

UK Biodiversity Indicators 2018

This document supports
C9a. Animal genetic resources:
Effective population size of Native Breeds at Risk

Technical background document:

For further information on C9a. Animal genetic resources –
Effective population size of Native Breeds at Risk
visit <http://jncc.defra.gov.uk/page-4240>

For further information on the UK Biodiversity Indicators visit
<http://www.jncc.gov.uk/page-1824>

Technical Background Document:

Calculation of UK Biodiversity Indicator C9a – Effective Population Size of Native Breeds at Risk.

Obtaining Data

The UK Farm Animal Genetic Resources (FAnGR) Committee [breed inventory](#) was first published in 2014 with information for pigs, goats and horses, and was expanded in 2015 to include sheep and cattle. The inventory published in 2016, 2017 and 2018 extended the data available.

Data in the inventory is sourced from individual breed society records. As all pedigree animals need to be registered with their respective society to receive their pedigree certificate, the breed society records are comprehensive. To maximise efficiency in data collection, central database suppliers who maintain the breed society databases supply the data to the Defra FAnGR team. Breed societies have given their permission for these companies to supply the data every year for this exercise.

In addition, data for additional breeds is collected from individual breed societies on a three yearly basis, the latest in October 2015. The most recent triennial data exercise collected data for 2012, 2013 and 2014, so for some breeds there are missing values for the most recent three years. It is anticipated that the next triennial exercise will be in late 2018, and will collect data for the years 2015, 2016, and 2017. As the indicator is published in mid-July 2018, the data for 2015-17 are therefore considered as provisional.

The figures in the indicator are based on the inventory published on 3 May 2018.

The inventory published in 2018 includes newly available historic data for some breeds of sheep and cattle, this indicator is therefore not directly comparable with the previous publication.

Calculating average effective population size

The indicator was calculated in three steps:

1. The effective population size (N_e) for each breed in the inventory was calculated using Sewell Wright's formula; $N_e = 4 \frac{MF}{(M+F)}$
where M = number of sires and F = number of dams
2. Data for breeds flagged as Native Breeds at Risk (NBAR) were selected; and
3. The geometric mean of the N_e for NBAR breeds within a species was calculated.

Data for each breed within a species have been combined using a geometric mean rather than an arithmetic mean, as this reduces the influence of very common or very rare breeds on the overall number calculated. This technique is used for a number of other UK biodiversity indicators – such as for birds, bats and butterflies.

Wright's formula makes a number of assumptions; it usually produces an estimate of N_e that is higher than would be produced by a calculation using breed by breed pedigree information. However, such information is not readily available, and the indicator could not be calculated if it relied on such a methodology. Wright's formula has the advantage of being simple to calculate, and importantly, can be applied to the data available.

For many other UK Biodiversity Indicators the variability in the data is presented through confidence intervals, and the number of species increasing or decreasing within the trend lines

shown. Given that it is necessary to register offspring as pedigree before they can themselves be used to produce pedigree offspring, the data in the inventory are census rather than sample data, and therefore confidence intervals are not necessary – the value is what the value is. In bringing the data together as an average, that is itself the only value that can be calculated, so unlike most averages which are based on sampling data, it is not appropriate to calculate confidence intervals. The datasheet contains the values from which the geometric means have been calculated – this will allow users to see the range of values combined within the geometric means.

It is noted that there may be a delay in registering pedigree offspring, such that the data for a year in the inventory may actually partly represent individuals born in the previous year.

Graphical presentation

Three graphs are drawn.

1. The average effective population size of native breeds at risk as a line graph, which incorporates a dotted line for $N_e=50$ to show where the average is relative to the threshold considered to be a minimum by the United Nations Food and Agriculture Organisation. Colours have been chosen to be tonally discrete in both black and white and for someone who is red-green colour-blind – see Table C9ai.
2. Column graphs, per species, to show the number of breeds per year which have $N_e<50$. These are all with the same vertical axis to aid comparability, and all in the same tone (Red = 0, Green = 100; Blue = 140).
3. A line graph showing the number of breeds for each species which contribute to the indicator is included in this Technical Document. This uses the same colour scheme as Figure C9ai to aid cross referencing and consistency.

The datasheet provides the values for each of these graphs, plus a list of the breeds which are within Figure C9aii.

Table C9ai. Colours used for the lines on Figures C9ai and C9aiii

Species	Red	Green	Blue
Cattle	255	158	22
Goats	201	228	165
Horses	153	203	227
Pigs	119	188	31
Sheep	0	124	186
All Breeds	166	166	166
$N_e = 50$ (dotted)	0	0	0

Indicator description

Simply defined, a breed can be taken to mean a specific group of animals that, through selection and breeding, have similar characteristics (including, for example, appearance and behaviour) that are passed on to their offspring and which distinguish them from other animals of the same species. However, worldwide use of the term 'breed' and the various breed categories (for example 'autochthonous', 'native', 'indigenous', 'heritage', 'patrimonial', 'naturalised', or 'locally adapted') does not guarantee that these terms are defined in the same way. The UK has adopted some of these terms; definitions are provided in Appendix 1 of the [2012 UK Country Report on Farm Animal Genetic Resources](#).

Effective population size is a calculation which takes account of the total number of animals in a population. A low effective population size signifies a greater likelihood of in-breeding and

risk of loss of genetic diversity. A larger effective population size implies a lower risk of inbreeding and higher genetic diversity.

The indicator shows the change in the average effective population sizes (N_e) for breeds of goats, pigs, horses, sheep and cattle classified by the UK Farm Animal Genetic Resources Committee as Native Breeds at Risk (NBAR). In the inventory published in 2018, all five native breeds of goats, all 11 native breeds of pigs, 14 of 19 native horse breeds, 46 of 59 native sheep breeds, and 29 of 38 native cattle breeds were classified as NBAR (for definitions of native breeds, and native breeds at risk, see Appendix 1 of the [UK Country Report on Farm Animal Genetic Resources 2012](#)).

For goats and pigs, data to calculate effective population size is available for all years for all breeds included in the indicator (from 2004 to 2017 for four goat breeds, and from 2000 to 2017 for 11 pig breeds). However for horses, sheep and cattle, the number of breeds contributing to the indicator increases over time as more data becomes available.

Table C9aⁱⁱ provides information on the number of breeds in the indicator in 2017, and context of the total number classified as NBAR.

Table C9aⁱⁱ. The number of breeds contributing to the indicator in 2017

Species	Number of breeds in the indicator*	Total number of native breeds at risk	Percentage coverage by the indicator
Goats	4	5	80
Pigs	11	11	100
Horses	13	14	93
Sheep	31	46	67
Cattle	20	29	69

* Data represents 79 of the 105 UK breeds (75%) classified as NBAR within these species.

Table C9aⁱⁱⁱ provides information on the maximum number of breeds in the indicator in a year, and context of the total number classified as NBAR.

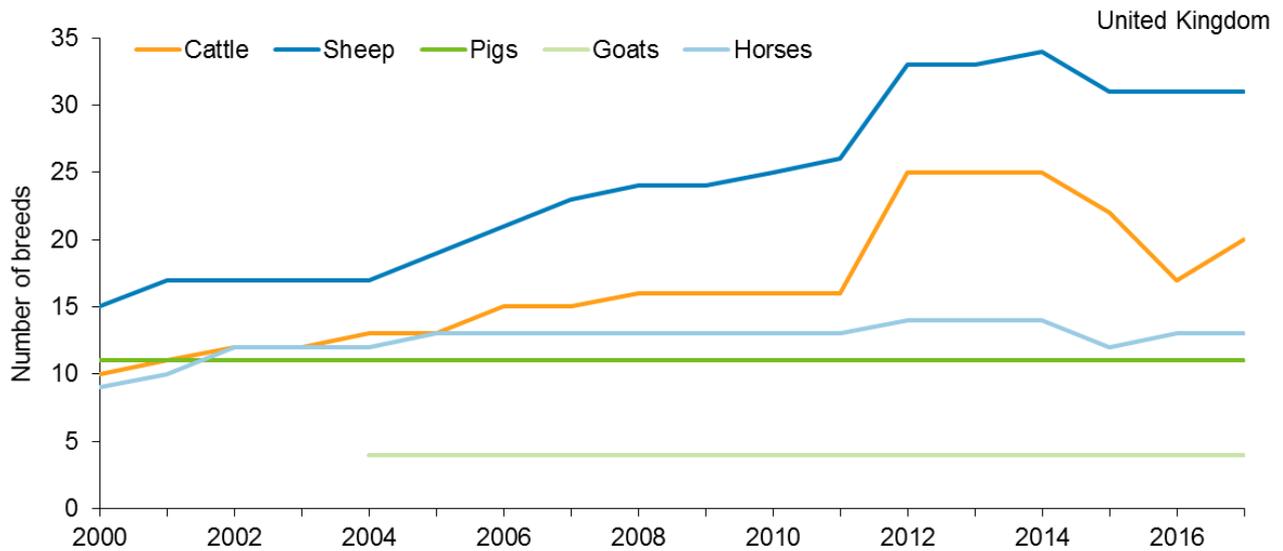
Table C9aⁱⁱⁱ. The maximum number of breeds contributing to the indicator

Species	Maximum number of breeds in the indicator*	Total number of native breeds at risk	Percentage coverage by the indicator
Goats	4	5	80
Pigs	11	11	100
Horses	14	14	100
Sheep	34	46	74
Cattle	25	29	86

* Data represents 88 of the 105 UK breeds (84%) classified as NBAR within these species.

The calculations in this indicator are for the breeds for which there are currently data; this is a subset of the native breeds at risk. Figure C9aⁱⁱⁱ shows the number of native breeds at risk for which it was possible to calculate effective population size in a year, and thus contribute to the indicator.

Figure C9aiii. The number of NBAR breeds contributing to the indicator, calculated using the inventory published in 2017



Notes:

1. Based on data in the UK Farm Animal Genetic Resources Breed Inventory published on 3 May 2018.
2. Strictly these are discrete rather than continuous data, and should be represented with a column graph rather than a line graph, but the presentation in figure C9aiii is clearer using a line graph.

Source: British Pig Association, Defra, Grassroots Systems Ltd., Rare Breeds Survival Trust, and participating breed societies.

There is an increase in the number of breeds in the indicator for 2012-2014 as a result of incorporating the data from the triennial data collection exercise. It is expected that this exercise will be repeated in 2018 to collect data for 2015-17, at which point the breeds for which only three years of data currently exist in the inventory will be extended to six years. The datasheet provides information on the number of breeds included in the indicator each year under the tabs ‘Data C9aiii’, and ‘Ne for NBAR’.

Previous indicator

A [previous UK biodiversity indicator](#) for animal genetic resources presented the change in genetic diversity in native breeds of cattle and sheep in the UK for 2001 and 2007, as measured by their effective population size calculated from population statistics and rates of change of inbreeding over time. The indicator was based upon a research contract undertaken in 2008-09 which calculated effective population size for a set of sheep and cattle breeds for which full pedigree data were made available by breed societies. While the measure developed was state of the art at that time, it was not possible to repeat the work subsequently, nor is it likely that resources will be available to repeat the work in the future. In addition, the indicator only covered two species, and therefore omitted much of the breadth of UK domesticated animal resources. The indicator was replaced in 2015 with the current indicator, based on the UK Farm Animal Genetic Resources breed inventory.