BTO RESEARCH REPORT 772

BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds.

Massimino, D., Woodward, I.D., Hammond, M.J., Harris, S.J., Leech, D.I., Noble, D.G., Walker, R.H., Barimore, C., Dadam, D., Eglington, S.M., Marchant, J.H., Sullivan, M.J.P., Baillie, S.R. & Robinson, R.A.

BTO Birds Science People

BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds

Sparrowhawk numbers have nearly doubled over 42 years due to increases which occurred between 1975 and 1995. However it has been in decline since around 2005, and raises an alert over 25-years in this report.

Key findings

Species list

Using the BirdTrends pages

The BTO's BirdTrends report is a one-stop shop for information about the population status of the common breeding birds of the wider UK countryside. The report is based on data gathered by the many thousands of volunteers who contribute to BTO-led surveys.

For each of 121 species, users can quickly access the latest information on trends in population size, breeding performance and survival rates, as measured by our long-term monitoring schemes. For each species, you will find:

- The latest conservation listings and estimates of UK population size
- A summary of changes in the size of the population and the possible causes of these changes
- Graphs and tables showing changes in UK population size, breeding performance and survival since our monitoring began
- Wherever possible, graphs and tables separately for UK countries (England, Scotland, Wales and Northern Ireland)
- Alerts, drawing attention to population declines of greater than 25%, or greater than 50%, that have occurred over the the most recent five-, ten- and 25-year assessment periods and the maximum period available (usually 50 years).

Text, tables, graphs and presentation for each species are updated annually to include the latest results alongside interpretative material from the literature. Information on demographic trends and on the causes of change is gradually being expanded.

There is far more to this report besides the species pages! Supporting pages describe the field and analytical methods that were used to produce the results for each species and to identify alerts. We discuss overall patterns of trends in abundance and breeding success, and compare the latest trend information and alerts with the Birds of Conservation Concern list, last updated in 2015 (Eaton *et al.* 2015). Summary tables list alerts and population changes by scheme, and you can use our 'table generator' to select and display tables of population change to your own specification. A detailed References section lists more than 820 of the most relevant recent publications, with onward links to abstracts or to full text where freely available, and is a valuable key to recent scientific work by BTO and other researchers.The Key

findings page provides a brief overview of our main findings this year.

We would value your comments on this report and particularly any suggestions on how it can be improved:

EMAIL YOUR COMMENTS

Authors

These web pages constitute an annual report that is part of the BTO Research Report series. Authors were Ian Woodward, Dario Massimino, Mark Hammond, Sarah Harris, Dave Leech, David Noble, Ruth Walker, Carl Barimore, Daria Dadam, Sarah Eglington, John Marchant, Martin Sullivan, Stephen Baillie and Rob Robinson. The recommended citation for the report is as follows, and is given in the page footer throughout the report:

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Key findings

This section summarises the key findings of the report, under six headings, based on the results presented and discussed in the Summary tables and Discussion sections. It concentrates on the alerts raised by this edition of the report and changes to alerts since previous reports in this series.

Amber and red listings for breeding trends use similar criteria to the BirdTrends alerts and were reviewed in 2015. This report, using four further year's data not available to BoCC4, suggest potential updates to current conservation concern for Redshank, House Martin and Willow Warbler (from amber to red), Sparrowhawk, Sedge Warbler and Garden Warbler (from green to amber) and Greenfinch (straight from green to red). However, it should be noted that Sedge Warbler and Garden Warbler have both shown frequent fluctuations in trends over the long-term. In addition, although a long-term CBC/BBS trend is not available for Swift, the 22-year BBS trend suggests a potential update to the current conservation concern level for this species (from amber to red).

Conversely this report also suggests potential downgrading of the alert status as a result of improved recent trends (and provided no changes in the other amber or red listing criteria have occurred), from red to amber for Song Thrush and Grey Wagtail, and from amber to green for Dipper and Reed Bunting. This potential change in status is also dependent on the recent upturns being sustained until the next listing review, and it should be noted in particular that the last three of these species have all shown fluctuating long-term trends.

Declining species

Turtle Dove is the fastest declining UK species,
and is one of five species with a long-term decline of 90% or more.

In the current report, there are 28 species for which our best long-term trends show statistically significant population declines of greater than 50% over periods of 32–50 years (see Latest long-term alerts).

These are Little Grebe, Grey Partridge, Lapwing, Redshank, Woodcock, Snipe, Turtle Dove, Cuckoo, Little Owl, Willow Tit, Marsh Tit, Skylark, House Martin, Willow Warbler, Whitethroat, Starling, Mistle Thrush, Spotted Flycatcher, Nightingale, House Sparrow, Tree Sparrow, Yellow Wagtail, Tree Pipit, Greenfinch, Linnet, Lesser Redpoll, Yellowhammer and Corn Bunting (taxonomic order).

Little Grebe and House Martin have been added to this list in the current report as the declines are again statistically significant; both species previously raised a formal alert in BirdTrends 2017 report but did not do so last year due to the wide confidence intervals around the estimates.

One further species shows a non-significant decline greater than 50% over a long timescale. Change for Lesser Spotted Woodpecker is non-significant over the longest period but only because data are sparse and monitoring ceased in 1999; a further strong decline has since been logged by Atlas data.

The steepest long-term populations declines we have measured are for Turtle Dove, Tree Sparrow, Nightingale, Willow Tit and Grey Partridge, which have all declined by 90% or more since 1967, as, almost certainly, has Lesser Spotted Woodpecker. Turtle Dove shows the biggest decline of any species in this report (98%) and its rate of decline suggests it may soon disappear as a British breeding bird.

These 28 species that have halved in population size outweigh the 20 species found to show an equivalent increase, i.e. a doubling of population size, over similar periods. The gap between the numbers of species halving and doubling over the long-term has increased by five species in this year's report. Unusual weather conditions caused decreases for many species in 2018 (the "Beast from the East" and strong adverse winds affecting summer migrants) (Harris *et al.* 2019), and several species close to the boundaries have changed category. These changes are likely to be temporary and the gap is expected to reduce again in future years assuming that such unusual conditions do not become more frequent.

Except for Little Owl, which as an introduced species is not eligible, and Whitethroat, which has shown sustained, though still limited, recovery following considerable losses in the late 1960s, all but one of these rapidly declining species already benefit from listing as either red or amber Birds of Conservation Concern (PSoB/BoCC4). The other exception is the green-listed Greenfinch, which raises a high alert after a rapid decline in the last ten years, following a period of sustained population increases during the 1980s and 1990s.

Four species listed as amber after the 2015 review (BoCC4) arguably meet red-list criteria for breeding population decline: these are Snipe, Redshank, House Martin and Willow Warbler.

A further nine species raise lower-level concern, as a result of statistically significant long-term declines of between 25% and 50%. These are Common Sandpiper, Tawny Owl, Sedge Warbler, Garden Warbler, Song Thrush, Dunnock, Grey Wagtail, Meadow Pipit and Bullfinch. These species are already on the amber list on account of their population declines, except for Song Thrush and Grey Wagtail which are red listed, and Sedge Warbler and Garden Warbler which for now both remain on the green list. Populations Common Sandpiper and Tawny Owl have been in recent decline, whereas the more sustained recent increases by Song Thrush, Dunnock and Bullfinch have been insufficient to fully reverse earlier declines. Numbers of Sedge Warbler, Garden Warbler, Grey Wagtail and Meadow Pipit have fluctuated recently.

In addition, Curlew (now red listed) has declined by more than 25% (as also shown by atlas data), but raises no formal long-term alert because the confidence intervals around its change estimates are too wide.

Three species with much shorter monitoring histories have also decreased by more than half during just a 22-year period. Two of these are already red listed (Wood Warbler and Whinchat), and the third is currently amber listed (Swift). Set against these three species are seven that have more than doubled over equivalent shorter periods (see Positive changes). In addition, Wheatear, which has a shorter monitoring history, declined by between 25% and 50% over a 22-year period. This species is currently green-listed and shows a fluctuating trend over this period, although the last eight years have all seen negative changes.

Many of the declining species are farmland and woodland specialists, and some of the alerts may therefore relate to common pressures in these habitats which are reflected in the negative trends for both habitats in the UK Biodiversity Indicators, although some species may be subject to more specific issues which are detailed in the species accounts, for example the Greenfinch decline has been linked to trichomonasis disease. Four species commonly associated with urban habitats (Swift, House Martin, Starling and House Sparrow) have also been affected by the declines

Recent changes to alerts

Following a severe recent decline attributed to disease caused by the *Trichomonas* parasite, Greenfinch raises higher level alerts.

The *BirdTrends* report raises species alerts for population change to conservation bodies when the best available estimates of long-term decline are statistically significant and pass criteria set at -25% and -50%.

Species with declines close to these threshold values often change category between years. Discussion tables A1–A3 indicate four changes to the long-term alerts since *BirdTrends 2018*, affecting four different species, plus one additional change to species listed in Table A3 that did not raise a formal alert.

- For the amber-listed House Martin, the 50-year CBC/BBS decline for England again raises a high alert in this year's report. Although the long-term decline has been above 50% for several years, a formal alert was not raised for this species in *BirdTrends 2018* due to the wide confidence intervals around the estimate.
- The green-listed Garden Warbler again raises formal lower level alerts, based on 50-year CBC/BBS trend. This species has raised a similar alert in previous reports but did not raise a formal alert in *BirdTrends 2018* as the estimates were not statistically significant due to wide confidence intervals.
- The green-listed Sparrowhawk raises a formal CBC/BBS alert for the first time in this report. Numbers increased strongly between the 1970s and the early 1990s before stabilising, but have declined since around 2006 and the rate of decline is now sufficient to raise a lower level alert over 25-years.
- The 42-year WBS/WBBS decrease for Little Grebe also again raises a formal high alert. As for Garden Warbler this species has raised formal alerts in some of the recent BirdTrends reports but not in others, as the confidence intervals have changed and hence the estimates have not always been statistically significant.
- The amber-listed Oystercatcher is listed in Table A3 as the 25-year decline is statistically significant, but does not raise a formal alert as the decline is not greater than 25%.

Amber and red listings use similar criteria and were reviewed in 2015. This report, using four further year's data not available to BoCC4, suggest potential updates to current conservation concern for Redshank, Sparrowhawk, House Martin, Willow Warbler and Greenfinch and possibly Sedge Warbler and Garden Warbler. In addition, although a long-term CBC/BBS trend is not available for Swift, the 22-year BBS trend suggests a potential update to the current conservation concern level for this species (from amber to red).

Alerts from WBS/WBBS (Table A4) are unchanged, apart from the change in alert status for Little Grebe which is described above.

The alerts for CES (Table A5) are unchanged from *BirdTrends 2018*.

Positive changes

The Great Spotted Woodpecker population has trebled in the UK since 1967.

Although much of this report focuses on declines and their conservation significance, there are many species that are increasing in number as breeding birds in the UK.

In the current report, there are 20 species for which our most representative long-term trends show a statistically significant doubling in population size over periods of 23–50 years.

These are Mute Swan, Greylag Goose, Canada Goose, Shelduck, Mallard, Goosander, Buzzard, Coot, Stock Dove, Woodpigeon, Collared Dove, Green Woodpecker, Great Spotted Woodpecker, Jackdaw, Carrion Crow, Chiffchaff, Blackcap, Nuthatch, Wren and Goldfinch (in taxonomic order). Magpie, Long-tailed Tit and Reed Warbler have been removed from this list in the current report, as the population increase has dropped just below the threshold for inclusion following decreases between 2017 and 2018.

The steepest long-term increases we have measured have been forBuzzard, Greylag Goose, Great Spotted Woodpecker and Shelduck, which have all increased by 300% or more since 1967; note however that the increase for Shelduck covers up to 1999 only as more recent trends are unavailable, so it is not known whether the increases have been sustained subsequently.

The 20 species that have doubled over the long term are set against the 28 that have halved in number over similar periods (see Declining species).

Seven further species, monitored only over a shorter period, have also more than doubled (see Increasing species). These areMandarin Duck, Gadwall, Little Egret, Red Kite, Barn Owl and Ring-necked Parakeet (all monitored by BBS over 22-years) andCetti's Warbler (monitored by CES over the period 1990–2017). Three additional species have more than halved over this shorter period (see Declining species).

For fifteen species that are listed in this report for a population decline over the long term – Ten-year trends and evidence of species recovery).

Three further formerly declining species –Linnet, Tree Sparrow and Bullfinch – have reversed their population trend to show statistically significant increases over the last ten years. For all these species, however, overall population levels remain severely depleted, despite the recent increases.

Whilst many of the declining species are farmland and woodland specialists, several of the increasing species are associated with wetland habitats. Many of the others which were historically associated with woodland are generalists and have been able to successfully move into suburban habitats: these species have almost certainly benefited from the widespread provision of supplementary food in gardens. Some increases can also be attributed to species-specific reasons, for example reduced persecution (Buzzard) or successful reintroduction (Red Kite). Four of the increasing species are non-native and hence could raise concerns as they may impact on native breeding species.

Reduced breeding success

There is increasing evidence to suggest that Willow Warbler population declines have been driven, at least in part, by a reduction in breeding success.

Our best measure of nest-level breeding success is Fledglings Per Breeding Attempt (FPBA), calculated from brood sizes and nest failure rates recorded by participants in the Nest Record Scheme, which indicates the mean number of young fledging from each nest in a given year.

FPBA has changed significantly and is currently lower than in the late 1960s for 14 species: three red-listed species (Wood Warbler, Tree Pipit and Linnet), five amber-listed species (Nightjar, Willow Warbler, Dunnock, Meadow Pipit and Reed Bunting) and six green-listed species (Moorhen, Great Tit, Garden Warbler, Treecreeper, Blackbird and Chaffinch).

While the overall trend in productivity of Moorhen, Great Tit, Willow Warbler, Garden Warbler, Linnet and Reed Bunting has been linear, i.e. falling over the last 50 years, trends for the other eight species are curvilinear and for some species in this latter group, FPBA is currently only marginally lower than in the 1960s. For seven of the species showing curvilinear trends, FPBA increased between the mid 1960s and mid 1980s or mid 1990s and decreased thereafter; whereas in the case of Nightjar, productivity decreased from the mid 1960s until the mid 2000s but has increased slightly over the last ten years.

Productivity declines in migratory species: Nightjar, Willow Warbler, Garden Warbler and Tree Pipit, may be driven in part by birds returning in poorer condition as a result of changes in habitat or climate on their African wintering grounds. For Willow Warbler and Garden Warbler there is evidence that conditions on the breeding grounds and, in the case of the latter, grazing pressure from deer, may also be important. The majority of species exhibiting productivity declines, including residents such as Reed Bunting, are reliant on invertebrates to feed their young and there is increasing evidence that climatic change and/or anthropogenic factors, such as pesticides, are leading to a reduction in the size of prey populations. Additionally, climatic warming may have resulted in a developing asynchrony between laying dates and the availability of insect prey on the breeding grounds. So, although this report shows that many species are advancing laying dates (see early breeding), for some species these advances may not be sufficient to match the advances in peak food availability. Long-distance migrants are thought to be particularly susceptible to such disjunction but residents may also be affected, particularly those reliant on seasonal peaks in caterpillars, such as Great Tit, Chaffinch and, to a lesser extent, Treecreeper; however, numbers of Great Tit and Chaffinch have increased over period covered by this report and we cannot exclude the possibility that the observed reduction in breeding success is due to density-dependent processes. Lack of food for nestling and parent Linnet due to a paucity of stubbles and weeds in more intensively farmed agricultural habitats is likely to have contributed to the reduction in the species' breeding success. The driver for increased Moorhen nest failure is at present unclear, but increases in aquatic mammalian predators and Coot populations have been proposed as potential causes.

The key breeding success parameter from CES ringing, the ratio of juveniles to adults captured data, provides an integrated measure productivity across the whole season, and reflects both the number of young leaving the nest and the survival of these juveniles in the first few weeks after fledging. According to this measure, productivity has fallen significantly for six of the 23 species monitored. Sedge Warbler and Reed Bunting have exhibited declines of more than 50% over the last 33 years, while reductions of between 25% and 49% have been observed for Blue Tit, Blackbird and Song Thrush, and Blackcap productivity has declined by 24%. For species such as Blackcap, where a concurrent population increase has occurred, reductions in productivity may be at least partly driven by density-dependent processes, whereby increased competition for resources in an expanding population will mean that some pairs occupy poorer quality habitat and reduces the mean breeding success per pair. Alternatively, climate induced mismatch with invertebrate food supplies may be impacting negatively on productivity and/or post-fledging survival, particularly in the case of the caterpillar-dependent tit species. Song Thrush and Sedge Warbler have experienced significant declines in abundance, either on CES sites or more widely (based on CBC/BBS figures), but previous analyses suggest that falling survival rates are likely to have been a more important contributor to population changes than reduced productivity. There is, however, evidence that a reduction in the number of offspring produced may be preventing recovery of the UK Reed Bunting population.

Increased breeding success

Nuthatch has exhibited the greatest increase in productivity of any species over the past 49 years, due to a combination of increasing brood sizes and nest survival rates

Our best overall measure of breeding success is Fledglings Per Breeding Attempt (FPBA), calculated from brood sizes and nest failure rates, which indicates the mean number of young leaving each nest in a given year.

FPBA has changed significantly and is currently higher than in the late 1960s for 28 species, across a wide range of taxonomic groups. This total includes 10 species for which the change has been linear, i.e. consistent increases in productivity across the last 50 years, and 18 species which show curvilinear trends (i.e. early decreases in FPBA were followed by increases, or vice-versa). For some species in the latter group, FPBA is currently only slightly higher than in the late 1960s.

Population trends are also positive for 18 of the 28 species, including raptors (Sparrowhawk, Buzzard, Barn Owl, Merlin, Peregrine), pigeons (Stock Dove, Woodpigeon, Collared Dove), corvids (Magpie, Jackdaw, Carrion Crow, Raven), and some small passerines (Reed Warbler,Nuthatch, Wren, Robin, Redstart and Pied Wagtail). It is therefore possible that increasing productivity has contributed to the population growth exhibited by these species over recent decades.

Conversely, 10 species (Little Owl, Tawny Owl, Kestrel, Skylark, Starling, Dipper, House Sparrow, Tree Sparrow, Grey Wagtail and Yellowhammer) have declined in number as FPBA has increased, suggesting that a density-dependent reduction in intraspecific competition, or a retreat into better quality habitat, may have enabled breeding success to rise.

CES ringing data integrate productivity across the whole season, including juvenile survival in the first few weeks or months after fledging. According to this measure, productivity has risen significantly for just two of the 23 species monitored (Reed Warbler and Chaffinch). For Reed Warbler this may be due to warmer temperatures increasing insect resources in reedbeds. The discrepancy between the positive Chaffinch CES trend and the decline in breeding success identified by the NRS warrants further study, but increased survival rates in post-fledging period could contribute to this, although data are sparse for this vital period.

Early breeding

The advance in Redstart laying dates is the greatest exhibited by any migratory species; the species now breeds a fortnight earlier, on average, than it did in the mid-1960s.

Data from the Nest Record Scheme provide strong evidence of shifts towards earlier laying in a range of species, linked to climatic change. We have now identified 40 species that, on average, are laying between three and 21 days earlier, on average, than in the mid 1960s.

The species now laying earlier in the year represent a wide range of taxonomic and ecological groups, including raptors (Kestrel – 10 days), waders (Oystercatcher – 3 days), migrant insectivores (e.g. Pied Flycatcher – 10 days, Swallow – 12 days), resident insectivores (e.g. Robin – 10 days, Great Tit – 10 days), corvids (e.g. Magpie – 20 days) and resident seed-eaters (e.g. Greenfinch – 21 days).

For some species these shifts towards earlier laying may be insufficient to match seasonal advances in the peaks of food availability. Recent research has shown that significantly stronger phenological responses to climate change are displayed at lower trophic levels (such as the food birds eat) than at higher levels (such as the birds themselves), increasing the potential for disjunction and resulting productivity declines. However, the evidence for for a population-level effect of reduction in breeding success is mixed and more research is needed to determine the extent to which declines in abundance will result.

Only four species demonstrate a significant delay in average laying dates, of between one and 21 days: Woodpigeon, Barn Owl, Blackbird and Yellowhammer (taxonomic order). All of these species initiate multiple breeding attempts per season and there is increasing evidence that species which are less reliant on seasonal peaks in resource availability may be able to extend their breeding seasons further into the summer, resulting in a later mean value for laying date.

Introduction

Gathering quantitative information on the bird populations of the UK has been a key function of the BTO ever since its formation in 1933. Its nationwide network of volunteer observers, many of whom are highly skilled and long-term contributors to survey schemes, provides the ideal way to monitor bird populations, particularly for the commoner species that are widely distributed across the countryside. BTO data, from such schemes as the Common Birds Census, Nest Record Scheme and BTO/JNCC/RSPB Breeding Bird Survey, have been increasingly influential in determining nature conservation policy in the UK. The partnership between JNCC and BTO has ensured that these schemes are operated and developed in ways that provide high-quality information for nature conservation.

The value of the monitoring work undertaken by the BTO is reflected in their use in government biodiversity and wildlife statistics. The BTO's schemes fulfil a considerable portion of the government's monitoring needs for UK birds, at species level and as multi-species *indicators* of bird population changes (Gregory *et al.* 2004). Indicators of trends in breeding birds (e.g. Defra 2015) help the government track the UK's progress towards international targets, such as those set by the Convention on Biological Diversity in October 2010. This approach has been extended more widely through a collaboration between EBCC, BirdLife and RSPB to produce pan-European bird indicators (PECBMS 2018b).

Our 2019 report is the latest in a series, begun in 1997, produced under the BTO's Partnership with the Joint Nature Conservation Committee (on behalf of Natural England, Scottish Natural Heritage, Natural Resources Wales, and the Department of Agriculture, Environment and Rural Affairs - Northern Ireland) as part of its programme of research into nature conservation.

Only the first two reports were published on paper, with subsequent ones being produced solely as web documents. A complete list of all the previous reports and links to those published online can be found here. The first 12 reports were titled *Breeding Birds in the Wider Countryside: their conservation status* but this is now known as 'the *BirdTrends* report', with an informal title that matches its web link.

All the commonest and most widespread UK breeding bird species have a *BirdTrends* page, updated annually to incorporate the latest survey data and assessments of trends. Colonial seabirds, which are well covered by the results of Seabird 2000 (Mitchell *et al.* 2004) and by the JNCC's Seabird Monitoring Programme (JNCC 2016), and species covered by the Rare Breeding Birds Panel (Holling & RBBP 2017), are in general not included here – though with a handful of exceptions.

The main emphasis of this report is on trends in the abundance and demography of individual breeding species. The system of alerts, derived from the BTO's census and nest record data, ensures that conservation bodies are quickly made aware of important demographic changes.

Trends in wintering populations of waterfowl are covered by the Wetland Bird Survey annual reports, also now fully available online (Frost *et al.* 2019a), and by the *WeBS alerts* system (Woodward *et al.* 2019).

Monitoring UK breeding birds

Long-running bird surveys operated by BTO contribute to an overall programme of Integrated Population Monitoring (IPM) that has been developed by the BTO, in partnership with JNCC, to monitor the numbers, breeding performance and survival rates of a wide range of bird species. IPM has the following specific aims (Baillie 1990, 1991):

1. to establish thresholds that will be used to notify conservation bodies of requirements for further research or conservation action;
2. to identify the stage of the life cycle at which demographic changes are taking place;
3. to provide data that will assist in identifying the causes of such changes; and
4. to distinguish changes in population sizes or demographic rates induced by human activities from those that are due to natural fluctuations.

Changes in numbers of breeding birds have been measured by:

- the BTO/JNCC/RSPB Breeding Bird Survey (BBS) – which began in 1994 and replaced the CBC (below) as the major monitoring scheme for landbirds, after a seven-year overlap. BBS is based on around 3,000 1-km squares, within each of which birdwatchers count and record birds in a standardised manner along a 2-km transect. Because the survey squares are chosen randomly, the results are representative of all habitats and regions. Combined CBC/BBS indices now provide long-running and ongoing population monitoring for many common birds.
- the *Common Birds Census* (CBC) – which ran from 1962 to 2000. This scheme mapped the breeding territories of common birds through intensive fieldwork on 200–300 mainly farmland and woodland plots each year, averaging about 70 and 20 ha respectively.
- the Waterways Breeding Bird Survey (WBBS) – which began in 1998 and replaced the WBS (below) as the major monitoring scheme for breeding birds along rivers and canals, after a ten-year overlap. It is a transect scheme akin to BBS but with the transects running alongside linear waterways. Transects comprise up to ten 500-m sections and cover typically 3–3.5 km of bird-rich habitat. Around 250–300 sites are covered each year, mostly randomly selected. Combined WBS/WBBS indices now provide long-running and ongoing population monitoring for many common waterside birds.
- the *Waterways Bird Survey* (WBS) – which ran from 1974 to 2007. WBS observers mapped the territories of birds along rivers, streams and canals on 80–130 plots each year, each on average 4.5 km in length. Around 70 of these sites are currently incorporated within WBBS.
- the Constant Effort Sites scheme (CES) – which began in 1983 and is based on breeding-season bird ringing at over 100 sites. The catching effort is kept constant at each site during each year, so that changes in numbers of birds caught will reflect population changes and not variation in catching effort.
- the Heronries Census – through which counts of 'apparently occupied nests' have been collected from a high proportion of the UK's heronries every year since 1928.

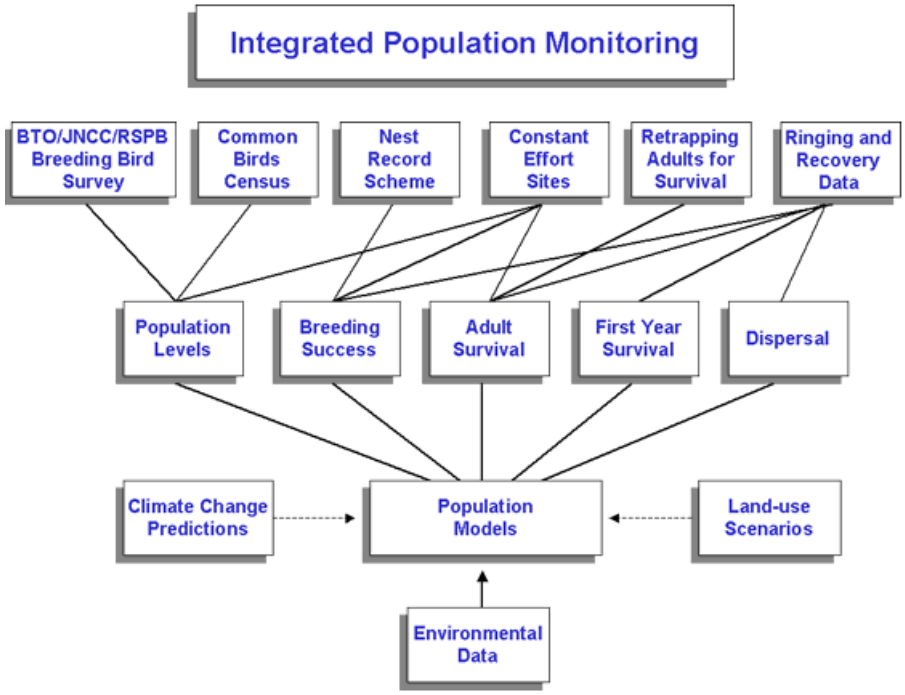
Changes in breeding performance are measured by:

- the Nest Record Scheme – which began in 1939 and collates standardised information on up to 35,000 individual nesting attempts per year. This allows the measurement of:
  - laying dates
  - clutch sizes
  - brood sizes
  - nesting success during egg and chick stages
  - fledglings per breeding attempt (integrating success across all nesting stages).
- CES (see above) – which provides information on overall productivity for a range of species by measuring the ratio of juveniles to adults caught each year.

Changes in survival are measured by:

- the British and Irish Ringing Scheme – which provides information on the finding circumstances and longevity of ringed birds found dead by members of the public.
- CES also provides information on survival rates, based on the recapture of ringed birds at constant-effort sites.
- Further information on survival rates is provided through the Retrapping Adults for Survival scheme (RAS).

The ways in which the schemes fit together are shown in the diagram below, which also demonstrates the way in which the BTO aims to combine all this information, using population models, to elucidate the mechanisms behind the changes we observe in population size.


Integrated Population Monitoring
BTO/JNCC/RSPB Breeding Bird Survey
Common Birds Census
Nest Record Scheme
Constant Effort Sites
Retrapping Adults for Survival
Ringing and Recovery Data
Population Levels
Breeding Success
Adult Survival
First Year Survival
Dispersal
Climate Change Predictions
Population Models
Land-use Scenarios
Environmental Data

Combining results from different schemes

Monitoring the changes in the size of a population does not in itself provide sufficient information on which to base an effective conservation strategy (Goss-Custard 1993, Furness & Greenwood 1993). Concurrent monitoring of breeding performance and survival rates is necessary to allow changes in population size to be properly interpreted (Temple & Wiens 1989, Crick *et al.* 2003) and, for long-lived species, can provide early warning of impending conservation problems (Pienkowski 1991).

Where good long-term data sets for breeding performance and survival are lacking, conservation action might have to be taken without an adequate understanding of the mechanisms involved or might need to wait years for detailed research to be undertaken. As this report demonstrates, however, there are many species for which BTO already holds the necessary data, collected by volunteer observers over periods of several decades (Greenwood 2000).

For a long-lived species, a decline in population may not begin until a long period of low survival or reduced reproductive output has already passed. The classic example is that of the Peregrine, which in the UK suffered from poor breeding performance during the 1940s and 1950s due to sub-lethal DDT contamination. This drop in productivity decreased the capacity of the non-breeding section of the population to buffer the severe mortality of breeding adults that occurred due to cyclodiene poisoning from the mid 1950s onward (Ratcliffe 1993). Monitoring of breeding performance gave an early warning of impending numerical decline (Pienkowski 1991). Another example of a decline in breeding performance that presaged population decline is the catastrophic breeding failures of seabirds, particularly Arctic Terns, in Shetland (Monaghan *et al.* 1989, 1992, Walsh *et al.* 1995, Mavor *et al.* 2003, 2004, Wanless *et al.* 2005).

Farmland birds

During the mid 1980s, the BTO identified rapid declines in the population sizes of several farmland bird species (O'Connor & Shrubb 1986, Fuller *et al.* 1995). The BTO has since been able to investigate the demographic mechanisms underlying these declines, using its long-term historical data sets (Siriwardena *et al.* 1998a, 2000a).

This investigation, which was funded by Government and undertaken jointly with Oxford University, looked at changes in population size, breeding performance and survival rates of a variety of species in relation to changing farming practice. It showed that species responded to different aspects of agricultural change, but that typically these aspects were linked to intensification or regional specialisation. Declines in survival rates were found to be the main factor driving population decline in these species, with the exception of Linnet, for which the main factor appears to have been a decline in nesting success at the egg stage (Siriwardena *et al.* 2000b). The study was therefore able to eliminate some possible causes of change, and identify areas for future research, thus helping conservation bodies to use their scarce resources productively. This work made an important contribution to the wider programme of work on farmland birds undertaken by many research and conservation organisations (Aebischer *et al.* 2000, Vickery *et al.* 2004).

This report describes a number of other cases where the combined analysis of BTO data sets has helped to identify the causes of population declines, for example on the pages for Integrated population analysis'.

Biodiversity Action Plans

The ability to quickly determine the stage of the life cycle exerting the greatest influence on population declines is particularly important for the conservation agencies when considering remedial action for species on the lists of conservation concern. Analysis of BTO data sets, which has already helped to build these lists, is a key point in several of the UK Government's biodiversity action plans for rapidly declining species. Once conservation actions have been initiated, the BTO's Integrated Population Monitoring programme has a further function, because the success of these actions will be measured and assessed by continued BTO monitoring.

The aims of this report

The BirdTrends report is used by conservation practitioners as a ready reference to changes in status among breeding birds in the UK. Here on the BTO website, it is available to a much wider audience including BTO supporters, who may have contributed data, and the general birdwatching public. We hope that it also provides a useful resource for schools, colleges and universities, the media, ecological consultants, Wildlife Trusts, decision-makers, local government, and the more general world of industry and commerce. In summary, its aims are:

1. To provide, to as wide a readership as possible, a species-by-species overview of the trends in breeding population, reproductive performance and survival rate for birds covered by BTO monitoring schemes since the 1960s, at the UK and UK-country scales.
2. To provide warning alerts to JNCC and country agencies and to other conservation bodies about worrying declines in population size or reproductive success, with special reference to species on the UK red and amber lists of Birds of Conservation Concern.

Acknowledgements

Volunteer fieldwork

The volunteers who collected the data on which this website is based deserve full credit for their achievement. The population trends and other results that we present rely on the sustained, long-term fieldwork effort of many thousands of BTO volunteers. Our knowledge of the conservation status of the UK's bird populations is possible only as a result of their dedication. The conservation community owes them all an enormous debt of gratitude for their work. Without their enthusiasm, the cause of conservation in the UK would be very much the poorer.

We are also very grateful to the many land managers and landowners who permitted census work, nest recording and ringing to take place on their land.

Report production and analysis

This website presents the latest in a series of reports, prepared within the partnership between the British Trust for Ornithology (BTO) and the Joint Nature Conservation Committee (JNCC) (on behalf of the Department of Agriculture, Environment and Rural Affairs - Northern Ireland, Natural England, Natural Resources Wales and Scottish Natural Heritage), as part of its programme of research into nature conservation.

Mr and Mrs J A Pye's Charitable Settlement provided additional support towards the development of the website.

Our report includes results from the Breeding Bird Survey, which is funded jointly by BTO, JNCC and RSPB. The BBS partners are very grateful to the Department of Agriculture, Environment and Rural Affiars in Northern Ireland and to the Royal Society for the Protection of Birds in Scotland for supporting professional surveys in areas that would otherwise be difficult to cover. The report also includes results from the Ringing Scheme, which is funded by the JNCC, BTO and the ringers themselves.

Paul Woodcock of JNCC provided helpful discussions, comments and support during the production of this report. Helen Baker, Chris Cheffings, Jacquie Clark, Nigel Clark, David Gibbons, Jeremy Greenwood, Rowena Langston, Ian McLean, Ian Mitchell, Deborah Procter, David Stroud, Pierre Tellier, Malcolm Vincent and Lawrence Way provided helpful comments on earlier editions of this publication.

The analyses would not have been possible without the hard work of many past and present BTO staff who have organised schemes, collated data sets or overseen analyses, including: Sue Adams, Dawn Balmer, Lee Barber, Richard Bashford, Jeremy Blackburn, Jacquie Clark, Mark Collier, Greg Conway, Rachel Coombes, Humphrey Crick, Diana de Palacio, Steve Freeman, Mark Grantham, Bridget Griffin, Andrew Joys, Allison Kew, Stuart Newson, Mike Raven, Brenda Read, Anna Renwick, Kate Risely, Sabine Schaeffer, Richard Thewlis, Anne Trewhitt and Jane Waters.

The work is also heavily dependent on the BTO's computer and database systems overseen by Andy Musgrove. Iain Downie and Karen Wright were previously joint leaders of the BTO's IT team and contributed to the production of this report. Susan Waghorn, Laura Smith and Mandy Andrews also exercised great skill in helping to design and build the website. The site is now managed by William Skellorn.

We are very grateful to all of the organisations and individuals listed above for their contributions to this report.

Methods

Eight monitoring schemes have contributed data to this report. Six provide data on changes in abundance: these are the Breeding Bird Survey, Common Birds Census, Waterways Breeding Bird Survey, Waterways Bird Survey, Heronries Census and the Constant Effort Sites ringing scheme. Two schemes, the Nest Record Scheme and Constant Effort Sites, provide data on changes in breeding productivity. Data on survival rates come from detailed analyses of the retrappings and recoveries of ringed birds, from Retrapping Adults for Survival, Constant Effort Sites and the general Ringing Scheme. In addition, information on waterbirds from the Wetland Bird Survey is included where relevant.

The methodologies of the monitoring schemes are described in turn, including information on fieldwork, data preparation, sampling considerations and the statistical methods used in analysis. Most of the analyses and the preparation of tables and graphs were undertaken using SAS software (SAS 2011).

The two final parts of the methods section concern the alert system. These deal, first in descriptive terms and second in statistical detail, with the system by which the results of monitoring surveys raise alerts and thereby are brought to the attention of conservation bodies.

Breeding Bird Survey

The BTO/JNCC/RSPB Breeding Bird Survey (BBS) was launched in 1994, following two years of extensive pilot work and earlier desk-based studies. The introduction of the BBS was a move designed to overcome the limitations of the Common Birds Census (CBC), which had monitored bird populations since 1962. In particular, it improves the geographical spread of UK bird monitoring, thus boosting coverage of species and of habitats.

The BBS uses line transects rather than the more intensive territory-mapping method that had been used by the CBC. The average time observers spend per visit on counting birds is only around 90 minutes and, even with travel and data-input time, this survey is relatively quick to undertake and is therefore accessible to a large number of volunteers. Sampling units are the 1x1-km squares of the Ordnance Survey national grid, of which there are some 254,000 in the UK. From these we make random selections for inclusion in the scheme (see Square selection, below). The BBS requires a relatively large sample of survey squares, and the initial aim was to achieve coverage of about 2,500 squares (1%). This total is now well exceeded.

An important aspect of BBS is its coordination through a network of volunteer BBS Regional Organisers. The Regional Organisers find and encourage willing volunteers for their squares and provide paper forms as required. Since 2003, when online submission of BBS data was introduced, most data have been returned online – see the BBS pages of the main BTO website for details.

Fieldwork involves up to three visits to each survey square each year. The first is to record details of habitat and to establish or re-check the survey route, while the second and third (termed 'early' and 'late') are to count birds. A survey route is composed of two roughly parallel lines, each 1 km in length, although for practical reasons routes typically deviate somewhat from the ideal. Each of these lines is divided into five sections, making a total of ten 200-m sections, and birds and habitats are recorded within these ten units. The two bird-count visits are made about four weeks apart (ideally in early May and early June), ensuring that late-arriving migrants are recorded. Volunteers record all the birds they see or hear as they walk along their transect routes. Birds are noted in three distance categories (within 25 m, 25–100 m, or more than 100 m on either side of the line, measured at right angles to the transect line), or as in flight. Recording birds within distance bands provides a measure of bird detectability in different habitats and thus allows population densities to be estimated more accurately. The total numbers of each species, excluding juveniles, are recorded in each 200-m transect section and distance category, as well as the timing of the survey and weather conditions. In 2014, the optional recording of the method of detection was included in BBS for the first time, and observers can now record whether they detect each individual bird by sight, by song or by call. This information is not currently used to calculate trends, but it is anticipated that it will help further refine the calculation of population densities for some species.

By 1998, more than 2,300 BBS squares were being surveyed annually, close to the original target of 2,500. Only around a quarter of these plots were covered in 2001, owing to Foot & Mouth Disease access restrictions, but (thanks to our keen observers) the sample recovered immediately. The original target of 2,500 was surpassed in 2004 and coverage had increased further to 3,729 in 2007, running marginally below that level over the next few years during and just after the 2007–11 Bird Atlas, before increasing again, with over 4,000 squares being covered for the first time in 2018 (*Harris et al. 2019*). Squares are distributed throughout the UK and cover a broad range of habitats, including uplands and urban areas. There are now 117 species that are present on 40 or more BBS squares annually and so can be monitored with good precision at the UK scale (Joys *et al.* 2003, *Harris et al. 2019*), although a few present special difficulties because of their colonial or flocking habit or their wide-ranging behaviour. For most of these species, BBS can also assess annual population changes within England alone, using data from 30 or more squares, and for about half the species also within Scotland and Wales as separate units. Sample sizes in Northern Ireland already allow more than 30 species to be indexed annually. In the 2017 BBS report (*Harris et al. 2019*), shorter-term 5-year and 10-year trends were shown for the first time in addition to the trends covering the full BBS period since 1994. For six of the 117 species which can be monitored by BBS, results can only be produced over these shorter time periods, due to the lower sample sizes in the early years of the survey.

Square selection

Survey squares are chosen randomly using a stratified random sampling approach from within 83 sampling regions, which in most cases are the standard BTO regions. Survey squares are chosen at random within each region, to a density that varies with the number of BTO members resident there. Regions with larger numbers of potential volunteers are thereby allotted a larger number of squares, enabling more birdwatchers to become involved in these areas. This does not introduce bias into the results because the analysis takes the regional differences in sampling density into account.

Data analysis

Change measures between years are assessed using a log–linear model with Poisson error terms. For each species and square, counts are summed across all sections and distance bands for each visit ('early' and 'late') and the higher value is used in the model (or the single count if the square was visited only once). Counts are modelled as a function of square and year effects. Each observation is weighted by the number of 1-km squares in each region divided by the number of squares counted there, to correct for the differences in sampling density between regions. The upper and lower confidence limits of the changes indicate the certainty that can be attached to each change measure. When the limits are both positive or both negative, we can be 85% confident that a real change has taken place (see here for details).

Trends are presented as graphs in which annual population indices are shown alongside a smoothed trend and its 85% confidence limits. A caveat, 'small sample', is provided against the trends for England, Northern Ireland, Wales and Scotland where the mean sample size is between 30 and 40 plots per year.

Go to the BBS section of the main BTO website.

Common Birds Census

The Common Birds Census (CBC) ran from 1962 to 2000 and was the first of the BTO's schemes for monitoring population trends among widespread breeding birds. It has now been superseded for this purpose by BBS.

The CBC was instigated to provide sound information on farmland bird populations in the face of rapid changes in agricultural practice. Although the original emphasis was on farmland, woodland plots were added by 1964. Fieldwork was carried out by a team of 250–300 volunteers. The same observers surveyed the same plots using the same methods year after year. On average, plots were censused for around seven consecutive years but a few dedicated observers surveyed the same sites for more than 30 years. Farmland plots averaged around 70 hectares in extent. Woodland plots were generally smaller, averaging just over 20 hectares. A small number of plots of other habitats, including heathlands and small wetlands, were also surveyed annually, especially before 1985.

A territory-mapping approach was used to estimate the number and positions of territories of each species present on each survey plot during the breeding season (

CBC instructions (PDF, 1.90 MB)
: Marchant 1983). Volunteers visited their survey plots typically eight to ten times between late March and early July and all contacts with birds, either by sight or sound, were plotted on outline maps at a standard scale of 1:2,500 (25 inches to the mile). Codes were used to note each bird's species, with sex and age where possible, and also to record activity such as song or nest-building. The registrations were then transferred to species maps and returned to BTO headquarters for analysis. The pattern of registrations on the species maps reveals the numbers of territories for each species. All assessments of territory number were made by a small team of trained BTO staff, applying rigorous guidelines, for maximum consistency between estimates across sites and years. Observers also provided maps and other details of the habitat on their plots. This makes it possible to match the distribution of bird territories with contemporaneous habitat features, providing the potential for detailed studies of bird–habitat relationships.
In 1990, the results from the CBC were brought together in the book*Population Trends in British Breeding Birds*(Marchant *et al.* 1990). This landmark publication discussed long-term population trends for the years 1962 to 1988 for 164 species, with CBC or Waterways Bird Survey population graphs for around two-thirds of these.

The weaknesses of the CBC as a monitor of UK-wide bird populations were largely related to the time-consuming nature of both fieldwork and analysis. This inevitably limited the number of volunteers able to participate in the scheme, with the result that areas with few birdwatchers were under-represented. Constrained by its relatively small sample size, CBC concentrated on farmland and woodland habitats. Bird population trends in built-up areas and the uplands were therefore poorly represented. Furthermore, as the plots were chosen by the observers, they might not have been representative of the surrounding countryside and some bias towards bird-rich habitats might be suspected. It is for these reasons that the BBS was introduced in 1994. The two surveys were run in parallel for seven years to allow calibration between the results: for many species, CBC and BBS trends can be linked to form joint CBC/BBS trends that provide ongoing monitoring, continuous since the 1960s (Freeman *et al.* 2003, 2007a).

The results from the CBC provided reliable population trends for more than 60 of the UK's commoner breeding species and, through the linking of CBC with BBS to form this report's long-term trends, continue to be hugely influential in determining conservation priorities in the UK countryside. The archive of detailed maps of almost a million birds' territories, collected through the CBC and maintained at BTO HQ since the early 1960s, is a uniquely valuable resource for investigating the relationships between breeding birds and their environment, over wide temporal and spatial scales.

Validation studies

The CBC was the first national breeding bird monitoring scheme of its kind anywhere in the world and its contribution is widely recognised. The territory-mapping method adopted by the CBC is acknowledged as the most efficient and practical way of estimating breeding bird numbers in small areas, and has been well validated. Although intensive nest searches may sometimes reveal more birds, a comparison by Snow (1965) concluded that mapping censuses were a good measure of the true breeding population for 70% of species. Experiments to test differences between observers' abilities to detect birds found that, although there was considerable variation between individual abilities, the observers were consistent from year to year (O'Connor & Marchant 1981). As the CBC relies on data from plots covered by the same observer in consecutive years, this source of bias has no implications for the CBC's ability to identify population trends. It has also been confirmed that the sample of plots from which CBC results are drawn changed little in composition or character over the years (Marchant *et al.* 1990) and that the results of territory analysis are not affected by changes in analysts, once trained (O'Connor & Marchant 1981). Fuller *et al.* (1985) found that farmland CBC plots were representative of ITE lowland land-classes throughout England (excluding the extreme north and southwest), and closely reflected the agricultural statistics for southern and eastern Britain.

Data analysis

Population changes are modelled using a generalised additive model (GAM), a type of log–linear regression model that incorporates a smoothing function (Fewster*et al.* 2000). This has replaced the Mountford model that employed a six-year moving window (Mountford 1982, 1985, Peach & Baillie 1994) and was used to produce annual population indices until 1999, but the principles are similar. These models are also very similar to log–linear Poisson regression as implemented by program TRIM (Pannekoek & van Strien 1996). Counts are modelled as the product of site and year effects on the assumption that between-year changes are homogeneous across plots. Smoothing is used to remove short-term fluctuations (e.g. those caused by periods of severe weather or by measurement error) and thus reveal the underlying pattern of population change. This is achieved by setting the degrees of freedom to about a third of the number of years in the series. Confidence limits on the indices are estimated by bootstrapping (a resampling method; Manly 1991), to avoid making any assumptions about the underlying distribution of counts.

CBC-only graphs and tabulated trends are presented in this report for a small number of species whose numbers have become too depleted for annual monitoring to continue. Smoothed indices are plotted as the blue line on these graphs. The two green lines on the graphs, above and below the index line, are the upper and lower 85% confidence limits. Caveats are provided to show where the data suffer from a 'Small sample' if the mean number of plots was less than 20. Data are flagged as 'Unrepresentative?' if the average abundance of a species in 10-km squares containing CBC plots was less than that in other 10-km squares of the species' distribution in the UK (as measured from 1988–91 Breeding Atlas data (Gibbons *et al.* 1993)) or, where average abundances could not be calculated, if expert opinion judged that CBC data might not be representative.

In practice nearly all CBC data included in this report have been combined with BBS data to provide joint CBC/BBS trends, using the methods described in the next section. These methods for producing joint trends represent an extension of those described above.

More information on the

Common Birds Census (PDF, 87.11 KB)
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CBC/BBS trends

CBC and BBS have been described separately in earlier sections. This page describes how the results have been combined to derive joint CBC/BBS trends, extending from the 1960s to the present.

As previously noted, the CBC has been an enormously influential project, providing the main source of information on national population levels in the UK since its inception in 1962. Coverage was predominantly in lowland England, where the numbers of potential volunteers are greatest, while coverage was more patchy in more sparsely populated regions and especially the uplands (Marchant *et al.* 1990). CBC plots were situated in a limited number of habitats, predominantly farmland and woodland. Within a large rectangle of southeastern Britain (covering England and Wales south and east from Seascale, Scarborough and Exeter), the plots are nevertheless believed to be broadly representative, at least of lowland land-classes (Fuller *et al.* 1985). For species such as Wood Warbler and Meadow Pipit that have the greater part of their numbers in the far west or north of Britain, however, the CBC may not have accurately reflected UK trends.

The BBS, on account of its more rigorous, stratified random sampling design, and its simplicity in the field, produces better coverage of the previously under-represented regions and habitats. In some early editions of 'Breeding Birds in the Wider Countryside' (e.g. Baillie *et al.* 2002), separate indices were published from CBC and BBS data, for those species with sufficiently large sample sizes. There being no new CBC data since 2000, however, it is unnecessary to present a CBC-only trend – except for those few species that are now so rare that BBS has been unable to contribute.

For most purposes, the presentation and analysis of longer time-series is required, dating back to before the establishment of the BBS but coming right up to the present day. The calculation of 25-year alert designations, as in this report, provides just one example. This need led the BTO to research the compatibility of indices from BBS and CBC data in various years and regions, and the possibility of deriving trustworthy long-term indices from the two data sources in combination (Freeman *et al.* 2003, 2007a). This research suggested that for the vast majority of species considered there was no significant difference between population trends, calculated from the two surveys, based on that part of the country where CBC data are sufficient to support a meaningful comparison. Where a statistically significant difference was found, this was sometimes for very abundant species for which the power to detect even a biologically insubstantial difference was considerable. Within this region, therefore, long-term trends based on CBC and BBS data can be produced for almost all species previously monitored by the CBC alone. For (Freeman *et al.* 2003, 2007a) this was the area covered by Fuller *et al.* (1985), because CBC plots in that region were shown to be representative of lowland farmland there. As this region covers the bulk of England, and for consistency with the rest of this report, we have produced joint indices for CBC/BBS for the whole of England (the CBC/BBS England index), rather than just the English part of the 'Fuller rectangle'.

A second question then is whether one can obtain reliable trends over the same period for the entire UK. That is, since prior to 1994 only CBC data are available, are the population trends within the region well covered by the CBC typical of those for the UK as a whole? The shortage of CBC data in the north and west means that the only way of investigating this is via the BBS data. Significant differences in trends between the area well covered by the CBC and the rest of the UK were found for approximately half the species (see Freeman *et al.* 2003, 2007a, for full details). For such species, a regional bias in CBC data means that no reliable UK index can be produced prior to 1994. In summary, joint population indices dating back to the start of the CBC can continue to be produced for that part of the country well served by the CBC (essentially England) for almost all common species. However, a similar UK index can be produced for only about 50% of species (CBC/BBS UK index).

Data analysis

This report presents joint CBC/BBS trends for the UK and/or England, as appropriate. Ideally the trends would have been estimated using generalised additive models (Fewster *et al.* 2000) but these were too computationally intensive, given the large number of sites involved. Therefore we fitted a generalised linear model, with counts assumed to follow a Poisson distribution, and a logarithmic link function, to the combined CBC/BBS data. Standard errors were calculated via a bootstrapping procedure and there is therefore no need to model overdispersion, as it does not affect the parameter estimates. BBS squares were weighted as in standard BBS trend analyses. CBC plots were assigned the average weight of all BBS squares as this allows them to be incorporated within the analysis while retaining the convention of not applying weights within the BBS sample. The population trend was smoothed using a thin-plate smoothing spline with degrees of freedom about one third the total number of years. Confidence intervals were calculated via a bootstrap procedure. Bootstrap samples were generated by resampling sites from the original data set, with replacement. A generalised linear model was then fitted to each bootstrap replicate and a smoothing spline fitted to the annual population indices as described above. Confidence limits were then calculated as the appropriate percentiles from the sets of smoothed estimates. The overall result is a smoothed trend that is mathematically equivalent to that produced from a generalised additive model. The method of estimation is less statistically efficient because the smoothing is not incorporated within the estimation procedure, and is likely to have resulted in more conservative statistical tests and wider confidence intervals. However this compromise was necessary to make it possible to fit the trends within a reasonable amount of computer time (still several weeks).

Data presentation

Indices are plotted on the graphs as annual estimates, with a smoothed trend and its 85% confidence interval.The CBC started on farmland in 1962 and on woodland in 1964. However, the early years of the CBC population indices are strongly influenced by the effects of the unusually severe winters of 1961/62 and 1962/63, as well as by developments in methodology (Marchant *et al.* 1990). Joint CBC/BBS indices have been calculated using only the data from 1966 onward, therefore, and population changes are calculated back to 1967.

Waterways Bird Survey & Waterways Breeding Bird Survey

Waterways Bird Survey 1974–2007

The Waterways Bird Survey (WBS) monitored the population trends of riparian bird species on canals and rivers throughout the UK during the breeding seasons of 1974–2007. WBS used a territory-mapping method like that of its parent scheme, the Common Birds Census, to estimate the breeding population of waterbirds on each of a number of observer-selected survey plots. Detailed territory maps were prepared alongside habitat data that show which features of linear waterways are important to breeding birds. The plots averaged 4.4 km in length. Almost half were slow-flowing lowland rivers with the rest either fast-flowing rivers/streams or canals. In the scheme's closing years there were around 90 plots distributed throughout the UK. The north and west of Britain were better represented by WBS than by the CBC although, as with CBC, coverage outside England was relatively poor (Marchant *et al.* 1990).

All fieldwork was carried out by BTO volunteers. Observers were asked to survey their plots on nine occasions between March and July, mapping all the birds seen or heard onto 1:10,000 maps (six inches to the mile). Registrations were then transferred to species maps, which were analysed to reveal the numbers and positions of territories for each species. For the first 20 years all territory analysis was performed by trained headquarters staff but, during 1994–2007, observers mostly completed their own territory analysis, based on the scheme's written guidelines, with results checked and corrected by BTO staff. As WBS employed very similar methods to those of CBC, the validation studies carried out for the latter generally held true for WBS (see CBC section). Marchant *et al.* (1990) found that there had been little change by 1988 in the composition of the WBS sample, in terms of waterway type or geographical spread.

Population changes along waterways have been reported historically for up to 25 riparian species. For specialist waterbirds, including Mute Swan, Goosander, Little Grebe, Common Sandpiper, Kingfisher, Sand Martin, Dipper and Grey Wagtail, targeted surveys along waterways can provide a better precision of monitoring than is possible through the more generalised BBS surveys. Waterways indices can also add a new perspective on trends in waterbirds that are monitored, largely in different habitats, by CBC/BBS. For Lapwing, for example, populations declined rapidly on arable farmland during the late 1980s while numbers on WBS plots, typically representing populations along river floodplains, were more stable. Yellow Wagtails have declined much more steeply alongside rivers and canals than elsewhere.

Waterways Breeding Bird Survey and joint indices

WBS had limitations as a monitoring scheme similar to those that led to the CBC's replacement by BBS. In particular, plot distribution was biased geographically and possibly also towards sites that were good for birds, and an intensive survey method was used that severely limited the sample size (Marchant *et al.* 1990). A drawback specific to WBS was that it only covered waterbirds.

BTO addressed these issues by setting up the Waterways Breeding Bird Survey (WBBS), which ran in parallel with WBS from 1998 to 2007 and now continues as a permanent annual survey, supplementing BBS. WBBS uses BBS-style transect methods along random waterways, and includes all species of birds (and mammals, too). WBBS has received some of its funding from the Environment Agency. In 2014, it began collecting most of its data online via the BBS web pages.

Trends are available from WBBS alone for more than 80 species. These include the waterbirds previously covered by WBS and a further range of common species for which waterways are not the primary habitat. WBBS-only trends are of relatively short duration (since 1998) and are not presented in this report.

In a similar development to joint CBC/BBS indices, it has proved possible to link the two waterways schemes to provide joint WBS/WBBS indices, some dating back to 1974, for the species previously covered by WBS (see below).

Data analysis and presentation

Population trends are generated from the combined WBS and WBBS data using a generalised linear model with counts assumed to follow a Poisson distribution and a logarithmic link function. Standard errors were calculated via a bootstrapping procedure involving 199 replications. For presentation in the figures, both the population trend and its confidence limits were also subsequently smoothed using a thin-plate smoothing spline. The overall result is a smoothed trend that is mathematically equivalent to that produced from a generalised additive model, as previously used for the WBS data alone.

More information on

WBS (PDF, 77.53 KB)
and WBBS.

Heronries Census

As predators at the top of the freshwater food chain, herons may be excellent indicators of environmental health in the countryside. They build large stick nests, mostly in colonies at traditional sites, thus lending themselves to direct counts of active nests.

The BTO Heronries Census began in 1928 and is the longest-running breeding-season bird monitoring scheme in the world. The aim of this census is to collect annual nest counts of Grey Herons from as many sites as possible in the United Kingdom. Volunteer observers make counts of 'apparently occupied nests' at heron colonies each year. Changes in the numbers of nests, especially over periods of several years, provide a clear measure of the population trend.

In recent seasons, observers have also counted the nests of Little Egrets *Egretta garzetta*, which have been appearing in an increasing number of southern heronries since the first UK breeding records in 1996, and even of Cattle Egrets *Bubulcus ibis,* Night-herons *Nycticorax nycticorax* and Spoonbills *Platalea leucorodia.* Since egrets are fully included in the Heronries Census, data are requested from all breeding sites, whether or not Grey Herons are also present. Data submitted for the Heronries Census for Little Egrets and other rare species are shared with the Rare Breeding Birds Panel, who hold the more complete data sets. Counts ofCormorant colonies, which often occur alongside heronries, are also recorded and contribute to broader monitoring of that species (Newson *et al.* 2007, 2013).

Coverage is coordinated through a network of regional organisers. A core of birdwatchers and ringers monitor their local colonies annually, providing a backbone of regular counts. The number of heronries counted each year has grown in recent years to more than 600. Around two-thirds of the heronries in England and Wales are currently counted each year, with more-complete censuses carried out in 1929, 1954, 1964, 1985, 2003 and 2018. Historically rather few counts have been made of heronries in Scotland and Northern Ireland, except during the special surveys, but support there for the Heronries Census has been growing fast in recent years. Almost all the known heronries have been counted in Northern Ireland annually in recent years.

Online data submission was made available for Heronries Census observers for the first time in 2015.

Data analysis

Population changes are estimated using a ratio-estimators approach derived from that described by Thomas (1993). Essentially, the ratios of the populations in any two (not necessarily consecutive) years of the survey are estimated from counts at sites visited in each of those years. These ratios can be used to estimate the counts at sites that were not visited, and hence build an estimate of the total population. The population model also allows for cases where the extinction of colonies and the establishment of new ones had not been observed directly (Marchant *et al.* 2004).

Data presentation

On the Grey Heron page of this report, the UK trend is presented graphically as annual estimates of apparently occupied nests, with a smoothed trend and its 85% confidence limits. The smooth trend line is based on a non-parametric regression model, using thin-plate smoothing splines with degrees of freedom approximately 0.3 times the number of years in the model. Trends are also shown for England and Wales together, and for England, Wales and Scotland alone.

Visit the Heronries Census page of the BTO website.

Constant Effort Sites scheme

The Constant Effort Sites (CES) scheme uses changes in catch sizes across a network of standardised mist-netting sites to monitor changes in the abundance and breeding success of common passerines in scrub and wetland habitats. At each constant effort site, licensed ringers erect a series of mist nets in the same positions, for the same amount of time, during 12 visits evenly spaced between 1 May and 31 August (Peach *et al.* 1996). Year-to-year changes in the number of adults caught provide a measure of changing population size, while the ratio of young birds to adults in the total catch is used to monitor annual productivity (breeding success). By summing the abundance of young birds between May and August, the CES method should integrate contributions to annual productivity from the entire nesting season, including second and third broods for multi-brooded species, but will also include a small component of mortality during the immediate post-fledging period. More detailed information about analytical methods is given below and were also provided by Peach *et al.* (1998) (abundance) and Robinson *et al.* (2007) (productivity). Between-year recaptures of ringed birds are also used to calculate annual survival rates of adult birds using specialised analytical techniques (Peach 1993).

The CES scheme began in 1983 with 46 sites and now has approximately 140. The distribution of CES sites tends to reflect the distribution of ringers within Britain and Ireland. The majority are operated in England, and there are smaller numbers in Scotland, Wales, Northern Ireland and the Republic of Ireland. CES routinely monitors the populations of 24 species of passerines in scrub, woodland and reedbed habitats.

Data analysis

Smoothed trends in the abundance of adults and young are separately assessed using a generalised additive model (GAM), with 85% confidence intervals calculated by bootstrapping (Fewster *et al.* 2000). At sites where catching effort in a year falls below the standard 12 visits, but no more than four visits have been missed, annual catch sizes are corrected according to experience during years with complete coverage, by incorporating an offset into the model (see Peach *et al.* 1998 for full details). Sites with fewer than eight visits in a given year are omitted for the year in question.

Annual indices of productivity (young per adult) are estimated from logistic regression models applied to the proportions of juvenile birds in the catch, the year-effects then being transformed to measures of productivity relative to an arbitrary value of 100 in the most recent year. As above, catch sizes are corrected where small numbers of visits have been missed. It should be noted that these indices are only relative figures, and are not estimates of the actual numbers of young produced per adult (Robinson *et al.* 2007).

Annual estimates of adult survival are derived from a form of the standard Cormack–Jolly–Seber capture–mark–recapture model (Lebreton*et al.* 1992), modified to account for the presence of transient birds. Transients are birds passing through the site, or perhaps living on its periphery, and which therefore have a much lower probability of capture than resident birds living in the vicinity of the net rides. The presence of transients thus tends to decrease the estimated survival rates. We allow for this by introducing an additional 'survival period' in the year of first capture (Hines *et al.* 2003). As with our other schemes, we assume survival probabilities vary annually in a similar fashion across all sites, though mean survival probabilities may differ between sites. Because of the standardised capture protocol, we assume that recapture probabilities are site-specific, but constant through time. For each bird we also insert an additional period after the first capture, indicating whether the bird was caught subsequently in the same season. The probability of surviving this period can be regarded as the probability that the bird is resident on the site (that is the probability that it is available for recapture). The survival and recapture probabilities for this initial period are assumed constant across years and sites. Note that the annual estimates of annual survival presented are in fact the probability that adult birds return to the same CE site the following year; this will be lower (to a small but unknown extent) than the true survival rate. We do not estimate survival rates for juvenile birds, because of their much greater propensity to disperse.

Data presentation

Abundance and productivity data are presented graphically with a smoothed trend and its 85% confidence limits. No trend is currently fitted to the survival data, but the individual estimates are presented with 95% confidence limits. A caveat is provided for 'Small samples' when the average number of plots per year is between 10 and 20.

Visit the CES section of the BTO website.

Retrapping Adults for Survival scheme

RAS aims to provide information on adult survival for a range of species in a variety of habitats, particularly those not caught in sufficient numbers on CES sessions or during more general mist-netting. As with CES, between-year recaptures of ringed birds are used to calculate annual survival rates of adults (Peach 1993).

Each RAS project targets an individual species and operates within a defined study area, aiming to catch or resight the majority of the adults breeding within the site each year. RAS ringers often employ colour rings to increase the probability of detecting returning individuals. The minimum annual sample size should ideally be sufficient to include 30 individuals retrapped or resighted from previous years, whilst maintaining a constant trapping/resighting effort. Each RAS study must run for a minimum of five years, but preferably much longer, to allow calculation of long-term trends in survival rate. Examples of analyses of RAS data have been published by Robinson *et al.* (2008, 2010).

The RAS scheme was launched in 1998 and about 200 projects are currently active, covering about 60 species in total. Data for several of these are presented in this report. Study sites are well distributed throughout the UK.

Data analysis and presentation

Annual estimates of adult survival are derived from a form of the standard Cormack–Jolly–Seber capture–mark–recapture model (Lebreton et al. 1992). As with our other schemes, we assume survival probabilities vary annually in a similar fashion across all sites, though mean survival probabilities may differ between sites. Where individuals can be sexed we include a sex-specific intercept, but assume survival varies similarly across years for both sexes; where few individuals of one sex are caught, we exclude these from the models. We model the annual recapture probabilities as a function of either the number days on which the RAS project operated in that year or the amount of effort recorded, choosing the one that best fits the data. Note that the annual estimates of annual survival presented are in fact the probability that adult birds are found to have returned to the same RAS site the following year; this will be lower (to a small but unknown extent) than the true survival rate. We do not estimate survival rates for juvenile birds, because of their much greater propensity to disperse.

Visit the RAS section of the BTO website.

Nest Record Scheme

The BTO's Nest Record Scheme is the largest, longest-running and most highly computerised of such schemes in the world and employs the most advanced and efficient techniques of data gathering, data capture and analysis (Crick *et al.* 2003). BTO now holds more than 1.8 million nest records, of which approximately 60% are already computerised.

The primary aim of the Nest Record Scheme is to monitor the breeding performance of a wide range of UK birds annually as a key part of the BTO's data collection. Periodic reports are published in *BTO News* (e.g. Leech & Barimore 2008) or *Life Cycle* magazine and the significant results communicated immediately to JNCC. Another primary aim is to undertake detailed analyses of breeding performance of species of conservation interest (e.g. Crick *et al.* 1994, 2002, Brown *et al.* 1995, Peach *et al.* 1995a, Crick 1997, Chamberlain & Crick 1999, 2003, Siriwardena*et al.* 2001, Freeman & Crick 2003, Browne *et al.* 2005, Tryjanowski *et al.* 2006, Douglas et al. 2010b).

The Nest Record Scheme gathers data on the breeding performance of birds in the UK through a network of volunteer ornithologists. Each observer is given a code of conduct that emphasises the responsibility of recorders towards the safety of the birds they record and explains their legal responsibilities. These observers complete standard nest record cards for each nest they find, or submit computerised data, giving details of nest site, habitat, contents of the nest at each visit and evidence for success or failure. When cards are received by the BTO staff, they are checked, sorted and prepared for input and analysis. Data are prioritised for computer input according to their potential for population monitoring and for specific research projects. Those for Schedule 1 species are kept confidential. (These are species protected from disturbance at the nest by Schedule 1 of the Wildlife and Countryside Act 1981: they are generally rare species and the location of their nests may need to be protected from egg collecting (an illegal activity for every wild bird) or other potential disturbance. A special licence is required to visit any nest of a Schedule 1 species.) Computer programs developed by BTO check the data for errors and calculate first-egg date, clutch size and rates of nest loss at the egg and chick stages.

Currently the BTO collects c.40,000 nest records per year for about 180 species. Typically, more than 150 records are received each year for 50 species and over 100 for a further 15–25 species. The quality of records improved substantially in 1990 with the introduction of a new recording card, which promotes greater standardisation and clarity. Currently, volunteers may submit data on card, via the MS Windows software 'IPMR' or via the online portal 'Demography Online'. The general distribution of completed nest records is patchy at the county scale but is more even over larger regions of the UK. Overall, Northern Ireland and parts of Scotland (southeast, Western Isles) and parts of England (West Midlands, southwest) have relatively low coverage, often reflecting observer density. A major analysis of trends over time in various aspects of breeding performance found relatively few differences between major regions, when analysed using analysis of covariance (Crick *et al.* 1993). The scheme receives records from all the UK's major habitats. Most records come from woodland, farmland and freshwater sites, but the scheme also receives data from scrub, grassland, heathland and coastal areas.

Data analysis

Five different variables are analysed for this report: laying date; clutch size; brood size; and daily nest failure rates during egg and nestling stages, calculated using the methods of Mayfield (1961, 1975) and Johnson (1979) (see Crick *et al.* 2003 for a review).

To minimise the incidence of errors and inaccurately recorded nests, a set of rejection criteria was applied to the data: laying date included only cases where precision was within ±5 days; clutch size was not estimated for nests which had been visited only once, for nests which were visited when laying could still have been in progress, or for nests which were visited only after hatching; and maximum brood size was calculated only for nests which were observed after hatching. The last variable is an underestimate of brood size at hatching, because observers may miss early losses of individual chicks; it differs from clutch size because some eggs may be lost during incubation or fail to hatch.

Daily failure rates of whole nests were calculated using a formulation of Mayfield's (1961, 1975) method as a logit–linear model with a binomial error term, in which success or failure over a given number of days (as a binary variable) was modelled, with the number of days over which the nest was exposed during the egg and nestling periods as the binomial denominator (Crawley 1993, Etheridge *et al.* 1997, Aebischer 1999). Numbers of exposure days during the egg and nestling periods were calculated as the midpoint between the maximum and minimum possible, given the timing of nest visits recorded on each nest record (note that exposure days refer only to the time span for which data were recorded for each nest and do not represent the full length of the egg or nestling periods). Each calculation assumes that failure rates were constant during the period considered. Violations of this assumption of the Mayfield method can lead to biased estimates if sampling of nests is uneven over the course of each period. It is unlikely that any such bias would vary from year to year so, although absolute failure rates may be biased, annual comparisons should be unaffected (Crick *et al.* 2003). In this report, therefore, we present only temporal trends in daily nest failure rates.

As the combined influence of concurrent trends in these individual breeding parameters on overall productivity is difficult to assess, the estimates produced are used to derive an annual mean estimate of the number of 'fledglings produced per breeding attempt' (FPBA) according to the equation below (Crick *et al.* 2003):

$$FPBA = CS \times HS \times (1 - EF)EP \times (1 - YF)YP$$

where CS represents clutch size, HS represents hatching success, EF and YF represent egg- and chick-stage daily failure rates and EP and YP represent the length of the egg and nestling periods. Standard errors were derived using the formula given by Siriwardena *et al.* (2000b).

Statistical analyses of nest record data were undertaken using SAS programs (SAS 2011). Regressions through annual mean laying dates, clutch sizes and brood sizes were weighted by sample size. Nest survival was analysed by logistic regression. Quadratic regressions were used when the inclusion of a quadratic term provided a significant improvement over linear regression. These are described as 'curvilinear' in the tables on species pages. Significant linear trends are described as 'linear'. The better-fitting regressions (i.e. quadratic or linear) are presented on the figures in this report. Where neither regression is significant, the linear regression line is shown for illustration.

Data presentation

Results are presented only if the mean sample size of records for a particular variable and species exceeds 10 per year, and are presented with a caveat for small sample sizes if the mean number of records contributing data was between 10 and 30 per year.

Note that the data presented are modelled figures. As a result, the presented figures may appear anomalous under certain unusual circumstances, as was the case for Buzzard in the *BirdTrends 2017* report, which showed a figure for the number of fledglings per breeding attempt that was higher than the brood size in the same year. As each variable is modelled separately using the best fitting regression line for that variable, this anomaly can occur if the best fitting model is different for each variable.

Visit the Nest Record Scheme section of the BTO website.

Integrated population analysis

The BTO operates, in partnership with others, several schemes aimed at monitoring the numbers and demography of a range of widespread UK birds. A key aim of this monitoring is to investigate how and why bird populations change, and thus to make species conservation more effective and to contribute evidence that supports the conservation of wider biodiversity and the environment. All population changes are a consequence of underlying demographic factors, which are themselves determined largely by environmental conditions. Thus analyses of trends in numbers (from BBS, CES and other schemes) are complemented by the Ringing and Nest Record schemes which aim to monitor demographic patterns underlying population changes.

Populations may change because the number of individuals either entering the population (productivity) or leaving it (survival) changes. For an island such as Britain, immigration and emigration, which may also cause changes at more local scales, can be safely ignored (e.g. Robinson *et al.* 2012). To gain a full picture of how these processes operate, it is best to consider them simultaneously (along with the changes in numbers) in an integrated fashion and, ideally, incorporate them into a single statistical model (Besbeas *et al.* 2002, Buckland *et al.* 2004, Brooks *et al.* 2004). This is for a number of reasons. Firstly, it makes most efficient use of all the collected data and can help quantify processes for which the available data are sparse. Secondly, such factors might interact, through processes like density dependence, so to understand the consequences fully, they cannot be viewed in isolation. Thirdly, and perhaps most importantly, we do not have data on all the processes – for instance, the proportion of adults breeding or the number of nesting attempts made by individuals of multi-brooded species can be really hard to measure. By constructing an integrated model we can acknowledge this uncertainty and assess to what extent it affects our conclusions about the causes of population change.

Robinson *et al.* (2014) constructed integrated population models (IPMs) for 17 species of common birds. They did this using newly developed statistical techniques which, although they require a lot of computing power, enable one to combine data from different sources, by specifying a common underlying model – in our case of population change. Information on changes in numbers came from the CBC and BBS schemes, information on brood sizes (for some species) and nest success from the Nest Record Scheme and information on brood size (for some species) and survival of young and adult birds from the Ringing Scheme, with the number of individuals ringed and subsequently found dead (mostly by members of the public) enumerated for each year.

The population size in any given year (N_{t+1}) depends on the population size in the previous year (N_t) as follows:

$$N_{t+1} = 0.5N_t \rho_t (B_t \varphi_{egg,t} \varphi_{yng,t} \varphi_{fy,t}) + N_t \varphi_{ad,t}$$

where B represents the mean brood size, φ_{egg} and φ_{yng} survival of the nest at the egg and chick stages, φ_{fy} survival during the first year following hatching (which for some species we can separate into the post-fledging and first-winter periods) and φ_{ad} adult survival, all in year *t* (Robinson *et al.* 2014). The final parameter, ρ, represents the unmeasured demographic rates, i.e. the number of adults actually breeding, the number of nesting attempts made (particularly in multi-brooded species) and (for some species) survival during the post-fledging period. We employed a Bayesian state-space approach (Brooks *et al.* 2004), generating five sets of 200,000 samples (of which we discarded the first 100,000 as 'burn-in' and kept every 50^{th} to minimise autocorrelation) using uninformative priors and the MCMC sampling algorithm in JAGS (Plummer 2003). For further details see Robinson *et al.* (2014).

Alert system

General approach

The alert system used within this report is designed to draw attention to developing population declines that may be of conservation concern, and has been described in detail by Baillie & Rehfisch (2006). It also identifies cases where long-term declines have reversed, leading to an improvement in conservation status. It must be stressed that the alerts and reversals reported here are advisory and do not supersede the agreed, longer-term UK conservation listings (Eaton *et al.* 2015; see PSoB pages). They are based on similar criteria to *Birds of Conservation Concern*, however, and so provide an indication of likely changes at future revisions.

The system is based on statistical analyses of the population trend data for individual species. Alerts seek to identify rapid declines (>50%) and moderate declines (>25% but <50%). These declines are measured over a number of time-scales, depending on the availability of data – the full length of the available time series, and the most recent 25 years, 10 years and five years for which change can be estimated. The conservation emphasis is particularly on the longer periods, but short-term changes help to separate declines that are continuing – or accelerating – from those that have ceased or reversed.

The alerts are calculated annually using standard automated procedures. Where species are at the margin of two categories (e.g. a decline of about 25%) they may raise alerts in some years but not others or, if around 50%, different levels of alert in different years.

Data for some species might be biased, owing to possibly unrepresentative monitoring, or imprecise, owing to small sample sizes. Because these data often provide the only information that is available, our general approach is to report all the alerts raised but to flag up clearly any deficiencies in the data.

Smoothing population trends

Bird populations typically show long-term changes that are complex and do not follow simple mathematical trajectories. In addition to the long-term trends, annual population indices also show short-term fluctuations resulting from a combination of natural population variability and statistical error. We use smoothing techniques that aim to extract the long-term pattern of population change, without forcing it to follow any particular shape (such as a straight line or a polynomial curve). These methods remove most of the effects of short-term fluctuations, including natural year-to-year variability, so that the long-term trend is revealed more clearly.

Technical details available here

Years used for analysis

Once a smoothed population trend has been calculated, change measures are calculated from the ratio of the smoothed population indices for the two years of interest. Population indices for the first and last years of a smoothed time series are less reliable than the others, and so we always drop them before calculating alerts. Because the latest year is not included, the alerts are therefore less up-to-date than they could be, but fewer false alarms are generated. The latest year's data points do contribute, however, to the smoothed curve and are dropped only after the smoothing has taken place.

The time it takes BTO to collate and analyse each year's intake of bird monitoring data is another factor affecting the years that can be included in these analyses. Full analyses of data sets are not usually all available until 12–15 months after the end of a particular breeding season. Thus for a report prepared in year *x* (e.g. 2019) we have analyses of monitoring data up to year *x*-1 (e.g. 2018). As we drop the final year of the smoothed time series, we report here on change measures up to year *x*-2 (e.g. 2017).

Long-term changes for most of the species included in this report are calculated from joint Common Birds Census and Breeding Bird Survey data (CBC/BBS indices), with population changes calculated back to 1967.

Confidence limits and statistical testing

We show 90% confidence limits for population change measures wherever possible. Any decline where the confidence interval does not overlap zero (no change) is regarded as statistically significant and will trigger an alert if it is of sufficient magnitude. Note that, because we are seeking to detect only declines, we are using a one-tailed test – with a *P* value of 0.05. These confidence limits therefore do not indicate whether *increases* are statistically significant.

The graphs of population trends show 85% confidence limits because these allow an approximate visual test of whether the difference between the index values for any two given years is statistically significant: if the index values for two given years are assumed to be independent, and normally distributed with standard errors of comparable size (standard errors differing by a factor of up to about 2 are quite acceptable), then to a good approximation the difference between them is significant at the 5% level if there is no overlap in their 85% confidence intervals (Buckland *et al.* 1992, Anganuzzi 1993). This test is fairly robust, and the independence assumption is reasonable if the years are well separated.

Data-deficient species

There is uncertainty about the reliability of the results for some species, either because data may be unrepresentative or because they are based on a very small sample of plots. In these cases the cause of the uncertainty is recorded in the comment column of the population change table.

Unrepresentative data

In this report we present joint UK or England CBC/BBS trends only if there was no substantial or statistical difference between the trends from the two schemes over the period when they ran in parallel (Freeman *et al.* 2007a). Thus, since BBS results are drawn from a random sample, the trends are always considered to be representative of the region concerned.

For CBC data representativeness was assessed using the criteria developed by Gibbons *et al.* (1993). Data from the 1988–91 Breeding Atlas were used to compare the average abundance of a given species in 10-km squares with and without CBC plots. If average abundance is higher in squares without CBC plots, it is likely that much of the population is not well sampled by the CBC. In past reports, CBC data for such species were labelled as "unrepresentative". Where there are insufficient data to undertake such calculations, expert opinion was used instead.

Sample size

Sample size is assessed from the average number of plots contributing to the population indices for a given species in each year. A plot with a zero count would be included provided that the species had been recorded there in at least one year and that records for that plot were available for at least two years. Plots where a species has never been recorded do not enter the index calculations. These average sample sizes are shown in column four ('plots') of the population change tables. For CBC, WBS and CES, a mean of between 10 and 20 plots (when rounded to a whole number) is flagged as a small sample. For BBS indices for individual countries a mean in the range 30–40 plots is flagged as a small sample. UK BBS indices are presented only where samples reach at least 40 plots.

Statistical methods for alerts

The alert system page presents an overview of how the alert system works. More detail is given below about the statistical methods used to estimate population changes and their confidence intervals.

General structure of the data

The data for all of the schemes reported here consist of annual counts made over a period of years at a series of sites. They can thus be summarised as a data matrix of sites x years, within which a proportion of the cells contain missing values because not all of the sites are covered every year. Such data can be represented as a simple model:

log (count) = site effect + year effect

Each site has a single site-effect parameter. These site parameters are not usually of biological interest but they are important because abundance is likely to differ between sites. The main parameters of interest are the year effects. These can be modelled either with the same number of parameters as years (an annual model), or with a smaller number of parameters, representing a smoothed curve.

A simple annual model would be fitted as a generalised linear model with Poisson errors and a logarithmic link function. This is the main model provided by the program TRIM (Pannekoek & van Strien 1996), which is widely used for population monitoring.

Fitting smoothed trends

Our preferred method for generating a smoothed population trend is to fit a smoothed curve to the data directly using a generalised additive model (GAM) (Hastie & Tibshirani 1990, Fewster *et al.* 2000). Thus the model from the previous section becomes:

log (count) = site effect + smooth (year)

where smooth (year) represents some smoothing function of the year effect. It was not straightforward to fit GAMs to the bird census data and we have therefore fitted smoothed curves with a similar degree of smoothing to the annual indices (details below).

The non-parametric smoothed curve fitted in our models is based on a smoothing spline. The degree of smoothing is specified by the number of degrees of freedom (df). A simple linear trend has df = 1, whereas the full annual model has df = t-1, where t is the number of years in the time series. Here we set df to be approximately 0.3 times the number of years in the time series (Fewster *et al.* 2000). The degrees of freedom used for the main data sets presented in this report are summarised below.

	Years	Length of time series	df for smoothed index
CBC/BBS	1966–2018	53	16
WBS/WBBS	1974–2018	45	14
Breeding Bird Survey	1994–2018	25	8
Heronries Census	1928–2018	91	27
Constant Effort Sites	1983–2018	36	11

Note that the numbers of years shown here are different from those available for calculating change measures, because we use the whole time series available for analysis (i.e. prior to the truncation of end points), and because we count the number of years in the time series rather than the number of annual change measures.

CBC/BBS, WBS/WBBS and BBS trends

The model fitted to the combined CBC/BBS and WBS/WBBS data is that historically employed for the BBS – a generalised linear model with counts assumed to follow a Poisson distribution and a logarithmic link function. Standard errors were calculated via a bootstrapping procedure involving 199 replications. For presentation in the figures, both the population trend and its confidence limits were also subsequently smoothed using a thin-plate smoothing spline. The overall result is a smoothed trend that is mathematically equivalent to that produced from a generalised additive model.

Heronries Census trends

The Heronries Census data were analysed using a modified sites x years model based on ratio estimation which incorporates information about new colonies (sites) that have been established and other colonies from the sample that are known to have become extinct. The method was developed by Thomas (1993) specifically in relation to the heronries data set. Since then the heronries database has been substantially upgraded and the method has been applied to the full data set (Marchant *et al.* 2004).

Such a method of analysis cannot be easily applied within a GAM framework. Therefore we fitted a smooth curve to the annual population estimates. This was done using PROC TSPLINE of SAS (SAS 2011). This procedure should give very similar estimates to a GAM analysis but it does not provide confidence intervals for the smoothed population trend or the change measures derived from it. Bootstrapped confidence intervals, where available, are thus presented instead for the Grey Heron trend.

Constant Effort Sites trends

GAMs were fitted to the CES data for catches of adults and juveniles separately with the addition of an offset to correct for missing visits. Confidence limits were fitted using a bootstrap technique to avoid restrictive assumptions about the distribution of the data. Bootstrap samples were drawn from the data by sampling plots with replacement. We generated 199 bootstrap samples from each data set and fitted a GAM to each of them. Confidence limits for the smoothed population indices (85% cl) and change measures (90% cl) were determined by taking the appropriate percentiles from the distributions of the bootstrap estimates, in a similar manner to that

employed for the WBS/WBBS trends.

Species

Access the page for a species by clicking its link on the list below. Each species page has alphabetical and taxonomic listings giving access to all the others.

Jump to

List of species (in BOU taxonomic order)

WILDFOWL

Mute Swan
Greylag Goose
Canada Goose
Shelduck
Gadwall
Mallard
Mandarin Duck
Tufted Duck
Goosander

GAMEBIRDS

Red-legged Partridge
Red Grouse
Grey Partridge
Pheasant

WATERBIRDS

Red-throated Diver
Cormorant
Little Egret
Grey Heron
Little Grebe
Great Crested Grebe

HAWKS, etc.

Red Kite
Hen Harrier
Sparrowhawk
Buzzard
Moorhen
Coot

WADERS

Oystercatcher
Golden Plover
Lapwing
Ringed Plover
Curlew
Common Sandpiper
Redshank
Woodcock
Snipe
Common Tern

PIGEONS, etc.

Feral Pigeon
Stock Dove
Woodpigeon
Collared Dove
Turtle Dove
Cuckoo

OWLS, etc

Barn Owl
Little Owl
Tawny Owl
Nightjar
Swift
Kingfisher
Green Woodpecker
Great Spotted Woodpecker
Lesser Spotted Woodpecker
Kestrel
Merlin
Hobby
Peregrine
Ring-necked Parakeet

CROWS, etc.

Magpie
Jay
Jackdaw
Rook
Carrion Crow
Hooded Crow
Raven

TITS, etc.

Goldcrest
Blue Tit
Great Tit
Coal Tit
Willow Tit
Marsh Tit

LARKS, etc.

Woodlark
Skylark
Sand Martin
Swallow
House Martin

WARBLERS, etc.

Cetti's Warbler
Long-tailed Tit
Wood Warbler
Chiffchaff
Willow Warbler
Blackcap
Garden Warbler
Lesser Whitethroat
Whitethroat
Grasshopper Warbler
Sedge Warbler
Reed Warbler
Nuthatch
Treecreeper
Wren
Starling
Dipper

THRUSHES, etc.

Ring Ouzel
Blackbird
Song Thrush
Mistle Thrush
Spotted Flycatcher
Robin
Nightingale
Pied Flycatcher
Redstart
Whinchat
Stonechat
Wheatear

SPARROWS, etc.

Dunnock
House Sparrow
Tree Sparrow
Yellow Wagtail
Grey Wagtail
Pied Wagtail
Tree Pipit
Meadow Pipit

FINCHES, etc.

Chaffinch
Bullfinch
Greenfinch
Linnet
Lesser Redpoll
Common Crossbill
Goldfinch

BUNTINGS

Yellowhammer
Reed Bunting
Corn Bunting

Information to aid interpretation of the pages for individual species can be found on the Key to species texts page.

The following seabird species are not covered by *BirdTrends* but full trend information is available from the*JNCC 2015), a separate web site produced by a partnership of which both BTO and JNCC are part.*

SEABIRDS

Fulmar
Manx Shearwater
Storm Petrel
Leach's Petrel
Gannet
Shag
Arctic Skua
Great Skua
Kittiwake
Black-headed Gull
Mediterranean Gull
Common Gull
Lesser Black-backed Gull
Herring Gull
Great Black-backed Gull
Sandwich Tern
Roseate Tern
Arctic Tern
Little Tern
Guillemot
Razorbill
Black Guillemot
Puffin

Key to species texts

The 121 species in this report can be accessed in any order, via the alphabetic and taxonomic 'Species links'. The taxonomic sequence is that maintained by the British Ornithologists' Union and updated in in its current British List. The vernacular and scientific names we use are also drawn from that list. Given this report's limited geographical scope, we use British rather than the international English names. Depending on the availability of data, the following will be found beneath each species heading:

1. Conservation listings: Global, European and UK conservation categories are given, in that order.

Global listings

BirdLife International is responsible for maintaining the global red list for birds that is part of the cross-taxa listings being compiled by IUCN (International Union for Conservation of Nature). On the BirdLife International web site, there is a page of information for every species in which justification for its conservation listing is given (BirdLife International 2015a). We show the global conservation category for each species, with a link to its BirdLife species page.

The IUCN categories relevant to this report are:

- VULNERABLE (VU) - A species is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see IUCN Red List Criteria), and it is therefore considered to be facing a high risk of extinction in the wild.
- NEAR THREATENED (NT) - A species is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
- LEAST CONCERN (LC) - A species is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.

European listings

Conservation listings for Europe that use the same categories as the global assessment have been recently provided by BirdLife International for the first time (BirdLife International 2015b). A broad geographical definition is used for Europe as well as a political one (EU27) that covers the very much smaller area represented by the countries of the European Union. We show the whole-European red list category, with a link to the relevant species page on the BirdLife International web site, along with the EU27 listing if it is different.

These listings supersede the 'species of European concern' (SPEC) categories formerly used (BirdLife International 2004).

UK conservation listing

The UK conservation listing is taken from *The Population Status of Birds in the UK* (Eaton *et al.* 2015 (BoCC4); see PSoB pages). These assessments supersede three earlier Birds of Conservation Concern listings (Gibbons *et al.* 1996, Gregory *et al.* 2002, Eaton *et al.* 2009). There are three categories, as follows:

- Red – high conservation concern
- Amber– medium conservation concern
- Green– all other species (except introduced species, which are not classified)

The main reason or reasons for listing as red or amber, which are tabulated in the full paper (Eaton *et al.* 2015) are summarised here.

Like its predecessor, BoCC4 also classifies races, for polytypic species, where two or more races occur regularly in the UK. On occasion the listing for a race may differ from that for the species as a whole. These race-level assessments are given alongside those for species level in our species pages.

A note appears in this section if the species is one for which the Rare Breeding Birds Panel currently requires all UK breeding records to be submitted, or on which it has reported in the past.

2. Long-term trend: This summarises the headline trend in population size since 1967 from CBC/BBS,1975 from WBS/WBBS data, or 1984 from CES data. If there are no data available from these schemes, any assessment of trends covers the period since about the mid 1960s, but may also take historical data into account. Increases and declines that are described as 'shallow', 'moderate' or 'rapid' are generally statistically significant (see the population trends table). The following terms are used:

- Rapid decline: >50% population decline according to CBC/BBS, WBS/WBBS or CES
- Moderate decline: 25–50% population decline according to CBC/BBS, WBS/WBBS or CES
- Shallow decline: 10–25% population decline according to CBC/BBS, WBS/WBBS or CES
- Decline/Increase: information has been derived from sources other than CBC/BBS, WBS/WBBS or CES
- Probable/Possible increase/decline: information has been derived from sources other than CBC/BBS, WBS/WBBS or CES, and the information is uncertain – see the status summary for details
- Stable/Fluctuating, with no long-term trend: no overall change, or change <10%
- Uncertain: the information from two monitoring schemes conflicts, or the data are unrepresentative of the species' total UK population – see the status summary for details
- Unknown: no information on the UK population trend is available
- Shallow increase: 10–50% population increase according to CBC/BBS, WBS/WBBS or CES
- Moderate increase: 50–100% population increase according to CBC/BBS, WBS/WBBS or CES
- Rapid increase: >100% population increase according to CBC/BBS, WBS/WBBS or CES

3. UK population size: Estimates of population sizes of birds in Britain and in the UK, for the breeding season and for winter, are agreed periodically by the Avian Population Estimates Panel (APEP), on which BTO, GWCT, JNCC, RSPB and WWT are represented (Stone *et al.* 1997, Baker *et al.* 2006, Musgrove *et al.* 2013). UK population estimates from APEP's third report (Musgrove *et al.* 2013) are given for each of our species, with a shortened reference (APEP13) and a summary of how each estimate was derived. Any new information potentially superseding APEP13 is also presented.

4. Key facts table: This table giving a summary of key facts for migration, habitat and diet.

5. Status summary: This section provides a brief summary of the trends detailed for the species.

European trends are also described in this section for species for which they are published (PECBMS 2018a). Note that the terms used to describe the European trends are as given in the PECBMS report. These terms are sometimes the same as those used to describe UK long-term trends ('moderate decline'/'moderate increase'), but are assessed in a different way, as described on the PECBMS website, and so do not have the same meaning as the equivalent UK long-term trend categories used in this report, listed above.

6. Population trend graphs: The first, headline graph shows the most representative long-term trend in abundance for the species, and is followed under the 'Population changes in detail' header by further graphs from other schemes, including BBS graphs for separate UK countries, as available. Generally for these graphs there are annual estimates (dots), with a smoothed trend line and its 85% confidence interval. The Methods section provides details about how the trend data are calculated for each scheme. Index values provide a relative measure of population size on an arithmetic scale relative to an arbitrary value of 100 in one of the years of the sequence. If an index value increases from 100 to 200, the population has doubled; if it declines from 100 to 50, it has halved. A narrow confidence interval indicates that the index series is estimated precisely, and a wider one that it is less precise, though the scale of the *y*-axis varies throughout and must always be taken into account. The use of 85% confidence limits allows relatively straightforward comparison of points along the modelled line: non-overlap of the 85% confidence limits is equivalent to a statistically significant difference at approximately the 5% level (Anganuzzi 1993).

CBC/BBS joint trends are produced only where there was no significant difference between CBC and BBS trends during the period of overlap between the two schemes (1994–2000). Where a joint CBC/BBS UK trend cannot be justified it is sometimes possible to present aCBC/BBS England one, provided that CBC and BBS trends were not significantly different across the 'Fuller rectangle' during the overlap period (see CBC/BBS trends, Alert system). CBC/BBS England trends use all data from England and become the headline trend if no long-term UK index is available.

7. Population trends table: This table provides details of summarised percentage changes in population size, over the maximum period from each source, and from the past 25 years, 10 years and 5 years, where these figures are available. Further columns indicate the years included, the average number of census plots included in the analysis for each year, the percentage change (an increase if presented with no sign) and the upper and lower 90% confidence limits of that change. Note that positive and negative percentage changes are not directly equivalent: for example, a decrease of 20% would require an increase of 25% to restore the population to its former level. Where the confidence interval does not include zero, population declines are regarded as statistically significant. The 'Alert' column indicates where a statistically significant population decline is estimated to be of greater than 50% (>50) or between 25% and 50% (>25) (see the Alerts section for further details). The 'Comment' column lists any caveats that must be considered when interpreting the estimates. The caveats include:

- Small sample: For CBC/BBS, WBS/WBBS and CES data, a mean sample size of less than 20 (but more than 10) census plots was available; for BBS data from individual countries, a mean sample of less than 40 (but more than 30) plots was available.
- Unrepresentative?: Some trends may be marked as possibly unrepresentative of the stated region, owing to the original CBC plots being self-selected by observers and thus potentially a biased sample. This judgment was made either because the species' average abundance in 10-km squares containing CBC plots was less than that in other occupied 10-km squares, as measured by 1988–91 Breeding Atlas timed counts or frequency indices (Gibbons *et al.* 1993) or, where these figures could not be calculated, on expert opinion.

8. Population trends by habitat: This section appears for a subset of the most abundant and widespread species. It refers to BBS data for the 16-year period 1995–2011 and has not been updated to the current year. A chart shows the species' BBS trends for each of 12 broad, mutually exclusive habitat types. The data presented vary by species according to their sample sizes. The vertical axis shows the estimated percentage change over the period, with its 95% confidence interval, in relation to the overall change, indicated by a dashed line. Under 'More on habitat trends', the data for each habitat trend are presented as a table and as a graph.The graphs allow the patterns of change to be compared between habitat categories over time. There is more information on these trends here on the BBS pages.

9. Demography graphs: Graphs from Constant Effort Sites, Nest Record Scheme or Ringing Scheme data illustrate trends in productivity and survival. NRS graphs show annual means, with error bars to denote ±1 standard error; and quadratic or linear regression lines with their 95% confidence interval. For CES data, the smoothed trends are plotted with their 85% confidence limits (see CES section for details). CES survival graphs and ringing recoveries survival graphs show annual estimates with their 95% confidence interval, but trends for these data have not been assessed.

10. Demography table: This provides details of changes in demographic variables since 1968 (or a more recent year, depending on the availability of data). It lists the period of years concerned, the mean annual sample, the type of trend ('curvilinear' is for a significant quadratic trend, 'linear' is for a significant linear trend, 'none' is where the linear trend is not significantly different from horizontal), the modelled values (from the appropriate regression) for the first and last years and their difference (provided only where the trend is significant), and any caveats that must be considered when interpreting the data. Changes are presented either in the units given or as percentages, and are increases unless a minus sign is shown. The caveat 'Small sample'; is given when the mean number of nest record cards contributing annually was in the range 10–30, or when the mean annual number of CES plots recording the species was less than 20 (but more than 10). Note that where the trend is curvilinear, although inclusion in the table indicates that a significant quadratic trend has occurred, the overall change between 1968 and the current year may be small.

11. Causes of change: Further information on the causes of the population changes we have observed is given here. A brief summary is followed by more a detailed account which discusses any relevant references from the scientific literature and any relevant demographic information from this report which contribute towards our understanding of the drivers of population change. The length of this section is very variable: scientific research is usually focused on declining species which are of conservation concern and hence much more information tends to be available for these species. The evidence presented in this section is sparse or even lacking for some species; in most cases these are species which are increasing and are therefore of lower conservation concern.

12. Additional information: Links to atlas maps and tables from previous atlas surveys, and the relevant pages of BirdFacts, BirdTrack and Garden BirdWatch, as available from the BTO web site, are provided on the side bar of each species page.

Summary tables

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Tables of alerts and population increases from WBS/WBBS
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Tables of population declines and increases from BBS
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16. BBS – UK population increases of >50%
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Tables of breeding performance
1. Clutch size
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WBS/WBBS alerts & population increases

1. Table of alerts for WBS/WBBS waterways 1975-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Yellow Wagtail	42	23	-97	-99	-94	>50	
Snipe	42	14	-88	-98	-54	>50	Small sample
Redshank	42	23	-72	-92	-46	>50	
Sedge Warbler	42	74	-67	-79	-51	>50	
Reed Bunting	42	91	-67	-76	-55	>50	
Pied Wagtail	42	121	-66	-76	-56	>50	
Little Grebe	42	20	-55	-80	-7	>50	
Common Sandpiper	42	51	-48	-62	-34	>25	
Grey Wagtail	42	102	-40	-53	-21	>25	
Moorhen	42	128	-35	-50	-14	>25	

2. Table of alerts for WBS/WBBS waterways 1992-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Yellow Wagtail	25	21	-92	-96	-84	>50	
Redshank	25	25	-70	-83	-54	>50	
Lapwing	25	84	-59	-70	-44	>50	
Sedge Warbler	25	99	-57	-69	-41	>50	
Common Sandpiper	25	67	-41	-52	-28	>25	
Pied Wagtail	25	157	-38	-50	-26	>25	
Coot	25	82	-36	-58	-8	>25	
Curlew	25	60	-35	-55	-4	>25	

3. Table of alerts for WBS/WBBS waterways 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Yellow Wagtail	10	16	-52	-74	-15	>50	Small sample
Tufted Duck	10	48	-51	-63	-34	>50	
Sedge Warbler	10	99	-43	-55	-28	>25	
Coot	10	77	-42	-55	-27	>25	
Lapwing	10	84	-38	-54	-18	>25	
Redshank	10	22	-33	-53	-11	>25	
Little Grebe	10	18	-29	-43	-7	>25	Small sample
Moorhen	10	163	-26	-33	-19	>25	

4. Table of alerts for WBS/WBBS waterways 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Tufted Duck	5	46	-40	-52	-21	>25	
Sedge Warbler	5	96	-38	-53	-19	>25	
Coot	5	72	-31	-41	-21	>25	

5. Table of population increases for WBS/WBBS waterways 1975-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Mute Swan	42	86	65	7	139		
Mallard	42	178	169	105	236		

CBC/BBS alerts & population increases

1a. Table of population alerts for CBC/BBS UK 1967-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	50	98	-98	-99	-96	>50	
Willow Tit	50	42	-93	-97	-86	>50	
Grey Partridge	50	142	-92	-95	-89	>50	
Spotted Flycatcher	50	134	-89	-92	-83	>50	
Corn Bunting	50	83	-86	-93	-73	>50	
Marsh Tit	50	106	-80	-85	-72	>50	
Yellow Wagtail	50	94	-74	-86	-46	>50	
Little Owl	50	61	-72	-82	-54	>50	
Whitethroat	50	755	-63	-72	-48	>50	
Greenfinch	50	930	-61	-70	-51	>50	
Yellowhammer	50	656	-59	-66	-50	>50	
Mistle Thrush	50	646	-55	-62	-48	>50	
Lapwing	50	354	-54	-74	-26	>50	
Song Thrush	50	1126	-48	-57	-39	>25	
Sedge Warbler	50	173	-37	-67	-7	>25	
Bullfinch	50	400	-36	-51	-20	>25	
Dunnock	50	1158	-34	-43	-25	>25	
Garden Warbler	50	269	-29	-53	-1	>25	

1b. Table of population alerts for CBC/BBS England 1967-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	50	97	-98	-99	-96	>50	
Tree Sparrow	50	107	-96	-98	-91	>50	
Nightingale	50	24	-94	-98	-68	>50	
Spotted Flycatcher	50	99	-93	-96	-90	>50	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Willow Tit	50	38	-93	-97	-89	>50	
Grey Partridge	50	127	-92	-95	-89	>50	
Starling	50	746	-89	-92	-86	>50	
Tree Pipit	50	53	-88	-95	-76	>50	
Lesser Redpoll	50	52	-87	-96	-72	>50	
Corn Bunting	50	79	-85	-93	-73	>50	
Marsh Tit	50	97	-78	-84	-68	>50	
Cuckoo	50	311	-77	-83	-69	>50	
House Martin	50	359	-72	-91	-14	>50	
Yellow Wagtail	50	92	-72	-88	-38	>50	
Linnet	50	547	-70	-76	-61	>50	
Little Owl	50	59	-68	-82	-45	>50	
Willow Warbler	50	546	-66	-76	-56	>50	
Skylark	50	742	-63	-70	-57	>50	
Whitethroat	50	650	-63	-74	-51	>50	
Yellowhammer	50	570	-63	-72	-53	>50	
Mistle Thrush	50	517	-62	-68	-53	>50	
Greenfinch	50	789	-56	-67	-44	>50	
Meadow Pipit	50	230	-50	-78	-25	>25	
Song Thrush	50	889	-49	-56	-40	>25	
Sedge Warbler	50	114	-46	-72	-19	>25	
Lapwing	50	298	-39	-69	-13	>25	
Bullfinch	50	319	-38	-52	-21	>25	
Dunnock	50	949	-37	-47	-27	>25	

2a. Table of population alerts for CBC/BBS UK 1992-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	25	129	-95	-97	-93	>50	
Willow Tit	25	48	-87	-91	-81	>50	
Grey Partridge	25	217	-67	-73	-58	>50	
Little Owl	25	94	-58	-67	-46	>50	
Greenfinch	25	1715	-57	-62	-53	>50	
Spotted Flycatcher	25	189	-55	-66	-40	>50	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Marsh Tit	25	155	-51	-60	-40	>50	
Yellow Wagtail	25	157	-50	-66	-38	>25	
Corn Bunting	25	139	-43	-57	-21	>25	
Lapwing	25	649	-38	-47	-26	>25	
Mistle Thrush	25	1145	-36	-41	-29	>25	
Yellowhammer	25	1171	-35	-39	-29	>25	
Tawny Owl	25	108	-31	-45	-14	>25	

2b. Table of population alerts for CBC/BBS England 1992-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	25	127	-95	-97	-93	>50	
Willow Tit	25	43	-89	-92	-84	>50	
Spotted Flycatcher	25	133	-73	-79	-65	>50	
Tree Pipit	25	74	-72	-83	-55	>50	
Cuckoo	25	523	-71	-75	-67	>50	
Starling	25	1378	-71	-74	-68	>50	
Nightingale	25	34	-67	-79	-46	>50	
Grey Partridge	25	195	-64	-72	-56	>50	
Lesser Redpoll	25	65	-63	-89	-31	>50	
Little Owl	25	92	-55	-66	-42	>50	
Greenfinch	25	1451	-54	-58	-48	>50	
Yellow Wagtail	25	154	-49	-68	-37	>25	
Mistle Thrush	25	907	-47	-52	-40	>25	
Marsh Tit	25	142	-47	-57	-35	>25	
Corn Bunting	25	132	-43	-59	-22	>25	
Willow Warbler	25	928	-42	-50	-35	>25	
Yellowhammer	25	1017	-42	-48	-38	>25	
House Martin	25	698	-39	-57	-19	>25	
Meadow Pipit	25	425	-36	-50	-22	>25	
Sparrowhawk	25	290	-32	-40	-21	>25	
Skylark	25	1374	-28	-33	-22	>25	
Tawny Owl	25	93	-26	-40	-10	>25	
Garden Warbler	25	374	-26	-35	-13	>25	

3a. Table of population alerts for CBC/BBS UK 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	10	70	-83	-89	-77	>50	
Greenfinch	10	2105	-67	-68	-65	>50	
Willow Tit	10	38	-46	-60	-32	>25	
Little Owl	10	88	-43	-52	-33	>25	
Grey Partridge	10	221	-36	-44	-27	>25	
Lapwing	10	783	-33	-40	-26	>25	
Marsh Tit	10	164	-31	-40	-22	>25	
Moorhen	10	769	-29	-32	-24	>25	

3b. Table of population alerts for CBC/BBS England 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	10	68	-83	-89	-76	>50	
Greenfinch	10	1786	-65	-66	-63	>50	
Willow Tit	10	33	-52	-64	-40	>50	
Little Owl	10	86	-44	-53	-33	>25	
Spotted Flycatcher	10	119	-39	-49	-28	>25	
Grey Partridge	10	198	-37	-45	-29	>25	
Starling	10	1636	-35	-39	-31	>25	
Cuckoo	10	488	-32	-39	-27	>25	
House Martin	10	851	-32	-37	-26	>25	
Lapwing	10	673	-30	-36	-24	>25	
Chaffinch	10	2574	-30	-31	-28	>25	
Sparrowhawk	10	339	-29	-34	-22	>25	
Moorhen	10	714	-28	-32	-23	>25	
Tree Pipit	10	84	-27	-43	-7	>25	

4a. Table of population alerts for CBC/BBS UK 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	5	38	-51	-67	-35	>50	
Greenfinch	5	1969	-47	-49	-44	>25	

4b. Table of population alerts for CBC/BBS England 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	5	37	-50	-67	-33	>25	
Greenfinch	5	1676	-45	-47	-42	>25	
Nightingale	5	39	-36	-52	-25	>25	
Willow Tit	5	26	-29	-45	-7	>25	
Swallow	5	2041	-27	-29	-23	>25	

5a. Table of population increases of >50% for UK CBC/BBS 1967-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Robin	50	1318	52	39	69		
Pied Wagtail	50	673	57	17	124		
Great Tit	50	1226	90	65	115		
Magpie	50	1036	98	62	152		
Reed Warbler	50	79	99	31	334		
Chiffchaff	50	871	110	73	170		
Wren	50	1358	117	88	145		
Jackdaw	50	919	130	56	222		
Coot	50	151	142	43	427		
Mallard	50	718	154	93	220		
Woodpigeon	50	1296	162	33	442		
Nuthatch	50	301	268	185	441		
Mute Swan	50	137	270	71	845		
Blackcap	50	921	297	231	393		
Great Spotted Woodpecker	50	607	387	275	646		

5b. Table of population increases of >50% for England CBC/BBS 1967-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Pied Wagtail	50	511	58	25	128		
Robin	50	1050	65	47	83		
Reed Warbler	50	75	76	9	250		
Great Tit	50	1000	80	57	107		
Pheasant	50	833	94	52	166		
Long-tailed Tit	50	502	96	36	177		
Magpie	50	872	108	69	165		
Chiffchaff	50	735	115	78	181		
Wren	50	1072	116	90	146		
Jackdaw	50	740	129	55	287		
Goldfinch	50	750	131	70	198		
Carrion Crow	50	1056	137	89	178		Includes Hooded Crow
Coot	50	137	143	42	464		
Green Woodpecker	50	423	162	87	263		
Woodpigeon	50	1036	178	52	527		
Mallard	50	603	180	112	248		
Stock Dove	50	416	237	135	413		
Mute Swan	50	118	252	69	640		
Blackcap	50	788	255	185	349		
Nuthatch	50	260	280	179	439		
Great Spotted Woodpecker	50	530	325	202	547		
Buzzard	50	374	850	540	3013		

CES alerts & population increases

1. Table of alerts for CES adults 1984-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Willow Warbler	33	90	-77	-82	-71	>50	
Willow Tit	33	16	-72	-90	-36	>50	Small sample
Lesser Whitethroat	33	38	-66	-81	-48	>50	
Reed Bunting	33	61	-64	-75	-51	>50	
Whitethroat	33	65	-55	-70	-34	>50	
Sedge Warbler	33	68	-53	-69	-39	>50	
Chaffinch	33	77	-41	-69	-4	>25	
Garden Warbler	33	65	-33	-57	-8	>25	
Reed Warbler	33	59	-27	-44	-7	>25	

2. Table of alerts for CES adults 1992-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	25	44	-69	-81	-56	>50	
Willow Warbler	25	96	-67	-72	-61	>50	
Willow Tit	25	14	-67	-87	-24	>50	Small sample
Lesser Whitethroat	25	39	-64	-77	-50	>50	
Sedge Warbler	25	75	-50	-60	-42	>50	
Chaffinch	25	84	-50	-62	-36	>25	
Reed Bunting	25	67	-46	-60	-29	>25	
Whitethroat	25	73	-32	-52	-4	>25	
Garden Warbler	25	70	-30	-44	-16	>25	

3. Table of alerts for CES adults 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	10	40	-69	-78	-60	>50	
Chaffinch	10	76	-53	-60	-46	>50	
Willow Warbler	10	90	-33	-40	-26	>25	
Garden Warbler	10	67	-26	-34	-17	>25	

4. Table of alerts for CES adults 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	5	35	-54	-66	-34	>50	
Whitethroat	5	81	-44	-53	-36	>25	
Chaffinch	5	73	-36	-44	-27	>25	
Willow Warbler	5	94	-30	-36	-22	>25	

5. Table of population increases for CES adults 1984-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Robin	33	96	53	32	81		
Wren	33	103	68	43	99		
Goldfinch	33	36	76	9	210		
Blackcap	33	95	103	72	149		
Chiffchaff	33	80	285	151	565		

BBS population declines & increases

1. BBS – UK alerts – 22 years
2. BBS – England alerts – 22 years
3. BBS – Scotland alerts – 22 years
4. BBS – Wales alerts – 22 years
5. BBS – Northern Ireland alerts – 22 years
6. BBS – UK alerts – 10 years
7. BBS – England alerts – 10 years
8. BBS – Scotland alerts – 10 years
9. BBS – Wales alerts – 10 years
10. BBS – Northern Ireland alerts – 10 years
11. BBS – UK alert – 5 years
12. BBS – England alerts – 5 years
13. BBS – Scotland alerts – 5 years
14. BBS – Wales alerts – 5 years
15. BBS – Northern Ireland alerts – 5 years
16. BBS – UK population increases of >50%– 22 years
17. BBS – England population increases of >50%– 22 years
18. BBS – Scotland population increases of >50%– 22 years
19. BBS – Wales population increases of >50% – 22 years
20. BBS – Northern Ireland population increases of >50%– 22 years

1. Table of declines >25% for BBS UK 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	22	126	-94	-96	-92	>50	
Willow Tit	22	46	-83	-88	-76	>50	
Grey Partridge	22	224	-63	-67	-56	>50	
Wood Warbler	22	53	-63	-75	-44	>50	
Greenfinch	22	1856	-59	-62	-57	>50	
Little Owl	22	93	-57	-66	-49	>50	
Swift	22	1070	-57	-61	-52	>50	
Whinchat	22	78	-56	-69	-42	>50	
Starling	22	1834	-52	-56	-49	>50	
Curlew	22	538	-48	-54	-43	>25	
Yellow Wagtail	22	167	-46	-54	-35	>25	
Spotted Flycatcher	22	191	-46	-59	-29	>25	
Redshank	22	89	-44	-62	-20	>25	
Marsh Tit	22	151	-44	-53	-33	>25	
Lapwing	22	701	-42	-48	-35	>25	
Pied Flycatcher	22	40	-42	-71	-6	>25	
Cuckoo	22	704	-41	-48	-36	>25	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Peregrine	22	53	-36	-54	-11	>25	
Wheatear	22	370	-34	-42	-20	>25	
Kestrel	22	692	-32	-38	-25	>25	
Corn Bunting	22	145	-30	-42	-13	>25	
Tawny Owl	22	97	-29	-40	-12	>25	Nocturnal species
Dipper	22	66	-28	-45	-2	>25	
Common Sandpiper	22	74	-26	-43	-9	>25	
Garden Warbler	22	469	-26	-35	-16	>25	
Mistle Thrush	22	1219	-25	-31	-19	>25	

2. Table of declines >25% for BBS England 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	22	124	-94	-96	-92	>50	
Willow Tit	22	40	-85	-90	-79	>50	
Cuckoo	22	538	-70	-73	-67	>50	
Spotted Flycatcher	22	132	-67	-72	-59	>50	
Nightingale	22	33	-62	-77	-47	>50	
Starling	22	1490	-61	-64	-58	>50	
Grey Partridge	22	200	-60	-66	-54	>50	
Little Owl	22	90	-57	-67	-45	>50	
Greenfinch	22	1567	-57	-60	-54	>50	
Swift	22	922	-56	-60	-51	>50	
Tree Pipit	22	76	-53	-67	-28	>50	
Common Sandpiper	22	32	-49	-64	-18	>25	
Whinchat	22	33	-48	-64	-27	>25	
Redshank	22	64	-46	-58	-33	>25	
Yellow Wagtail	22	163	-45	-53	-36	>25	
Dipper	22	32	-44	-68	-3	>25	
Willow Warbler	22	965	-43	-49	-35	>25	
Marsh Tit	22	138	-42	-53	-31	>25	
Mistle Thrush	22	959	-38	-43	-34	>25	
House Martin	22	766	-34	-40	-28	>25	
Grasshopper Warbler	22	41	-34	-55	-1	>25	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Feral Pigeon/Rock Dove	22	595	-31	-39	-20	>25	
Garden Warbler	22	381	-31	-38	-23	>25	
Corn Bunting	22	138	-31	-43	-15	>25	
Curlew	22	353	-30	-38	-18	>25	
Yellowhammer	22	1086	-30	-34	-26	>25	
Sparrowhawk	22	301	-29	-37	-20	>25	
Lapwing	22	591	-28	-37	-19	>25	

3. Table of declines >25% for BBS Scotland 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	22	110	-66	-73	-57	>50	
Curlew	22	130	-61	-68	-53	>50	
Kestrel	22	41	-59	-73	-35	>50	
Swift	22	56	-59	-69	-46	>50	
Lapwing	22	88	-55	-65	-45	>50	
Hooded Crow	22	54	-40	-58	-18	>25	
Oystercatcher	22	143	-38	-49	-26	>25	
Wheatear	22	88	-37	-53	-19	>25	
Rook	22	124	-37	-51	-16	>25	
Starling	22	166	-28	-43	-8	>25	

4. Table of declines >25% for BBS Wales 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Swift	22	69	-69	-76	-57	>50	
Greenfinch	22	116	-69	-77	-59	>50	
Curlew	22	35	-68	-78	-57	>50	
Starling	22	83	-68	-78	-53	>50	
Yellowhammer	22	33	-62	-74	-48	>50	
Rook	22	83	-60	-70	-48	>50	
Goldcrest	22	94	-46	-60	-18	>25	
Wheatear	22	60	-42	-54	-24	>25	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Chaffinch	22	219	-29	-36	-20	>25	
Whitethroat	22	94	-28	-42	-11	>25	
Magpie	22	178	-27	-35	-16	>25	

5. Table of declines >25% for BBS Northern Ireland 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	22	48	-75	-84	-57	>50	
Skylark	22	32	-47	-61	-37	>25	

6. Table of declines >25% for BBS UK 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	10	70	-83	-88	-77	>50	
Greenfinch	10	2105	-67	-68	-66	>50	
Little Owl	10	88	-43	-52	-32	>25	
Swift	10	1171	-42	-47	-37	>25	
Stonechat	10	217	-37	-46	-27	>25	
Grey Partridge	10	221	-36	-44	-27	>25	
Lapwing	10	783	-33	-40	-27	>25	
Marsh Tit	10	164	-31	-39	-20	>25	
Starling	10	2027	-29	-34	-25	>25	
Moorhen	10	769	-28	-33	-24	>25	
Wheatear	10	467	-27	-36	-19	>25	
Kestrel	10	792	-26	-31	-21	>25	
Grey Wagtail	10	276	-26	-34	-18	>25	

7. Table of declines >25% for BBS England 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	10	68	-83	-89	-77	>50	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	10	1786	-65	-66	-63	>50	
Willow Tit	10	33	-53	-67	-41	>50	
Little Owl	10	86	-44	-53	-33	>25	
Spotted Flycatcher	10	119	-40	-47	-27	>25	
Swift	10	1012	-39	-46	-33	>25	
Grey Partridge	10	198	-37	-46	-28	>25	
Redshank	10	75	-37	-49	-25	>25	
Starling	10	1636	-35	-39	-31	>25	
Cuckoo	10	488	-32	-38	-26	>25	
House Martin	10	851	-32	-37	-27	>25	
Lapwing	10	673	-30	-34	-24	>25	
Sparrowhawk	10	339	-29	-34	-23	>25	
Chaffinch	10	2574	-29	-31	-28	>25	
Moorhen	10	714	-28	-32	-23	>25	
Tree Pipit	10	84	-27	-45	-5	>25	
Nightingale	10	37	-27	-45	-1	>25	
Grey Heron	10	668	-25	-30	-21	>25	Non-breeders included

8. Table of declines >25% for BBS Scotland 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	10	126	-69	-74	-64	>50	
Stonechat	10	52	-51	-62	-41	>50	
Kestrel	10	40	-44	-62	-24	>25	
Swift	10	66	-43	-56	-24	>25	
Grey Wagtail	10	39	-40	-54	-21	>25	
Lapwing	10	90	-38	-50	-22	>25	
Goldcrest	10	125	-36	-46	-21	>25	
Wheatear	10	102	-32	-45	-18	>25	

9. Table of declines >25% for BBS Wales 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	10	125	-76	-80	-72	>50	
Rook	10	90	-51	-62	-36	>50	
Swift	10	70	-50	-65	-32	>50	
Curlew	10	31	-44	-59	-26	>25	
Starling	10	82	-32	-45	-17	>25	
Wheatear	10	69	-31	-46	-13	>25	
Chaffinch	10	250	-25	-31	-19	>25	

10. Table of declines >25% for BBS Northern Ireland 2007-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	10	50	-84	-88	-81	>50	
Linnet	10	44	-51	-65	-33	>50	
Lesser Redpoll	10	37	-51	-63	-34	>50	
Goldcrest	10	58	-34	-51	-9	>25	
Swallow	10	102	-31	-40	-22	>25	

11. Table of declines >25% for BBS UK 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Crossbill	5	71	-49	-63	-36	>25	
Greenfinch	5	1969	-46	-48	-44	>25	
Wheatear	5	479	-33	-39	-27	>25	
Swift	5	1144	-29	-34	-22	>25	

12. Table of declines >25% for BBS England 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	5	37	-50	-66	-33	>25	
Greenfinch	5	1676	-44	-47	-42	>25	
Wheatear	5	270	-39	-46	-31	>25	

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Nightingale	5	39	-38	-52	-24	>25	
Swift	5	982	-29	-36	-22	>25	
Swallow	5	2041	-26	-29	-23	>25	

13. Table of declines >25% for BBS Scotland 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	5	112	-49	-58	-40	>25	
Wheatear	5	108	-30	-40	-17	>25	

14. Table of declines >25% for BBS Wales 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	5	120	-58	-63	-51	>50	
Swift	5	75	-48	-61	-31	>25	
Rook	5	95	-48	-60	-30	>25	
Wheatear	5	81	-35	-46	-23	>25	
Chaffinch	5	275	-27	-31	-22	>25	

15. Table of declines >25% for BBS Northern Ireland 2012-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Greenfinch	5	39	-66	-73	-58	>50	
Lesser Redpoll	5	30	-43	-57	-30	>25	
Linnet	5	38	-28	-43	-9	>25	

16. Table of population increases for BBS UK 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Jackdaw	22	1935	55	44	66		

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Canada Goose	22	547	76	47	117		
Stonechat	22	170	87	45	135		
Buzzard	22	1177	96	81	117		
Nuthatch	22	576	96	77	126		
Tree Sparrow	22	202	113	63	169		
Chiffchaff	22	1749	115	103	125		
Great Spotted Woodpecker	22	1214	130	116	147		
Goldfinch	22	1880	146	133	160		
Blackcap	22	1823	149	136	164		
Greylag Goose	22	263	178	41	461		
Gadwall	22	46	213	77	452		
Barn Owl	22	52	289	175	502		
Mandarin	22	35	425	196	964		
Red Kite	22	169	1624	921	3141		
Ring-necked Parakeet	22	87	1710	848	6246		
Little Egret	22	54	2316	916	158735		

17. Table of population increases for BBS England 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Canada Goose	22	503	58	31	91		
Tree Sparrow	22	156	62	25	104		
Jackdaw	22	1556	69	57	82		
Stonechat	22	73	86	25	178		
Great Spotted Woodpecker	22	1053	102	88	115		
Nuthatch	22	491	103	86	127		
Chiffchaff	22	1464	116	103	130		
Blackcap	22	1544	121	110	133		
Goldfinch	22	1546	142	126	158		
Gadwall	22	43	182	63	414		
Buzzard	22	819	213	170	255		
Barn Owl	22	50	286	168	502		
Greylag Goose	22	218	322	180	603		
Ring-necked Parakeet	22	87	1711	789	6153		

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Little Egret	22	50	2153	872	55478		
Red Kite	22	127	19069	12032	99207		

18. Table of population increases for BBS Scotland 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Long-tailed Tit	22	35	54	8	137		
Magpie	22	62	55	17	126		
Lesser Redpoll	22	55	60	13	136		
Stonechat	22	41	61	13	141		
Wren	22	257	62	45	81		
Reed Bunting	22	70	67	28	115		
Tree Pipit	22	38	72	33	125		
Whitethroat	22	96	111	36	192		
House Martin	22	80	120	53	185		
Goldfinch	22	118	219	153	324		
Great Spotted Woodpecker	22	64	417	288	614		
Blackcap	22	80	451	319	740		
Chiffchaff	22	73	780	514	1325		

19. Table of population increases for BBS Wales 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Pheasant	22	107	55	13	107		
Chiffchaff	22	161	69	45	96		
House Sparrow	22	141	82	52	126		
Goldfinch	22	148	93	57	134		
Blackcap	22	144	153	110	206		
Stonechat	22	44	173	90	324		
Great Spotted Woodpecker	22	94	201	138	282		

20. Table of population increases for BBS Northern Ireland 1995-2017

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Alert	Comment
Song Thrush	22	82	64	25	100		
Dunnock	22	74	68	21	137		
Jackdaw	22	81	74	42	132		
Wren	22	97	77	38	118		
House Martin	22	48	98	27	226		
Woodpigeon	22	90	100	64	155		
Pheasant	22	45	105	22	290		
Collared Dove	22	37	110	49	341		
Great Tit	22	78	126	88	180		
Hooded Crow	22	86	166	106	232		
Goldfinch	22	55	455	272	1107		
Buzzard	22	36	1302	656	2815		
Blackcap	22	46	1468	1066	2297		

Breeding performance

1. Clutch size
2. Brood size
3. Egg-stage nest failure rate
4. Chick-stage nest failure rate

1. Table of significant trends in Clutch size measured between 1967-2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Great Tit	50	449	Linear decline	8.34 eggs	7.13 eggs	-1.21 eggs	
Blue Tit	50	638	Linear decline	9.47 eggs	8.62 eggs	-0.85 eggs	
Magpie	50	40	Linear decline	5.64 eggs	4.96 eggs	-0.68 eggs	
Long-tailed Tit	50	47	Curvilinear	7.79 eggs	7.18 eggs	-0.61 eggs	
Peregrine	50	20	Curvilinear	3.91 eggs	3.32 eggs	-0.59 eggs	Small sample
Grey Heron	50	14	Linear decline	4.01 eggs	3.42 eggs	-0.59 eggs	Small sample
Buzzard	50	37	Curvilinear	2.05 eggs	1.64 eggs	-0.41 eggs	
Great Crested Grebe	50	15	Linear decline	3.52 eggs	3.14 eggs	-0.38 eggs	Small sample
Meadow Pipit	50	42	Curvilinear	4.27 eggs	3.99 eggs	-0.28 eggs	
Hen Harrier	50	11	Curvilinear	5.57 eggs	5.32 eggs	-0.25 eggs	Small sample
Wood Warbler	50	22	Linear decline	5.85 eggs	5.6 eggs	-0.25 eggs	Small sample
Woodpigeon	50	100	Curvilinear	1.95 eggs	1.71 eggs	-0.24 eggs	
Pied Wagtail	50	67	Linear decline	5.1 eggs	4.88 eggs	-0.22 eggs	
Ring Ouzel	50	11	Linear decline	4.05 eggs	3.88 eggs	-0.17 eggs	Small sample
Greenfinch	50	82	Linear decline	4.75 eggs	4.59 eggs	-0.16 eggs	
Linnet	50	128	Linear decline	4.74 eggs	4.6 eggs	-0.14 eggs	
Reed Bunting	50	44	Linear decline	4.5 eggs	4.36 eggs	-0.14 eggs	
Wren	50	101	Curvilinear	5.55 eggs	5.42 eggs	-0.13 eggs	
Chaffinch	50	97	Linear decline	4.29 eggs	4.16 eggs	-0.13 eggs	
Common Sandpiper	50	12	Curvilinear	3.99 eggs	3.9 eggs	-0.09 eggs	Small sample
Nightjar	50	21	Linear decline	1.97 eggs	1.88 eggs	-0.09 eggs	Small sample
Collared Dove	50	43	Linear decline	1.96 eggs	1.87 eggs	-0.09 eggs	
Moorhen	50	111	Curvilinear	6.58 eggs	6.5 eggs	-0.08 eggs	
Blackcap	50	46	Curvilinear	4.52 eggs	4.44 eggs	-0.08 eggs	
Grey Wagtail	50	40	Curvilinear	4.79 eggs	4.76 eggs	-0.03 eggs	
Oystercatcher	50	158	Curvilinear	2.76 eggs	2.81 eggs	0.05 eggs	
Stock Dove	50	138	Curvilinear	2.08 eggs	2.14 eggs	0.06 eggs	
Lapwing	50	188	Curvilinear	3.66 eggs	3.74 eggs	0.08 eggs	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Stonechat	50	41	Curvilinear	4.96 eggs	5.06 eggs	0.1 eggs	
Dunnock	50	116	Curvilinear	3.87 eggs	4.02 eggs	0.15 eggs	
Skylark	50	34	Curvilinear	3.32 eggs	3.54 eggs	0.22 eggs	
Redstart	50	57	Curvilinear	5.92 eggs	6.21 eggs	0.29 eggs	
Little Owl	50	26	Linear increase	3.35 eggs	3.72 eggs	0.37 eggs	Small sample
Tree Sparrow	50	397	Curvilinear	4.77 eggs	5.17 eggs	0.4 eggs	
Starling	50	76	Linear increase	4.47 eggs	4.93 eggs	0.46 eggs	

2. Table of significant trends in Brood size measured between 1967-2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Great Tit	50	963	Linear decline	7.5 chicks	6.02 chicks	-1.48 chicks	
Long-tailed Tit	50	39	Linear decline	6.58 chicks	5.52 chicks	-1.06 chicks	
Sand Martin	50	102	Curvilinear	4.61 chicks	3.57 chicks	-1.04 chicks	
Blue Tit	50	1208	Curvilinear	7.56 chicks	7.02 chicks	-0.54 chicks	
Carrion Crow	50	78	Curvilinear	2.93 chicks	2.4 chicks	-0.53 chicks	Includes Hooded Crow
Grey Heron	50	88	Linear decline	2.86 chicks	2.36 chicks	-0.5 chicks	
Chiffchaff	50	51	Linear decline	5.07 chicks	4.7 chicks	-0.37 chicks	
Wood Warbler	50	41	Linear decline	5.57 chicks	5.24 chicks	-0.33 chicks	
Greenfinch	50	101	Linear decline	4.09 chicks	3.76 chicks	-0.33 chicks	
Magpie	50	77	Curvilinear	3.39 chicks	3.07 chicks	-0.32 chicks	
House Sparrow	50	171	Linear decline	3.48 chicks	3.16 chicks	-0.32 chicks	
Rook	50	72	Curvilinear	2.2 chicks	1.94 chicks	-0.26 chicks	
Meadow Pipit	50	88	Curvilinear	3.93 chicks	3.69 chicks	-0.24 chicks	
Hobby	50	30	Curvilinear	2.34 chicks	2.12 chicks	-0.22 chicks	
Great Crested Grebe	50	14	Curvilinear	2.25 chicks	2.05 chicks	-0.2 chicks	Small sample
Ring Ouzel	50	23	Linear decline	3.76 chicks	3.56 chicks	-0.2 chicks	Small sample
Raven	50	75	Curvilinear	3.27 chicks	3.11 chicks	-0.16 chicks	
Pied Wagtail	50	137	Linear decline	4.49 chicks	4.34 chicks	-0.15 chicks	
Reed Bunting	50	62	Curvilinear	4.02 chicks	3.89 chicks	-0.13 chicks	
Woodpigeon	50	141	Curvilinear	1.8 chicks	1.74 chicks	-0.06 chicks	
Linnet	50	147	Curvilinear	4.1 chicks	4.06 chicks	-0.04 chicks	
Yellowhammer	50	64	Curvilinear	2.97 chicks	2.95 chicks	-0.02 chicks	
Buzzard	50	118	Curvilinear	1.85 chicks	1.84 chicks	-0.01 chicks	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Dunnock	50	129	Curvilinear	3.41 chicks	3.42 chicks	0.01 chicks	
Stonechat	50	83	Curvilinear	4.62 chicks	4.63 chicks	0.01 chicks	
Collared Dove	50	73	Curvilinear	1.74 chicks	1.77 chicks	0.03 chicks	
Tree Pipit	50	31	Curvilinear	4.26 chicks	4.32 chicks	0.06 chicks	
Mute Swan	50	69	Curvilinear	4.45 chicks	4.53 chicks	0.08 chicks	
Spotted Flycatcher	50	125	Linear increase	3.69 chicks	3.79 chicks	0.1 chicks	
Grey Wagtail	50	83	Curvilinear	4.06 chicks	4.17 chicks	0.11 chicks	
Sparrowhawk	50	65	Curvilinear	3.15 chicks	3.29 chicks	0.14 chicks	
Skylark	50	64	Curvilinear	3.1 chicks	3.28 chicks	0.18 chicks	
Peregrine	50	61	Linear increase	2.39 chicks	2.58 chicks	0.19 chicks	
Corn Bunting	50	14	Curvilinear	3.3 chicks	3.49 chicks	0.19 chicks	Small sample
Willow Warbler	50	150	Linear increase	5.14 chicks	5.37 chicks	0.23 chicks	
Dipper	50	166	Curvilinear	3.42 chicks	3.7 chicks	0.28 chicks	
Tree Sparrow	50	515	Curvilinear	3.81 chicks	4.12 chicks	0.31 chicks	
Merlin	50	60	Curvilinear	3.34 chicks	3.66 chicks	0.32 chicks	
Little Owl	50	55	Linear increase	2.51 chicks	2.9 chicks	0.39 chicks	
Redstart	50	100	Curvilinear	5.13 chicks	5.57 chicks	0.44 chicks	
Starling	50	238	Linear increase	3.23 chicks	3.75 chicks	0.52 chicks	
Jay	50	11	Linear increase	3.39 chicks	4 chicks	0.61 chicks	Small sample
Moorhen	50	105	Curvilinear	2.53 chicks	3.14 chicks	0.61 chicks	
Wren	50	132	Curvilinear	3.59 chicks	4.33 chicks	0.74 chicks	
Nuthatch	50	90	Linear increase	4.93 chicks	5.84 chicks	0.91 chicks	

3. Table of significant trends in Daily failure rate (eggs) measured between 1967-2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Magpie	50	46	Curvilinear	0.0317 nests/day	0.0039 nests/day	-0.0278 nests/day	
Redshank	50	29	Linear decline	0.0398 nests/day	0.0124 nests/day	-0.0274 nests/day	Small sample
Long-tailed Tit	50	65	Curvilinear	0.0387 nests/day	0.0119 nests/day	-0.0268 nests/day	
Dipper	50	126	Curvilinear	0.0322 nests/day	0.006 nests/day	-0.0262 nests/day	
Woodlark	50	26	Curvilinear	0.0526 nests/day	0.0299 nests/day	-0.0227 nests/day	Small sample
Yellowhammer	50	61	Curvilinear	0.0502 nests/day	0.028 nests/day	-0.0222 nests/day	
Snipe	50	13	Linear decline	0.0323 nests/day	0.0117 nests/day	-0.0206 nests/day	Small sample
Carrion Crow	50	46	Curvilinear	0.021 nests/day	0.0053 nests/day	-0.0157 nests/day	Includes Hooded Crow

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Woodpigeon	50	113	Curvilinear	0.046 nests/day	0.0306 nests/day	-0.0154 nests/day	
Stock Dove	50	129	Curvilinear	0.0193 nests/day	0.0068 nests/day	-0.0125 nests/day	
Pied Wagtail	50	90	Linear decline	0.0175 nests/day	0.0068 nests/day	-0.0107 nests/day	
Robin	50	234	Curvilinear	0.0248 nests/day	0.0144 nests/day	-0.0104 nests/day	
Tawny Owl	50	68	Curvilinear	0.0116 nests/day	0.0021 nests/day	-0.0095 nests/day	Nocturnal species
Starling	50	123	Linear decline	0.0113 nests/day	0.0021 nests/day	-0.0092 nests/day	
Great Crested Grebe	50	23	Curvilinear	0.0295 nests/day	0.0208 nests/day	-0.0087 nests/day	Small sample
Wood Warbler	50	27	Curvilinear	0.0242 nests/day	0.016 nests/day	-0.0082 nests/day	Small sample
Sand Martin	50	83	Curvilinear	0.0153 nests/day	0.0073 nests/day	-0.008 nests/day	
Buzzard	50	30	Linear decline	0.0083 nests/day	0.0004 nests/day	-0.0079 nests/day	
Barn Owl	50	37	Linear decline	0.0079 nests/day	0.0004 nests/day	-0.0075 nests/day	
House Sparrow	50	127	Linear decline	0.0109 nests/day	0.0035 nests/day	-0.0074 nests/day	
Grey Wagtail	50	60	Linear decline	0.017 nests/day	0.0098 nests/day	-0.0072 nests/day	
Nuthatch	50	68	Linear decline	0.0089 nests/day	0.0019 nests/day	-0.007 nests/day	
Redstart	50	86	Curvilinear	0.0149 nests/day	0.0081 nests/day	-0.0068 nests/day	
Kestrel	50	44	Curvilinear	0.0078 nests/day	0.0011 nests/day	-0.0067 nests/day	
Marsh Tit	50	22	Linear decline	0.0075 nests/day	0.0009 nests/day	-0.0066 nests/day	Small sample
Wren	50	145	Linear decline	0.0182 nests/day	0.0121 nests/day	-0.0061 nests/day	
Jackdaw	50	80	Curvilinear	0.0089 nests/day	0.0032 nests/day	-0.0057 nests/day	
Merlin	50	23	Linear decline	0.0071 nests/day	0.0015 nests/day	-0.0056 nests/day	Small sample
Tree Sparrow	50	516	Linear decline	0.0085 nests/day	0.003 nests/day	-0.0055 nests/day	
Tree Pipit	50	16	Curvilinear	0.0444 nests/day	0.0393 nests/day	-0.0051 nests/day	Small sample
Peregrine	50	27	Linear decline	0.0072 nests/day	0.0025 nests/day	-0.0047 nests/day	Small sample
Sparrowhawk	50	29	Linear decline	0.0042 nests/day	0.0007 nests/day	-0.0035 nests/day	Small sample
Curlew	50	21	Curvilinear	0.0271 nests/day	0.0239 nests/day	-0.0032 nests/day	Small sample
Pied Flycatcher	50	514	Curvilinear	0.006 nests/day	0.003 nests/day	-0.003 nests/day	
Great Tit	50	873	Linear decline	0.005 nests/day	0.0023 nests/day	-0.0027 nests/day	
Raven	50	23	Curvilinear	0.0029 nests/day	0.0002 nests/day	-0.0027 nests/day	Small sample
Coal Tit	50	57	Linear decline	0.0043 nests/day	0.0017 nests/day	-0.0026 nests/day	
Treecreeper	50	22	Curvilinear	0.0237 nests/day	0.0214 nests/day	-0.0023 nests/day	Small sample
Spotted Flycatcher	50	111	Curvilinear	0.0178 nests/day	0.0157 nests/day	-0.0021 nests/day	
Blackcap	50	58	Curvilinear	0.0229 nests/day	0.0211 nests/day	-0.0018 nests/day	
Greenfinch	50	113	Curvilinear	0.0271 nests/day	0.0254 nests/day	-0.0017 nests/day	
Blue Tit	50	1137	Curvilinear	0.0039 nests/day	0.0023 nests/day	-0.0016 nests/day	
Collared Dove	50	61	Curvilinear	0.0302 nests/day	0.03 nests/day	-0.0002 nests/day	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Chiffchaff	50	57	Curvilinear	0.0216 nests/day	0.0219 nests/day	0.0003 nests/day	
Grey Heron	50	16	Curvilinear	0.0001 nests/day	0.0004 nests/day	0.0003 nests/day	Small sample
Dunnock	50	163	Curvilinear	0.0257 nests/day	0.0272 nests/day	0.0015 nests/day	
Little Grebe	50	14	Curvilinear	0.0354 nests/day	0.0399 nests/day	0.0045 nests/day	Small sample
Reed Warbler	50	225	Curvilinear	0.0195 nests/day	0.024 nests/day	0.0045 nests/day	
Stonechat	50	47	Linear increase	0.0055 nests/day	0.0109 nests/day	0.0054 nests/day	
Sedge Warbler	50	39	Curvilinear	0.0152 nests/day	0.0206 nests/day	0.0054 nests/day	
Linnet	50	177	Linear increase	0.0182 nests/day	0.0244 nests/day	0.0062 nests/day	
Goldfinch	50	41	Linear increase	0.0191 nests/day	0.029 nests/day	0.0099 nests/day	
Willow Warbler	50	69	Linear increase	0.0091 nests/day	0.0195 nests/day	0.0104 nests/day	
Garden Warbler	50	24	Curvilinear	0.0175 nests/day	0.0283 nests/day	0.0108 nests/day	Small sample
Meadow Pipit	50	53	Curvilinear	0.0224 nests/day	0.0333 nests/day	0.0109 nests/day	
Lapwing	50	207	Curvilinear	0.0156 nests/day	0.0269 nests/day	0.0113 nests/day	
Nightjar	50	26	Curvilinear	0.0082 nests/day	0.0207 nests/day	0.0125 nests/day	Small sample
Chaffinch	50	184	Curvilinear	0.0293 nests/day	0.0438 nests/day	0.0145 nests/day	
Moorhen	50	138	Linear increase	0.0104 nests/day	0.0252 nests/day	0.0148 nests/day	
Ringed Plover	50	127	Curvilinear	0.0252 nests/day	0.041 nests/day	0.0158 nests/day	
Skylark	50	42	Curvilinear	0.0374 nests/day	0.0534 nests/day	0.016 nests/day	
Blackbird	50	350	Curvilinear	0.0248 nests/day	0.0413 nests/day	0.0165 nests/day	
Oystercatcher	50	174	Curvilinear	0.0101 nests/day	0.0281 nests/day	0.018 nests/day	
Reed Bunting	50	52	Linear increase	0.0072 nests/day	0.0307 nests/day	0.0235 nests/day	
Whinchat	50	20	Linear increase	0.0064 nests/day	0.0305 nests/day	0.0241 nests/day	Small sample

4. Table of significant trends in Daily failure rate (chicks) measured between 1967-2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Sand Martin	50	109	Curvilinear	0.0282 nests/day	0.0013 nests/day	-0.0269 nests/day	
Skylark	50	52	Linear decline	0.0483 nests/day	0.0287 nests/day	-0.0196 nests/day	
Magpie	50	45	Curvilinear	0.023 nests/day	0.0043 nests/day	-0.0187 nests/day	
Reed Warbler	50	174	Curvilinear	0.0243 nests/day	0.0122 nests/day	-0.0121 nests/day	
Grey Wagtail	50	59	Linear decline	0.0194 nests/day	0.0088 nests/day	-0.0106 nests/day	
Jackdaw	50	71	Curvilinear	0.0141 nests/day	0.0038 nests/day	-0.0103 nests/day	
Blackbird	50	282	Curvilinear	0.0317 nests/day	0.0222 nests/day	-0.0095 nests/day	
Tree Sparrow	50	361	Curvilinear	0.0157 nests/day	0.0064 nests/day	-0.0093 nests/day	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Merlin	50	30	Linear decline	0.0105 nests/day	0.0015 nests/day	-0.009 nests/day	
Redstart	50	62	Curvilinear	0.0146 nests/day	0.0061 nests/day	-0.0085 nests/day	
House Sparrow	50	127	Curvilinear	0.0155 nests/day	0.0079 nests/day	-0.0076 nests/day	
Carrion Crow	50	40	Linear decline	0.0067 nests/day	0.0012 nests/day	-0.0055 nests/day	Includes Hooded Crow
Meadow Pipit	50	76	Curvilinear	0.0353 nests/day	0.0316 nests/day	-0.0037 nests/day	
Starling	50	137	Curvilinear	0.0068 nests/day	0.0036 nests/day	-0.0032 nests/day	
Collared Dove	50	55	Curvilinear	0.0219 nests/day	0.0187 nests/day	-0.0032 nests/day	
Stock Dove	50	83	Linear decline	0.0105 nests/day	0.0074 nests/day	-0.0031 nests/day	
Barn Owl	50	184	Curvilinear	0.0032 nests/day	0.0003 nests/day	-0.0029 nests/day	
Tawny Owl	50	108	Curvilinear	0.0034 nests/day	0.0006 nests/day	-0.0028 nests/day	Nocturnal species
Nuthatch	50	75	Linear decline	0.0043 nests/day	0.002 nests/day	-0.0023 nests/day	
Corn Bunting	50	14	Curvilinear	0.0496 nests/day	0.0491 nests/day	-0.0005 nests/day	Small sample
Great Tit	50	595	Curvilinear	0.0059 nests/day	0.0062 nests/day	0.0003 nests/day	
Spotted Flycatcher	50	101	Curvilinear	0.0088 nests/day	0.0103 nests/day	0.0015 nests/day	
Stonechat	50	78	Curvilinear	0.0164 nests/day	0.0181 nests/day	0.0017 nests/day	
Woodpigeon	50	91	Curvilinear	0.0211 nests/day	0.0229 nests/day	0.0018 nests/day	
Swallow	50	570	Linear increase	0.0029 nests/day	0.0048 nests/day	0.0019 nests/day	
Whinchat	50	33	Curvilinear	0.0241 nests/day	0.0263 nests/day	0.0022 nests/day	
Moorhen	50	51	Linear increase	0.0003 nests/day	0.0029 nests/day	0.0026 nests/day	
Pied Flycatcher	50	433	Linear increase	0.0037 nests/day	0.0071 nests/day	0.0034 nests/day	
Wren	50	99	Linear increase	0.0073 nests/day	0.0111 nests/day	0.0038 nests/day	
Nightjar	50	24	Curvilinear	0.0018 nests/day	0.0079 nests/day	0.0061 nests/day	Small sample
Linnet	50	127	Linear increase	0.0159 nests/day	0.0221 nests/day	0.0062 nests/day	
Reed Bunting	50	52	Curvilinear	0.0272 nests/day	0.036 nests/day	0.0088 nests/day	
Long-tailed Tit	50	44	Linear increase	0.0079 nests/day	0.0207 nests/day	0.0128 nests/day	
Garden Warbler	50	21	Linear increase	0.012 nests/day	0.0252 nests/day	0.0132 nests/day	Small sample
Wood Warbler	50	34	Curvilinear	0.0227 nests/day	0.0472 nests/day	0.0245 nests/day	

Discussion

In this discussion we:

1. Review the latest population change measures and alerts for species that are on the Birds of Conservation Concern (BoCC4) red or amber lists for the UK for reasons of population decline (Eaton *et al*. 2015) (*here*).
2. Identify species not on the BoCC4 lists but which raise alerts on account of long-term declines and, conversely, currently listed species where recovery may be sufficient to downgrade their listing status in the future (*here*).
3. Briefly review declines along waterways and in scrub and wetland habitats as shown by the WBS/WBBS and CES schemes (*here*).
4. Review trends over the last 10 years in species that have shown long-term declines, to identify the extent of ongoing declines and check for any evidence of recovery (*here*).
5. Identify those species that have shown rapid long-term population increases (*here*).
6. Discuss patterns of changes in breeding performance and relationships between trends in abundance and breeding performance (*here*).
7. Summarise the overall patterns found (*here*).

Except where otherwise indicated, our discussion is based on the best long-term trend that is available for each species. This is usually a joint CBC/BBS UK trend or, if this trend could not be constructed because CBC and BBS trends were different during the period of overlap of the two schemes, a CBC/BBS England trend (see Key to species texts). A WBS/WBBS trend replaces these for certain waterway species.

Details of estimating and comparing trends are given in the Methods section. Full details of all trends available for each species are given on the Species pages. Summary tables of all alerts raised by each scheme are presented in the Summary tables.

Of course, a number of species included in the BoCC4 red and amber lists are not covered by this report, and not every species listed red or amber is in UK population decline. Thus our tables relating to birds listed red or amber do not include every species on these lists.

Latest long-term alerts

A standardised system for setting 'alerts' in this report has been agreed between the providers and users of population monitoring information in the UK. Alerts are raised by population declines of 25–50% and of >50% over short, medium and longer terms (five years, ten years and 25+ years respectively) and noted in the 'Alert' column in the population change and demography tables. These help to highlight the scale and timing of declines, and act as an aid to interpreting the trend graphs presented.

These alerts are important for conservation practitioners who need to set priorities for conservation action, but we hope that they will also interest readers of the report more generally. Similar Alerts for wetland birds are provided by the Wetland Bird Survey (Woodward *et al.* 2019).

Our main emphasis in this section is on long-term declines measured over the longest period available (usually 50 years) and over 25 years, which is one of the periods used to determine 'Birds of Conservation Concern' red and amber listing for the UK (Eaton *et al.* 2015).

Alerts triggered over the short term should be considered as early warnings, indicating that conservation issues may be developing for the species concerned. Some short-term declines might stem, however, from normal fluctuations in abundance, from which the population is able to recover without assistance. The steep decline of a suite of species of similar ecology should be considered as a stronger indication that potential problems may be developing. Details of the methodology used to raise alerts are given in the Methods section.

Where this section discusses red-listed or amber-listed species, it uses the current version of these lists, introduced in December 2015 and abbreviated as BoCC4. The full paper (Eaton *et al.* 2015) details the criteria by which each listed species qualifies for its red or amber status and these criteria are also summarised on our species pages under 'Conservation listings' (see Key to species texts). Our tables here of red and amber species include only those that met the criteria (red or amber, respectively) for UK breeding population decline.

Long-term trends of 'Birds of Conservation Concern' red-listed species

The species considered in this section are red listed under BoCC4 wholly or partly because of severe UK population declines revealed by annual census data, amounting to more than 50% over the 25-year period 1987–2012, the 45-year period 1967–2012, or both. The latest long-term population changes and alerts for these severely declining species are shown in Table A1, over the maximum period available (usually the 50 years 1967–2017) and over 25 years (1992–2017). This table thus updates the figures that were used to produce the new BoCC4 red list, by five years.

The 24 species in Table A1 are listed in descending order of their longest-term percentage change.Turtle Dove remains the species with the strongest long-term UK decline (-98%). Tree Sparrow, which headed this table recently, has shown significant increases in numbers since 1995 and is now in second place, albeit still with a decline of 96% since 1967. The figures for Lesser Spotted Woodpecker are likely to be a very large underestimate of the current population change, because the species had by 1999 become too rare for further annual monitoring. Were recent data available, this species might easily surpass Turtle Dove and Tree Sparrow in the strength of its decline. Similarly, there is strong evidence that the decline for Woodcock has continued since it was last included in CBC/BBS monitoring.

Two other species, which are also red listed under BoCC4 because of severe UK population declines, are not included in Table A1 as long-term monitoring data are not available: Wood Warbler and Whinchat. Shorter monitoring histories from BBS show that both species have declined by more than 50% over 22 years (1995–2017).

Table A1 Latest trends for red-listed species

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	50	CBC/BBS UK	-98	-99	-96	>50	
Turtle Dove	25	CBC/BBS UK	-95	-97	-93	>50	
Tree Sparrow	50	CBC/BBS England	-96	-98	-91	>50	
Tree Sparrow	25	CBC/BBS England	11	-56	71		
Nightingale	50	CBC/BBS England	-94	-98	-68	>50	
Nightingale	25	CBC/BBS England	-67	-79	-46	>50	
Willow Tit	50	CBC/BBS UK	-93	-97	-86	>50	
Willow Tit	25	CBC/BBS UK	-87	-91	-81	>50	
Grey Partridge	50	CBC/BBS UK	-92	-95	-89	>50	
Grey Partridge	25	CBC/BBS UK	-67	-73	-58	>50	
Spotted Flycatcher	50	CBC/BBS UK	-89	-92	-83	>50	
Spotted Flycatcher	25	CBC/BBS UK	-55	-66	-40	>50	
Starling	50	CBC/BBS England	-89	-92	-86	>50	
Starling	25	CBC/BBS England	-71	-74	-68	>50	

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Tree Pipit	50	CBC/BBS England	-88	-95	-76	>50	
Tree Pipit	25	CBC/BBS England	-72	-83	-55	>50	
Lesser Redpoll	50	CBC/BBS England	-87	-96	-72	>50	
Lesser Redpoll	25	CBC/BBS England	-63	-89	-31	>50	
Corn Bunting	50	CBC/BBS UK	-86	-93	-73	>50	
Corn Bunting	25	CBC/BBS UK	-43	-57	-21	>25	
Marsh Tit	50	CBC/BBS UK	-80	-85	-72	>50	
Marsh Tit	25	CBC/BBS UK	-51	-60	-40	>50	
Cuckoo	50	CBC/BBS England	-77	-83	-69	>50	
Cuckoo	25	CBC/BBS England	-71	-75	-67	>50	
Woodcock	31	CBC to 1999	-74	-88	-49	>50	Small sample
Woodcock	25	CBC to 1999	-76	-88	-51	>50	Small sample
Yellow Wagtail	50	CBC/BBS UK	-74	-86	-46	>50	
Yellow Wagtail	25	CBC/BBS UK	-50	-66	-38	>25	
House Sparrow	40	CBC/BBS England	-70	-80	-60	>50	
House Sparrow	25	CBC/BBS England	-23	-36	-13		
Linnet	50	CBC/BBS England	-70	-76	-61	>50	
Linnet	25	CBC/BBS England	-11	-20	2		
Skylark	50	CBC/BBS England	-63	-70	-57	>50	
Skylark	25	CBC/BBS England	-28	-33	-22	>25	
Lesser Spotted Woodpecker	31	CBC to 1999	-60	-81	40		Small sample
Lesser Spotted Woodpecker	25	CBC to 1999	-73	-86	-31	>50	Small sample
Yellowhammer	50	CBC/BBS UK	-59	-66	-50	>50	
Yellowhammer	25	CBC/BBS UK	-35	-39	-29	>25	
Mistle Thrush	50	CBC/BBS UK	-55	-62	-48	>50	
Mistle Thrush	25	CBC/BBS UK	-36	-41	-29	>25	
Lapwing	50	CBC/BBS UK	-54	-74	-26	>50	
Lapwing	25	CBC/BBS UK	-38	-47	-26	>25	
Song Thrush	50	CBC/BBS UK	-48	-57	-39	>25	
Song Thrush	25	CBC/BBS UK	30	22	39		
Grey Wagtail	42	WBS/WBBS waterways	-40	-53	-21	>25	
Grey Wagtail	25	WBS/WBBS waterways	3	-15	23		
Curlew	50	CBC/BBS England	-36	-77	26		
Curlew	25	CBC/BBS England	-18	-32	-2		

For Song Thrush and Grey Wagtail, the populations have increased over the last five years, so the long-term decline is now less than 50%, prompting a lower level alert; and the 25-year decline is now less than 25% for both species so no longer triggers an alert. These species were on the red list under BoCC4. Based on current figures

they could potentially be changed to amber when the list is next reviewed.

For ten other species – Yellow Wagtail, Tree Sparrow, Corn Bunting, House Sparrow, Linnet, Skylark, Yellowhammer, Mistle Thrush and Lapwing – the 25-year change is now less than 50%, indicating that, while these species meet red-list criteria for long-term change, their rate of decline in more recent years has been slower than for most other red-listed birds, although their populations are still at a much lower level than in the 1960s. For Grey Wagtail and Tree Sparrow, the 25-year trend is effectively stable, and Song Thrush numbers have increased slightly. Though Curlew is red listed for its UK breeding population decline, its long-term CBC/BBS trends do not currently meet the >50% criterion; the key information for red listing comes from other surveys.

Long-term trends of declining amber-listed species

There are 25 amber-listed species under BoCC4 that are included in this report, of which about half (13 species) are listed because of UK population declines over the periods 1987–2012 or 1967–2012. Long-term trends are available from annual census data for 12 of these species (all except Swift); their trends are listed in Table A2 in descending order of longest-term percentage change (normally over the 50 years 1967–2017). A 25-year change (1992–2017) is also shown.

Table A2 Latest trends for declining amber-listed species

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Redshank	42	WBS/WBBS waterways	-72	-92	-46	>50	
Redshank	25	WBS/WBBS waterways	-70	-83	-54	>50	
House Martin	50	CBC/BBS England	-72	-91	-14	>50	
House Martin	25	CBC/BBS England	-39	-57	-19	>25	
Willow Warbler	50	CBC/BBS England	-66	-76	-56	>50	
Willow Warbler	25	CBC/BBS England	-42	-50	-35	>25	
Meadow Pipit	50	CBC/BBS England	-50	-78	-25	>25	
Meadow Pipit	25	CBC/BBS England	-36	-50	-22	>25	
Common Sandpiper	42	WBS/WBBS waterways	-48	-62	-34	>25	
Common Sandpiper	25	WBS/WBBS waterways	-41	-52	-28	>25	
Bullfinch	50	CBC/BBS UK	-36	-51	-20	>25	
Bullfinch	25	CBC/BBS UK	19	12	30		
Dunnock	50	CBC/BBS UK	-34	-43	-25	>25	
Dunnock	25	CBC/BBS UK	23	14	30		
Tawny Owl	50	CBC/BBS UK	-21	-50	14		
Tawny Owl	25	CBC/BBS UK	-31	-45	-14	>25	
Dipper	42	WBS/WBBS waterways	-21	-43	2		
Dipper	25	WBS/WBBS waterways	-2	-21	17		
Reed Bunting	50	CBC/BBS UK	-13	-33	13		
Reed Bunting	25	CBC/BBS UK	17	2	32		
Kestrel	50	CBC/BBS England	-11	-35	23		
Kestrel	25	CBC/BBS England	-21	-29	-11		
Shelduck	31	CBC to 1999	300	94	787		Small sample
Shelduck	25	CBC to 1999	12	-40	118		

Three amber-listed species raise high alerts, having shown significant declines of greater than 50%, and so potentially are red-list candidates:

- Redshank has declined steeply in lowland Britain, according to waterways surveys, raising high alerts; a major decline is also documented for its breeding sites on

saltmarsh, and BBS data show that declines have occurred recently across a wide range of habitats. BBS declines do not yet meet the red-list criterion, however.

- The English House Martin population meets the red-list criterion for long-term population decline measured by CBC/BBS trends (over 50-years), although BBS shows that numbers in Scotland and Northern Ireland have increased over 22 years (the longest trend available for this species in those countries), and consequently there has been little change in the UK as a whole since 1995.
- English Willow Warblers also meet the red-list criterion for long-term population decline (over 50-years), but there has been little change in Wales and the overall change in Scotland and Northern Ireland since 1995 has been upward.

Although it is not included in Table A2 as no long-term trend is available, the shorter length trend from BBS (1995–2017) shows that a significant decline of greater than 50% has also occurred for Swift over 22 years.

Five other species raise only the lower level of alert. Common Sandpiper and Meadow Pipit meet the 25% criterion (equivalent to amber listing) in both the 25-year and the 50-year periods. Populations of Bullfinch and Dunnock have been recovering and both show increasing trends over the shorter, 25-year period. Tawny Owl raises an alert over the 25-year period but does not do so over the longer 50-year period. Though amber listed for population decline, Dipper, Reed Bunting, Kestrel and Shelduck do not formally raise alerts on the present data (note that in the case of Shelduck long-term CBC/BBS trends cannot be produced and the data presented here are for the 31-year period to 1999).

Long-term declines of species that are not currently red or amber listed (for declines)

This section of the report draws attention to declines which currently surpass red or amber criteria but which were not recognised in the BoCC4 listings (Table A3). These species may be candidates for conservation listing (for declines) at the next review.

Table A3 Long-term trends for declining species not on the red or amber list (for declines)

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Snipe	42	WBS/WBBS waterways	-88	-98	-54	>50	Small sample
Snipe	25	WBS/WBBS waterways	-64	-93	7		Small sample
Little Owl	50	CBC/BBS UK	-72	-82	-54	>50	
Little Owl	25	CBC/BBS UK	-58	-67	-46	>50	
Whitethroat	50	CBC/BBS UK	-63	-72	-48	>50	
Greenfinch	50	CBC/BBS UK	-61	-70	-51	>50	
Greenfinch	25	CBC/BBS UK	-57	-62	-53	>50	
Little Grebe	42	WBS/WBBS waterways	-55	-80	-7	>50	
Little Grebe	25	WBS/WBBS waterways	-38	-62	2		
Sedge Warbler	50	CBC/BBS UK	-37	-67	-7	>25	
Tufted Duck	25	WBS/WBBS waterways	-36	-60	3		
Sparrowhawk	25	CBC/BBS England	-32	-40	-21	>25	
Garden Warbler	50	CBC/BBS UK	-29	-53	-1	>25	
Red-legged Partridge	50	CBC/BBS UK	-28	-53	9		
Oystercatcher	25	WBS/WBBS waterways	-25	-38	-1		

The WBS/WBBS trend for Snipe is based now on a very small sample of plots, the species having deserted so many of its former riverside haunts. It is currently amber-listed solely because its UK breeding range has contracted sharply, especially in lowland England, and not for UK population decline. BBS data indeed do not show any decline at the UK scale over the longest period covered by this survey (22 years).

Little Owl meets red-list criteria for population decline but, as a species introduced to the UK, is not eligible for any conservation listing. Whitethroat also raises a high alert over the long term, but the species is currently in recovery from its sudden losses in the late 1960s and therefore does not warrant a conservation listing. WBS/WBBS also indicates a possible strong decline for Little Grebe over both the 42-year and 25-year timescales, with the 42-year trend raising a formal alert in this report. However, small waterbodies are not well-covered by WBBS and relative stability on BBS squares casts doubt upon the true nature of this species' population trend.

Stanbury *et al.* 2017). Another green listed species, Sparrowhawk, raises an alert having declined by more than 25% over 25-years.

Potential declines of >25% have also occurred for Tufted Duck over the 25-year period, but this estimate has wide confidence intervals and is not statistically significant, so does not formally raise an alert. The apparent decline of Red-legged Partridge is also not statistically significant, and is of no conservation concern because the

species is not native to the UK.

Declines along linear waterways

The Waterways Bird Survey and Waterways Breeding Bird Survey supplement the results from CBC and BBS, which include all habitat types, by measuring trends in bird populations alongside rivers and canals. Joint WBS/WBBS trends allow trend assessments to be continuous since 1974 for up to 25 species that were covered by WBS. WBBS, ongoing since 1998, includes all bird species but trends are presented here only for waterway-specialist species, for which joint WBS/WBBS trends are available.

For 13 species that are abundant in waterway habitats, WBS/WBBS provides the headline population trend for this report, generally because sample sizes exceed those from CBC/BBS. These species include one that is red-listed (Grey Wagtail), seven amber-listed species (Greylag Goose, Oystercatcher, Common Sandpiper, Redshank, Snipe, Kingfisher and Dipper) and four green-listed species Tufted Duck, Goosander, Little Grebe and Sand Martin), along with Canada Goose, which, as a non-native species in the UK, is excluded from the BoCC4 listings.

For four of the WBS/WBBS headline species that are in decline (Common Sandpiper, Redshank, Snipe and Grey Wagtail), latest trends appear also in Tables A1, A2 or A3, as appropriate. Dipper also appears in Table A2 as it is amber-listed as a result of declines, but does not currently raise an alert. Two other species (Oystercatcher and Tufted Duck) appear in Table A3 as a result of potential declines (of >25%, but not statistically significant). Even where WBS/WBBS is not the headline trend for a species, however, the waterways data provide valuable supplementary information from this sensitive habitat.

Table A4 lists all statistically significant declines of greater than 25% recorded from the full period of waterway monitoring (nominally 42 years, 1975–2017).

Table A4 Population declines of greater than 25% recorded by the joint Waterways Bird Survey/Waterways Breeding Bird Survey (WBS/WBBS) between 1975 and 2017

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Yellow Wagtail	42	WBS/WBBS waterways	-97	-99	-94	>50	
Snipe	42	WBS/WBBS waterways	-88	-98	-54	>50	Small sample
Redshank	42	WBS/WBBS waterways	-72	-92	-46	>50	
Sedge Warbler	42	WBS/WBBS waterways	-67	-79	-51	>50	
Reed Bunting	42	WBS/WBBS waterways	-67	-76	-55	>50	
Pied Wagtail	42	WBS/WBBS waterways	-66	-76	-56	>50	
Lapwing	37	WBS/WBBS waterways	-56	-76	-21	>50	
Little Grebe	42	WBS/WBBS waterways	-55	-80	-7	>50	
Common Sandpiper	42	WBS/WBBS waterways	-48	-62	-34	>25	
Grey Wagtail	42	WBS/WBBS waterways	-40	-53	-21	>25	
Moorhen	42	WBS/WBBS waterways	-35	-50	-14	>25	

Six species are included here for which the WBS/WBBS trend is not the headline one and so is not listed in Tables A1–A3. These species are discussed briefly below. The trends for Yellow Wagtail and Sedge Warbler are consistent in direction with the 50-year trends reported from CBC/BBS, but the declines on waterways have been more severe. The CBC/BBS trend for Reed Bunting is not statistically significant, but shows a substantial increase in the first eight years until the mid-1970s followed by a substantial decline in the late 1970s and early 1980s, and therefore would be consistent with WBS/WBBS if both trends had started in 1975. The Pied Wagtail declines along waterways are particularly intriguing because they contrast markedly with the fluctuating but generally upward trend, in more terrestrial habitats, as measured by CBC/BBS.

In the early 1980s, population increases forLapwing reported by WBS/WBBS contrasted sharply with decline on CBC/BBS sites but long-term trends from both schemes show there has been a steep decline. It is possible that the initial WBS/WBBS increases may have been caused by redistribution of breeding birds into wetland areas during the early stages of the decline. Moorhen numbers have dipped sharply by all measures over the last ten years, perhaps through extra mortality in cold winters, and its long-term WBS/WBBS change has tipped over the alert threshold.

Alerts raised by WBS/WBBS, and long-term increases detected by that index, are tabulated in WBS/WBBS alerts and population increases. A full set of this year's WBS/WBBS trends can be obtained from the Table generator.

Declines on CES plots

The Constant Effort Sites Scheme provides trends from standardised ringing in scrub and wetland habitats. It is possibly our best scheme for monitoring some bird populations inhabiting reed beds, but its main objective is to collect integrated data on relative abundance, productivity and survival for a suite of species. The longest trends currently available from the CES cover a period of 33 years (Table A5).

Table A5 Population declines of greater than 25% recorded by the Constant Effort Sites scheme between 1984 and 2017

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Willow Warbler	33	CES adults	-77	-82	-71	>50	
Willow Warbler	25	CES adults	-67	-72	-61	>50	
Willow Tit	33	CES adults	-72	-90	-36	>50	Small sample
Willow Tit	25	CES adults	-67	-87	-24	>50	Small sample
Greenfinch	25	CES adults	-69	-81	-56	>50	
Lesser Whitethroat	33	CES adults	-66	-81	-48	>50	
Lesser Whitethroat	25	CES adults	-64	-77	-50	>50	
Reed Bunting	33	CES adults	-64	-75	-51	>50	
Reed Bunting	25	CES adults	-46	-60	-29	>25	
Whitethroat	33	CES adults	-55	-70	-34	>50	
Whitethroat	25	CES adults	-32	-52	-4	>25	
Sedge Warbler	33	CES adults	-53	-69	-39	>50	
Sedge Warbler	25	CES adults	-50	-60	-42	>25	
Chaffinch	33	CES adults	-41	-69	-4	>25	
Chaffinch	25	CES adults	-50	-62	-36	>25	
Garden Warbler	33	CES adults	-33	-57	-8	>25	
Garden Warbler	25	CES adults	-30	-44	-16	>25	
Reed Warbler	33	CES adults	-27	-44	-7	>25	

Most of the species that are declining on CES sites show broadly similar trends to those from CBC/BBS or WBS/WBBS dataWillow Tit is red listed on the strength of its long-term CBC/BBS declines (Table A1). Willow Warbler and Reed Bunting are similarly amber listed (Table A2).Greenfinch and Sedge Warbler are currently green listed but the long-term population trends now show a decline of >50% and >25% respectively (Table A3).

For reasons unknown, CES trends for Whitethroat, Reed Bunting and especially Lesser Whitethroat are considerably more negative than those from census data over similar periods.

Chaffinch also raises a CES alert following several years of population decline. Recent BBS data also show a sharp decline but as this followed longer-term increases it has not yet triggered any BBS alerts.

A full set of alerts raised by CES and long-term increases are tabulated in CES alerts and population increases.

Ten-year trends and evidence of species recovery

If the status of species that have shown long-term declines were now improving, we would expect to find trends to be more positive in recent years than in the earlier part of the time series. To examine this, we list in Table B1 the best change estimates over the most recent ten-year period for which we have data (2007–17 in all but three cases), for all of the declining species listed in Tables A1–A3 (previous section). For Lesser Spotted Woodpecker, Woodcock and Shelduck, the ten-year period for which data are tabulated is 1989–99.

Table B1 also includes four further species that are listed red or amber in BoCC4 because of recent breeding decline, and for which we can report ten-year trends, but which lacked annual monitoring data before 1994. These are Whinchat, Grasshopper Warbler and Wood Warbler (all red listed), and Swift (amber listed).

Table B1 Ten-year trends for species that have shown long-term declines

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Turtle Dove	10	CBC/BBS UK	-83	-89	-77	>50	
Greenfinch	10	CBC/BBS UK	-67	-68	-65	>50	
Tufted Duck	10	WBS/WBBS waterways	-51	-63	-34	>50	
Lesser Spotted Woodpecker	10	CBC to 1999	-51	-75	-22	>50	Small sample
Willow Tit	10	CBC/BBS UK	-46	-60	-32	>25	
Little Owl	10	CBC/BBS UK	-43	-52	-33	>25	
Swift	10	BBS UK	-42	-47	-37	>25	
Woodcock	10	CBC to 1999	-40	-62	-11	>25	Small sample
Grey Partridge	10	CBC/BBS UK	-36	-44	-27	>25	
Starling	10	CBC/BBS England	-35	-39	-31	>25	
Lapwing	10	CBC/BBS UK	-33	-40	-26	>25	
Redshank	10	WBS/WBBS waterways	-33	-53	-11	>25	
Cuckoo	10	CBC/BBS England	-32	-39	-27	>25	
House Martin	10	CBC/BBS England	-32	-37	-26	>25	
Marsh Tit	10	CBC/BBS UK	-31	-40	-22	>25	
Little Grebe	10	WBS/WBBS waterways	-29	-43	-7	>25	Small sample
Sparrowhawk	10	CBC/BBS England	-29	-34	-22	>25	
Tree Pipit	10	CBC/BBS England	-27	-43	-7	>25	
Nightingale	10	CBC/BBS England	-27	-46	5		
Whinchat	10	BBS UK	-23	-41	0		
Oystercatcher	10	WBS/WBBS waterways	-22	-34	-9		
Common Sandpiper	10	WBS/WBBS waterways	-19	-29	-3		
Sedge Warbler	10	CBC/BBS UK	-19	-29	-7		
Wood Warbler	10	BBS UK	-19	-43	13		
Kestrel	10	CBC/BBS England	-18	-23	-13		
Grasshopper Warbler	10	BBS UK	-18	-33	4		
Grey Wagtail	10	WBS/WBBS waterways	-17	-28	-3		
Mistle Thrush	10	CBC/BBS UK	-17	-21	-12		

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Willow Warbler	10	CBC/BBS England	-17	-23	-10		
Red-legged Partridge	10	CBC/BBS UK	-13	-18	-7		
Garden Warbler	10	CBC/BBS UK	-12	-21	-3		
Tawny Owl	10	CBC/BBS UK	-11	-24	2		
Spotted Flycatcher	10	CBC/BBS UK	-11	-21	5		
Skylark	10	CBC/BBS England	-9	-12	-6		
Yellowhammer	10	CBC/BBS UK	-9	-13	-4		
Curlew	10	CBC/BBS England	-5	-14	3		
Dunnock	10	CBC/BBS UK	-1	-3	2		
Shelduck	10	CBC to 1999	3	-21	40		
Meadow Pipit	10	CBC/BBS England	3	-4	13		
Song Thrush	10	CBC/BBS UK	3	0	6		
Whitethroat	10	CBC/BBS UK	3	-1	9		
House Sparrow	10	CBC/BBS England	3	-1	9		
Corn Bunting	10	CBC/BBS UK	3	-13	21		
Dipper	10	WBS/WBBS waterways	5	-7	17		
Reed Bunting	10	CBC/BBS UK	5	-2	13		
Yellow Wagtail	10	CBC/BBS UK	12	-2	31		
Bullfinch	10	CBC/BBS UK	24	18	33		
Linnet	10	CBC/BBS England	28	20	36		
Tree Sparrow	10	CBC/BBS England	32	9	52		
Lesser Redpoll	10	CBC/BBS England	33	-8	83		
Snipe	10	WBS/WBBS waterways	53	-6	93		

Species are listed in ascending order of population change. Thus the species with the steepest recent decline appear first. Towards the foot of the table are species that remain in long-term decline but have shown partial recovery of those losses during the recent ten-year period.

As indicated by their position at the top of Table B1, there is high confidence that the populations ofTurtle Dove, Greenfinch and Tufted Duck have halved within just the last ten years, or even a shorter period. These are the only species in long-term decline that suffered a 50% fall during 2007–17 (but Lesser Spotted Woodpecker also met these criteria during the most recent ten-year period for which data are available). Note that whilst the 25-year WBS/WBBS decline for Tufted Duck in Table A3 does not raise a formal alert due to wide confidence intervals, the 10-year decline is statistically significant so does raise a high alert: unless this recent steep decline is reversed it is likely that formal alerts will be raised against the longer-term trends in the future. A further 14 species also raise alerts, having declined significantly by more than 25% (but less than 50%) in their most recent ten-year period. All these declines compound earlier losses for these species.

The ongoing declines of so many of the species listed in Table B1 raises serious conservation concern. A special case isTurtle Dove, for which the 10-year decline has remained at 80% or greater in each of the last nine BirdTrend report and shows no sign of slowing.

The 25% threshold, which is used to define decreases over the 25-year period that are worthy of amber listing, is equivalent to a change of 10.9% over ten years, assuming a constant rate of change. Thus a decrease of 11% or greater listed in Table B1 indicates that these species (32 in all, including non-significant declines for Nightingale, Whinchat, Wood Warbler, Grasshopper Warbler, Tawny Owl and Spotted Flycatcher) are on course for new or renewed red or amber listing for breeding population decline.

A smaller decrease, or an increase, indicates that the population decline may be easing off. Species that have declined in the longer term but with losses smaller than 11%, or with no significant population change, over the ten-year period are Skylark, Yellowhammer, Curlew, Dunnock, Shelduck, Meadow Pipit, Song Thrush, Whitethroat, House Sparrow, Corn Bunting, Dipper, Reed Bunting, Yellow Wagtail, Lesser Redpoll and Snipe.

Three species at the foot of the table show significant gains in population over the last ten years. The strong increase inLinnet and Tree Sparrow numbers is very welcome but the upturns are coming from such a low level that numbers remain far below those of the mid 1970s, with the population trend graphs still showing little sign of clear recovery. Bullfinch remains on the amber list, because the recent increases also represent only a small recovery from earlier losses.

Species groups

Waterbirds

Species	Long-term Trend	Primary Demographic	Primary Ecological
Mute Swan	Rapid Increase (UK, Eng)	Survival	Other
Greylag Goose	Rapid Increase (UK)	Unknown	Unknown
Canada Goose	Rapid Increase (UK)	Unknown	Unknown
Gadwall	Rapid Increase (UK, Eng)	Unknown	Unknown
Mallard	Rapid Increase (UK, Eng)	Unknown	Unknown
Mandarin Duck	Increase (UK, Eng)	-	-
Tufted Duck	Possible Increase	Unknown	Unknown
Goosander	Rapid Increase (UK)	Unknown	Unknown
Cormorant	Increase (UK)	Unknown	Unknown
Little Egret	Rapid Increase (UK, Eng)	Unknown	Unknown
Grey Heron	Possible shallow increase (UK, Eng) Probable moderate decline (Scot, Wales)	Survival	Unknown
Little Grebe	Uncertain	Unknown	Unknown
Great-crested Grebe	Stable	Unknown	Unknown

Most waterbird species are increasing in the UK. It is likely that increased water quality and warmer winter temperatures, reducing mortality, are at least partly responsible but there is little direct evidence on the causes of change for most species. For Wood *et al* 2019). Ingestion of lead shot similarly appears to be associated with population declines in wintering ducks (Green & Pain 2016).

Both Greylag Goose and Canada Goose extensively exploit urban habitats where low mortality rates of adult birds and a relatively high reproductive rate may both contribute to the population increases.

Study of breeding populations of ducks is difficult, the adults are not easy to catch and nest are hard to find and access, so less is known about these species than almost any other group of British birds.

Until the 1990s the Musgrove 2002). There is little direct evidence as to why this might be, but a combination of warmer winters, increased water quality and provision of new habitat, in form of remediated gravel pits may all have played a part. It is likely other species, such as Purple Heron, Great White Egret and Cattle Egret may join the Little Egret as British breeding species in the near future, all have successfully bred for the first time in recent years. Herons and egrets, though, are susceptible to cold winters reducing prey availability and increasing mortality (Holt 2012), and the effects of the recent cold winters can be seen in downturns in the trend of both Little Egret and Grey Heron.

Raptors, Owls and Raven

Species	Long-term Trend	Primary Demographic	Primary Ecological
Red Kite	Rapid Increase (UK, Eng)	Unknown	Unknown
Hen Harrier	Probable Increase (UK)	Breeding Success	Other
Sparrowhawk	Moderate Increase (Eng)	Breeding Success	Other
Kestrel	Fluctuating (Eng)	Survival	Unknown
Merlin	Probable increase (UK)	Unknown	Unknown
Hobby	Increase (UK, Eng)	Unknown	Unknown
Peregrine	Increase (UK, Eng, NI); Decline (Scot, Wales)	Breeding Success	Ban on organochlorine pesticides
Buzzard	Rapid Increase (Eng)	Breeding Success	Other
Barn Owl	Possible Decline (UK)	Survival	Other

Little Owl	Rapid Decline (UK, Eng)	Juvenile Survival	Agricultural Intensification
Tawny Owl	Shallow Decline (UK, Eng)	Unknown	Unknown
Raven	Increase (UK)	Unknown	Unknown

In the last few decades, most birds of prey have increased in number as a result of reduction in the use of certain pesticides, reductions in persecution and, for some species, changes in habitat availability.

During the 1950s and 1960s the widespread use of organochlorine and organophosphate pesticides reduced population numbers of many raptor species, of which the Newton 2013). Following a ban on their use, numbers gradually increased. Being towards the top of the food chain, though, birds of prey remain vulnerable to the risk of secondary poisoning, and there are current concerns more recently around the use of anticoagulant rodenticides which bear further investigation.

Concurrent with these changes, increased legal protection of these species led to a reduction in levels of control and persecution, particularly in lowland areas for species such as Elliott & Avery 1991). Illegal persecution, in particular of Murgatroyd *et al.* 2019). Similar considerations apply to the Wilson *et al.* 2019) .

Positive conservation measures have been particularly successful for two species. Provision of nest boxes for Carter 2001).

The two species found most commonly on farmland (Kestrel and Little Owl) are faring less well, probably due, at least in part, to changes (and intensification) in land management reducing the availability of prey. Habitat availability has apparently played a more positive role in Kettel *et al* 2018b).

Waders

Species	Long-term Trend	Primary Demographic	Primary Ecological
Oystercatcher	Moderate Increase (UK)	Unknown	Unknown
Golden Plover	Probable Decline (UK)	Unknown	Unknown
Lapwing	Rapid Decline (UK); Moderate Decline (Eng)	Breeding Success	Agricultural Intensification
Ringed Plover	Decline (UK)	Breeding Success	Unknown
Curlew	Moderate Decline (Eng)	Breeding Success	Agricultural Intensification
Common Sandpiper	Moderate Decline (UK)	Unknown	Unknown
Redshank	Decline (UK)	Unknown	Agricultural Intensification
Woodcock	Probable Rapid Decline (UK)	Unknown	Unknown
Snipe	Rapid Decline (UK)	Unknown	Unknown

Breeding populations of most waders in Britain are declining, mostly as a result of habitat loss/intensification.

A key reason for the decline in breeding wader species, particularly Wilson *et al.* 2005a) and more intensive grassland management (Smart *et al.* 2008).

As they nest on the ground, waders are vulnerable to nest predation and densities of generalist predators are higher in UK than elsewhere in Europe (Roos *et al.* 2018). Habitat loss has concentrated breeding populations into smaller areas increasing their vulnerability (Bolton *et al.* 2007). Predation of nests is also an issue in other habitats, such as on the machair of the Uists where populations of Calladine *et al.* 2017).

Woodland Residents

Species	Long-term Trend	Primary Demographic	Primary Ecological
Great Spotted Woodpecker	Rapid Increase (UK, England)	Breeding Success	Decreased Competition for nests
Lesser Spotted Woodpecker	Rapid Decline	Unknown	Unknown
Jay	Fluctuating (UK, England)	Unknown	Unknown
Goldcrest	Fluctuating (England)	Unknown	Unknown
Blue Tit	Shallow Increase (UK, England)	Survival	Other
Great Tit	Moderate Increase (UK, England)	Survival	Other
Coal Tit	Fluctuating (UK, England)	Unknown	Unknown
Willow Tit	Rapid Decline (UK, England)	Unknown	Changes in Woodland

Marsh Tit	Rapid Decline (UK, England)	Survival	Changes in Woodland
Long-tailed Tit	Moderate Increase (Eng)	Survival	Weather
Nuthatch	Rapid Increase (UK, England)	Breeding Success	Unknown
Treecreeper	Fluctuating (England)	Survival	Weather
Wren	Rapid Increase (UK, England)	Survival	Climate Change
Blackbird	Shallow Decline (UK, England)	Survival	Unkown
Song Thrush	Moderate Decline (UK, England)	Juvenile survival	Unknown
Robin	Moderate Increase (UK, England)	Productivity	Unknown
Dunnock	Moderate Decline (UK, England)	Survival	Agricultural Intensification
Chaffinch	Fluctuating	Survival	Other
Lesser Redpoll	Rapid Decline (England)	Survival	Changes in Woodland
Siskin	Increase (UK)	Unknown	Unknown

Most resident species of woodland habitats are increasing, with the exception of those that have specialised habitat requirements, notably Lesser Spotted Woodpecker, Willow Tit and Marsh Tit.

In part, these increases are due to flexible, generalist nature of the habitat requirements of these species. Most are species of the woodland edge and leafy suburban habitats, in particular, provide a suitable alternative habitat for many, with the extensive provision of food in gardens being an additional attractant. Indeed, those species that have increased their use of gardens the most, such as Plummer *et al.* 2019).

In many species this has led to relatively high survival, perhaps particularly overwinter, although warmer winters will also have played a role, contributing to the population increases. One notable recent exception is the Lawson *et al.* 2018).

The causes of decline in the woodland specialist species are less clear, but the scale of the changes, especially in Lesser Spotted Woodpecker (which is now so uncommon that we can no longer monitor its population through BBS), Lesser Redpoll and Willow Tit suggest fundamental changes in woodland habitat quality in the last few decades.

Woodland Migratory Species

Species	Long-term Trend	Primary Demographic	Primary Ecological
Nightjar	Uncertain	Unknown	Changes in Heath and woodland
Wood Warbler	Decline (UK)	Unknown	Unknown
Chiffchaff	Rapid Increase (UK, Eng)	Survival	Unknown
Willow Warbler	Rapid Decline (Eng)	Breeding Success	Climate Change?
Blackcap	Rapid Increase (UK, Eng)	Unknown	Unknown
Garden Warbler	Moderate Decline (UK)	Unknown	Unknown
Nightingale	Decline (Eng)	Unknown	Changes in Woodland
Spotted Flycatcher	Rapid Decline (UK, England)	Survival	Unknown
Pied Flycatcher	Decline (UK)	Survival	Wintering Habitat Change
Redstart	Fluctuating (UK, England)	Productivity	Unknown
Tree Pipit	Rapid Decline (England)	Breeding Success	Changes in Woodland

Population trends in migratory species in woodland habitats depend largely on migration distance, those with shorter migratory journeys (wintering in Europe or North Africa) tend to be increasing, while those with longer journeys (wintering in central Africa) tend to be declining (Thaxter *et al.* 2010).

Increases in the short-distance migratory species are likely a result of climate change and warmer winters, with species such as Plummer *et al.* 2015).

Reasons for the declines in the longer distance migratory species are less well known, although in at least some species, such as Hewson *et al.* 2005), although this may not be true for all species (Mallord *et al.* 2016).

Farmland Resident Species

Species	Long-term Trend	Primary Demographic	Primary Ecological
Woodpigeon	Rapid Increase (UK, England)	Survival	Agricultural Intensification
Starling	Rapid Decline (England)	Juvenile Survival	Agricultural Intensification
Song Thrush	Moderate Decline (UK, England)	Juvenile Survival	Unknown
Stonechat	Fluctuating (UK)	Unknown	Unknown
Chaffinch	Fluctuating (UK)	Survival	Other
Bullfinch	Moderate Decline (UK, Eng)	Adult Survival	Agricultural Intensification
Greenfinch	Rapid Increase (Eng)	Survival	Availability of Food
Linnet	Rapid Decline (Eng)	Breeding Success	Agricultural Intensification
Goldfinch	Rapid Increase (Eng)	Survival	Availability of Food
Yellowhammer	Rapid Decline (UK, England)	Survival	Agricultural Intensification
Reed Bunting	Fluctuating (UK, England)	Survival	Agricultural Intensification
Corn Bunting	Rapid Decline (UK, England)	Unknown	Agricultural Intensification

Most resident species on farmland are declining, or have declined in the past, with trends in these generally reflecting fluctuations in food supply.

The declines in farmland bird are well studied and generally relate to the reduced availability of food resources, especially in seeds in winter for species like Robinson & Sutherland 2002). These declines generally reverse earlier increases in the 1950s and 60s as agriculture (particularly arable) expanded in extent from a previous low. Food availability in grassland habitats has also likely reduced affecting those that feed primarily on soil invertebrates such as Baker *et al.* 2012; Dadam & Siriwardena 2019).

In contrast, those species that are increasing have adapted to using other food resources, such as gardens in the case of Lawson *et al.* 2018).

Farmland Migratory Species

Species	Long-term Trend	Primary Demographic	Primary Ecological
Turtle Dove	Rapid Decline (UK, England)	Breeding Success	Agricultural Intensification
Whitethroat	Rapid Decline (UK, England)	Survival	Changes on Wintering Grounds
Lesser Whitethroat	Uncertain (UK)	Unknown	Unknown
Whinchat	Decline (UK)	Breeding Success	Agricultural Intensification
Wheatear	Possible Decline (UK)	Unknown	Unknown
Yellow Wagtail	Rapid Decline (UK, England)	Unknown	Agricultural Intensification

All migratory species living on farmland, with the possible exception of Lesser Whitethroat, are declining in both numbers and range and some (Whinchat, Wheatear) are now restricted to marginal habitats in more upland areas.

The declines have generally been caused by intensification of agricultural practices in both grass (Vickery *et al.* 2001) and arable (Browne & Aebischer 2001) habitats. The catastrophic decline of the Whitethroat in the late 1960s was caused by drought conditions on its wintering grounds in the Sahelian region of Africa from which it is yet to recover.

Increasing species

Population changes of species for which our best long-term trend estimate from CBC/BBS (usually over 50 years) or from WBS/WBBS (a maximum of 42 years) shows an increase of more than 50% are shown in Table C1. There are 30 species listed, the same as in *BirdTrends 2018*; however the increase for Oystercatcher is now just below the cut-off and it has been replaced in the table by Coal Tit which is now just above the cut-off. Twenty of the species have more than doubled their population size over the periods in which they have been monitored (24–50 years).

Table C1 Long-term population increases of greater than 50% from CBC/BBS (1967-2017) or WBS/WBBS (1975-2017), using the best survey for each species

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Buzzard	50	CBC/BBS England	850	540	3013		
Greylag Goose	24	WBS/WBBS waterways	461	187	1754		
Great Spotted Woodpecker	50	CBC/BBS UK	387	275	646		
Shelduck	31	CBC to 1999	300	94	787		Small sample
Collared Dove	45	CBC/BBS UK	299	154	475		
Blackcap	50	CBC/BBS UK	297	231	393		
Mute Swan	50	CBC/BBS UK	270	71	845		
Nuthatch	50	CBC/BBS UK	268	185	441		
Stock Dove	50	CBC/BBS England	237	135	413		
Green Woodpecker	50	CBC/BBS England	162	87	263		
Woodpigeon	50	CBC/BBS UK	162	33	442		
Mallard	50	CBC/BBS UK	154	93	220		
Goosander	36	WBS/WBBS waterways	148	53	322		
Coot	50	CBC/BBS UK	142	43	427		
Carrion Crow	50	CBC/BBS England	137	89	178		
Canada Goose	36	WBS/WBBS waterways	137	37	511		
Goldfinch	50	CBC/BBS England	131	70	198		
Jackdaw	50	CBC/BBS UK	130	56	222		
Wren	50	CBC/BBS UK	117	88	145		
Chiffchaff	50	CBC/BBS UK	110	73	170		
Reed Warbler	50	CBC/BBS UK	99	31	334		
Magpie	50	CBC/BBS UK	98	62	152		
Long-tailed Tit	50	CBC/BBS England	96	36	177		
Pheasant	50	CBC/BBS England	94	52	166		
Great Tit	50	CBC/BBS UK	90	65	115		
Sparrowhawk	42	CBC/BBS England	87	9	229		
Pied Wagtail	50	CBC/BBS UK	57	17	124		
Goldcrest	50	CBC/BBS England	54	-12	242		
Robin	50	CBC/BBS UK	52	39	69		

Species	Period (yrs)	Source	Change (%)	Lower limit	Upper limit	Alert	Comment
Coal Tit	50	CBC/BBS UK	50	-3	147		

Table C1 is led by Buzzard, by a wide margin, but it should be noted that seven of the fastest-increasing species in this report are actually not included here, because their monitoring data cover too short a period. The UK's non-native population of Ring-necked Parakeets is estimated to have risen by 1710% (more than a 18-fold increase) over the 22 years 1995–2017. Arguably, however, this is more a conservation problem than a success! Mandarin Duck (+54% over 2007-17) is another fast-increasing non-native species. Undoubted success stories are the growth during 1995–2017, estimated through BBS, of Barn Owl (+289%), Gadwall (+213%) and the re-introduced Red Kite (+1624%). Little Egret has increased by more than 20-fold during 1995–2017. Though the trajectory has been moderated by recent cold-weather-related setbacks, attention should also be drawn to the rapid rise of Cetti's Warbler, a recently established native species, which CES now estimates to have increased by 988% during 1992–2017.

Four groups stand out among the increasing species: corvids – especially Carrion Crow, Magpie and Jackdaw; doves – Collared Dove, Stock Dove and Woodpigeon; woodpeckers and other smaller species of woodland and gardens; and some waterbirds. Corvids appear to have benefited from changed gamebird management practices in recent years, and the larger doves from the increased acreage of brassica crops (particularly oilseed rape).

The majority of the third group are species primarily of woodland that are also common in gardens in some areas: Great Spotted Woodpecker, Green Woodpecker, Nuthatch, Blackcap, Wren, Great Tit, Coal Tit, Long-tailed Tit, Goldcrest and Robin. The reasons for these increases are presently unclear but may, in many cases, relate to improved feeding opportunities in gardens. Pied Wagtail has increased in numbers by 57% on CBC/BBS plots over 50 years, but declined by 66% on WBS/WBBS plots over the past 42 years, although the CBC/BBS index is likely to be most representative of the UK population as a whole. Reed Warbler, also an insectivore, has been expanding its range northwards and westwards and might be benefiting from climate change. Declines on CES plots suggest the benefits might not be universal, with the habitat quality in 'core' sites possibly decreasing, while warming climates facilitate the colonisation of new sites.

A number of species associated with freshwater habitats are becoming more abundant, although differences between their ecological requirements make it unlikely that there is a single causal factor common to all. For Mallard, the CBC/BBS increase was matched by a WBS/WBBS increase of 169% over 42 years. The long-term increases recorded for Mute Swan on both CBC/BBS and WBS/WBBS plots are likely to be the result, at least in part, of banning the use of lead weights by anglers, which took effect in 1986. Greylag Goose, Shelduck, Canada Goose, Coot and Goosander are other wildfowl among this report's increasing species.

Two widespread raptors have shown remarkable recoveries from low population levels after the banning of certain poisonous farmland pesticides in the early 1960s, assisted by lower levels of illegal predator control. Buzzards increased in England by 850% between 1967 and 2017, with an increase of 46% over the last ten years alone. Sparrowhawks, too scarce for CBC to monitor until the mid 1970s, show a 87% increase over the 42-year period from 1975 to 2017. However, their recovery appears to have been completed earlier than Buzzard's, and the population is now in moderate decline (for unknown reasons), prompting a lower level alert to be raised over the 25-year period (see Latest long-term alerts).

While Pheasant holds a place in this table, its increase in census data has been driven largely by increasing, but poorly quantified, scale of releases of artificially reared poults for shooting. Corvids, and other generalist predators, may also have benefited, exploiting both through the food provided for poults and the high mortality of poults, resulting in an abundant level of carcasses.

Changes in breeding performance

Changes in a range of aspects of breeding performance can be measured under the Nest Record Scheme (NRS) and the Constant Effort Sites (CES) scheme. The NRS provides information on components of breeding performance (clutch size, brood size and failure rates at the egg and nestling stages) that can be combined to give an overall estimate of productivity per nesting attempt (FPBA) – see NRS page for further information. The CES scheme provides an index of breeding performance accrued over all nesting attempts in a particular year. CES results also take into account any changes in the survival rates of fledglings in the first few weeks after leaving the nest, a period when losses of young can be high.

Breeding performance may be influenced by a variety of factors, including food availability, predation pressure and weather conditions. Variation in breeding performance may contribute to fluctuations in abundance and even be the main demographic factor responsible for determining the size of the population. Conversely, the breeding performance of a population may be inversely related to its size, with productivity decreasing as the number of individuals increases, and vice versa. Such a relationship might occur due to the action of density-dependent factors, such as competition for resources: as numbers increase, competition for resources is likely to increase, possibly resulting in poorer productivity. Alternatively, increases in abundance may be accompanied by range expansion into less suitable habitats or areas where breeding performance is poorer, thus reducing the average productivity of the population. The converse is also true, and where declines result from the loss of individuals from these suboptimal habitats, there may be a subsequent increase in average productivity recorded depending on how the driver of change affects the population.

Changes in Fledglings Per Breeding Attempt from Nest Record Scheme data

The NRS started collating nest histories of individual breeding attempts in 1939 and sufficient data are available for trends to be produced from the mid 1960s onward. The data collected allow annual variation in clutch size, brood size and stage-specific nest failure rates to be assessed, and these breeding parameters are included in the Summary tables. While detailed exploration of annual variation in productivity is essential if the impacts of environmental factors on breeding success are to be fully understood, the combined effects of concurrent changes in the number of offspring and failure rates can be difficult to interpret. These measures are therefore integrated into a single annual figure representing the mean number of young leaving each nest, termed Fledglings per Breeding Attempt (FPBA; Siriwardena *et al.* 2000b, Crick *et al.* 2003).

All species displaying significant temporal trends in mean FPBA over the full report period (50 years) are included in Table D1. In total, 42 species exhibited significant trends in productivity, of which 14 species now show lower FPBA: three red-listed species (Wood Warbler, Tree Pipit and Linnet), five amber-listed species (Nightjar, Willow Warbler, Dunnock, Meadow Pipit and Reed Bunting) and six green-listed species (Moorhen, Great Tit, Garden Warbler, Treecreeper, Blackbird and Chaffinch). While the trend for Moorhen, Great Tit, Willow Warbler, Garden Warbler, Linnet and Reed Bunting has been linear, i.e. falling consistently over the last 50 years, trends for the other eight species are curvilinear, and for some species in this latter group, FPBA is currently only marginally lower than in the 1960s. For seven of the species showing curvilinear trends, FPBA increased between the mid 1960s and mid 1980s or mid 1990s and decreased thereafter; whereas in the case of Nightjar, productivity decreased from the mid 1960s until the mid 2000s but has increased slightly over the last ten years.

Two further species have recorded significant trends in FPBA but are not listed in Table D1 as the data do not cover the full 50-year period. The red-listed Song Thrush shows a curvilinear trend in productivity (an increase followed by a decrease) over 36 years (1981-2017), and the green-listed Coot shows a linear decline in FPBA over 26 years (1991-2017).

Table D1 Significant trends in fledglings per breeding attempt measured between 1967 and 2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Reed Bunting	50	48	Linear decline	2.8 fledglings	2 fledglings	-0.8 fledglings	
Moorhen	50	51	Linear decline	2.62 fledglings	1.84 fledglings	-0.78 fledglings	
Garden Warbler	50	20	Linear decline	3.07 fledglings	2.32 fledglings	-0.75 fledglings	Small sample
Great Tit	50	594	Linear decline	5.96 fledglings	5.3 fledglings	-0.66 fledglings	
Willow Warbler	50	69	Linear decline	3.6 fledglings	3.11 fledglings	-0.49 fledglings	
Nightjar	50	23	Curvilinear	1.58 fledglings	1.13 fledglings	-0.45 fledglings	Small sample
Linnet	50	127	Linear decline	2.71 fledglings	2.3 fledglings	-0.41 fledglings	
Meadow Pipit	50	52	Curvilinear	1.97 fledglings	1.68 fledglings	-0.29 fledglings	
Chaffinch	50	125	Curvilinear	1.63 fledglings	1.37 fledglings	-0.26 fledglings	
Wood Warbler	50	26	Curvilinear	2.86 fledglings	2.66 fledglings	-0.2 fledglings	Small sample
Treecreeper	50	21	Curvilinear	2.77 fledglings	2.67 fledglings	-0.1 fledglings	Small sample
Blackbird	50	282	Curvilinear	1.48 fledglings	1.4 fledglings	-0.08 fledglings	
Tree Pipit	50	16	Curvilinear	1.71 fledglings	1.64 fledglings	-0.07 fledglings	Small sample
Dunnock	50	126	Curvilinear	1.69 fledglings	1.68 fledglings	-0.01 fledglings	
Collared Dove	50	54	Curvilinear	0.79 fledglings	0.8 fledglings	0.01 fledglings	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Woodpigeon	50	91	Curvilinear	0.52 fledglings	0.6 fledglings	0.08 fledglings	
Reed Warbler	50	173	Curvilinear	2.24 fledglings	2.39 fledglings	0.15 fledglings	
Robin	50	214	Curvilinear	2.29 fledglings	2.55 fledglings	0.26 fledglings	
House Sparrow	50	114	Curvilinear	2.32 fledglings	2.59 fledglings	0.27 fledglings	
Skylark	50	41	Curvilinear	0.91 fledglings	1.2 fledglings	0.29 fledglings	
Yellowhammer	50	48	Curvilinear	0.83 fledglings	1.18 fledglings	0.35 fledglings	
Stock Dove	50	83	Linear increase	1.01 fledglings	1.37 fledglings	0.36 fledglings	
Buzzard	50	30	Curvilinear	1.33 fledglings	1.71 fledglings	0.38 fledglings	
Raven	50	22	Curvilinear	2.75 fledglings	3.13 fledglings	0.38 fledglings	Small sample
Carrion Crow	50	38	Curvilinear	1.66 fledglings	2.05 fledglings	0.39 fledglings	Includes Hooded Crow
Sparrowhawk	50	29	Curvilinear	2.61 fledglings	3.06 fledglings	0.45 fledglings	Small sample
Wren	50	99	Curvilinear	2.36 fledglings	2.87 fledglings	0.51 fledglings	
Pied Wagtail	50	90	Linear increase	3.02 fledglings	3.55 fledglings	0.53 fledglings	
Peregrine	50	26	Linear increase	1.78 fledglings	2.31 fledglings	0.53 fledglings	Small sample
Little Owl	50	19	Linear increase	1.88 fledglings	2.43 fledglings	0.55 fledglings	Small sample
Kestrel	50	43	Curvilinear	2.9 fledglings	3.48 fledglings	0.58 fledglings	
Tawny Owl	50	68	Linear increase	1.38 fledglings	2.01 fledglings	0.63 fledglings	Nocturnal species
Grey Wagtail	50	56	Linear increase	2.64 fledglings	3.36 fledglings	0.72 fledglings	
Jackdaw	50	68	Curvilinear	1.52 fledglings	2.29 fledglings	0.77 fledglings	
Barn Owl	50	37	Curvilinear	2.07 fledglings	2.88 fledglings	0.81 fledglings	
Dipper	50	93	Curvilinear	2 fledglings	2.88 fledglings	0.88 fledglings	
Starling	50	115	Linear increase	2.56 fledglings	3.48 fledglings	0.92 fledglings	
Merlin	50	21	Linear increase	2.46 fledglings	3.43 fledglings	0.97 fledglings	Small sample
Tree Sparrow	50	361	Linear increase	2.79 fledglings	3.85 fledglings	1.06 fledglings	
Redstart	50	62	Curvilinear	3.38 fledglings	4.64 fledglings	1.26 fledglings	
Magpie	50	40	Curvilinear	1.1 fledglings	2.37 fledglings	1.27 fledglings	
Nuthatch	50	68	Linear increase	3.7 fledglings	5.5 fledglings	1.8 fledglings	

See Key to species texts for help with interpretation

A recent review paper focusing on long-distance migrant declines (Vickery *et al.* 2014) highlighted the important role demographic data play in the identification of mechanisms. Work by Morrison *et al.* (2013b) using BBS data reported a consistent positive relationship between latitude and the trajectory of long-distance migrant population trends within the UK, suggesting that abundance is, at least in part, determined by breeding success. This conclusion was supported by a study focusing specifically on contrasting regional trends in Willow Warbler numbers (Morrison *et al.* 2016c), which identified reduced productivity at lower latitudes as the underlying driver. There is increasing evidence that organisms at lower trophic levels are responding to climatic change more rapidly than those towards the top of the food chain (Visser & Both 2005, Thackeray *et al.* 2010, 2016). Resulting mismatches in the timing of food availability and of offspring food demand, referred to as phenological disjunction, can have severe impacts on breeding success and ultimately on population trends of bird species (Both *et al.* 2009), although there is evidence that the magnitude of these impacts may vary with diet and breeding habitat (Dunn & Møller 2014).

Long-distance migrants are thought to be particularly susceptible todisjunction between birds and their preydue to their later arrival on the breeding grounds and the energetic demands of their journey northwards, which may constrain their ability to advance their laying dates (Rubolini *et al.* 2010, Ockendon *et al.* 2012, Gilroy et al. 2016 but see Goodenough *et al.* 2011, Winkler *et al.* 2014); the resultant negative impacts on breeding success may be exacerbated by increased competition with less disadvantaged residents (Wittwer *et al.* 2015). Recent studies have detected negative correlations between May temperatures and both the population trajectories (Pearce-Higgins *et al.* 2015) and the extincton risk (Mustin *et al.* 2014) in a range of migrant species, lending weight to this hypothesis and potentially explaining the productivity declines reported here for Nightjar, Tree Pipit, Willow Warbler and Garden Warbler. Alteration to some habitats by humans may increase competition

further by causing a reduction in nest site availability (Higginson 2017).

Trans-Saharan migrants may also be experiencing negative impacts ofclimate change in their African wintering grounds or on passage, with reduced rainfall leading to a fall in insect abundance and a subsequent loss of condition, resulting in a lower reproductive output during the following spring (Saino *et al.* 2004, 2012, Schaub *et al.* 2011, Finch *et al.* 2014); although for most species breeding ground climatic effects may be more important (Ockendon*et al.* 2013). Similar carry-over effects has been found for Dobson *et al.* 2017). The importance of conditions outside the breeding grounds was emphasised by Gilroy*et al.* (2016), who found that species inhabiting larger wintering ranges relative to the size of their breeding range were less likely to exhibit population declines, this increased migratory diversity potentially buffers the impacts of reduced quality within individual wintering regions or habitats. Climate change in the UK is also affecting bird populations, mainly through increased over-winter survival, but changes to rainfall and temperature during breeding and post-breeding may also affect productivity for some species, particularly in the longer term (Pearce-Higgins & Crick 2019).

Long-distance migrants are not alone in being at risk from changes to the timing of seasonal events, and short-distance migrants and residents may also be affected (Franks *et al.* 2018). The gap between the timing of seasonal events can also vary at different latitudes, and hence the effects of mismatch may differ across the UK (Burgess *et al.* 2018, Bell *et al.* 2019). Disjunction risk is predicted to vary spatially in relation to the duration of resource peaks and previous research has reported more marked migrant population declines in highly seasonal habitats (Both *et al.* 2010), of which woodlands are a prime example. Invertebrate food availability in the canopy increases rapidly during the brief period when larval Lepidoptera emerge to take advantage of the spring leaf burst, prior to the foliage toughening and developing chemical defences. As springs have become warmer, oak leafing dates have advanced, a shift matched by caterpillars (Buse *et al.* 1999), but apparently not by tits (Visser *et al.* 1998) or flycatchers (Both *et al.* 2009), despite the apparent plasticity of passerine laying dates in response to environmental drivers (Phillimore*et al.* 2016). The figures presented in this report indicate that Greenwood & Baillie 2008). The population level impacts of disjunction-related productivity declines are still unclear and there is some evidence that reduced productivity under warmer temperatures may be buffered by density-dependent increases in survival in some species, including Reed *et al.* 2012, 2013, 2015), and possibly also in clutch size (Saether*et al.* 2016). Although advances in laying dates do not necessarily match the shifts of food sources, the potential resultant declines may be offset by other benefits, e.g. increased fledgling development time is believed to have contributed to better first year survival for Pied Flycatchers in the Netherlands (Tomotani *et al.* 2018).

Recent declines in the number of aerial insects (Shortall *et al.* 2009), particularly moths (Conrad *et al.* 2006, Fox 2013) and butterflies (Fox *et al.* 2015), have been reported across the UK. These invertebrate groups form a significant element of the diet of all the long-distance migrants identified as displaying productivity declines and a reduction in food availability may increase the incidence of whole brood failure due to starvation or desertion by under-nourished parents. The latitudinal variation in population trends identified by Morrison *et al.* (2013b) in the UK may reflect a more pronounced drop in invertebrate numbers in the south where conditions are generally drier. An alternative explanation may be a lower usage of neonicotinoid pesticides in the north, as it is becoming apparent that detrimental impacts on invertebrate numbers may not be limited to the agricultural areas to which they are applied (Hallmann *et al.* 2014). Looking at trends in insectivorous bird species across Europe, Bowler *et al.* (2019) found that declines in these species were mostly associated with agricultural intensification and loss of grasslands.

Clearly, declining food availability due tochanges in farming practices, including agrochemical usage may also be an issue for farmland bird species displaying negative trends in FPBA. Brickle *et al.* (2000) observed that Siriwardena *et al.* 1998b, Peach *et al.* 1999, Siriwardena *et al.* 2000b). If adults of stubble-feeding species are in poorer condition at the start of the breeding season, their investment in reproduction may also be reduced, and the granivorous diet of Siriwardena *et al.* 1999, 2000b).

Egg-stage failure rates are implicated in the reduced productivity of nine of the 14 species exhibiting significant declines in FPBA (Groom 1993, Stoate & Szczur 2001, 2006, White *et al.* 2014), while previous studies have failed to find any evidence of a significant impact at a national scale (Gooch*et al.*1991, Thomson *et al.* 1998, Chamberlain *et al.* 2009, Newson *et al.* 2009, Vögeli *et al.* 2011, reviewed by Madden *et al.* 2015). Ground nesting birds, in particular waders, may be vulnerable to predation from mammals such as red fox and hedgehogs, and several studies have identified predation as a factor or partial factor causing low productivity and hence population declines (e.g. Teunissen *et al.* 2008, MacDonald & Bolton 2008b, Mason *et al.* 2017, Calladine *et al.* 2017; see also review by Roos *et al.* 2018). Moreover, lower abundance may further worsen productivity for some wader species through density-dependent effects, as fewer breeding pairs may become less efficient at defending nests (Moller *et al.* 2018). Several recent studies have also suggested that predation pressure may increase in response to climatic warming. For example, Cox *et al.* (2013) found that the incidence of nest predation by birds and snakes, but not mammals, increased with temperature in the USA; Auer & Martin (2013) demonstrated an increase in the proportion of predated nests across a range of species due to climate-induced shifts in plant–herbivore interactions. Kubelka *et al.* (2018) linked shifts in patterns of wader nest predation to changes of climate though the robustness of these patterns is debated (Bulla *et al.* 2019, Kubelka *et al.* 2019). Development of land can also alter predator type and number, with negative consequences for nest survival, as demonstrated by Hethcoat & Chalfoun (2015). Large-scale releases of pheasants and red-legged partridges have also been linked to higher numbers of avian predators, as they provide additional food resources, enhancing over-winter survival and hence abundance during subsequent breeding seasons (Pringle *et al.* 2019). Predation rates may therefore be increasing and further research into the impacts of nest predators on population trajectories, at a variety of spatial scales, is urgently required.

Increased grazing pressure by deer, numbers of which are rising rapidly in many areas of the UK (Newson*et al.* 2012), has been identified as a possible driver of population declines in the UK (Fuller *et al.* 2005) and the USA (Martin *et al.* 2011), the removal of the herb and shrub layers potentially reducing the availability of both food and well-concealed nesting sites. Mustin *et al.* (2014) demonstrated that Garden Warbler were less likely to colonise woodland sites with poorly developed undergrowth and experimental exclusion of deer has been shown to impact positively on this species. Similarly, Holt *et al.* (2010, 2011) showed that Nightingale territory density was much higher within deer exclosures, and Newson *et al.* (2012) identified a negative correlation between deer and the population trends of five woodland species, including Willow Warbler, which may also have been driven by reduced productivity.

Increasing human activity in the countryside, resulting from a growing population, could increase disturbance levels, in turn influencing the rates of predation and desertion. An investigation of Langston *et al.* 2007a) and a review of recreational disturbance impacts found breeding success to be adversely affected by human activity levels in 28 out of 33 papers cited (Steven *et al.* 2011). However, Lowe *et al.* (2014) observed that, while Nightjar territory selection was influenced by disturbance, there appeared to be no concurrent impact on breeding success.

The colonisation of urban habitats by Chamberlain *et al.* 2009a) and more research is needed to see whether these are representative at a national scale. Supplementary feeding in gardens is influencing the composition of bird communities across large spatial scales (Plummer *et al.* 2019), which may in turn affect productivity through density-dependent and interspecific effects. Whilst the effect of feeding on bird populations may be positive for some species, it may also increase risks of disease transmission (Lawson *et al.* 2018). The recent outbreak of trichomonosis, which has significantly and rapidly reduced the abundance of Robinson*et al.* 2010b; Lawson et al. 2018), could have impacted on breeding success and may also provide a good test of the hypothesis that productivity declines over the last 50 years represent a density-dependent response. Lehikoinen *et al.* 2013), and it is unclear whether the more recent steep downturn in the UK since 2012 is linked to trichomonosis or other causes (Lawson *et al.* 2018).

FPBA has changed significantly and is currently higher than in the late 1960s for 28 species, across a wide range of taxonomic groups. This total includes ten species for which the change has been linear, i.e. consistent increases in productivity across the last 50 years, and 18 species which show curvilinear trends (i.e. early decreases in FPBA were followed by increases, or vice-versa). For some species in the latter group, FPBA is currently only slightly higher than in the late 1960s. Population trends are also positive for 18 of the 28 species, including raptors (Sparrowhawk, Buzzard, Barn Owl, Merlin, Peregrine), pigeons (Stock Dove, Woodpigeon, Collared Dove), corvids (Magpie, Jackdaw, Carrion Crow, Raven), and some small passerines (Reed Warbler, Nuthatch, Wren, Robin, Redstart and Pied Wagtail). It is therefore possible that increasing productivity has contributed to the population growth exhibited by these species over recent decades. Conversely, 10 species (Little Owl, Tawny Owl, Kestrel, Skylark, Starling, Dipper, House Sparrow, Tree Sparrow, Grey Wagtail and Yellowhammer) have declined in number as FPBA has increased, suggesting that a density-dependent reduction in intraspecific competition, or a retreat into better quality habitat, may have enabled breeding success to rise.

Changes in productivity from Constant Effort Sites ringing data

The CES started monitoring populations in 1983, so the changes in productivity (Table D2) cover roughly half the period of the Nest Record Scheme results. The CES data set is unique in providing relative measures of adult abundance and productivity from the same set of sites in mostly wetland and scrub habitats. While the NRS data set monitors the productivity of individual nesting attempts, the proportion of juveniles in the CES catch provides a relative measure of annual variation in productivity that integrates the effects of the number of fledglings produced per attempt, number of nesting attempts and immediate post-fledging survival. Use of these two techniques in combination provides a powerful method of determining which factors are responsible for observed declines in recruitment of young birds into the breeding population.

Table D2 Changes in productivity indices (percentage juveniles) for CES, 1984-2017, calculated from smoothed trend

Species	Period (yrs)	Plots (n)	Change (%)	Lower limit	Upper limit	Comment
Reed Bunting	33	64	-61	-81	-27	
Sedge Warbler	33	74	-52	-73	-22	
Blue Tit	33	106	-46	-58	-26	
Song Thrush	33	93	-40	-59	-17	
Blackbird	33	104	-27	-46	-0	
Blackcap	33	102	-24	-42	-1	
Reed Warbler	33	66	44	6	115	
Chaffinch	33	84	80	6	231	

See Key to species texts for help with interpretation

Overall, six species exhibit significant declines in the proportion of juveniles captured (Table D2). The apparent productivity ofSedge Warbler and Reed Bunting has fallen by more than 50% over the last 25 years, while Blue Tit, Song Thrush and Blackbird show reductions in relative productivity of between 25% and 50%, and Blackcap productivity has declined by 24%.

Although two of these species, Peach *et al.* 1991, 1995a, 1999, Robinson *et al.* 2004, 2010, 2014, Baillie *et al.* 2009).

Peach *et al.* 1999). For species such as 2019) found that, whilstGreat Tit density effects were driven mainly by intraspecific competition, Blue Tits were also be affected by competition with Great Tits: this could possibly explain the relatively greater decrease in breeding performance for Blue Tit following increases in the populations of both species.

Only two of the 23 species monitored shows significant positive trends in CES productivity Chaffinch and Reed Warbler). The discrepancy between the positive Chaffinch CES trend and the decline in breeding success identified by the NRS warrants further study, but increased survival rates in post-fledging period could contribute to this, although data are sparse for this vital period.

A positive trend might be predicted if climatic warming enabled multi-brooded species, such asReed Warbler, to extend their breeding season, increasing the number of broods reared per adult (Dunn & Møller 2014). Eglington *et al.* (2015) found that, using CES data from across Europe,Reed Warbler was the one species experiencing temperature dependent increases in productivity, particularly in the north of its range and results of a recent food supplementation study suggest that this is as predicted if climatic change has increased food availability (Vafidis *et al.* 2016).

Changes in average laying dates from Nest Record Scheme data

Since the mid 1970s, many species have exhibited a trend towards progressively earlier clutch initiation (Crick*et al.* 1997) with laying dates showing curvilinear responses over the past 50 years as spring temperatures have cooled and then warmed (Crick & Sparks 1999). Table D3 confirms that the majority of species exhibiting significant trends since the late 1960s have advanced laying. Thus 40 species are laying between three and 21 days earlier, on average, than they were 50 years ago.

The results of previous studies predict laying-date advancement to be more constrained in long-distance migrants (Both*et al.* 2009, Rubolini *et al.* 2010, Kluen *et al.* 2016, Samplonius *et al.* 2018), although the extent to which populations are able to adjust migratory strategies in response to environmental pressures and the predicted impact on population size is currently the focus of much discussion (James & Abbott 2014, Winkler *et al.* 2014, Kristensen *et al.* 2016). Species which have advanced their laying date least, whether migrants or residents, have generally experienced the biggest negative population trends (Franks *et al.* 2018). It is interesting to note that the magnitude of the laying-date shift in both Pied Flycatcher and Redstart (10 days and 14 days respectively) is greater than that displayed by many resident species, although their mean laying date is still approximately a fortnight later than non-migratory species with similar nestling diets, such as Blue Tit and Great Tit. No taxonomic or ecological associations are apparent within the group of species displaying laying-date advancements and a wide range of taxa demonstrate trends of a similar magnitude (Crick *et al.* 1997).

Table D3 Significant trends in laying date measured between 1967 and 2017

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Greenfinch	50	83	Linear decline	May 26	May 5	-21 days	
Magpie	50	31	Curvilinear	Apr 27	Apr 7	-20 days	
Goldfinch	50	27	Curvilinear	Jun 5	May 16	-20 days	Small sample
Long-tailed Tit	50	58	Linear decline	Apr 20	Apr 4	-16 days	
Redstart	50	72	Linear decline	May 24	May 10	-14 days	
Coal Tit	50	45	Linear decline	May 3	Apr 19	-14 days	
Blackcap	50	46	Linear decline	May 24	May 11	-13 days	
Swallow	50	243	Linear decline	Jun 24	Jun 12	-12 days	
Dipper	50	79	Linear decline	Apr 18	Apr 6	-12 days	
Nuthatch	50	40	Linear decline	May 1	Apr 19	-12 days	
Chaffinch	50	117	Linear decline	May 12	Apr 30	-12 days	
Reed Warbler	50	251	Linear decline	Jun 20	Jun 9	-11 days	
Chiffchaff	50	65	Linear decline	May 14	May 3	-11 days	
Marsh Tit	50	14	Linear decline	Apr 28	Apr 17	-11 days	Small sample
Kestrel	50	26	Linear decline	May 5	Apr 25	-10 days	Small sample
Grey Wagtail	50	63	Linear decline	May 9	Apr 29	-10 days	
Robin	50	151	Linear decline	Apr 28	Apr 18	-10 days	
Stonechat	50	53	Linear decline	May 7	Apr 27	-10 days	
Sedge Warbler	50	44	Curvilinear	May 29	May 19	-10 days	
Pied Flycatcher	50	517	Linear decline	May 20	May 10	-10 days	
Great Tit	50	535	Linear decline	May 4	Apr 24	-10 days	
Corn Bunting	50	16	Linear decline	Jun 25	Jun 15	-10 days	Small sample
Whitethroat	50	21	Curvilinear	May 27	May 18	-9 days	Small sample
Garden Warbler	50	23	Linear decline	May 28	May 19	-9 days	Small sample
Treecreeper	50	13	Linear decline	May 6	Apr 27	-9 days	Small sample
House Sparrow	50	70	Linear decline	May 25	May 16	-9 days	
Ring Ouzel	50	24	Linear decline	May 14	May 6	-8 days	Small sample
Blue Tit	50	834	Linear decline	May 2	Apr 24	-8 days	
Carrion Crow	50	28	Linear decline	Apr 17	Apr 9	-8 days	Includes Hooded Crow
Willow Warbler	50	89	Linear decline	May 20	May 13	-7 days	
Jackdaw	50	33	Linear decline	Apr 26	Apr 19	-7 days	
Tree Pipit	50	23	Curvilinear	May 28	May 22	-6 days	Small sample
Wren	50	91	Linear decline	May 14	May 8	-6 days	
Linnet	50	128	Linear decline	May 24	May 19	-5 days	
Moorhen	50	81	Linear decline	May 9	May 5	-4 days	

Species	Period (yrs)	Mean annual sample	Trend	Predicted in first year	Predicted in last year	Change	Comment
Dunnock	50	89	Linear decline	May 3	Apr 29	-4 days	
Wood Warbler	50	39	Linear decline	May 25	May 21	-4 days	
Starling	50	85	Linear decline	Apr 28	Apr 24	-4 days	
Tree Sparrow	50	393	Linear decline	May 27	May 23	-4 days	
Oystercatcher	50	72	Curvilinear	May 18	May 15	-3 days	
Blackbird	50	280	Curvilinear	Apr 22	Apr 23	1 days	
Yellowhammer	50	25	Linear increase	May 30	Jun 9	10 days	Small sample
Barn Owl	50	23	Linear increase	May 1	May 21	20 days	Small sample
Woodpigeon	50	103	Linear increase	Jun 2	Jun 23	21 days	

See Key to species texts for help with interpretation

The population-level consequences of phenological change are the subject of many current scientific studies, including several ongoing projects at BTO. Advanced laying is typically beneficial as early-nesting parents have an increased chance of recruiting offspring into the next generation (Visser *et al.* 1998). Climate-induced advances in phenology have been observed across a wide range of taxa and are occuring most rapidly at lower trophic levels, so that the annual cycles of predators are increasingly mis-timed with those of their prey (Thackeray *et al.* 2016). A frequently used model system is that of woodland passerines, where the timing of leaf emergence is advanced and the speed of caterpillar development is increased at higher temperatures (Buse *et al.* 1999, Visser & Holleman 2001), resulting in a food peak advancement that nesting birds are unable to match and a subsequent reduction in breeding success (though see Phillimore *et al.* 2016).

Both *et al.* (2006) demonstrated that mismatches between periods of food availability and chick demand can affect abundance in Dutch Pied Flycatcher populations, with those exhibiting the largest disjunction between arrival in spring and peak caterpillar abundance experiencing the greatest declines. Another study by Both and his colleagues, also in the Netherlands, suggested that the magnitude of disjunction may be mediated by habitat type, with species in more seasonal habitats at greatest risk of negative impacts on productivity (Both *et al.* 2010). However, while Dutch Reed *et al.* 2012, 2013, 2015). The ability to switch to different food sources to provide for chicks, as demonstrated for Wood Warbler (Mallord *et al.* 2017), may provide another buffer for some species. Whether such compensations will persist as the climate warms further remains to be seen and the population-level significance of trophic mismatches remains an active research area with potentially important policy implications for conservation. Projections of climatic suitability in Great Britain under future climate scenarios suggest that climatic suitability could increase for 44% of species and reduce for 9% of species by 2080, with the largest gains in abundance expected to occur in northern and western areas; however many of the species which are expected to reduce are those that are already red listed following long-term population declines (Massimino *et al.* 2017).

Only four species exhibit significant trends towards later laying (Cornulier *et al.* 2009) which, as mean laying dates are calculated across all broods, would result in the observed shift. Increased production of repeat broods could be stimulated by climatic amelioration, with later nests being more productive in warmer conditions, or by movement of birds away from farmland and into habitats where they are released from constraints on multiple brooding. A recent study using data from North America and Europe identified a positive temporal trend in the length of the breeding season of multi-brooded, but not single-brooded, bird species, consistent with the hypothesis that climate change is extending the window of opportunity for nesting for species less reliant on peaks in seasonal resources (Dunn & Møller 2014).

It is possible that the laying dates of the majority of those species that do not show a significant trend in timing of breeding, such as Raven, are related to weather, but that their weather-mediated cues do not show any trend over time (Crick & Sparks 1999).

Conclusion

This report is designed to be useful as a ready source of information for conservation practitioners, and as a source of information for those involved in more strategic conservation policy-making, as well as to the general student of bird populations. It provides a relatively simple and concise overview of the way in which populations are changing, suggesting areas where further research is required or where conservation action needs to be taken. The information presented here is a summary of a very extensive and much more detailed data set held by the BTO.

Alerts are raised as a result of declines in the population sizes of a considerable number of species. These alerts will help conservation organisations to prioritise future conservation action, alongside the Birds of Conservation Concern list (Eaton *et al.* 2015) and other information.

The demographic information contained in this report should also help conservation organisations to target their resources more effectively. For declining species of conservation importance, declines in breeding performance may indicate that conservation action should be targeted towards the breeding season; such responses may sometimes be masked, however, by density-dependent improvements in breeding success as the population declines (Green 1999). The lack of a decline in breeding performance may suggest that factors other than nesting success, such as loss of habitat or changes in survival rates are more likely to be influencing the observed population declines. An analysis looking across species (Robinson et al. 2014) suggested that temporal variation in declining species was associated more with productivity and recruitment of young, while for increasing species, adult survival was relatively more important in determining population change. However, as evidenced by Lapwing, the effect of demographic rates may interact, so they need to be considered in the context of the life-cycle as a whole. A report of this kind can provide only an initial summary of such information, and a full assessment of the population dynamics of a declining species will generally require more detailed investigations (e.g. Peach *et al.* 1999, Freeman & Crick 2003, Robinson *et al.* 2004, 2014).

Finally, we hope that users of this report will provide feedback on how it can be improved. We would welcome comments on any aspect of this report, as they will help us to produce a better and more useful next edition.

EMAIL YOUR COMMENTS

Utilities

With the exception of the trends by habitat, the tables of population change that appear on the species pages are species-based selections from a single unified table, with data newly calculated for this edition of the report. A number of additional selections from this table, by scheme and time period, are presented in the Summary tables and Discussion sections. Using the Table generator, you can interrogate the master table by data source or time period, for all species or for your own selection of species, and choose how your extract will be sorted.

This edition of the BirdTrends report is the latest in an annual series that began in 1997. Citations for previous editions are listed under Previous reports. Links are given to the full text of previous reports, which are mostly still available online.

The Utilities section also holds a unified list of the References that have been cited throughout the report.

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Note that graphs which show only Breeding Bird Survey (BBS) trends are also available to download from the BBS pages on the BTO website. In addition, the BBS download page also includes more BBS graphs which are not shown in BirdTrends, such as graphs showing trends for the nine English government regions. Any graphs obtained from the BBS pages should be given the appropriate BBS acknowledgement/citation which is provided on the BBS download pages.

Which graphs are available to download?

All the graphs which are have been updated in BirdTrends 2018 are currently available to download. This includes all demography graphs, and all trend graphs with the exception of the trend graphs for Shelduck, Woodcock and Lesser Spotted Woodpecker, which show only CBC data and have not therefore been updated since 1999. In addition to these three graphs, the graphs showing population trends by habitat are also not currently available to download.

How do I download graphs or csv files?

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Description of fields in the csv files:

CBC/BBS, BBS and CES graphs:

- unsm – the (unsmoothed) index value for the survey year.
- sm – the smoothed index value for the survey year.
- sm_ll85 and sm_ul85 – the lower and upper 85% confidence intervals for the smoothed index values.

Further information about the survey methodology and data analysis can be found on the survey information pages in this report: Breeding Bird Survey; CBC/BBS trends; CES Scheme.

BTO Heronries Census:

- unsm – the (unsmoothed) estimate of the number of 'apparently occupied nests' for the survey year.
- unsm_ll85 and unsm_ul85 – the lower and upper 85% confidence intervals for the (unsmoothed) estimate of the number of 'apparently occupied nests'.
- sm – the smoothed estimate of the number of 'apparently occupied nests' for the survey year.

Further information about the survey methodology and calculations can be found on the Heronries Census page in this report.

Demography graphs:

(i.e. Fledglings per breeding attempt, laying date, Clutch size, brood size, egg and chick stage nest failures)

- unsm - the (unsmoothed) index value for the survey year
- unsm_ll and unsm_ul - the lower and upper 85% confidence intervals for the (unsmoothed) index values
- sm - the smoothed index value for the survey year
- sm_ll and sm_ul - the lower and upper 85% confidence intervals for the smoothed index values

Further information about the survey methodology and calculations can be found on the Nest Record Scheme page in this report.

Survival graphs (CES and ringing recoveries):

- unsm - the (unsmoothed) estimate of the proportion of birds surviving for the survey year
- sm_ll and sm_ul - the lower and upper 95% confidence intervals for the survival estimate

Previous reports

Previous reports in this series are listed, from the most recent to the earliest. The first two (Crick *et al.* 1997, 1998) were produced as paper reports, but all subsequent editions are purely web-based and url addresses must be included in their citations.

Note that www.bto.org/about-birds/birdtrends will always link to the home page of the most recent version of this report. Web addresses including a year (e.g. .../birdtrends/2014/...) may lead you to earlier reports in the series, now superseded.

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Clicking on reference links within the text of this report will bring you to its full details in this section: the reference sought will be at the very top of your view.

In some cases, we provide an onward link either to an abstract or, where it is freely available, to the full text of the listed publication. Alternatively, your own web search will often take you to the summary of an article and the opportunity to purchase the text in full. The doi (digital object identifier), where given, is a permanent link to wherever an article can be found online.

Most of the listed publications are available in printed form to BTO members and other bona fide researchers through the Chris Mead Library at BTO headquarters in Thetford. Further information on how to access freely available ornithological publications online is here on the BTO web site.

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Images: Sparrowhawk, by Sarah Kelman / BTO; Lapwing, by Sarah Kelman / BTO

BirdTrends 2019: trends in numbers, breeding success and survival for UK breeding birds.

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