time feeding. Summer was a time of food shortage, and this was reflected in low body weights and high juvenile mortality. This shortage was brought about by a reduction in the number of fields in which the birds could feed, an absence of grain, and the disappearance of large invertebrates (earthworms and leatherjackets) from the surface soil. The high density of **rooks** in north-east Scotland was related to relatively large amounts of grain available over winter and to the later spring sowings which coincide with the breeding season.

In a before-after experiment in Ireland, McNamera *et al*. (2002) examined the incidence of bird damage to silage bales left spread out on grass-stubble fields. Damage was at least partly attributed to corvids, but there was no specific mention of the likely species involved.

4.7.2.3 Public health, public safety and spread of disease (GL3)

- **Rook faeces host several pathogens of humans and domestic livestock.**

Droppings from 112 urban **rooks** from Besan on in eastern France were cultured for the presence of Listeria species (Bouttefroy *et al*. 1997). Overall, 46% of **rooks** sampled harboured one or more Listeria species. Of all birds examined, 33%, 24% and 8%, respectively, were infected with *Listeria monocytogenes*, *Listeria innocua* and *Listeria seeligeri*. The high percentage of Listeria species observed and the diversity of strains of *L. monoytogenes* suggest that **rooks** widely contribute to spreading this pathogen in our environment. These birds represent an important wildlife reservoir of *L. monocytogenes* which may contaminate silage, vegetables or fruits and play a role in food-borne listeriosis. In the opinion of the authors of that report, **rooks** probably do not play a major role in the epidemiology of human listeriosis however. Other sources of infection should be considered first, but one cannot neglect **rooks** as a possible source of infection when environmental contamination is suspected, particularly when **rooks** are present in large numbers in an urban area.

A study by Kmet *et al*. (2013) looked at the antibiotic resistance and virulence factors of faecal *Escherichia coli* isolated from **rooks** breeding in an urban area of eastern Slovakia. Three similar nesting colonies of **rooks** in the city of Košice were monitored during two years of research with the aim of confirming the persistence of microbial resistance in **rook** populations. The results showed that **rooks** can serve as a reservoir of antibiotic resistant *E. coli* with avian pathogenic virulence factors, and potentially transmit such *E. coli* over long

distances. The sources of infection of **rooks** with *E. coli* could be food and/or drinking water. Ecological studies and ornithological observation of **rooks** in the field have shown an omnivorous feeding pattern in agricultural, rural and urban habitats during winter. **Rooks** infected with pathogenic and antibiotic resistant bacteria from animal and human sources may disseminate these bacteria over long distances and pose a risk for environmental contamination.

Human enteropathogens, *Cryptosporidium parvum* and *Giardia lamblia* were tested from a total of 499 faecal droppings from 308 wild, 90 captive, and 101 domestic birds using conventional, immunological, and molecular techniques (Majewska *et al*. 2009). A total of 23 (7.5%) wild birds, comprising carrion crow and **rook** tested positive for cysts, whereas 18 (5.8%) wild birds again including corvids tested positive for oocysts. Whilst *G. lamblia* cysts and *C. parvum* oocysts were found in corvids, they were significantly more frequently found in faecal droppings of free-ranging aquatic birds than in birds not normally associated with water.

A study in Wroclaw sampled 15 collective sets of droppings from urban **rooks** for microsporidia, opportunistic pathogens that can infect all animal phyla, and including humans (Perec-Matysiak *et al*. 2017). The study revealed the presence of *Enterocytozoorr bieneusi D*, *Peru 6*, and *Encephalito-zoon hellem 1A* genotypes, which suggested that excreta of urban **rooks** can be an important source of human infection with these pathogens.

The possible cause of disease and mortality in corvids at an outdoor pig unit in the north of England between August 2007 and March 2008 was investigated (Strugnell *et al*. 2011). Nine carrion crows and nine **rooks**, comprising five live-caught birds with clinical signs of respiratory disease, one live-caught bird without respiratory disease, and 12 birds submitted dead were examined. Clinical signs, gross and histopathological examination, microbiology and toxicology indicated that *Pasteurella multocida* infection was the cause of disease. This work suggested that corvids are potential vectors of *P. multocida* and could pose a risk to domestic poultry.

Vlahović *et al*. (2010) looked at the occurrence of bacteria and fungi in populations of urban **rooks** in relation to human disease. They investigated the prevalence of bacteria and fungi in the faeces of **rooks** in the City of Zagreb, during their breeding period in 2006. Microbiological examination of fresh faecal samples revealed the occurrence of *Escherichia coli, Bacillus spp., Staphylococcus* species, *Streptococcus* species, *Agrobacterium radiobacter*, and *Acinetobacter* species. One **rook** tested positive for *Campylobacter jejuni*. The fungal species *Mucor* species, *Cladosporium species, Rhodotorula rubra., Aspergillus (A) fumigatus* and *A. flavus, Alternaria species, Candida species,* and *Penicillium* species were also isolated.

4.8 Great Black-backed Gull

4.8.1 Status and change in distribution / abundance

Breeding **great black-backed gulls** are nearly exclusively coastal (or close to coasts) in Scotland. Breeding numbers have declined in recent decades with most losses in the west, though local shifts in distribution indicate some gains (around most coasts) as well as losses. In common with other gull species, there has been a recent tendency to breed in urban areas, though numbers of **great black-backed gulls** using urban sites remains quite small (Calladine *et al.* 2005). The species is more widespread in winter, including extensive use of inland areas across the central belt. Winter numbers have also declined (Banks *et al.* 2009), however, with losses in distribution most apparent in inland and southern Scotland.

Great black-backed gull is on the list of species that have decreased markedly on account of a 48% decrease in winter abundance since 1993/94. It is also included on the list of species that have experienced localised increases.
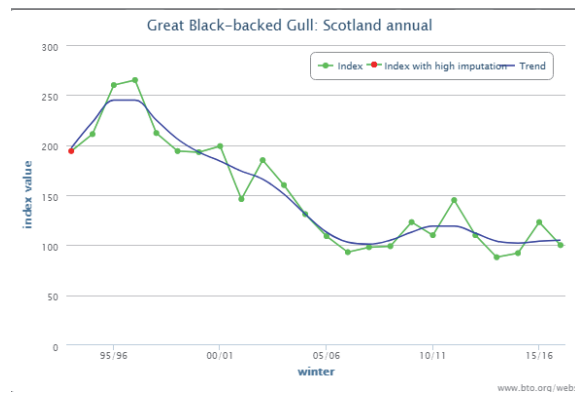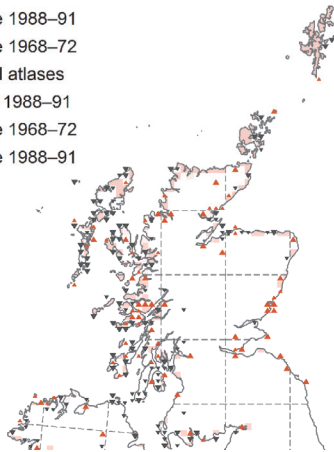

*Figure 4.8.1 **Great Black-backed Gull**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trends (with annual indices also plotted) for winter abundance in Scotland 1993-4 to 2016-17 (WeBS).*

4.8.2 Systematic review findings

4.8.2.1 Impact on the conservation of wild birds (GL1)

- **A generalist feeder that is known to prey upon a wide range of bird species, particularly adults, young, and eggs of seabirds and waterfowl. Discarded fishery wastes can supplement natural food at sea and in the inter-tidal zone with other refuse supplementing natural foods in the terrestrial environments.**

(a) Impact on seabirds and waterfowl

A before-and-after study at a common tern *Sterna hirundo* colony in eastern Canada (Guillemette & Brousseau 2001) found that fledging success was higher in 1994 when chick-depredating gulls (four herring gulls and one **great black-backed gull**) were selectively shot, compared with 1993 and 1995, when no gulls were culled (16% of 115 eggs fledged vs. no chicks fledging from 165 eggs).

Nesting **great black-backed gulls** and herring gulls were removed from a recently abandoned tern (*Sterna* species) colony in the Gulf of Maine and Bay of Fundy, USA and Canada through a combination of poisoning and shooting (Anderson & Devlin 1999). Following gull control, all three species of tern that had nested in the colony prior to the arrival of the gulls returned and nested in increasing numbers. In addition to the restoration of the terns, removal of the gulls led to colonisation and / or significant increases in the populations of four other seabirds.

From 2003-2005, the effects of gull predation and a predator control program on tern nesting success were studied at Eastern Egg Rock, Maine (Donehower *et al*. 2007). In 2003, gull predation was uncontrolled, and in 2004 and 2005, attempts were made to shoot herring, **great black-backed**, and laughing *Larus atricilla* gulls that preyed on common, Arctic *S. paradisaea*, and roseate *S. dougallii* tern adults, eggs, and chicks. To evaluate the effectiveness of gull removal, daily watches were performed from an observation tower and tern hatching and fledging success were measured annually. Despite shooting efforts in 2004-2005, many known predators could not be removed. Using disappearance of eggs and chicks from monitored nests as a proxy for gull predation pressure, an estimated 23% of common, 32% of Arctic, and 6% of roseate tern nests were deprecated by gulls during the study period.

In a study by Guillemette & Brousseau (2001) the authors tested the effectiveness of removing individual predatory gulls, including **great black-blacked gull** as a management technique for enhancing the productivity of common terns nesting in Carleton, Quebec, Canada. The productivity and fate of common tern chicks were assessed by following ringed individuals from hatching to fledging during three breeding seasons (1993-95). Concurrently, predation and consumption rates of all predatory gulls were measured before and after the culling started. The culling programme was conducted serially in 1994 by removing what was believed to be the most important individual predator first until all predators were removed. The rate of chick disappearance was lower and the life span of tern broods was higher in 1994 when the culling was conducted, compared with 1993 and 1995. As a result, the productivity of the tern colony was zero in 1993 and 1995, but positive in 1994 (0.33 chicks / pair). Average predation rates for 1993 (23.3 chicks day) and 1995 (14.8 chicks day) equated to 61% and 66% of available chicks being taken by gulls, respectively. The predation rate before the culling started in 1994 was similar to 1993 and 1995, with 15.9 chicks per day, but dropped to 5.1 chicks per day after the first gull was shot, and decreased to zero once all predatory gulls were removed. Only five individual predatory gulls were identified during the cull.

During 1998 and 1999, the impact of predation by herring gulls and **great black-backed gulls** on breeding success of kittiwakes *Rissa tridactyla* at Gull Island, Witless Bay, southeastern Newfoundland, was quantified in relation to the timing of the annual arrival of capelin *Mallotus villosus* to spawn (Massaro *et al*. 2000). The frequency of predation attempts by large gulls on kittiwakes was compared among three periods: before the mean hatching date for herring gulls between the mean hatching date for herring gulls and the arrival of the capelin; and following capelin arrival. The frequency varied significantly among the three periods, being highest after gull chicks hatched but before the capelin arrived. The frequency of gull predation was significantly correlated with the percentage of kittiwake eggs and chicks that disappeared each week. An estimated 43% and 30% of kittiwake eggs and chicks at Gull Island were taken by gulls in 1998 and 1999, respectively.

A study on the variability and partitioning of diets between the herring and **great black-backed gulls**, both generalist predators, during incubation and early chick rearing was carried out on Kent Island, Bay of Fundy, Canada (Steenweg *et al*. 2011). The authors assessed diets from pellets collected around nests, regurgitates from captured birds, and stable-isotope analysis of prey items and tissues (blood and feathers) obtained from chicks

and adults. Pellet analyses indicated that both species relied primarily on fish (28 to 45% of identified prey items) and crabs (15 to 43%).

Common eider breeding success and gull-eider interactions were studied at Stratton Island, Maine, USA in 2004 and 2005 (Donehower & Bird 2008). Eiders suffered little nest predation, and most egg losses to gulls were either facilitated by researcher intrusions or confined to newly initiated, unattended nests. Despite high nest success (>80%) in both study years, predation watches indicated that few, if any, ducklings survived to fledging as a result of extreme harassment and predation by **great black-backed gulls**. Gull attacks were opportunistic, involved one to 36 gulls, and often resulted in complete crèche destruction.

The number of common eider ducklings surviving to fledging in the Bay of Fundy decreased from >14% of the adult breeding population prior to 1991 to <10% between 1995 and 1998 (Mawhinney *et al*. 1999). In contrast the breeding population in the Grand Manan Archipelago produced more ducklings that survived to fledgling between 1995 and 1998. It was suggested that higher duckling production in the Grand Manan Archipelago reflected lower predation rates by **great black-backed gulls**.

A study of nesting success of common eiders was carried out at two adjacent colonies on the islands of Grindøya and Hakøya in northern Norway between 2006 and 2011 (Stien & Ims 2016). Over the study period, nesting success was consistently higher on Hakøya (69-82%) than on Grindøya (35-60%). Between 2009 and 2011 camera monitoring of individual nests was used to identify determinants of nest survival and predation. Under high levels of human disturbance, camera monitoring indicated that the main cause of breeding failure was predation, primarily by hooded crows, but also to some extent **great black-backed gulls**.

The diet of **great black-backed gulls** was quantified at two colonies, Gull Island, Witless Bay, Newfoundland, and Gannet Islands, Labrador (Veitch *et al*. 2016). At the Gannet Islands, **great black-backed gulls** primarily kleptoparasitized Atlantic Puffins *Fratercula arctica* bringing sandlance (*Ammodytes* species) to their chicks, whereas at Gull Island, seabirds formed the bulk of the gulls' diet. **Great black-backed gulls** preferred murre (*Uria* species) eggs at both sites, selecting them in far greater proportion than their abundance, and consuming up to 40% of common murre (*U. aalge*) eggs laid on Gull Island. **Great black-backed gulls** also targeted kittiwake (*Rissa tridactyla*) eggs, chicks, and adults at Gull Island. **Great black-backed gulls** clearly selected certain seabird prey disproportionately to their availability.

(b) Impact on breeding waders
Predation by **great black-backed gulls** were responsible for less than 1% of wader nest failures in machair and associated habitats of the Uists (Calladine *et al*. 2017)

4.8.2.2   Prevention of serious damage (GL2)

- **There was no evidence that great black-backed gulls are likely to result in serious damage to livestock, foodstuffs for livestock, crops, vegetables or fruit.**

4.8.2.3   Public health, public safety and spread of disease (GL3)

- **Great black-backed gull faeces may host several pathogens of humans and domestic livestock.**

Birds of wetland and aquatic environments constitute the major reservoir of Influenza A viruses of all subtypes (H1-H16, and N1-N9). In particular birds belonging to *Anseriformes* (ducks, geese and swans) and *Charadriiformes* (gulls, terns and waders) have been reported to be efficient hosts. The birds do not usually develop clinical disease, but they

shed a large number of virus particles in their faeces, which may cause serious disease outbreaks when introduced into poultry flocks. The prevalence of influenza A virus infection, and the distribution of different subtypes of the virus, were studied in 1,529 ducks and 1,213 gulls shot during ordinary hunting from August to December in two consecutive years, 2006 and 2007, in Norway (Germundsson *et al*. 2010). The highest prevalence (12.8%) of infection was found in dabbling ducks (Eurasian wigeon, common teal *Anas crecca* and mallard *Anas platyrhyncos*). In gulls (common gull, herring gull, black-headed gull, lesser black-backed gull, **great black-backed gull** and kittiwake) the prevalence of influenza A virus was 6.1%. The infection prevalence peaked during October / November for gulls.

Gulls in general have been reported to carry bacteria (e.g. *Bacillus* species*, Clostridium* species*, Campylobacter* species*, Escherichia coli, Listeria* species*, Salomonella* species) that cause enteric disease of humans (Fenlon 1981, Butterfield *et al*. 1983, Monaghan *et al*. 1985, Quessy & Messier 1992). Although causal relationships for transmission of diseases from gulls to humans are difficult to document, evidence suggests that gulls may be important vectors (see below).

In Scotland, Reilly *et al*. (1981) determined that gulls in general were the source of contamination for 3 of 26 occurrences of human and animal salmonellosis. Contamination of public water supplies by gull faeces has been stated as the most plausible source for disease transmission (e.g. Jones *et al*. 1977). However, evidence suggests that gulls act as dispersal agents for pathogens (e.g. *Salmonella*) rather than being primary sources (Hatch 1996).

Atterby *et al*. (2017) found genetic similarity between human isolates and antibiotic resistant *E. coli* in several species of gull, including **great black-backed** and herring gull in Sweden. This result supports the hypothesis that gulls can function as environmental reservoirs of antibacterial resistance. In addition, the results suggest that gulls could be used as indicators of what types of antibiotic resistance are circulating in a human population. This finding highlights the need for effort to minimise the risk of exposing wildlife to human waste and sewage to prevent further contamination and dissemination of antibiotic resistance. A similar study from the Netherlands has also found antibiotic resistance in **great black-backed**, herring and lesser black-backed Gulls (Veldman *et al*. 2013).

An investigation was carried out into the prevalence of thermophilic *Campylobacter* and *Cryptosporidium* species in fresh faecal specimens collected from members of the gull family (*Larus* species) from three coastal locations in Northern Ireland (Moore *et al*. 2002). A total of 205 fresh faecal specimens were collected from gulls, of which 28 of 205 (13.7%) were positive for *Campylobacter* species and none of 205 for *Cryptosporidium* species.

The effectiveness of sewage treatment to remove faecal pathogens has increased (e.g. Hendricks and Pool 2012) and the numbers of open refuse tips and their associated gulls have declined (Coulson 2015). These factors could conceivably have reduced the prevalence of gulls in the transmission of diseases to humans since publication of some of the earlier studies cited above, however, there remains evidence that gulls could still be important vectors even in circumstances where there is relatively low prevalence of pathogens (e.g. Atterby *et al*. 2017).

4.9 Lesser black-backed Gull

4.9.1 Status and change in distribution / abundance

Breeding around all coasts and inland across central Scotland, **lesser black-backed gulls** are most numerous in the central belt and on the Solway coast. There has been little net change in their distribution, with losses in the north and west coastal areas being balanced by gains inland, especially in the central belt, Fife and Angus. Overall population size is likely to have increased but the scale of increase is unclear because of incomplete counts in inland areas during some surveys. The shift in distribution is also apparent with an increase in numbers breeding in urban areas (Calladine *et al.* 2005). In winter, the distribution of **lesser black-backed gulls** is similar to that in the breeding season but is generally more widespread with numbers either increasing (Banks *et al.* 2009) or possibly fluctuating but broadly stable (WeBS). Few remain in mid-winter however, especially in eastern and northern areas.

Lesser black-backed gull is on the list of species that have increased markedly on account of its 52% increase in winter abundance since 2008/09. It could also be included on a list of species that have increased locally during the breeding season.
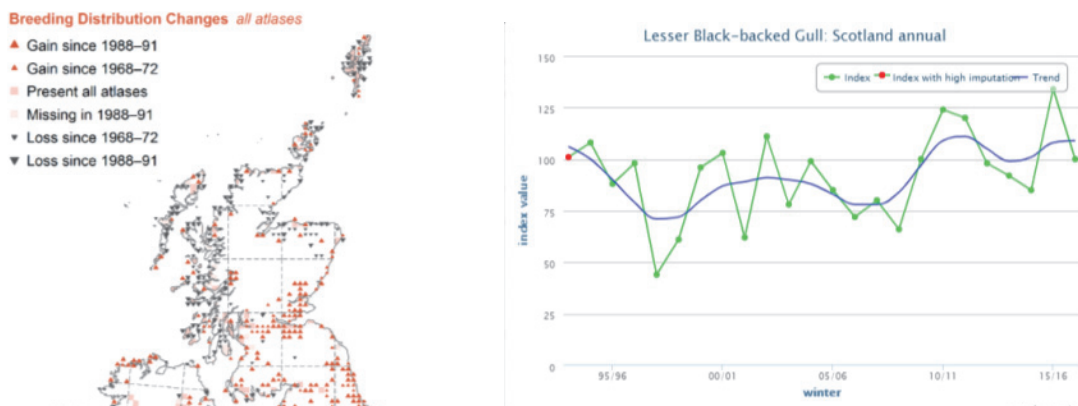

*Figure 4.9.1. **Lesser Black-backed Gull**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trends (with annual indices also plotted) for winter abundance in Scotland 1993-4 to 2016-17 (WeBS).*

4.9.2 Systematic review findings

4.9.2.1 Public health, public safety and spread of disease (GL3)

- **Roof-nesting lesser black-backed gulls may act aggressively to people.**

- **Lesser black-backed gull faeces may host several pathogens of humans and domestic livestock.**

(a) Roof-nesting

Widespread use of roofs and other urban areas by gulls, particularly of **lesser black-backed** and herring gulls, has occurred only recently (Monaghan 1979, Vermeer *et al*. 1988). Success of roof-nesting colonies is attributed partially to their exploitation of anthropogenic food (Monaghan 1979). Several authors (e.g. Dolbeer *et al*. 1990) have hypothesized that roofs were suboptimal nesting habitat, a consequence of the dispersal of breeding adults in a population experiencing rapid growth and lacking more suitable nest sites. In contrast, other studies (Monaghan 1979, Belant 1993) have suggested that roofs are a suitable

habitat for gulls that only recently have been exploited. Roof-nesting by gulls has continued to increase and now occurs with some regularity.

Lesser black-backed gulls nesting on roofs may act aggressively towards people, and arguably could be considered a threat to public safety (Monaghan & Coulson 1977, Vermeer *et al*. 1988, Belant 1993).

(b) Disease concern

Birds of wetland and aquatic environments constitute the major reservoir of Influenza A viruses of all subtypes (H1-H16, and N1-N9). In particular birds belonging to Anseriformes (ducks, geese and swans) and Charadriiformes (gulls, terns and waders) have been reported to be efficient hosts. The birds do not usually develop clinical disease, but they shed a large number of virus particles in their faeces, which may cause serious disease outbreaks when introduced into poultry flocks. The prevalence of influenza A virus infection, and the distribution of different subtypes of the virus, were studied in 1,529 ducks and 1,213 gulls shot during ordinary hunting from August to December in two consecutive years, 2006 and 2007, in Norway (Germundsson *et al*. 2010). The highest prevalence (12.8%) of infection was found in dabbling ducks (Eurasian wigeon, common teal and mallard). In gulls (common gull, herring gull, black-headed Gull, **lesser black-headed gull**, great black-backed gull and kittiwake) the prevalence of influenza A virus was 6.1%. The infection prevalence peaked during October / November for gulls.

Gulls have been reported to carry bacteria (e.g., *Bacillus* speices*, Clostridium* species*, Campylobacter* species*, Escherichia coli, Listeria* species*, Salomonella* species) that cause enteric disease of humans (Fenlon 1981, Butterfield *et al*. 1983, Monaghan *et al*. 1985, Quessy & Messier 1992). Although causal relationships for transmission of diseases from gulls to humans are difficult to document, evidence suggests that gulls may be important vectors.

In England, Monaghan *et al*. (1985) described the prevalence of *Salmonella* species in herring gulls and determined a significant, positive correlation between the proportion of gulls carrying salmonellae and the incidence of salmonellosis in the human population in the same area. Gulls are opportunistic scavengers that feed at sites where raw sewage is released. They appear to be relatively resistant to disease but may serve as effective carriers of *Salmonella* and other bacteria and are therefore a source of infection for other animals.

In Scotland, Reilly *et al*. (1981) determined that gulls were the source of contamination for 3 of 26 occurrences of human and animal salmonellosis. Contamination of public water supplies by gull faeces has been stated as the most plausible source for disease transmission (e.g. Jones *et al*. 1977). However, evidence suggests that gulls act as dispersal agents for pathogens (e.g. Salmonella) rather than being primary sources (Hatch 1996). Gull faeces have also been implicated in accelerated nutrient loading of aquatic systems (Portnoy 1990).

Faecal samples of 85 water birds (25 greylag geese, 20 Eurasian coots *Fulica atra*, and 40 gulls, mostly **lesser black-backed gull**, herring gull, and black-headed gull, were collected near the shores of recreational waterbodies in the Netherlands and sent to the laboratory for analysis (Meerberg *et al*. 2011). Faecal droppings from these three species groups were distinguished from one another in the field. Results indicated that gull faeces contained a greater average concentration of *E. coli* per gram than do geese or coot faeces. However, contamination risk also depends on bird abundance.

The emergence and spread of antimicrobial-resistant (AMR) bacteria in natural environments is a major concern with implications for human and animal health. Thirty faecal samples were collected from a number of species: herring gulls, black-headed gulls, **lesser black-backed gulls**, hybrid deer species *Cervus elaphus x Cervus nippon*) and twenty-six from starlings *Sturnus vulgaris* (Carroll *et al*. 2015). A total of 115 *E. coli* isolates were isolated from 81 of 146 samples. Confirmed *E. coli* isolates were tested for their susceptibility to seven antimicrobial agents. In total, 5.4% (8/146) of samples exhibited multidrug-resistant phenotypes, including samples from herring gull and **lesser black-backed gull**. This study indicated that wild birds and mammals may function as important host reservoirs and potential vectors for the spread of resistant bacteria and genetic determinants of AMR.

The effectiveness of sewage treatment to remove faecal pathogens has increased (e.g. Hendricks and Pool 2012) and the numbers of open refuse tips and their associated gulls have declined (Coulson 2015). These factors could conceivably have reduced the prevalence of gulls in the transmission of disease to humans since publication of some of the earlier studies cited above, however, there remains evidence that gulls could still be important vectors even in circumstances where there is relatively low prevalence of pathogens (e.g. Atterby *et al*. 2017).

4.10 Herring Gull

4.10.1 Status and change in distribution / abundance

Herring gulls breed principally around coasts, most abundantly on the east coast and also occurring inland in central Scotland. The species has shown a marked redistribution, with declines in coastal breeding birds, especially in the west and north, and increases in inland and urban areas. Overall breeding numbers have declined in recent decades. In winter, numbers of herring gulls in Scotland are augmented by birds from Scandinavia (Wernham *et al.* 2002) however their distribution, and recent changes, are comparable to those in the breeding season with a decline in numbers since the 1990s (Banks *et al.* 2009).

Herring gull is included on a list of species that have decreased on account of its 51% decrease in winter abundance since 1993/94. It is also on a list of species that have increased locally in some places during the breeding season.
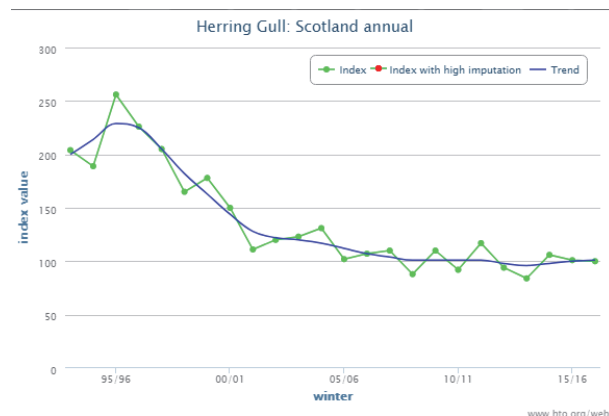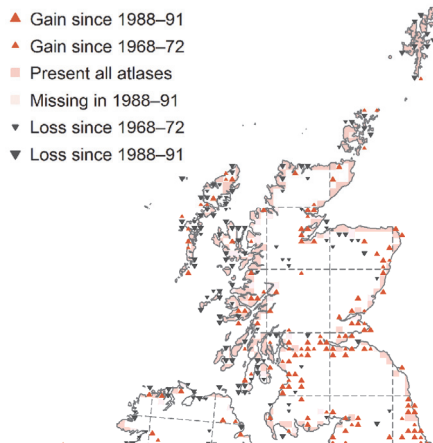

*Figure 4.10.1 **Herring Gull**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trends (with annual indices also plotted) for winter abundance in Scotland 1993-4 to 2016-17 (WeBS).*

4.10.2 Systematic review findings

4.10.2.1 Public health, public safety and spread of disease (GL3)

- **Roof-nesting herring gulls may act aggressively to people.**

- **Herring gull faeces may host several pathogens of humans and domestic livestock.**

(a) Roof-nesting

Widespread use of roofs and other urban areas by gulls, particularly of lesser black-backed and **herring gulls** has occurred only recently (Monaghan 1979, Vermeer *et al.* 1988, Vermeer 1992). Success of roof-nesting colonies is attributed partially to their exploitation of anthropogenic food (Monaghan, 1979). Several authors (e.g. Dolbeer *et al.* 1990) have hypothesized that roofs were suboptimal nesting habitat, a consequence of the dispersal of breeding adults in a population experiencing rapid growth and lacking more suitable nest sites. In contrast, other studies (Monaghan 1979, Belant 1993) have suggested that roofs are a suitable habitat for gulls that only recently have been exploited. Roof-nesting by gulls has continued to increase and now occurs with some regularity. Populations of roof-nesting

herring gulls in the British Isles increased 17% annually during the 1970s (Monaghan & Coulson 1977).

Herring gulls nesting on roofs may act aggressively towards people, and arguably could be considered a threat to public safety (Monaghan & Coulson 1977, Vermeer *et al*. 1988, Belant, 1993).

(b) Disease concern

Birds are the primary hosts of *Chlamydia psittaci*, a bacterium that can cause avian chlamydiosis in birds and psittacosis in humans. Wild seabirds are frequently admitted to wildlife rescue centres (WRC) at European Atlantic coasts, for example, in connection with oil spills. To investigate the extent of chlamydial shedding by these birds and the resulting risk for animals in care and the medical staff, seabirds from a French WRC were sampled from May 2011 to January 2014 (Aaziz *et al*. 2015). A total of 195 seabirds belonging to 4 orders, 5 families and 13 species were examined, of which 18.5% proved to be *Chlamydiaceae* positive. The highest prevalence of shedders was found in gannets *Morus bassanus* (41%), followed by **herring gulls** (14%)

Birds of wetland and aquatic environments constitute the major reservoir of Influenza A viruses of all subtypes (H1-H16, and N1-N9). In particular birds belonging to *Anseriformes* (ducks, geese and swans) and *Charadriiformes* (gulls, terns and waders) have been reported to be efficient hosts. The birds do not usually develop clinical disease, but they shed a large number of virus particles in their faeces, which may cause serious disease outbreaks when introduced into poultry flocks. The prevalence of influenza A virus infection, and the distribution of different subtypes of the virus, were studied in 1,529 ducks and 1,213 gulls shot during ordinary hunting from August to December in two consecutive years, 2006 and 2007, in Norway (Germundsson *et al*. 2010). The highest prevalence (12.8%) of infection was found in dabbling ducks (Eurasian wigeon, common teal and mallard). In gulls (common gull, **herring gull**, black-headed gull, lesser black-headed gull, great black-backed gull and kittiwake) the prevalence of influenza A virus was 6.1%. The infection prevalence peaked during October / November for gulls.

Gulls as a group have been reported to carry bacteria (e.g. *Bacillus* species*, Clostridium* species*, Campylobacter* species*, Escherichia coli, Listeria* species*, Salomonella* species) that cause enteric disease of humans (Fenlon 1981, Butterfield *et al*. 1983, Monaghan *et al*. 1985, Quessy & Messier 1992). Although causal relationships for transmission of diseases from gulls to humans are difficult to document, evidence suggests that gulls may be important vectors.

In England, Monaghan *et al*. (1985) described the prevalence of *Salmonella* species in **herring gulls** and determined a significant, positive correlation between the proportion of gulls carrying salmonellae and the incidence of salmonellosis in the human population in the same area. Gulls are opportunistic scavengers who feed at sites where raw sewage is released. They appear to be relatively resistant to disease but may serve as effective carriers of *Salmonella* and other bacteria and are therefore a source of infection for other animals.

In Scotland, Reilly *et al*. (1981) determined that gulls were the source of contamination for 3 of 26 occurrences of human and animal salmonellosis. Contamination of public water supplies by gull faeces has been stated as the most plausible source for disease transmission (e.g. Jones *et al*. 1977). However, evidence suggests that gulls act as dispersal agents for pathogens (e.g. *Salmonella*) rather than being primary sources (Hatch 1996). Gull faeces has also been implicated in accelerated nutrient loading of aquatic systems (Portnoy 1990).

Faecal samples of 85 water birds (25 greylag geese, 20 Eurasian coots *Fulica atra*, and 40 gulls, mostly lesser black-backed gull, **herring gull**, and black-headed gull, were collected near the shores of recreational waterbodies in the Netherlands and sent to the laboratory for analysis (Meerberg *et al*. 2011). Faecal droppings from these three species groups were distinguished from one another in the field. Results indicated that gull faeces contained a greater average concentration of *E. coli* per gram than do geese or coot faeces. However, contamination risk also depends on bird abundance.

Atterby *et al*. (2017) found genetic similarity between human isolates and anti-biotic resistant *E. coli* in several species of wild gull, including great black-backed and **herring gull** in Sweden This supports the hypothesis that gulls can function as environmental reservoirs of antibacterial resistance. In addition, the results suggest that gulls could be used as indicators of what types of antibiotic resistance are circulating in a human population. This finding highlights the need for effort to minimise the risk of exposing wildlife to human waste and sewage to prevent further contamination and dissemination of antibiotic resistance. A similar study from the Netherlands has also found antibiotic resistance in great black-backed, **herring** and lesser black-backed gulls (Veldman *et al*. 2013).

The emergence and spread of antimicrobial-resistant (AMR) bacteria in natural environments is a major concern with implications for human and animal health. Thirty faecal samples were collected from a number of species: **herring gulls,** black-headed gulls *Larus ridibundus*, lesser black-backed gulls, hybrid deer species *Cervus elaphus x Cervus nippon*) and twenty-six from starlings *Sturnus vulgaris* (Carroll *et al*. 2015). A total of 115 *E. coli* isolates were isolated from 81 of 146 samples. Confirmed *E. coli* isolates were tested for their susceptibility to seven antimicrobial agents. In total, 5.4% (8/146) of samples exhibited multidrug-resistant phenotypes, including samples from **herring gull** and lesser black-backed gull. This study indicated that wild birds and mammals may function as important host reservoirs and potential vectors for the spread of resistant bacteria and genetic determinants of AMR bacteria

A study by Hollmen *et al*. (2000) measured antibodies to infectious bursal disease virus (IBDV) in blood of nesting common eider females and immature **herring gulls** in the Baltic Sea, and in blood of spectacled eider *Somateria fischeri* females nesting in a remote area of western Alaska. Positive IBDV occurred in 75% of the eiders and 45% of the **herring gull** chicks. It is suggested that eider and **herring gulls** have been exposed to IBDV. The presence of this virus in wild bird populations is important because it causes mortality of up to 30% in susceptible poultry.

An investigation was carried out into the prevalence of thermophilic *Campylobacter* and *Cryptosporidium* species in fresh faecal specimens collected from several species of the gull family (*Larus* species) from three coastal locations of Northern Ireland (Moore *et al*. 2002). A total of 205 fresh faecal specimens were collected from gulls, of which 28 of 205 (13.7%) were positive for *Campylobacter* species and none of 205 for *Cryptosporidium* species.

The effectiveness of sewage treatment to remove faecal pathogens has increased (e.g. Hendricks and Pool 2012) and the numbers of open refuse tips and their associated gulls have declined (Coulson 2015). These factors could conceivably have reduced the prevalence of gulls in the transmission of disease to humans since publication of some of the earlier studies cited above, however, there remains evidence that gulls could still be important vectors even in circumstances where there is relatively low prevalence of pathogens (e.g. Atterby *et al*. 2017).

4.11 Feral Pigeon

4.11.1 Status and change in distribution / abundance

Monitoring programmes rarely distinguish between **feral pigeons** and their ancestral rock doves, as both 'forms' readily mix and intergrade. Apparently pure rock doves tend to predominate in the Western Isles and also occur elsewhere on the west and north coasts and in the northern isles. Elsewhere, the species is widely assumed to be predominantly or exclusively **feral pigeons**. Combined, the continuum of **feral pigeons** and rock doves is present in all seasons across most of Scotland and is generally absent only from inland upland areas of the Highlands and Southern Uplands. It is most abundant in the eastern lowlands, urban conurbations and some other areas, for example Orkney. A recent apparent expansion in range (from Atlas data, Balmer *et al*. 2013) is not apparent in BBS trends as might be expected for such a widespread and numerous species. The apparent contradiction may be related to the species not being recorded consistently by one or other survey.

Feral pigeon is included on a list of species that has increased on account of 27% increase in the number of hectads occupied by breeding birds. These reported changes are for both **feral pigeon** and the wild ancestral form of rock dove combined as the two forms are widely integrated. In reality, indices of change will be representative mostly of the more abundant and widespread **feral pigeon** 'form'.
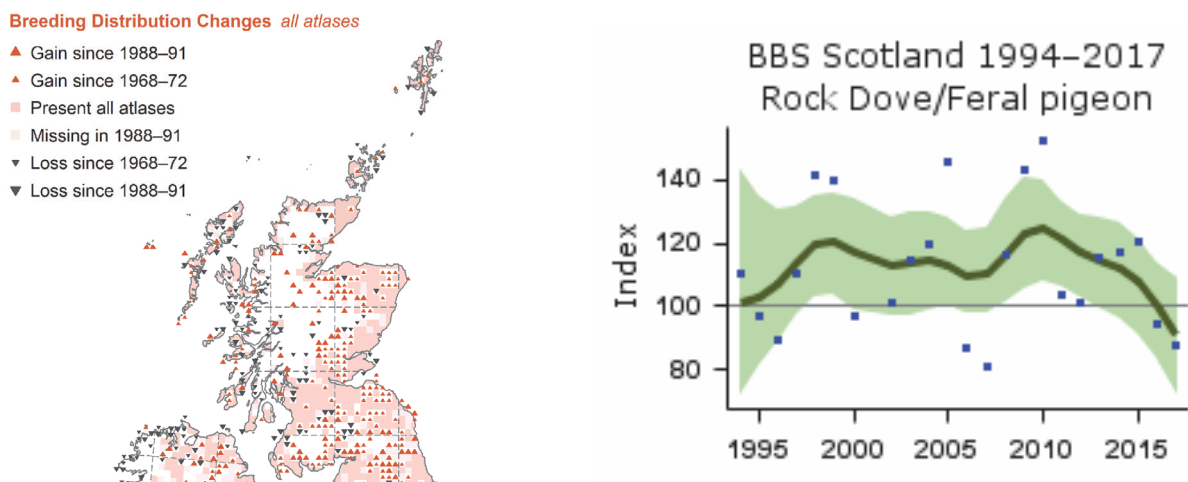

*Figure 4.11.1. **Feral Pigeon**/Rock Dove: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.11.2 Systematic review findings

4.11.2.1 Prevention of serious damage (GL2)

- **Few studies have tried to quantify the direct costs and economic losses related to Feral Pigeons in agricultural settings.**

(a) Damage to crops

In Poland, the number of **feral pigeons** is significantly higher in towns located in agricultural areas compared with those surrounded by forest (Hetmanski *et al*. 2011). **Feral pigeons** can commute 3 to 20 km to feeding areas, depending on the landscape and distribution of food resources (see Rose *et al*. 2006 for a review).

Feral pigeons have been recorded taking seeds when being sowed, feeding on newly sprouted cotyledon leaves, and on mature crops (Johnston & Janiga 1995). Where wheat and maize are intensely cultivated, most of the damage occurs during crops storage (Saini & Toor 1991). In sunflower fields, damage occurs at the sowing time and before harvesting (van Niekerk & van Ginkel 2004).

In Italy the impact on crops was estimated to be between 20-43 million euros / year, with an estimated cross loss of about 0.5-1% of the total yield (Zucconi *et al*. 2003). A more recent assessment suggested that the loss of sunflower seeds in South Africa caused by four species of Columbiformes amounts to 8.4% (van Niekerk 2009).

4.11.2.2 Public health, public safety and spread of disease (GL3)

- **Feral pigeons are reservoirs and potential vectors of microorganisms and a source of antigens of zoonotic interest, which could cause infections and allergic diseases, although the risk of transmission of disease appears to be low. This conclusion does not take into account the recent (and therefore not in reviewed literature) human deaths at the Glasgow Queen Elizabeth hospital, possibly due to inhaling fungal spores contained in feral pigeon droppings.**

(a) Disease

Pathogens from **feral pigeons** can be transmitted to humans mainly via excreta, secretions, or dust from feathers (Curtis *et al*. 2002, Geigenfeind & Haag-Wackernagel 2010). In addition, breeding and roosting sites can host a number of arthropods (e.g. fleas, mites and ticks) including the soft tick *Argas reflexus* which can cause local and systemic reactions in humans (Mumcuoglu *et al*. 2005). A summary of the different pathogenic organisms and the most common parasitic arthropods identified in **feral pigeons** is provided in Johnston & Janiga (1995), Haag-Wackernagel & Moch (2004) and Haag-Wackernagel (2006).

Chlamydophila psittaci is one of the most common pathogenic bacteria affecting **feral pigeons** in Europe (e.g. Magnino *et al*. 2009). Along with *Cryptococcus neoformans*, these are believed to be the most common pathogens transmitted from **feral pigeons** to humans.

Disease producing fungi are also commonly recorded in **feral pigeons**. Gallo *et al*. (1989) reported 7% of **feral pigeons** in rural areas were infected by yeasts, and up to 22% in urban areas. In the Czech Republic, Travnicek *et al*. (2002), carried out serological examination of 273 **feral pigeons** to look for the presence of *C. psittaci* antibodies. The authors found that the seropositivity varied between April 2000, June 2000 and April 2001, from 33.1 to 85.1%. In Madrid, Spain Vazquez *et al*. (2010) took samples from 118 **feral pigeons** captured in three samplings in 2006-2007 in public parks and gardens. PCR was used to screen for the presence of *Campylobacter jejuni*, *C. coli* and *Chlamydophila psittaci*, which have the zoonotic potential to infect humans. Positive samples were confirmed by DNA sequencing. The analyses demonstrated a high prevalence of *Chlamydophila psittaci* (52.6%) and *Campylobacter jejuni* (69.1%) among the birds captured. In contrast, *Campylobacter coli* was rarely detected (1.1%).

Infections caused by Salmonella from **feral pigeons** are believed to be very rare (Haag-Wackernagel & Moch 2004). A possible exception includes a study relating to *Salmonella enterica Indiana*, a food-borne serovar uncommon in most countries, which was responsible for an outbreak of abortion in a flock of Lacaune dairy ewes in southern Spain (Luque *et al*. 2009). Drinking water and feedstuff samples were analysed to try and determine the source of infection. **Feral pigeons** and turtle doves *Streptopelia turtur* in close contact with the ewes were captured and examined for the bacterium. *S. enterica Indiana* was isolated from the

ewes and wild birds. The genetic similarity among them suggests that wild birds might have been responsible for the outbreak in the ewes.

Other potential diseases spread by **feral pigeons** include histoplasmosis and cryptococcosis (Haag-Wackernagel & Moch 2004). Despite the above, the risk of transmission of pathogens from **feral pigeons** to healthy humans appears to be low, even for people in close contact with **feral pigeons** or their nests (Haag-Wackernagel & Moch 2004), although immuno-depressed people may experience greater risk. In Poland, a study on the prevalence of Chlamydia looked at 369 samples from 35 species of wild bird (Krawiec *et al*. 2015). Samples from 27 birds (7.3%) were positive for chlamydial DNA. This included from one of two woodpigeons sampled, and one of two **feral pigeons**.

During the period 12 March to 26 April 1998, 35 samples of fresh, undessicated **feral pigeon** droppings were collected from four localities within the city of Malmo, Sweden (Mattsson 1999), in which three fungi *Debaryomyces hansenii*, *Cryptococcus laurentii* and *Cryptococcus uniguttulatus* were found. The first two species are known to be pathogenic to humans. This provides support for the view that **feral pigeons** can be carriers of medically significant fungi.

Spread of Newcastle Disease to chickens has occurred in several European countries, including Great Britain where there were 20 outbreaks in unvaccinated chickens in 1984 as a result of using feed that had been contaminated by infected racing pigeons (Alexander *et al*. 1985). Three outbreaks in game birds in Great Britain were also caused by racing / **feral pigeons** with PPMV-1; these covered the period 1995 to 2006 and all appeared to be the result of spread from racing / **feral pigeons** as there were no outbreaks in other poultry at the time they occurred (Irvine *et al*. 2009). The disease in pigeons has now been recognized for over 30 years but still seems to remain enzootic in racing pigeons in many countries, with regular spread to wild pigeons and doves and thought to be a continuing threat to poultry.

Tracheal and cloacal swabs and blood samples were taken from 408 **feral pigeons** and 170 hunted woodpigeons in Germany and were tested for infection with avian influenza viruses (Kohls *et al* 2011). Influenza A virus was not isolated in the swab samples. Two of 123 serum samples from woodpigeons contained specific antibodies against influenza A virus, but not against the subtypes H5 and H7. This study indicated that that even after the occurrence of zoonotic highly pathogenic avian influenza virus (HPAIV) subtype H5N1 in the area of investigation in Germany, woodpigeons and **feral pigeons** did not play a major part in the transmission of influenza viruses.

Microbiological and parasitological investigation was carried out on **feral pigeons** located in a green area near the main hospital of a central Italian city (Marenzoni *et al*. 2016). One hundred pigeons were controlled and submitted for clinical examination. Cloacal swabs were taken to look for the presence of *Coxiella burnetii, Chlamydia psittaci, Chlamydophila* species, *Salmonella* species, *Campylobacter* species, and yeasts. An ELISA test was used to determine the presence of *Giardia* species, and *Cryptosporidium* species. Serological samples were also tested with a modified agglutination test to detect antibodies against *Toxoplasma gondii*. The samples proved to be negative for *C. burnetiid*, and positive for *C. psittaci* and *Chlamydophila* species. No Salmonella species were detected. *C. jejuni* and *C. coli* were found in 13% and 4% of the samples respectively. No *Giardia* species or *Cryptosporidium* species were detected. Thirty-three out of 100 samples (33%) were positive for yeast colonies. The seroprevalence for *T. gondii* was 8%. The findings of this study were interpreted as moderate incidence, with potentially zoonotic agents present.

Eighty **feral pigeons** and their faecal samples from two **feral pigeon** lofts in Switzerland were tested for a range of pathogens (Schreiber *et al*. 2015). Four pathogenic agents

transmissible to humans were detected (*Chlamydia* species, *Salmonella* species, *Campylobacter jejuni* and *Crytococcus neoformans*).

(b) Food preparation

Feral pigeons have the potential to foul foodstuffs. This is perhaps more relevant in specific places such as grain elevators or food industries, related to food preparation (Gingrich & Osterberg 2003).

4.12 Woodpigeon

4.12.1 Status and change in distribution / abundance

Woodpigeons are widespread across Scotland throughout the year being absent only from restricted areas of the west and central Highlands and some islands. They are most abundant in the eastern lowlands. Modest increases over recent decades have been associated with encroachment into some formerly unoccupied areas of the Highlands and islands. Colonisation of some areas, notably for example Shetland, may not yet have established any self-sustaining populations.

Woodpigeon is included on a list of species that have increased locally.
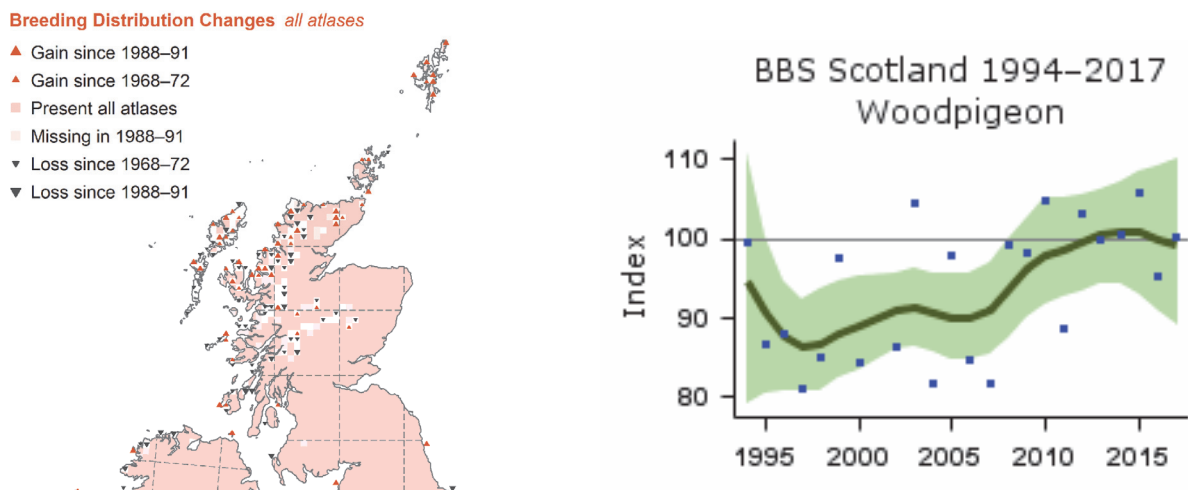

*Figure 4.12.1 **Woodpigeon**: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.12.2 Systematic review findings

4.12.2.1 Prevention of serious damage (GL2)

- **Woodpigeons have a wide and varied diet; consuming a wide range of plant material in addition to agricultural crops. In summer and autumn, the grains of cereal crops predominate, whilst in spring and winter the diet is dominated by fruit and seeds of trees.**

- **Most studies on woodpigeons are historical, with most having been undertaken over thirty years ago, prior to the large-scale introduction of oilseed rape.**

- **A consultation with growers of brassicas, oilseed rape and leafy salad crops in the UK carried out by Parrott *et al*. (2014) estimated the annual financial loss caused by woodpigeons was £125 / ha for oilseed rape, £250 / ha for peas, and £330-£1,250 ha for brassicas. These estimates of economic loss were often broad and lacked detail.**

(a) Crop damage

The number of studies investigating crop damage by **woodpigeons** in the past ten years is extremely small. In one of these, a study on the seasonal diet and food preferences of **woodpigeons** was carried in the Leinster region of Ireland (Ó hUullachain & Dunne 2013). The crop contents of 299 adult **woodpigeons** shot by local shooters as quarry or agricultural pests (depending on time of year) were examined. The diet of the **woodpigeon** was dominated by the fruit and seeds of trees and by cereal grains, with the proportion and occurrence of these food items varying significantly between seasons. In spring, the diet of **woodpigeons** was dominated by fruit and seeds of trees (Ivy), where they constituted 55% of the diet and were found in over 87% of the crops of birds analysed. Cultivated crops (Flax in particular) also featured prominently in the spring diet of **woodpigeons**, constituting 31.7% of the diet and occurring in over 70% of the birds. Clover and Buttercup leaves occurred regularly in the spring diet (62.5% and 54.2%, respectively); however, their relative proportion in the diet was small (6.0% and 3.2%, respectively). In summer, the **woodpigeon** diet was more variable. Cereal grains were the main food item taken (27.1%), followed by clover (22.3%). Weed material (19.0%) and grass (12.0%) constituted large proportions of the summer diet and occurred in 56.8% and 46.6% of the crops of the birds, respectively. The consumption of animal material (snails in particular) peaked in summer where they were found in over 27% of the birds and constituted 2.5% of the overall diet. In autumn, cereals were the main food item taken, constituting 52.1% of the diet and occurring in 67% of the birds analysed. Clover also constituted a large proportion (15.7%) of the autumn diet and was found in over 44% of the crops. In winter, the fruit and seeds of trees constituted the largest proportion of the diet (43.7), with Ivy in particular, but also beech-masts and haws being taken in large quantities. The proportion and occurrence of Ivy in the diet increased as the winter progressed. Cereals constituted 24.8 of the diet in winter.

During the winters of 1978/79 and 1980/81 in southern and central England, **woodpigeon** damage was recorded in 48 of 52 fields of oilseed rape (Inglis *et al*. 1989). Visual estimates of **woodpigeon** damage were positively correlated with measurements of yield at harvest. On a subset of ten fields which had large areas of both negligible and severe damage in April, yield in the severely damaged areas was a mean of 9% lower than in areas that had negligible damage. Severe **woodpigeon** damage resulted in fewer seeds, and these were lighter and had lower oil content. In terms of timing, damage to oilseed rape was negligible in December, and increased through January, February and March, before decreasing in April. The highest damage in February and March was considered to be due to alternative food sources being at their lowest during this period.

In the Vale of Evesham, financial damage to fields of spring cabbages and Brussels-sprouts during three winters between 1969/70 and 1970/71 was estimated by growers to be a mean of £105 per acre across two different study areas (Murton & Jones 1973). **Woodpigeons** usually ate only the cabbage-like top of the Brussels-sprouts leaving the buttons undamaged. In both sprouts and cabbages, **woodpigeons** showed a tendency to select plants that were smaller than average. The authors reported that disease or other factors resulted in stunted plant growth that appeared to improve the nutrient properties and resulted in plants that were more attractive to **woodpigeons**. The severest damage to Brussels-sprouts and cabbages occurred on fields that were peripheral to the main crop.

Dunning (1974) reported that during the late-1960s, **woodpigeon** damage to sugar beet occurred between April and July with damage most prevalent in June and July on late sown crops. Impacts of **woodpigeons** on crops in this and most papers were descriptive and lacked empirical measurements of damage levels.

The feeding activity and feeding rate of **woodpigeons** was examined in a study at Carlton, near Newmarket, Suffolk (Murton 1965). The proportion of the day spent searching for food

on various feeding grounds was determined by making repeated counts of the activity of the birds. Some birds were shot, enabling the food items collected to be measured. In winter each pigeon collected an average of 34,900 food items (mainly clover leaves) per day from pastures. This was equivalent to a dry weight of 47 gram. During early and mid-summer cereal crops were more important to **woodpigeons**. **Woodpigeons** spent less time feeding when grain was available on sowings, stubbles or standing corn. Cage tests and field observations were consistent in suggesting that the pigeons required about 50 grams of wheat or barley per day. Colquhoun (1951) also found that cereals were particularly important in early and mid-summer, whereas more recent studies (see above) have found cereals to be most important from late summer to early winter. This difference reflects a change in agricultural practices from spring-sown to winter-sown crops.

The feeding sites of **woodpigeon** were examined in a study area in Cambridgeshire by making repeated standardised observations between 1959 and 1963. (Murton *et al*. 1964). In addition, the crop contents of 614 **woodpigeons** shot throughout the period were analysed to determine the birds' diet. During the winter, **woodpigeons** fed primarily on clover leaves which they collected from leys and pastures, but also on weed leaves and, during periods of snow, those of various cultivated *brassicae*. Grain was taken from the spring cereal sowings, after which the birds reverted to clover feeding, supplementing this diet with tree leaf and flower buds. When cereals ripened these comprised the main food being collected from July to November, at first from standing crops and then from stubbles. Wheat was preferred to barley. In the autumn, beech nuts, acorns and other tree fruits were taken and when stocks of these and the cereals were exhausted the birds turned again to clover feeding. Weed seeds, especially pasture species, were collected especially in May and June but only in small amounts.

The diet of 48 **woodpigeons** shot in the South of Spain in late summer (1987-1989) was studied by means of digestive-contents analysis, including contents of the crop, stomach and gizzard (Jimenez *et al*. 1994). No animal prey was found, and the vegetal fraction was mainly composed of fruits and seeds of cultivated plants, including barley, chickpea, vetch, wheat and olives, with only a few wild seeds (e.g. Convolvulus species).

The contents of the crops and stomach content of 86 **woodpigeons** shot by local hunters in a farmland area of western Sicily in September 2008 or 2009 were assessed (Canale & Bue 2018). Of 77 full stomachs, 62 (81%) contained wheat grains, and 21 (27%) contained legumes. No tree-bearing fruits or animal items were recovered from any of the collected individuals.

4.12.2.2 Public health, public safety and spread of disease (GL3)

- **Woodpigeons are potential reservoirs and vectors of microorganisms, which could cause infections and allergic disease in humans and poultry. There is very little data on the prevalence of disease in woodpigeons, with the grey literature often referring to feral pigeon, where more has been published as a proxy (discussed in Horigan *et al*. 2014).**

(a) Spread of disease

A total of 1,531 diagnostic submissions to the Central Veterinary Laboratory, in Weybridge, UK, between June 1976 and December 1984 from a wide range birds were examined for the presence of *Chlamydia psittaci*. (Bevan & Bracewell 1986). The authors treated **woodpigeon** and collared dove together, for which 13 of 52 samples (25%) were positive for *Chlamydia psittaci*.

In Poland a study on the prevalence of Chlamydia looked at 369 samples from 35 species of wild bird (Krawiec *et al.* 2015). Samples from 27 birds (7.3%) were positive for chlamydial DNA. This included samples from one of two **woodpigeons** sampled, and one of two feral pigeons.

Tracheal and cloacal swabs and blood samples were taken from 408 feral pigeons and 170 hunted **woodpigeons** in Germany and were tested for infection with avian influenza viruses (Kohls *et al.* 2011). Influenza A virus was not isolated in the swab samples. Two of 123 serum samples from **woodpigeons** contained specific antibodies against influenza A virus, but not against the subtypes H5 and H7. This study indicated that that even after the occurrence of zoonotic highly pathogenic avian influenza virus (HPAIV) subtype H5N1 in the area of investigation in Germany, **woodpigeons** and feral pigeons did not play a major part in the transmission of influenza viruses.

Mycoplasma gallisepticum is the most important pathogenic avian *Mycoplasma* species and causes chronic respiratory disease in poultry. A study in Belgium, looked at the prevalence of *M. gallisepticum* in commercial poultry (5220 layers, 1224 broilers and 1020 meat turkeys), 56 racing pigeons and 890 wild birds (Michiels *et al.* 2016). In wild birds, only five birds were positive (1.7%), including one **woodpigeon**. It is concluded that wild birds, including **woodpigeons** probably play a limited role as a reservoir in the transmission of *Mycoplasmas*.

4.13 Collared Dove

4.13.1 Status and change in distribution / abundance

Having colonised Scotland from the end of the 1950s, **collared doves** are now widespread throughout the year being generally absent only from extensively upland areas of the Highlands and southern uplands. In recent decades, their range has expanded into some of the more upland areas and the northern and western islands.

Collared dove is on the list of species that have increased markedly on account of a 47% increase in the number of occupied hectads in the breeding season (noting also a similar change in winter distribution).
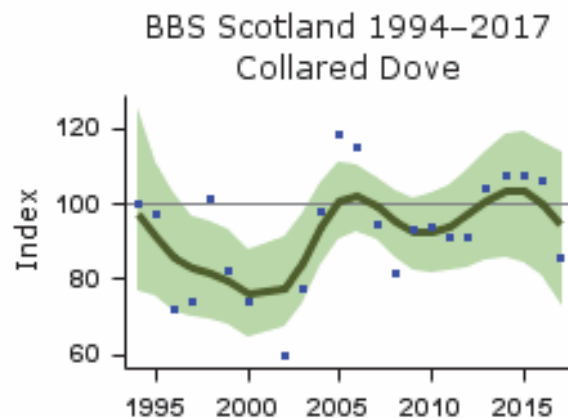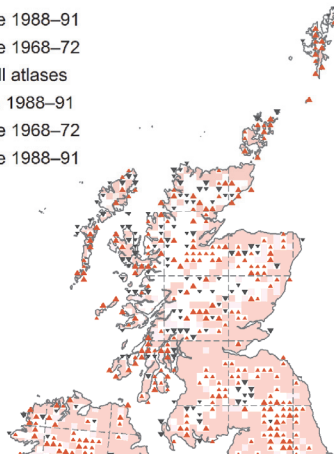

Figure 4.13.1. ***Collared Dove****: (Left) Summary of changes in hectads occupied by breeding birds from 1968-72 to 2008-11 (Bird Atlas); (Right) Smoothed trend and 95% confidence interval (with annual indices also plotted) for breeding abundance in Scotland 1994 to 2016 (BBS).*

4.13.2 Systematic review findings

4.13.2.1 Previous of serious damage (GL2)

- **Collared doves are considered a crop pest in Pakistan, where they eat and foul grain products (Roberts 1991). Whilst it is possible collared doves could damage agricultural crops in the UK, we could not find published evidence of serious damage to crops, livestock, foodstuffs for livestock, vegetables or fruit and could represent an evidence gap.**

4.13.2.2 Public health, public safety and spread of disease (GL3)

- **The collared dove is a potential reservoir and vector of microorganisms, which could cause infections and allergic disease in humans and poultry. However, there is very little data on the prevalence of disease in collared doves.**

(a) Spread of disease

A total of 1,531 diagnostic submissions submitted between June 1976 and December 1984 to the Central Veterinary Laboratory, in Weybridge, UK from a wide range birds were examined for the presence of *Chlamydia psittaci* (Beven & Bracewell 1986). The authors

treated woodpigeon and **collared dove** together, for which 13 of 52 samples (25%) were positive for *Chlamydia psittaci*.

Reviewing wild bird mortality incidents (2005–2011) in the UK, Beckmann *et al*. (2014) identified cases where species or post-mortem findings were indicative of chlamydiosis. Examining archived tissues for *Chlamydia psittaci* infection using PCR and ArrayTube Microarray assays, twenty-one of 40 birds tested positive, including two **collared doves**.

A study by Donati *et al*. (2015) investigated *Chlamydia* species occurrence in **collared doves** from urban and suburban areas in northern Italy. Among 76 doves screened, prevalence of *Chlamydia* species was 61%. *Chlamydia psittaci* genotype was identified in 33 of the 46 positive samples.

In animals, *Arcobacters* have been associated with abortion, mastitis and gastrointestinal disorders, they have also been detected in clinically healthy farm animals (Collado & Figueras 2011). In humans, *Arcobacter butzleri, Arcobacter cryaerophilus*, and *Arcobacter skirrowii* have been isolated from stool samples of patients with gastroenteritis (Wybo *et al*. 2004). *Arcobacter butzleri* has been classified as a serious hazard to human health and as an important foodborne zoonotic pathogen (Cardoen *et al*. 2009). In a study by Di Francesco *et al*. (2014), cloacal swabs from 95 **collared doves** were submitted to the Department of Veterinary Medical Sciences (Bologna, Italy) between 2011 and 2013 from various urban and suburban areas of the Emilia-Romagna region of Northern Italy and tested for the presence of *Arcobacter* species. Eighteen out of 95 (19%) samples showed positive for *Arcobacter*. Currently the potential epidemiological role as source of animal and human infections is not known.

Newcastle disease is one of the major threats for the poultry industry. In Catalonia, testing of wild birds (passive surveillance) for NDV has been carried out since 2010 (Napp *et al*. 2017), the objective being to provide an early warning system to prevent the infection of poultry. Since 2010, 35 episodes of mortality in wild birds in Catalonia have been attributed to NDV infection. Phylogenetic analyses indicate that two distinct sublineages of NDV, 4a and 4b, were circulating in Catalonia. Both sublineages seem to be endemic in the wild bird population, affecting mainly **collared doves**. So far, endemicity in wild birds has not resulted in Newcastle Disease outbreaks in poultry in Catalonia.

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ANNEX 1: GENERAL LICENCE SPREADSHEET

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