A Brief Introduction to the Wild Birds Populations Indicator

The annual Defra Wild Bird Populations National Statistics Release is published every autumn (see gov.uk). The headline indicator of this publication is the 'All Species' indicator, which shows trends in population size of species of bird that are native to, and breed in, the UK. The index includes species with a population of more than 500 breeding pairs for which there is sufficient information to calculate a trend. In the 2013 statistical release (updating the series with 2012 data) the all species index comprised 128 species.

Key points:

The indicator measures changes in populations of a range of species, relative to historical numbers, where 1970 is the baseline year. A five per cent decline in the overall index can mean that, on average, the population size of species included in the indicator has decreased by five per cent. It does not necessarily mean each species has declined by five per cent, or that the total number of birds in the UK has declined by five per cent. It can also mean that the species evenness in the indicator is decreasing (evenness refers to the degree of uniformity of the species proportions; high evenness occurs when many species have similar abundance, with no single species dominating).

Calculating the all species wild bird indicator

The creation of the all species wild bird indicator involves two steps: (1) the production of annual population indices for the individual species for which there is trend data, and (2) the amalgamation of these individual indices into a single aggregate index.

1. **Indices for individual species**

   These are generated by a statistical analysis of representative sites resurveyed year after year (e.g. in the Breeding Bird Survey) or based on annual estimates of total populations (e.g. Heronries Survey). The population trends for each species are made comparable by expressing them as indices relative to '100' in the start (baseline) year. Thus each annual index shows relative changes in population size from the start year: a rise to 200 in the index reflects a doubling in numbers, a decline to 50 a halving.

2. **Amalgamating into a single index**

   The all species index is calculated as the geometric mean[1] of all the individual indices[2], with no weightings - so each species has the same relative effect on the indicator. The geometric mean is used to ensure that a doubling in the population index of one species (e.g. 100 to 200) is balanced by a halving (e.g. 100 to 50). The geometric mean of 200 and 50 is 100 (see E.g. 1, Annex 1).

What does the indicator show?

The composite all species indicator shows the year-to-year fluctuations in population trends across all species that can be included, reflecting the observed changes in the annual survey results. Alongside this is the smoothed version of the trend, which is used to formally assess the statistical significance of change over time. The smoothed trend is derived using a published statistical methodology[3] and is used for assessments as it reduces the short-term peaks and troughs resulting from, for example, year-to-year impacts of weather and sampling variations. The index is considered to give reliable medium to long-term trends but strong reliance should not be attached to short term changes from one year to the next.

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[1] The geometric mean is equal to the nth root of the product of all 'n' species indices.

[2] Gregory, R.D. et al. *Generation of the Headline Indicator of Wild Bird Populations*. BTO research report 221. BTO & RSPB, Thetford

[3] See analytical methods on BTO website (www.bto.org/birdtrends2011/methodology.htm) Fewster et al. 2000. *Analysis of population trends for farmland birds using Generalised Additive Models*. Ecology 81: 1970-84

What does a change in the indicator mean?

Key points:

- An increase in the indicator from 100 to 110 would mean an average change of +10% in each of the species indices that make up the indicator. This is the same as saying that, on average, there are 10% more individuals in the population of each species.
- A decrease in the indicator from 100 to 90 would mean that the average change in each species index included in the indicator is -10%.
- However, it is important to remember that the all species index is an aggregate of individual species indices and hence masks a lot of variation among individual species and groups of species. Although its constituent species have shown both massive increases and severe declines, the all species index has remained largely stable since 1970 as increases and decreases in individual species have tended to balance one another. For this reason, composite indices for birds associated with each of the UK's major habitat types are also calculated (see below). These give a clearer picture of the state of wild birds in each and help to identify patterns. The best way to see variation in a specific species is to plot its trend. Plots for individual species are available on the BTO website www.bto.org.
- If the all species index goes up or down in a given year it does not necessarily mean that the majority of species in the UK have increased or decreased respectively, because the index can be strongly influenced by a large magnitude change in one of the species included (see E.g. 3 and E.g. 4, Annex 1), although the effect of a change in one species becomes less influential as the number of species in the index increases.
- Since the all species index treats every species as equivalent, and does not weight trends by the population size of each species, a 50% decrease in the population of a common species would have the same effect on the indicator as a 50% decrease in the population of an uncommon species. While the actual decrease in numbers of individuals would be very different, the change in the index is the same.
- The use of equal weights across species ensures changes in the indicator are not completely dominated by the trends in the most common species. This is apt because long-lived species at the top of the food chain (e.g. birds of prey) are naturally much less numerous and numbers tend to fluctuate less than prey species. For example, based on changes in population sizes without the use of equal weightings, declines of 75% in three rare species of 100 individuals each, would be masked by a 50% increase in one very common species of 10,000 individuals, and lead to a change in a composite indicator of +46% for the four species combined. Using equal weightings gives a -61% change (see E.g. 2, Annex 1).
- A conventional average can be overly influenced by one or two extreme values. A geometric mean is an average which is less influenced by any single value far from most others in the data set (an outlier). This is appropriate as outliers in population increases are relatively common. Extreme values can arise from new colonisers, such as little egret, which may increase their population several times over in a short period of time.

Additional indicators

The composite indices for breeding birds in the separate habitat categories are calculated in the same way as described for the all species index: farmland birds, woodland birds, water and wetland birds, and seabirds, as well as for wintering waterbirds. These indices are used an indicators for the state of bird populations within these broad habitats/groups. The same species are used in each indicator across years, except where species are added or removed, primarily due to changes in the availability of data and an

assessment of its reliability for use in the indicator, following procedures agreed by an Indicators Steering Group and with extensive consultation. A new species can be added without distorting the index by giving it the average value of the index for the earlier years when data for it is not available. Alternatively, if there is earlier data for the new species, the whole index can be recalculated, accepting that this will change the earlier values of the index.

Further information

For more general information on monitoring change in biodiversity using indicators and a discussion of alternative indices, please see:

Buckland, S. T., Magurran, A. E., Green, R. E. and Fewster, R. M. (2005). Monitoring change in biodiversity through composite indices. *Philosophical Transactions of the Royal Society of London B.* 360. p. 243–254. http://www.creem.st-and.ac.uk/stb/monitoring%20biodiversity.pdf

For a detailed discussion of the strengths and weaknesses of using the geometric mean of relative abundance indices to monitor biodiversity, please see:

Buckland, S. T., Studeny, A. C., Magurran, A. E., Illian, J. B. and Newson, S. E. (2011). The geometric mean of relative abundance indices: a biodiversity measure with a difference. *Ecosphere* 2:art100 http://www.esajournals.org/doi/abs/10.1890/ES11-00186.1

Annex 1:

Example 1: The geometric mean ensures that a doubling in the population index of one species is balanced by a halving.

	Index in year(X)	Index in year(Y)	Change
Species A	100	200	100%
Species B	100	50	-50%
Geometric Mean	100	100	0%
Arithmetic Mean	100	125	25%

Example 2: The use of equal weights across species ensures that changes in the indicator are not completely dominated by the trends in more common species.

	Index in year(X)	Index in year(Y)	Population size year(X)	Population size year(Y)
Species A	100	25	100	25
Species B	100	25	100	25
Species C	100	25	100	25
Species D	100	150	10000	15000
Total No. of individuals	NA	NA	**10300**	**15075**
Geometric mean	**100**	**39**	NA	NA
Change in indicator between year(Y) and year(X)		-61%		46%

Example 3: A decline in the index can occur even if more individual species increase than decrease.

	Change Measure	
Species A	5% increase	105
Species B	5% increase	105
Species C	50% decline	50
Geometric Mean		82
Change		-18%

Example 4: An increase in the index can occur even if more individual species decrease than increase.

	Change Measure	
Species A	5% decline	95
Species B	5% decline	95
Species C	100% increase	200
Geometric Mean		122
Change		22%