

UK Biodiversity Indicators 2019

This documents supports
C4a. Status of UK priority species: relative abundance

Technical background document

Fiona Burns, Tom August, Mark Eaton, David Noble, Gary Powney, Nick
Isaac, Daniel Hayhow

For further information on C4a. Status of UK priority species: relative abundance visit
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Indicator C4a. Status of UK priority species: relative abundance

Technical background document, 2019

NB this paper should be read together with C4b (<http://www.incc.gov.uk/ukbi-C4b>) which presents a companion statistic based on time series on frequency of occurrence (distribution) of priority species.

1. Introduction

The adjustments to the UK biodiversity indicators set as a result of the adoption of the [Strategic Plan for Biodiversity](#) (including the Aichi Targets) at the 10th Conference of Parties of the Convention on Biological Diversity mean there is a need to report progress against Aichi Target 12:

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Previously, the UK biodiversity indicator for threatened species used lead partner status assessments on the status of priority species from 3-yearly UK Biodiversity Action Plan (UK BAP) reporting rounds. As a result of the devolution of biodiversity strategies to the UK's 4 nations, there is no longer reporting at the UK level of the status of species previously listed by the BAP process.

This paper presents a robust indicator of the status of threatened species in the UK, with species identified as conservation priorities being taken as a proxy for threatened species. Despite the relatively high quality and quantity of both data and analytical methods in the UK, it should be recognised from the outset that any indicator on the status of priority species will be hampered by short comings in the availability of data.

2. Species List

The species list was derived from the biodiversity lists of the 4 UK countries. A link to the list for each country is provided below:

England – [Section 41 species](#)

Northern Ireland – [Northern Ireland Priority Species List](#)

Scotland – [Scottish Biodiversity List](#)

Wales - [Section 7 species](#)

The species lists are unchanged from those used in the 2017 indicator analysis. The criteria for inclusion in each of the 4 biodiversity lists are derived largely from those used to identify the UK BAP priority species list, most recently in 2007, but there has been some divergence in approaches, see Table 1. For example, the Scottish biodiversity list and the Northern Ireland priority species list both have criteria based on rarity alone, whereas the UK BAP criteria did not consider rarity; rare species were only listed if they were considered threatened or declining.

For the purposes of this indicator, an inclusive approach has been taken, whereby a species only has to be included in one of the country lists to be included on the combined list. The Scottish Biodiversity list has a final criterion based on the importance of species to people, however, species designated under this criterion were not considered here. The taxonomic composition of the combined 4 country list (FCL) is shown in Table 2.

Some countries have included a small number of taxa below the species level (i.e. sub-species) on their biodiversity lists. Such infra-specific taxa were only retained on the combined 4 country biodiversity list if the associated species was not included. For example, a sub-species of the willow tit (*Poecile montanus*) is included on the Welsh list but it is a full species on the Scottish Biodiversity list, thus on the combined list only the full species was retained.

Table 1: The biodiversity lists of the 4 countries of the UK

Country	Number of Taxa	Criteria for species inclusion
England (S41)	943	On the 2007 UK BAP list
		Hen Harrier
Northern Ireland (NI) priority species list	481	1: On the 2007 UK BAP list
		2: Rapid decline of $\geq 2\%$ per year
		3: Decline of $\geq 1\%$ per year and NI holds $\geq 50\%$ of Irish, or $\geq 20\%$ of UK population or Irish/UK population restricted to NI
		4: Rare in NI (1-2 sites) and NI holds $\geq 50\%$ of Irish, or $\geq 20\%$ of UK population or Irish/UK population restricted to NI
		5: $\geq 20\%$ of a well recognised sub-species in NI
		6: Irish Red data book species
		7: Red list Birds of Conservation concern Ireland or UK
Scottish Biodiversity List	2,090	S1: On the 2007 UK BAP list
		S2: International obligation
		S3: Species defined as 'nationally rare' in GB/UK ($< 15 \text{ } 10\text{km}^2$), which are present in Scotland
		S4: Species present in $\leq 5 \text{ km}^2$ or sites in Scotland
		S5: Decline of $\geq 25\%$ in 25 years in Scotland
		S6a: Endemic
		S6b: Endemic subspecies if also meets another criterion
Wales (S7)	567	International importance, IUCN Global Red List or Red listed in $\geq 50\%$ of EU countries where data is available or other source indicating international threat or decline
		International responsibility $\geq 25\%$ of EU/Global population in Wales and decline $\geq 25\%$ in 25 years in Wales
		Decline in Wales $\geq 50\%$ in 25 years
		Other for example decline and very restricted range

Country	Number of Taxa	Criteria for species inclusion
UK total (combined 4 country list)	2,890	

Table 2: Taxonomic breakdown of combined 4 country biodiversity list

Group	Number of Species
<i>Invertebrates</i>	
insect – beetle (Coleoptera)	191
insect – butterfly	25
insect – dragonfly (Odonata)	4
insect – hymenopteran	103
insect – moth	174
insect – orthopteran	6
insect – other	4
insect – riverfly	8
insect – true bug (Hemiptera)	15
insect – true fly (Diptera)	94
other Invertebrate	233
<i>Vertebrates</i>	
amphibian	4
bird	127
fish	57
marine mammal	22
terrestrial mammal	26
reptile	10
<i>Plants and fungi</i>	
vascular plants	409
alga	254
stonewort	15
lichen	546
bryophytes	301
fungi	262
Total	2,890

3. Data Sources

Robust population time series were sought for as many species on the combined 4 country biodiversity list as possible. The majority of these data have previously been published and many are used as part of the UK biodiversity indicator set currently; details of these analyses and the rules for species inclusion into the data sets are given in the following sections.

3.1. *Time series in relative abundance*

Tables 3 and 4 provide a summary of the relative abundance datasets included in the indicator. They show the analytical methods used to generate the species time series in each dataset. Although these vary in detail, the underlying method is similar. These datasets are generated largely from data collected by national monitoring schemes. In these schemes data are collected in a robust and consistent manner and the geographical coverage is good, with statistical approaches used to correct for biases in coverage. These datasets are ideal for producing population time series for widespread species; however, in some cases the sample size is insufficient to generate time series for cryptic, rarer or more range restricted species. Each scheme has a set of criteria to determine whether time series can be generated for each species and if they are sufficiently robust to be included in the published results of the scheme. Table 5 gives an overview of the quality of the data derived from each scheme. Further information about each monitoring scheme and the data analysis and results can be found in the references given at the end of this paper.

Bird time series are well documented and several data sources are available (Table 3). Some bird species are represented in more than one dataset. The order of the rows in Table 3 shows the hierarchy used, from top to bottom, to ensure that the most appropriate and robust data for each species was included in the indicator.

The majority of species time series start around 1970 and the date of the last available update is 2015. The Rothamsted moth data starts in 1968, but to avoid over representing these time series in the overall indicator, data were only used from 1970 onwards, and the time series were expressed as a proportion of the 1970 value. Some datasets begin later than 1970, for example the butterfly time series begin in 1976. The method of incorporating this variation in time period into the indicator is discussed in the Indicator method section (4) below. Some datasets do not continue until 2016; for these species the annual estimate was held at the value of the final data point for all years from the end of the available time series to 2016.

The steep decline in many moth species has an effect on the indicator as a whole. The impact of this on the assessment was considered in the 2013 indicator publication: if moths were excluded from the indicator the short-term decrease assessed in 2013 between 2005 and 2010 was not significant, and the indicator would have been assessed as 'no change'. Over 10 years, from 2000 to 2010, the indicator in 2013 without the moth data would have been slightly positive, but not sufficiently so to be assessed as an increase. This analysis has not been repeated, but it is likely that moths are having a very similar impact on the indicator.

Table 3: Summary of the analysis methods and criteria for species selection for bird datasets

Birds	Time period	Data Type	Species selection method	Analysis method
Time series used in current bird indicator - C5	Various		Unsmoothed index	Various, depending on the original dataset, all those used are described below
Statutory Conservation Agency and RSPB Annual Breeding Bird Scheme (SCARABBS)	Various	Population estimates from 2 or more national surveys	These surveys are designed to be in depth surveys for a particular species and so have sufficient data to allow population trends to be robustly estimated.	Linear interpolation was used to estimate annual values for years between national surveys.
Common Bird Census/Breeding Bird Survey (BBS) joint trends;	1970-2016	Unsmoothed index		Unsmoothed population time series were generated from a log-link linear regression with Poisson errors fitted to site x year data (BTO 2014a).
BBS	1995-2016	Unsmoothed index	Data from the BBS surveys were only included for species for which the BBS methodology is appropriate and which are recorded in on average 40 BBS squares per year of the survey period.	Unsmoothed time series are estimated using a similar procedure to the CBC/BBS joint trends described (BTO 2014a).
Rare Breeding Birds Panel	Various, largely 1970 - 2016	Annual estimate	Species were removed where survey effort was thought insufficient to generate a reliable trend. Additionally species where individuals were only infrequently present in the UK (taken as species where the maximum count was 10 or less and the median was 3 or less), were also removed.	Linear interpolation was used to estimate any missing data.
Seabird Monitoring Panel (SMP) and Seabird censuses	1986-2016	Unsmoothed index	Very small colonies and colonies where counting error is known, or suspected, to exceed 5% are excluded from SMP time series. The accuracy of time series obtained using the SMP sample was assessed by comparing them with data from 2 complete censuses of all breeding seabirds in the UK. A time series was rejected as inaccurate where a discrepancy of more than 15% occurred between the SMP estimate and the census figure (Thompson <i>et al.</i> 1997).	For the majority of species a combination of SMP and census data is used. The 2 census estimates are used, with linear interpolation for the intervening years. The SMP time series is anchored to the 2 nd census estimate and used in all subsequent years. For a small number of species the census data alone is used.
Wetland Bird Survey (WeBS)	1970-2016	Unsmoothed index	For core WeBS species there is a system of observer recorded quality of visit (visibility, areas	As for BBS time series

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Birds	Time period	Data Type	Species selection method	Analysis method
			<p>missed) within WeBS, which excludes poor quality site visits. Only sites that have a good overall level of coverage are used (at least 50% of possible visits undertaken) Further species-specific details of analytical methods are published (BTO 2017; Maclean and Ausden 2006).</p>	

Table 4: Summary of the analysis methods and criteria for species selection for other taxonomic groups

Group	Dataset and provider	Time period and Data Type	Species selection method	Analysis method
Moths	UK moth trends from Rothamsted Insect Survey light trap network (1968 to 2016)	1968-2016, TRIM annual index.	Data for 766 moth species were analysed using data from Rothamsted Insect Survey light trap network (Harrower <i>et al.</i> 2019). The 766 species that were analysed are mostly macro-moths as the majority of micro-moths had to be excluded due to inconsistencies in their recording over the time period. Of the species analysed 432 species produced reliable trends based on expert assessment of the underlying data and the analysis results.	The Generalised Abundance Index (GAI) methodology proposed by Dennis <i>et al.</i> (2006) was used to produce UK abundance trends. This methodology involves estimation of standardised annual flight periods curves for each species. These flight curves are used to estimate the annual total abundance for each site whilst correcting for gaps in the surveying. Poisson regression models, with site and year explanatory variables, are then fitted to the estimated annual total abundance values to determine the abundance trends and also yearly abundance indices. Confidence intervals were produced by bootstrapping (1,000 samples).
Moths	Butterfly Conservation (BC)	~2000-2016. TRIM annual index.	Expert opinion (Mark Parsons – Butterfly Conservation) was used to judge whether the number of sites monitored was sufficient to represent the national time series, given each species' distribution.	Site x year Log-linear Poisson regression models in TRIM (Pannekoek and van Strien 1996) were used.
Bats	National Bat Monitoring Programme (Bat Conservation Trust)	1997-2016 Unsmoothed index.	A power analysis determined that across all surveys, a sample size of 30-40 repeat sites (surveyed for more than one year) would give sufficient data to calculate robust species time series. This would provide 90% power to detect a decline of 25% over 25 years (0.1 sig. level). Borderline cases are judged based on the quality of the time series, primarily from the confidence limits (Walsh <i>et al.</i> 2001, Bat Conservation Trust 2013).	As BBS time series (Barlow <i>et al.</i> 2015). In addition, mixed models are used to investigate factors that could influence time series (e.g. bat detector make, temperature). Over dispersion is a problem for bat detector surveys, where a single bat repeatedly flying past the observer may give rise to a large count of bat passes. Based on the results of simulations a binomial model of the proportion of observation points on each survey where the species was observed is used.
Dormice	National dormouse monitoring scheme (PTES)	1995-2016 Unsmoothed index.		As BBS time series. Time series are estimated monthly. The data for June are used following advice from PTES.

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Hedgehog	Mammals on Roads (PTES)	2001-2016 Unsmoothed index		As BBS time series.
Butterflies	UK Butterfly Monitoring Scheme (BC)	1976-2016 Unsmoothed index	Indices are calculated for butterfly species that have been recorded from 5 or more sites per year. The wider countryside butterfly survey has only 3 counts during summer and requires twice as many monitored sites to achieve comparable precision to the 26-week butterfly monitoring scheme. 430 monitoring sites on average are required to achieve 80% power (5% significance level) for detecting a 25% decline in abundance over 10 years.	Annual indices were derived from a log-linear Poisson regression model fitted to site x year data where GAMs were used to impute missing values (Dennis <i>et al.</i> , 2015)

Table 5: Assessment of robustness of monitoring schemes (based on a 2013 assessment) – Data quality = Red > Amber > Green

	Dataset	~Effort	Survey design	Field method
Moths	Rothamsted moth survey (1968-)	80	Consistent, Non-random	Light trap
Butterflies	Wider countryside butterfly survey (2007-)	750	Consistent, Random	Transect
	UK butterfly monitoring scheme (1976-)	1,000	Consistent, Non-random	Transect
Mammals	National Dormouse Survey (1993-)	300	Consistent, Known sites	Nest box search
	Breeding bird survey (1995-)	2,400	Consistent, Random	Transect
	National Bat monitoring scheme (1997-)	1,300	Consistent, Random	Various, field/ roost counts
	Mammals on Roads (2001-)	500	Consistent, Random	Transect
Birds	Breeding bird survey (1995-)	3,200	Consistent, Random	Transect
	Common bird census (1970-2000)	300	Consistent, Non-random	Territory mapping
	Seabird monitoring programme, (1986 -) seabird censuses (1969 ,85,00)	Species specific	Consistent, Non-random or Total	Colony counts
	Wetland bird survey (1970-)	3,000	Consistent, Non-random (or almost total for some species)	Site counts
	Rare birds breeding panel (1970-)	Species specific	Some variation over time, all or most known sites	Site counts and individual records
	SCARABBS (1974-)	Species specific	Consistent, stratified random, bespoke for species	Various, transects

4. Indicator Methods

Table 6 gives a summary of the relationship between the number of species on the combined 4 country biodiversity list (FCL) and the number of these for which population time series are available.

As far as possible, previously published methods of indicator creation were used, both because these are well-established, are likely to have undergone peer review and allow comparison of this indicator with existing species indicators for birds (C5), butterflies (C6) and bats (C8). These methods are described briefly below and references are given for further information.

Table 6: Summary of species time series included in the Species Indicator

Group	Species on FCL	Species on FCL with data and meeting criteria
Birds	127	104
Butterflies	25	23
Mammals	26	11
Moths	174	76
Total	352	214

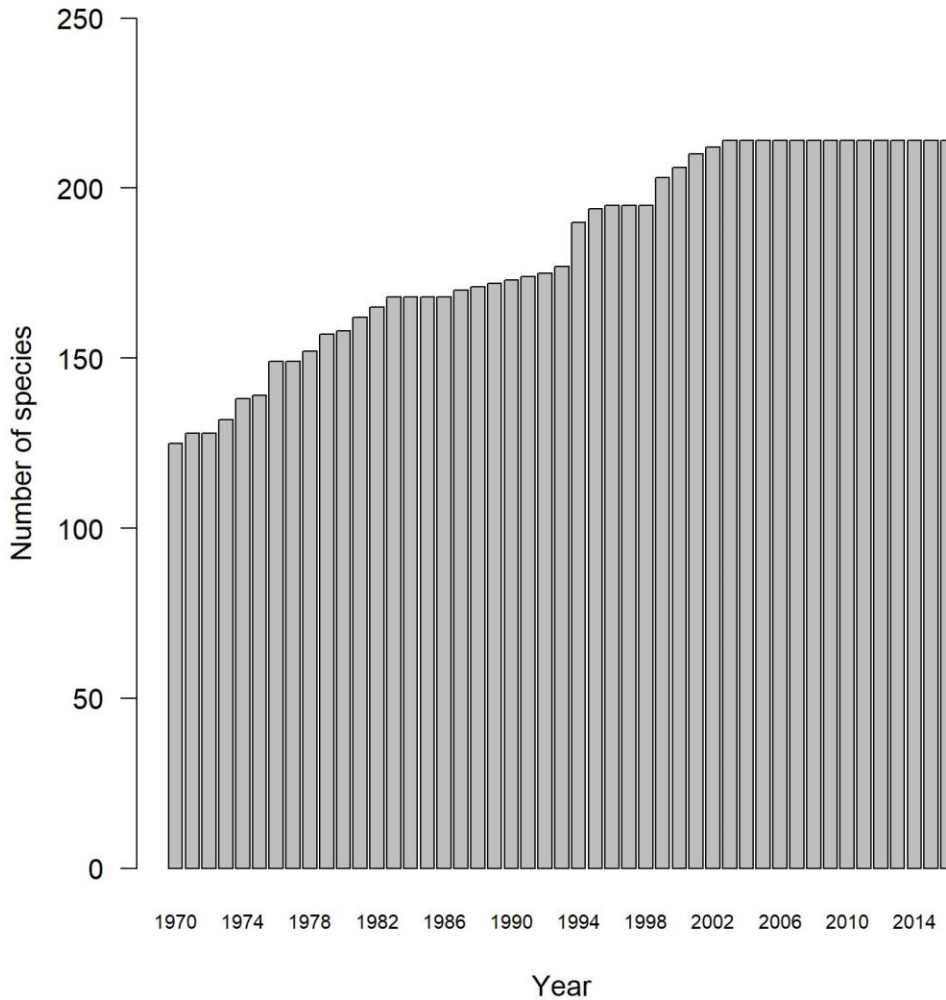
The majority of species time series had values estimated for each year. In the few cases where a species year combination was missing, these values were estimated using log-linear interpolation (Collen *et al.*, 2008). Time series were not extrapolated before the first year or after the last. Where time series ended prior to 2016 they were extended by holding the final data value constant in all subsequent years. Since the indicator is focussed on threatened species some of these species are rare and a few time series contained zero counts for one or more years. This was largely in the Rare Breeding Birds Panel data. As the composite indicator is calculated using the geometric mean it is not possible to include zero values. This issue was addressed by adding 1% of the average value of the time series to the whole series of those species' time series containing zeros (Loh *et al.*, 2005).

Each time series was expressed as a proportion of the first year of the time series, so that the first year equals 100. Extremely large or small index values can have a disproportionate influence on composite indicators. Following the methods used in the current wild bird index (C5); any index value greater than 10,000 or less than one was set to these values until the index dropped below 10,000 again or above one (Noble *et al.*, 2004). Two species had a time series that went above 10,000 and 4 species had time series that dropped below one, these are identified in the species list in Appendix 1.

Each species in the indicator was weighted equally. When creating a species indicator weighting may be used to try to address biases in a dataset, for example, if one taxonomic group is represented by far more species than another, the latter could be given a higher weight so that both taxonomic groups contribute equally to the overall indicator. Complicated weighting can, however, make the meaning and communication of the indicator less transparent. Groups with many species on the FCL could be considered more threatened than others and therefore should contribute more to the overall indicator. Although there was some variation between

taxonomic groups in the proportion of species on the list for which data were available, this proportion was substantial for all groups where at least some data were available. The main bias on the data is that some taxonomic groups are not represented at all, which cannot be addressed by weighting. For this reason, and to ensure clarity of communication, equal weighting was used.

Figure 1: Number of species contributing data in each year, 1970 to 2016

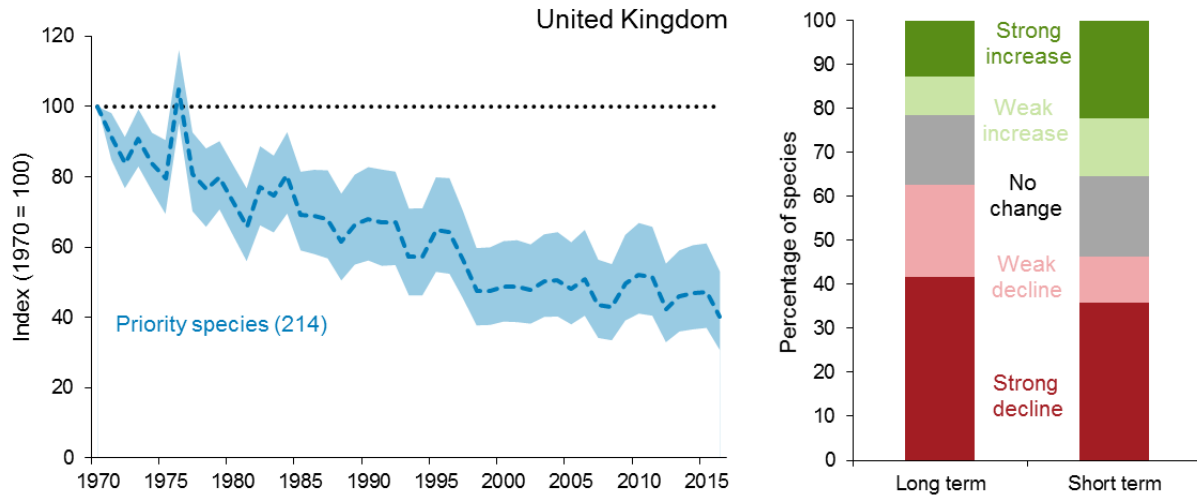


To create the composite index for a group (by data type or taxonomy) or overall, the geometric mean was calculated from the species time series data (Figure 2). Different species time series had different start dates. This was taken into consideration; for species time series entering the indicator after the first year, their first year is set to the geometric mean of those species time series already in the indicator in that year, in order that the additional time series does not influence the indicator in its year of entry. Confidence intervals for each composite indicator were created using bootstrapping (Buckland, 2005; Freeman *et al.*, 2001); in each iteration (n = 10,000) a random sample of species were selected with replication and the geometric mean calculated.

4.1 Headline Indicator - C4ai

The headline indicator (C4ai) was generated by combining 214 time series charting changes in relative species abundance using the methods described in the preceding section. In addition, bars showing the proportion of species showing increases or decreases (of any magnitude, and with no consideration of statistical significance) have been provided. These cover 2 time periods – ‘long term’, from 1970 to 2016, and ‘short term’, from 2011 to 2016.

Figure 2: Change in the relative abundance of priority species in the UK, 1970 to 2016



Notes:

1. The line graph shows the unsmoothed trend (dashed line) with its 95% confidence interval (shaded area).
2. The figure in brackets shows the number of species included in the composite index.
3. The bar chart shows the percentage of species within the indicator that have increased (weakly or strongly), decreased (weakly or strongly) or shown no change in abundance based on set thresholds of change.

4.2 Assessment of change – headline indicator

The assessment of change was based on the approach of Eaton *et al.* (2015). The long-term assessment was made by comparing the change and 95% confidence intervals (CI) of the composite indicator between 1970 and 2016. The overall indicator shows a consistent downward trajectory over its 46 years duration. The final value of the indicator in 2016 is 40 (95% CI: 31, 53) suggesting that on average those priority species represented in the indicator have declined by more than a half since 1970. To calculate trends over shorter-term periods, change statistics for the most recent 5-year (2011-16) period were calculated for each species (Eaton *et al.*, 2015). The geometric mean of these species level short-term change metrics was calculated and 95% confidence intervals were estimated using bootstrapping (n = 10,000). In 2015 the index of relative abundance of the 214 species included in the indicator had declined by 22% relative to the 2010 level (95% CI: 19, 24).

If the confidence interval is entirely below 100 the time series would be assessed as decreasing, if it was entirely above 100 the indicator would be assessed as increasing, if the confidence

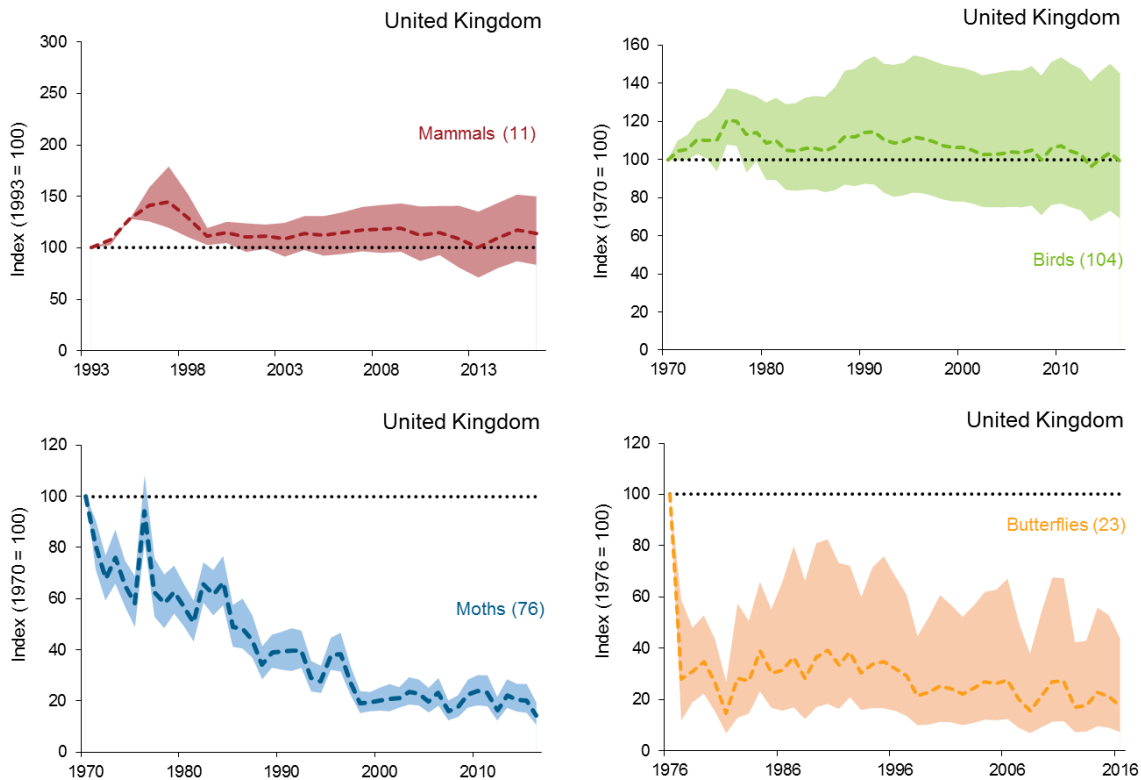
interval spanned 100 the indicator would be assessed as no significant change. Therefore, both the long-term (1970 to 2016) and short-term (2011 to 2016) change are assessed as a decrease.

This assessment of change over time is currently based upon unsmoothed annual estimates of relative abundance. This means that the percentage change over time can vary substantially depending on the time period assessed. One way to reduce this variation is to make the assessment based on smoothed time series based on generalised additive models (Freeman *et al.*, 2001). These dampen the inter-annual variation in the time series and thus aid the interpretation of important patterns of change. At present this type of information is not available for all the species in the indicator presented here, however, it is hoped it will be possible to work towards generating these data and using this methodology in future iterations of the indicator.

4.3 Change in priority species by taxonomic group

The headline indicator (Figure 2) masks variation within and between taxonomic groups. Figure 3 shows trends for each taxonomic group separately. These were generated using the same methods as the overall indicator.

Figure 3: Change in relative species abundance, by taxonomic group, 1970 to 2016



Notes:

1. The graphs show the unsmoothed trend (dashed line) together with the 95% confidence interval (shaded area) for each of the 4 taxonomic groups included in the composite indicator.
2. The figures in brackets show the number of species included in each measure.

This index for birds has remained roughly stable since the 1970s. There are several possible explanations for this. Birds have benefited from more investment in their conservation than other groups and, as a result, some species are increasing. This includes some species increasing rapidly from small numbers, like the marsh harrier (*Circus aeruginosus*) and the red kite (*Milvus milvus*) as well as species that have benefited from changes in legislation, like geese which have benefitted from increased protection from hunting. Additionally, the definition of priority species, as provided by the 4 Country lists, includes all species for which there is specific international obligation for conservation action (owing to the use of this as a criterion in the Scottish priority list). This has resulted in a large number of waterbird species within the indicator, many of which occur in the UK as wintering populations and which have shown substantial increases since the 1970s. The overall stable time series for birds masks some species which are still rapidly declining.

5. Overall long-term change in the relative abundance and distribution of priority species

5.1 Background

Currently, the priority species indicator comprises of 2 measures; this indicator ([C4a](#)) based on abundance data and [C4b](#) based on distribution data. The assessment is made separately for these 2 data types, resulting in 2, potentially conflicting priority species indicator assessments. The C4a assessment is described fully in this document, however in summary, it is based on the geometric mean index value across species, with uncertainty of the indicator calculated via bootstrapping across species. The C4b indicator is based on the mean growth rate across species, with an approach that incorporates the uncertainty in the individual species index estimates into the indicator (see the associated [technical background document](#) for further detail). Ideally, these would be combined into a single assessment, however such a combined indicator needs to address challenges about differences in the data types that contribute to C4a and C4b. Simply combining the species trends would assume equivalence across the 2 datatypes, i.e. that a 10% change in abundance is equivalent to a 10% change in distribution. This has, to date, been deemed an unreasonable assumption to make. Furthermore combining change from different datatypes leads to a lack of clarity around what the indicator is actually measuring when using magnitude of change.

The following section describes a technique to produce a combined evaluation of priority species, using both abundance and distribution data. The key development is that rather than assessing the indicator based on magnitude of change, the indicator assessment is based on the balance of increasing versus decreasing species. This is consistent with existing indicators, in that the assessment is a statement of confidence in whether the overall line has increased, decreased or showed no overall change. It also sidesteps the challenges of combining different data types by assuming only that the confidence with which we can assign a species as increasing or decreasing can be compared across data types. The assessment described below was based upon the indicators published in 2018, and has not been updated in 2019, so does not apply to the revised indicator published in the fiche.

5.2 Combined assessment calculations

First, for each species 1,000 index values for the first and last year in its time series (either abundance or distribution) are extracted. The values are random draws from a normal distribution informed by the mean and standard error of the indices in question, thereby

propagating the uncertainty in these annual indices forward to the indicator assessment. For each of the 1,000 pairs of values, an assessment is made as to whether the species increased (1) or decreased (0) over the course of its time series. This provides a combined total of 1,000 1s and 0s per species. For simplicity, these 1,000 1s and 0s are referred to as change indices. The mean of these 1,000 change indices for each species is the best estimate of the probability that the species has increased. For example, a value of 0.2 indicates a 20% probability that the species increased, so it could be said that, with 80% confidence, the species has declined. The change indices for each species are then collated into a matrix with 1,000 rows and n columns, where n is the total number of priority species in the indicator. For each row, the balance between increasing and decreasing species are calculated as the mean of the change indices across all species. These species means estimate the proportion of species that are increasing: values > 0.5 suggest that more species increased than decreased, values < 0.5 suggest that more species decreased. This gives 1,000 values of the balance between increasing and decreasing species, which is summarised using the mean and 95% confidence intervals (CIs). The assessment is made using the 95% CIs;

- If the 95% CIs span 0.5, the trend in priority species will be assessed as no overall change.
- If the 95% CIs are below 0.5, the trend in priority species will be assessed as a decline.
- If the 95% CIs are above 0.5, the trend in priority species will be assessed as increasing.

The mean across the 1,000 iterations is the best estimate of the balance of increasing vs decreasing species. The balance between increasing and decreasing priority species over the long term is 0.45 (95% CI: 0.43 to 0.47). Therefore, the overall assessment is that 45% of species increased and 55% declined: whilst the value is close to 50:50, the small width of the 95% CIs gives confidence in the assessment that declines outnumber increases. Thus, the combined 2018 C4 priority species indicator would be assessed as a decline using this new approach.

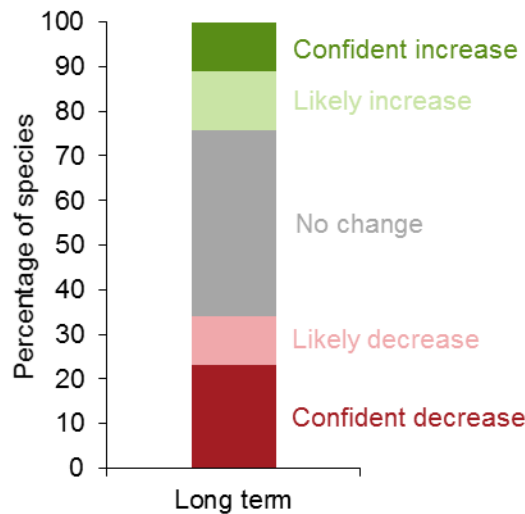
5.3 Presentation

As noted above, concerns have been raised around combining estimates of magnitude of change between abundance and distribution trend data. As a result, to date, no combined bar plot documenting the proportion of increasing and decreasing species has been presented. Here, rather than assessing species based on the magnitude of change, assessments of species are based on the probability that they were increasing or decreasing. Species were classified into one of 5 bins based on the mean value across the 1,000 binary estimates of change for the species in question as follows:

- Species were classified as a confident increase if the mean value was above 0.95.
- Species were classified as a confident decrease if the mean value was below 0.05.
- Species were classified as likely increasing if the mean value was above 0.75.
- Species were classified as likely decreasing if the mean value was below 0.25.
- The remaining species were classified as having no clear trend.

Of the 929 priority species included in C4a and C4b, 103 (11%) were classified as a confident increase, 122 (13%) as likely increasing, 387 (42%) as having no clear trend, 103 (11%) as likely decreasing and 214 (23%) as a confident decrease (Figure 4).

Figure 4: Overall change in the relative abundance and distribution of priority species in the UK, 1970 to 2015



Notes:

1. Based on 929 species included in the 2018 update of indicators C4a and C4b. Each species contributes once only – so either to C4a or to C4b.
2. The graph provides information on the percentage of species which have increased, decreased or remained unchanged; it does not assess the amount of change in those species.

In summary, 225 species (24%) have increased, 317 (34%) have decreased and 387 (42%) have shown no significant change in either abundance or distribution between 1970 and 2015. Overall, the long-term trend for the combined measure of priority species abundance and distribution in the UK is declining.

6. References

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Appendix 1 – Species List

A list of species included in the indicator. For each species we report the broad taxonomic group, have binary columns for each of the 4 country priority species lists, and have 2 columns showing the number of times the species scaled index estimates were truncated to 10,000 or 1.

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Accipiter gentilis</i>	northern goshawk	bird	N	Y	N	N	0	0
<i>Acrocephalus palustris</i>	marsh warbler	bird	Y	N	N	N	0	0
<i>Acrocephalus scirpaceus</i>	reed warbler	bird	N	N	Y	N	0	0
<i>Alauda arvensis</i>	skylark	bird	Y	Y	Y	Y	0	0
<i>Alcedo atthis</i>	kingfisher	bird	N	N	Y	N	0	0
<i>Anas acuta</i>	pintail	bird	N	Y	N	N	0	0
<i>Anas clypeata</i>	shoveler	bird	N	Y	N	N	0	0
<i>Anas querquedula</i>	garganey	bird	N	Y	Y	N	0	0
<i>Anser albifrons subsp. albifrons</i>	fronted goose	bird	Y	N	Y	N	0	0
<i>Anser albifrons subsp. flavirostris</i>	greenland white fronted goose	bird	N	Y	Y	Y	0	0
<i>Anthus trivialis</i>	tree pipit	bird	Y	Y	Y	Y	0	0
<i>Apus apus</i>	swift	bird	N	Y	Y	N	0	0
<i>Aquila chrysaetos</i>	golden eagle	bird	N	Y	Y	N	0	0
<i>Aythya ferina</i>	pochard	bird	N	Y	Y	N	0	0
<i>Aythya fuligula</i>	tufted duck	bird	N	Y	N	N	0	0
<i>Aythya marila</i>	scaup	bird	Y	Y	Y	N	0	0
<i>Botaurus stellaris</i>	great bittern	bird	Y	Y	Y	Y	0	0
<i>Branta bernicla subsp. bernicla</i>	dark bellied brent goose	bird	Y	N	N	Y	0	0
<i>Branta bernicla hrota</i>	pale bellied brent goose	bird	N	Y	N	N	0	0
<i>Branta leucopsis</i>	barnacle goose	bird	N	N	Y	N	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Bucephala clangula</i>	goldeneye	bird	N	Y	N	N	0	0
<i>Burhinus oedicephalus</i>	stone-curlew	bird	Y	N	N	N	0	0
<i>Calidris alpina</i>	dunlin	bird	N	Y	Y	N	0	0
<i>Calidris canutus</i>	knot	bird	N	Y	N	N	0	0
<i>Calidris maritima</i>	purple sandpiper	bird	N	N	Y	N	0	0
<i>Caprimulgus europaeus</i>	nightjar	bird	Y	Y	Y	Y	0	0
<i>Acanthis cabaret</i>	lesser redpoll	bird	Y	Y	Y	Y	0	0
<i>Carduelis cannabina</i>	linnet	bird	Y	Y	Y	Y	0	0
<i>Carduelis flavirostris</i>	twite	bird	Y	Y	Y	Y	0	0
<i>Carduelis spinus</i>	siskin	bird	N	N	Y	N	0	0
<i>Charadrius hiaticula</i>	ringed plover	bird	N	N	N	Y	0	0
<i>Charadrius morinellus</i>	dotterel	bird	N	N	Y	N	0	0
	eurasian marsh							
<i>Circus aeruginosus</i>	harrier	bird	N	N	Y	N	0	0
<i>Circus cyaneus</i>	hen harrier	bird	Y	Y	Y	Y	0	0
<i>Corvus cornix</i>	hooded crow	bird	N	N	Y	N	0	0
<i>Coturnix coturnix</i>	quail	bird	N	Y	N	N	0	0
<i>Crex crex</i>	corncrake	bird	Y	Y	Y	Y	0	0
<i>Cuculus canorus</i>	cuckoo	bird	Y	Y	Y	Y	0	0
<i>Cygnus bewickii</i>	bewicks swan	bird	Y	Y	Y	Y	0	0
<i>Cygnus cygnus</i>	whooper swan	bird	N	Y	Y	N	0	0
<i>Dendrocopos minor subsp.</i>	lesser spotted							
<i>Comminutus</i>	woodpecker	bird	Y	N	N	Y	0	0
<i>Emberiza calandra</i>	corn bunting	bird	Y	N	Y	Y	0	0
<i>Emberiza cirlus</i>	cirl bunting	bird	Y	N	N	N	0	0
<i>Emberiza citrinella</i>	yellowhammer	bird	Y	Y	Y	Y	0	0
<i>Emberiza schoeniclus</i>	reed bunting	bird	Y	Y	Y	Y	0	0
<i>Falco columbarius</i>	merlin	bird	N	N	Y	N	0	0
<i>Falco peregrinus</i>	peregrine falcon	bird	N	N	Y	N	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Falco subbuteo</i>	hobby	bird	N	N	Y	N	0	0
<i>Falco tinnunculus</i>	kestrel	bird	N	N	Y	Y	0	0
<i>Ficedula hypoleuca</i>	pie flycatcher	bird	N	N	N	Y	0	0
<i>Gavia arctica</i>	black-throated diver	bird	N	Y	Y	N	0	0
<i>Gavia stellata</i>	red-throated diver	bird	N	N	Y	N	0	0
<i>Haliaeetus albicilla</i>	white-tailed eagle	bird	N	Y	Y	N	14	0
<i>Jynx torquilla</i>	eurasian wryneck	bird	N	N	Y	N	0	0
<i>Lagopus lagopus</i>	red grouse	bird	Y	Y	Y	Y	0	0
<i>Lanius collurio</i>	red-backed shrike	bird	N	N	Y	Y	0	0
<i>Larus argentatus</i>	herring gull	bird	Y	Y	Y	Y	0	0
<i>Larus ridibundus</i>	black headed gull	bird	N	Y	Y	Y	0	0
<i>Limosa lapponica</i>	bar tailed godwit	bird	N	N	Y	Y	0	0
<i>Limosa limosa</i>	black tailed godwit	bird	Y	Y	Y	N	0	0
<i>Locustella luscinioides</i>	savi's warbler	bird	Y	N	N	N	0	0
<i>Lullula arborea</i>	woodlark	bird	Y	N	N	Y	0	0
<i>Melanitta nigra</i>	common scoter	bird	Y	Y	Y	Y	0	0
<i>Milvus milvus</i>	red kite	bird	N	N	Y	N	0	0
<i>Motacilla flava</i>	yellow wagtail	bird	Y	Y	Y	Y	0	0
<i>Muscicapa striata</i>	spotted flycatcher	bird	Y	Y	Y	Y	0	0
<i>Numenius arquata</i>	curlew	bird	Y	Y	Y	Y	0	0
<i>Pandion haliaetus</i>	osprey	bird	N	N	Y	N	0	0
<i>Panurus biarmicus</i>	bearded tit	bird	N	N	Y	N	0	0
<i>Passer domesticus</i>	house sparrow	bird	Y	Y	Y	Y	0	0
<i>Passer montanus</i>	tree sparrow	bird	Y	Y	Y	Y	0	0
<i>Perdix perdix</i>	grey partridge	bird	Y	N	Y	Y	0	0
<i>Pernis apivorus</i>	european honey-buzzard	bird	N	N	Y	N	0	0
<i>Phalaropus lobatus</i>	red-necked phalarope	bird	N	Y	Y	N	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Phylloscopus sibilatrix</i>	wood warbler	bird	Y	Y	Y	Y	0	0
<i>Pluvialis apricaria</i>	golden plover	bird	N	Y	Y	Y	0	0
<i>Podiceps auritus</i>	slavonian grebe	bird	N	N	Y	N	0	12
<i>Podiceps nigricollis</i>	black-necked grebe	bird	N	Y	Y	N	0	0
<i>Poecile montanus</i>	willow tit	bird	Y	N	Y	Y	0	0
<i>Poecile palustris subsp. palustris/dresseri</i>	marsh tit	bird	Y	N	Y	Y	0	0
<i>Porzana porzana</i>	spotted crane	bird	N	N	Y	N	13	0
<i>Prunella modularis</i>	dunnock	bird	Y	Y	Y	Y	0	0
<i>Pyrhacorax pyrrhacorax</i>	chough	bird	N	Y	Y	Y	0	0
<i>Pyrhula pyrnhula</i>	bullfinch	bird	Y	Y	Y	Y	0	0
<i>Scolopax rusticola</i>	woodcock	bird	N	N	Y	N	0	0
<i>Stercorarius parasiticus</i>	arctic skua	bird	N	Y	Y	N	0	0
<i>Sterna dougallii</i>	roseate tern	bird	Y	Y	Y	Y	0	0
<i>Sterna hirundo</i>	common tern	bird	N	N	Y	N	0	0
<i>Sterna paradisaea</i>	arctic tern	bird	N	N	Y	N	0	0
<i>Sterna sandvicensis</i>	sandwich tern	bird	N	N	Y	N	0	0
<i>Sterna albifrons</i>	little tern	bird	N	Y	Y	N	0	0
<i>Streptopelia turtur</i>	turtle dove	bird	Y	Y	Y	Y	0	0
<i>Sturnus vulgaris</i>	starling	bird	Y	Y	Y	Y	0	0
<i>Tetrao tetrix</i>	black grouse	bird	Y	N	Y	Y	0	0
<i>Tetrao urogallus</i>	capercaillie	bird	N	N	Y	N	0	0
<i>Tringa glareola</i>	wood sandpiper	bird	N	N	Y	N	0	0
<i>Tringa totanus</i>	redshank	bird	N	Y	N	N	0	0
<i>Troglodytes troglodytes subsp. fridariensis</i>	fair isle wren	bird	N	N	Y	N	0	0
<i>Turdus iliacus</i>	redwing	bird	N	Y	Y	N	0	0
<i>Turdus philomelos</i>	song thrush	bird	Y	Y	Y	Y	0	0
<i>Turdus pilaris</i>	fieldfare	bird	N	Y	N	N	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Turdus torquatus</i>	ring ouzel	bird	Y	Y	Y	Y	0	0
<i>Vanellus vanellus</i>	lapwing	bird	Y	Y	Y	Y	0	0
<i>Argynnis adippe</i>	high brown fritillary northern brown	butterfly	Y	N	N	Y	0	0
<i>Aricia artaxerxes</i>	argus pearl-bordered	butterfly	Y	N	Y	N	0	0
<i>Boloria euphrosyne</i>	fritillary small pearlbordered	butterfly	Y	N	Y	Y	0	0
<i>Boloria selene</i>	fritillary	butterfly	Y	N	Y	Y	0	0
<i>Coenonympha pamphilus</i>	small heath	butterfly	Y	Y	Y	Y	0	0
<i>Coenonympha tullia</i>	large heath	butterfly	Y	Y	Y	Y	0	0
<i>Cupido minimus</i>	small blue	butterfly	Y	Y	Y	Y	0	0
<i>Erynnis tages</i>	dingy skipper	butterfly	Y	Y	Y	Y	0	0
<i>Euphydryas aurinia</i>	marsh fritillary duke of burgundy	butterfly	Y	Y	N	Y	0	0
<i>Hamearis lucina</i>	fritillary	butterfly	Y	N	N	N	0	0
<i>Hipparchia semele</i>	grayling	butterfly	Y	Y	Y	Y	0	0
<i>Lasiommata megera</i>	wall	butterfly	Y	Y	Y	Y	0	0
<i>Leptidea sinapis</i>	wood white	butterfly	Y	N	N	Y	0	1
<i>Limenitis camilla</i>	white admiral	butterfly	Y	N	N	Y	0	0
<i>Maculinea arion</i>	large blue	butterfly	Y	N	N	N	1	0
<i>Melitaea athalia</i>	heath fritillary	butterfly	Y	N	N	N	0	0
<i>Plebejus argus</i>	silver-studded blue	butterfly	Y	N	N	Y	0	0
<i>Pyrgus malvae</i>	grizzled skipper white letter	butterfly	Y	N	N	Y	0	0
<i>Satyrrium w-album</i>	hairstreak	butterfly	Y	N	N	Y	0	23
<i>Thecla betulae</i>	brown hairstreak	butterfly	Y	N	N	Y	0	0
<i>Thymelicus acteon</i>	lulworth skipper	butterfly	Y	N	N	N	0	0
<i>Acronicta psi</i>	grey dagger	moth	Y	Y	Y	Y	0	0
<i>Acronicta rumicis</i>	knot grass	moth	Y	Y	Y	Y	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Agrochola helvola</i>	flounced chestnut	moth	Y	Y	Y	Y	0	0
<i>Agrochola litura</i>	brown-spot pinion	moth	Y	Y	Y	Y	0	0
<i>Agrochola lychnidis</i>	beaded chestnut	moth	Y	Y	Y	Y	0	0
<i>Allophyes oxyacanthae</i>	green-brindled crescent	moth	Y	Y	Y	Y	0	0
<i>Amphipoea oculea</i>	ear moth	moth	Y	Y	Y	Y	0	0
<i>Amphipyra tragopoginis</i>	mouse moth	moth	Y	Y	Y	Y	0	0
<i>Apamea anceps</i>	large nutmeg	moth	Y	N	Y	Y	0	0
<i>Apamea remissa</i>	dusky brocade	moth	Y	Y	Y	Y	0	0
<i>Arctia caja</i>	garden tiger	moth	Y	Y	Y	Y	0	0
<i>Brachionycha sphinx</i>	sprawler	moth	Y	Y	N	Y	0	0
<i>Atethmia centrago</i>	centre-barred sallow	moth	Y	Y	Y	Y	0	0
<i>Mniotype adusta</i>	dark brocade	moth	Y	Y	Y	Y	0	0
<i>Brachylomia viminalis</i>	minor shoulder-knot	moth	Y	Y	Y	Y	0	0
<i>Caradrina morpheus</i>	mottled rustic	moth	Y	Y	Y	Y	0	0
<i>Celaena haworthii</i>	haworth's minor	moth	Y	Y	Y	Y	0	0
<i>Celaena leucostigma</i>	crescent	moth	Y	Y	Y	Y	0	0
<i>Chesias legatella</i>	streak	moth	Y	Y	Y	Y	0	0
<i>Chesias rufata</i>	broom-tip rhesen	moth	Y	N	Y	Y	0	0
<i>Semiothisa clathrata</i>	latticed heath	moth	Y	Y	Y	Y	0	0
<i>Coleophora tricolor</i>	NA	moth	Y	N	N	N	0	0
<i>Cymatophorima diluta</i>	oak lutestring	moth	Y	N	Y	Y	0	0
<i>Dasypolia templi</i>	brindled ochre	moth	Y	Y	Y	Y	0	0
<i>Diarsia rubi</i>	small square-spot	moth	Y	Y	Y	Y	0	0
<i>Diloba caeruleocephala</i>	figure of eight	moth	Y	Y	Y	Y	0	0
<i>Ecliptopera silaceata</i>	small phoenix	moth	Y	Y	Y	Y	0	0
<i>Ennomos erosaria</i>	september thorn	moth	Y	N	Y	Y	0	0
<i>Ennomos fuscantaria</i>	dusky thorn	moth	Y	N	N	Y	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Ennomos quercinaria</i>	august thorn grey mountain	moth	Y	Y	Y	Y	0	0
<i>Entephria caesiata</i>	carpet	moth	Y	Y	Y	Y	0	0
<i>Epirrhoe galiata</i>	galium carpet	moth	Y	Y	Y	Y	0	0
<i>Paradiarsa glareosa</i>	autumnal rustic	moth	Y	Y	Y	Y	0	0
<i>Eulithis mellinata</i>	the spinach	moth	Y	N	Y	Y	0	0
<i>Eustroma reticulatum</i>	netted carpet moth	moth	Y	N	N	Y	0	0
<i>Euxoa nigricans</i>	garden dart	moth	Y	Y	Y	Y	0	0
<i>Euxoa tritici</i>	whilte-line dart dart	moth	Y	N	Y	Y	0	0
<i>Graphiphora augur</i>	double dart	moth	Y	Y	Y	Y	0	0
<i>Hemistola chrysoprasaria</i>	small emerald	moth	Y	N	Y	Y	0	0
<i>Hepialus humuli</i>	ghost moth	moth	Y	Y	Y	Y	0	0
<i>Hoplodrina blanda</i>	rustic	moth	Y	Y	Y	Y	0	0
<i>Hydraecia micacea</i>	rosy rustic	moth	Y	Y	Y	Y	0	0
<i>Hydraecia osseola subsp. hucherardi</i>	NA	moth	Y	N	N	N	0	0
<i>Idaea dilutaria</i>	silky wave	moth	Y	N	N	Y	0	0
<i>Idaea ochrata subsp. cantiata</i>	NA	moth	Y	N	N	N	0	0
<i>Lycia hirtaria</i>	brindled beauty	moth	Y	Y	Y	Y	0	0
<i>Semiothisa wauaria</i>	v moth	moth	Y	N	Y	Y	0	0
<i>Malacosoma neustria</i>	the lackey	moth	Y	N	Y	Y	0	0
<i>Melanchra persicariae</i>	dot moth	moth	Y	Y	Y	Y	0	0
<i>Ceramica pisi</i>	broom moth	moth	Y	Y	Y	Y	0	0
<i>Melanthia procellata</i>	pretty chalk carpet	moth	Y	N	N	Y	0	0
<i>Mesoligia literosa</i>	rosy minor shoulder-striped	moth	Y	Y	Y	Y	0	0
<i>Mythimna comma</i>	wainscot	moth	Y	Y	Y	Y	0	0
<i>Orthonama vittata</i>	oblique carpet	moth	Y	Y	Y	Y	0	0
<i>Orthosia gracilis</i>	powdered quaker	moth	Y	Y	Y	Y	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Pelurga comitata</i>	dark spinach	moth	Y	Y	Y	Y	0	0
<i>Perizoma albulata</i>	grass rivulet	moth	Y	Y	Y	Y	0	0
<i>Pyropteron chrysidiformis</i>	fiery clearwing	moth	Y	N	N	N	0	0
<i>Rhizedra lutosa</i>	large wainscot	moth	Y	N	Y	Y	0	0
<i>Scopula marginepunctata</i>	mullein wave	moth	Y	Y	Y	Y	0	0
<i>Scotopteryx chenopodiata</i>	shaded broad-bar	moth	Y	Y	Y	Y	0	0
<i>Scythris siccella</i>	NA	moth	Y	N	N	N	0	0
<i>Siona lineata</i>	black-veined moth	moth	Y	N	N	N	0	0
<i>Spilosoma lubricipeda</i>	white ermine	moth	Y	Y	Y	Y	0	0
<i>Spilosoma luteum</i>	buff ermine	moth	Y	Y	Y	Y	0	0
<i>Stilbia anomala</i>	anomalous	moth	Y	Y	Y	Y	0	0
<i>Thalera fimbrialis</i>	sussex emerald	moth	Y	N	N	N	0	0
<i>Tholera cespitis</i>	hedge rustic	moth	Y	Y	Y	Y	0	0
<i>Tholera decimalis</i>	feathered gothic round-winged	moth	Y	Y	Y	Y	0	0
<i>Thumatha senex</i>	muslin	moth	N	N	Y	N	0	0
<i>Timandra griseata</i>	blood-vein gwyfyn	moth	Y	N	Y	Y	0	0
<i>Trichiura crataegi</i>	pale eggar	moth	Y	Y	Y	Y	0	0
<i>Tyria jacobaeae</i>	cinnabar	moth	Y	Y	Y	Y	0	0
<i>Drepana binaria</i>	oak hook-tip	moth	Y	N	Y	Y	0	0
<i>Xanthia gilvago</i>	dusky-lemon sallow	moth	Y	N	Y	Y	0	0
<i>Xanthia ictertia</i>	sallow	moth	Y	Y	Y	Y	0	0
<i>Xanthorhoe munitata</i>	red carpet	moth	Y	Y	Y	Y	0	0
<i>Xanthorhoe ferrugata</i>	dark-barred twin-spot carpet	moth	Y	Y	Y	Y	0	0
<i>Xestia agathina</i>	heath rustic	moth	Y	Y	Y	Y	0	4
<i>Xestia castanea</i>	neglected rustic	moth	Y	Y	Y	Y	0	0
<i>Erinaceus europaeus</i>	hedgehog	mammal	Y	Y	Y	Y	0	0
<i>Lepus europaeus</i>	brown hare	mammal	Y	N	Y	Y	0	0

C4a. Status of UK priority species: relative abundance

Latin Name	Common Name	Group	England S41	NI Priority Species List	Scotland Biodiversity List	Wales S7	Cap 10,000	Cap 1
<i>Lepus timidus</i>	mountain hare	mammal	Y	Y	Y	N	0	0
<i>Gliridae</i>	dormouse	mammal	Y	N	N	Y	0	0
<i>Vespertilionidae</i>	daubenton's	mammal	N	N	Y	N	0	0
<i>Vespertilionidae</i>	natterer's	mammal	N	N	Y	N	0	0
<i>Vespertilionidae</i>	noctule	mammal	Y	N	Y	Y	0	0
<i>Microchiroptera</i>	common pipistrelle	mammal	N	N	Y	Y	0	0
<i>Pipistrellus pygmaeus</i>	soprano pipistrelle	mammal	Y	Y	Y	Y	0	0
<i>Vespertilionidae</i>	brown long-eared	mammal	Y	Y	Y	Y	0	0
<i>Rhinolophidae</i>	lesser horseshoe	mammal	Y	N	N	Y	0	0