

UK Biodiversity Indicators 2023

This document supports
C1. Protected Areas

**Technical background document:
Calculation of site extent and condition**

For further information on C1. Protected Areas
visit <http://www.jncc.gov.uk/ukbi-C1>

For further information on the UK Biodiversity Indicators visit
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Technical Background Document

UK Biodiversity Indicator C1, Protected Areas (<http://www.jncc.gov.uk/ukbi-C1>) comprises three measures:

a. Total extent of protected areas: on-land

b. Total extent of protected areas: at-sea

c. Condition of Areas / Sites of Special Scientific Interest

Many protected areas in the UK cover the same physical parcels of land, but for different reasons; as a result the designation types can overlap. For example, it is possible for an individual site to be designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site and National Nature Reserve (NNR), and could also be part of a National Park, an AONB (Areas of Outstanding Natural Beauty) or National Scenic Area (NSA).

Measures (a) and (b) are calculated using a computer program written by the Joint Nature Conservation Committee (JNCC) which uses a number of site designation files as input, and calculates a set of non-overlapping polygons for that entire set of designations for each year. This has allowed the basis of the indicator to be expanded over time (including more site types), and allows comparisons to be made between inclusion and exclusion of wider landscape designations (National Parks, AONBs, NSAs: see tables C1i and C1ii in the indicator fiche) by running the program with different input parameters. The program also splits the areas calculated into terrestrial, inshore (within 12 nautical miles of the coast), and offshore (beyond 12 nautical miles out to the edge of the UK Continental shelf). Inshore and offshore extent are combined in measure (b).

Measure (c) is based on data provided by the Statutory Nature Conservation Bodies (SNCBs) on the proportion of SSSIs (Area of Special Scientific Interest (ASSI), in Northern Ireland), SACs, or SPAs in favourable or unfavourable-recovering condition. To bring 4 sets of percentages together, a weighting algorithm is needed. This technical document explains how this is undertaken using the proportion of the relevant protected area in each country.

Calculation of site extent for indicator measures C1a and C1b

The basis for calculating the extent indicator is to show marine and terrestrial sites separately rather than showing the types of sites. The indicator is based on a spatial analysis of protected area polygons which removes overlaps between site types.

Method

1. The total areas of the terrestrial and marine regions are calculated in SQL Server 2008, using the following datasets:
 - a. Boundaries (regions):
 - Mean High Water (MHW) feature from the Ordnance Survey MasterMap dataset.
 - Open Data Northern Ireland outline. MHW and Republic of Ireland boundary.
 - Inshore (12 nautical miles) applied as a buffer to the terrestrial boundary.
 - Boundary-Line (OSMM) for the terrestrial country borders within Great Britain.
 - A UK Water boundary dataset used in the 'country' cutting data. Data supplied by JNCC Marine Team. Contains exclusive economic zone, continental shelf and Northern Ireland meridian polygons.
 - An area for Northern Ireland Offshore.

- b. Protected Areas (sites):
- SAC datasets downloaded from each of the 4 SNCB websites. Up to 31 May 2019.
 - UK collation of offshore SACs, administered by JNCC. Up to 31 May 2019.
 - SPA datasets downloaded from each of the 4 SNCB websites. Up to 31 March 2021.
 - Ramsar datasets downloaded from each of the 4 SNCB websites. Up to 31 May 2019.
 - SSSI/ASSI datasets downloaded from each of the 4 SNCB websites. Up to 31 March 2021.
 - NNRs, downloaded from each of the 4 SNCB websites. Up to 31 March 2021.
 - National Parks: The 2 Scottish site boundaries were downloaded from the Scottish Government website added 28 March 2014. The English National Parks boundary data downloaded from Natural England website on 3 April 2018 and Welsh National Parks data from Natural Resources Wales website, added December 2010.
 - AONBs, downloaded from the Natural England, Natural Resources Wales and Department of Environment Northern Ireland websites. Up to 7th July 2020.
 - NSAs, downloaded from the Scottish Government website, added 28 March 2014.
 - MCZs – data collated by JNCC for submission to the European Environment Agency nationally designated protected areas inventory (CDDA), up to October 2020.
 - Nature Conservation MPAs – downloaded from NatureScot website. Up to December 2020.
2. In 2013, the datasets were all re-projected into Albers Equal Area Conic to accommodate calculations on the furthest offshore sites. For 2014, the standard parallels of the Albers projection were changed slightly as recommended by JNCC Marine Team. In 2015, the MHW data used to cut the polygons was changed from Ordnance Survey BoundaryLine to Ordnance Survey MasterMap. In 2017 and 2018 the process for 2015 was repeated, using the same sets of sites. In 2019, the datasets were all re-projected into ETRS89 LAEA, again, to better accommodate calculations on the furthest offshore sites.
 3. A computer program is run which checks through all the site boundaries and their designated dates, compares them with all other sites and removes overlapping areas which were designated later, until only sites (or parts thereof) which do not overlap with any other sites which were designated before remain. These non-overlapping site boundaries are then intersected with the region boundaries; all site boundaries designated before or during each year which intersect each region are selected and summed.
 4. This creates a total protected area figure for each region, for each year, where each protected site contributes only once to the total area figure.

Changes over time

In 2011 and 2012, a spatial analysis using ArcGIS 9.2 was run which calculated a set of non-overlapping polygons and then summed their areas. Prior to this, the site area figures as provided on the site data forms were used to calculate the total protected area of SACs and

SPAs; an appropriate method when site overlaps within and between designations were minimal and few were not underpinned by SSSIs.

In 2013, a correction to the series was published to reflect the most appropriate date to allocate to designation of individual sites, defined as the year in which the largest portion of the site was designated, based upon the electronic boundaries for the current site series. The effect of this was that sites designated under the National Parks and Access to the Countryside Act 1949 and re-designated under the Wildlife and Countryside Act 1981 were allocated to the year in which the largest part of the site was designated. This corrected an error in the 2012 publication which only took account of the re-designation process, and therefore incorrectly allocated the date of designation for sites which were already designated under the 1949 Act.

Most appropriate dates have also been applied to SAC and SPA sites; that is, the date that the majority of the site were submitted to Ministers for approval for public consultation.

Some sites have been extended since the original designation. JNCC is not able to derive electronic boundary data to track all of these changes, some of which pre-date Geographic Information Systems. In these cases the whole of the site boundary has been allocated to the year in which the largest portion of the site has been designated. This is best illustrated by the following 3 examples:

1. a site originally designated in 1975 and then subsequently re-designated with a 10% increase in the boundary in 1988 with no changes since. In this case the whole of the site area would be allocated to 1975
2. a site designated in 1999 with an area of 1,000 hectares was subsequently extended to form a boundary of 2,500 hectares in 2005. In this case the whole of the site area would be allocated to the later of the 2 dates (i.e. 2005).
3. A site designated in 1996, with a hectarage of 100ha, then extended in 2005 to 1,000 hectares and then with a second extension in 2010 to bring the boundary to 1,100ha. In this case the whole of the site boundary would be allocated to 2005, this being the date on which the largest proportion of the site was designated.

Sites that were de-designated have not been included. For SSSIs, most of these “de-notifications” were done in the period between 1982 and 1990 and there are no electronic records of these boundaries (the method relies entirely on electronic boundary data because of the need to eliminate overlaps between different designations to avoid double counting). The de-designations of SSSI were almost always for very small sites and their incorporation into these statistics would have a negligible effect. Over 30 NNRs have been de-declared in Scotland since 2003; some of these were not small sites. However, de-declared NNRs are not included because they are all overlapped by existing SSSI or Natura sites and so inclusion of them would not significantly change the data.

The indicator was expanded in 2013 to include 3 wider landscape designations: Areas of Outstanding Natural Beauty (AONBs, England, Wales and Northern Ireland), National Scenic Areas (NSAs, Scotland), and National Parks (England, Scotland, Wales); In 2014 sites designated under the Convention on Wetlands of International Importance (Ramsar sites); and new Marine Protected Areas (MPAs) were added. In 2015, National Nature Reserves (NNRs) were added to the indicator.

In 2017 and 2018 calculations were re-run on the same basis, with extent calculations amended so that the program can be run either to end of calendar year, or to end of financial year. Amended weighting was used in the condition part of the indicator based on end of financial year extents for SACs and SPAs.

In 2019, the projection was changed to ETRS89 LAEA to better accommodate calculations on the furthest offshore sites. The differences due to the change in projection were calculated as minimal, and certainly not affecting the assessment of trend of the indicator. While drafting the fiche it was discovered that the 2018 results were in error due to a small shift in the spatial location of one of the designations when preparing the overlapping geometry, which led to an increase in the sum total area. This was corrected in the 2019 publication, but means that the results are not directly comparable with the previous publication.

In addition, in 2019, a change was made to a 'marine components approach'. Previously the split between marine and terrestrial was taken to be at the high-water mark. However, this meant that sites which straddle the high-water mark contributed to both the marine and terrestrial extent lines, regardless of what features they protect above or below high-water. From 2019, a marine 'components' approach has been implemented. This identifies which sites protect features (or 'components') in the marine environment (below high water), and therefore qualify the site as a marine protected area. Sites which straddle the high-water mark continue to contribute to the terrestrial line, but only those with marine components contribute to the marine line. The main change to the indicator is to the rise in the extent measures in 1980, which was due to the designation of 40 NSAs in Scotland. This rise now only occurs in the terrestrial extent line, as these sites are not considered to be marine protected areas, even though their boundaries are drawn to include areas below the high-water mark. The entire series has been recalculated, so this is consistent between years in the presentation in the 2019 publication.

In 2020 a bug was found when assigning designation dates to overlapping areas. Correcting this bug has increased the sum area for some earlier years.

In addition, in January 2020, the MHW coastline was updated with the latest data from the Ordnance Survey MasterMap dataset resulting in changes to inshore and land areas for sites that overlap MHW. This would have changed the balance between on-land and at-sea measures in the historic series, so has only been applied to data from 2019 onwards.

The timestamp for the extent data in 2021 is:

- terrestrial sites as at 31 March 2021.
- marine sites as at 31 March 2021.

The program can be run using different sets of inputs, which allows for the net extent per year to be calculated for different combinations of site types. Thus Table C1i in the fiche is based on all site types included in the indicator, and Table C1ii is based on a more restricted set to show the difference that including the wider landscape sites makes. Similarly just using SACs as an input parameter allows calculations of the extent of just that site type (used for weighting one of the background condition charts).

Calculation of the condition measure C1c

Requirement:

Production of a UK indicator, based on country results which allows a trend to be assessed and reported on in the 2010 and subsequent publications of Biodiversity In Your Pocket (BIYP) – subsequently renamed UK Biodiversity Indicators (UKBI).

A/SSSI sites can be designated for biological features (species or habitats), or geological features (e.g. fossils, or particular rock types / formations), or may have a mix of both biological and geological features. As this is a set of biodiversity indicators, measure (c) is intended to focus on the biological features, and therefore should be weighted by the sites designated for those features (i.e. biological or mixed sites).

The indicator presented in BIYP 2009 showed countries separately, in comparison with the 2006 results from the Common Standards Monitoring (CSM) report. A method was needed to create a single column of data for each year for which the results could be presented so trends can be assessed.

A report on the CSM programme was published by JNCC in 2006 based on data to the end of March 2005. Since then the countries of the UK have continued to evaluate the effectiveness of site management, but have customised their approach to national circumstances. In England, assessments are undertaken on management units – the parcels of land into which sites are split. In Scotland, Wales and Northern Ireland assessments are undertaken on a feature by feature basis.

Constraints:

- The UK indicator needs to be based on country level assessments of the condition of protected areas and the features on them.
- England are only able to provide data based on area assessments.
- The other countries provide data based on features.
- Wales do not have figures for SSSIs.

Assumptions:

- All necessary quality assurance has been done by countries.
- Combination of area data and feature number data (as percentages) does not lead to a significant bias in the results.
- There is no mathematical reason why percentages can't be combined.
- Data for the countries should be combined in proportion to the resource in each country.

Calculation (for each year)

Step 1. Data on the area of biological and mixed biological/geological A/SSSI sites are sourced (see notes below: as these are biodiversity indicators it was felt appropriate to

exclude geological only sites). Extent data for SACs and SPAs are calculated using the same program as that used for the extent measures, but just for one site type.

Step 2. This allows calculation of the proportion of the site networks in each country.

Step 3. Data on the percentage of each site type in favourable condition or in unfavourable-recovering condition are provided by each country.

Step 4. The proportion of the site network in favourable or unfavourable-recovering condition is multiplied by the area of that site network in a country to create an area equivalent (i.e. the area favourable or area recovering for a country for each of A/SSSI, SAC or SPA).

Step 5. The area calculated in step 4 is divided by the total area of the site type, to create a weighted proportion of the site type for the UK from that country. Note that as Wales do not provide SSSI monitoring data, the area of Welsh SSSIs is subtracted from the total area of A/SSSIs in the division above – as otherwise it would be impossible for the indicator to reach 100%.

Step 6. The percentage for each country is summed to provide a composite figure for the UK for a site type, which is then graphed (i.e. graphs for favourable plus unfavourable-recovering for each of A/SSSI, SAC, and SPA).

Changes over time

When the indicator was first developed it was recognised that the weighting would need to vary from year to year, as although A/SSSIs underpin most of the SACs and SPAs, the number and extent of all of these designations varies by country, and depending on when sites were designated, the proportion of a site type in each country can vary year to year.

Up to the 2014 publication, SNCBs (NE, NRW, SNH, NIEA) were requested, in parallel with providing the percentage of favourable and unfavourable-recovering for A/SSSI, SAC and SPA, to also provide figures for the extent of those networks in their country – to be used in the weighting. For the A/SSSIs they were requested to provide the figure for biological or mixed A/SSSIs.

In 2015, the weightings for the 2 background graphs (Figures C1iv and C1v, showing the condition of SACs and SPAs) were changed. The program used for measures (a) and (b) was used for a single site type – that is, just SACs or just SPAs to produce a set of extent figures for those site types, and those data used to weight the condition data for the background graphs. This was seen as a step forwards, as it provided a consistent way for calculating the extent of the SAC/SPA features in each country. The weighting used was for the terrestrial and inshore parts of the site networks, excluding offshore sites. An analysis of the changes that it would cause compared to the weightings previously provided by the countries was undertaken, and it was agreed within the indicator project group that although there were differences they were minor (less than one per cent different from the figures previously published). For the A/SSSI sites the data provided by the SNCBs continued to be used.

In 2015, the program used for measures (a) and (b) worked by calendar year – that is, the figure provided for a year is as at the end of that year. Because the condition data are as at the end of March (for all years but 2), the weighting actually used in 2015 was offset to the end of the *previous* calendar year – that is, the weighting used for March 2005 was the site extent at the end of 2004. This was because the end of the previous year is closer to the date of the condition data than the end of the actual calendar year of the extent data (e.g. December 2005).

While developing the information request for condition data for 2016 and 2017, an error in the underpinning spreadsheet was identified for the values previously published in 2015 for SACs and SPAs for 2014 and 2015. A correction was implemented on the JNCC website and the Biodiversity Indicators Steering Group were informed.

In 2017, this weighting was adjusted to the end of financial year (except for 2006 and 2008) to match the end of financial year date stamp of the condition data. This allows the values used for the weighting to be better matched to the condition data.

For A/SSSIs the weighting for Scotland, Wales and Northern Ireland was based on an analysis of the shapefiles for the A/SSSI sites, filtering out geological only sites, and calculating a pivot table of area designated per month, which then allowed a cumulative area to be calculated, and the weighting value for end of March (or December for 2006 and 2008) in a year identified. Note that this is not as simple as just a query on March of a year, as it depends on the designation date of sites – in some cases there were no sites designated in the first 3 months of a year, in which case the extent at the end of the previous financial year is the nearest appropriate value to use for the weighting. For England this was not possible, so the data provided by Natural England were used.

For SACs and SPAs the amended extent program was used as in 2015, but with calculations undertaken to end of March (except for 2006 and 2008 which were to end of December to match the time stamp of the condition data). In undertaking the analysis a further systematic error in the calculations for 2009 and 2010 was identified. This was as a result of an incorrect total area for the SAC and SPA site types. However, the differences caused were less than one percentage point.

To understand the impact of these potential variations, the UK condition percentages calculated from the different options were compared to the data published in 2015. The changes are mostly very small, and all are under one percentage point. These weightings make 'real world' sense, and accordingly it was decided by the indicator project group to implement the change.

Note that these changes make no difference to the overall red / amber / green *assessment of change* for the headline measure for A/SSSIs, nor for the changes in the SAC and SPA background charts.

In 2018 and 2019, the weighting used for SACs and SPAs was by financial year (except for 2006 and 2008 as described above for 2017). For A/SSSIs it was possible to calculate the area of biological and mixed sites for all countries following a further data request to the SNCBs. This means that the weighting for all 3 condition graphs (Figures C1ii, C1iv and C1v) the weighting is by financial year and calculated using the program used for measures C1a and C1b. Figures previously used were not recalculated, but could be if it was considered to be advantageous.

Example calculation

row / column	A	B	C	D	E	F						
1	Data at 31-3-2005					Green cells to be edited for 2005						
2	Country	England	Scotland	NI	Wales	UK totals (net) overlap considered (excluding offshore)						
3	Area SSSI total	1,072,475	958,416	91,853	256,608	2,379,351						
4	Area SAC total	888,788	901,166	53,935	591,609	2,435,497						
5	Area SPA total	636,460	603,089	72,155	136,838	1,448,542						
6	UK % SSSI	45.07%	40.28%	3.86%	10.78%							
7	UK % SAC	36.49%	37.00%	2.21%	24.29%							
8	UK % SPA	43.94%	41.63%	4.98%	9.45%							
9	% SSSI fav	45.02%	62.35%	63.80%	Not available							
10	% SSSI rec	22.34%	4.95%	4.00%	Not available							
11	% SAC fav	36.25%	58.90%	27.70%	24.30%							
12	% SAC rec	23.82%	9.40%	18.50%	16.60%							
13	% SPA fav	42.96%	77.58%	79.40%	85.70%							
14	% SPA rec	19.0%	2.6%	0.0%	0.0%							
15	UK SSSI fav	482,828	597,572	58,602		1,139,003	F+UR					
16	UK SSSI rec	239,591	47,442	3,674		290,707		1,429,709	67.35%			
17	UK SAC fav	322,179	530,787	14,940	143,761	1,011,666						
18	UK SAC rec	211,674	84,710	9,978	98,207	404,568		1,416,234	58.15%			
19	UK SPA fav	273,428	467,876	57,291	117,270	915,866						
20	UK SPA rec	120,727	15,801	0	0	136,528		1,052,394	72.65%			
21	% UK SSSI fav	22.75%	28.15%	2.76%	0.00%	53.66%						
22	% UK SSSI rec	11.29%	2.23%	0.17%	0.00%	13.69%						
23	% UK SAC fav	13.23%	21.79%	0.61%	5.90%	41.54%						
24	% UK SAC rec	8.69%	3.48%	0.41%	4.03%	16.61%						
25	% UK SPA fav	18.88%	32.30%	3.96%	8.10%	63.23%						
26	% UK SPA rec	8.33%	1.09%	0.00%	0.00%	9.43%						
	Green cells = data provided by Country Conservation Bodies (Steps 1 and 3)											
	Figures for SAC and SPA area altered 2017 to use the same method as the extent indicator, but with figures for a year aligned to the end of March											
	A/SSSI values edited in 2017 to be based on an analysis of which sites are flagged by the SNCBs as biological or mixed in the A/SSSI data downloadable from their websites. England data based on area provide by NE.											

Step 1. Area of biological and mixed sites calculated from shapefiles.

Total areas for a site type e.g. F3 = Sum (B3:E3)

Step 2. Proportion of site type in a country. e.g. E6 = E3/F3

Step 3. Proportion of sites by area or by features provided to JNCC by the Country Conservation Bodies

Column F is a sum of the area in favourable or recovering condition. e.g. F15 = Sum (B15:E15)

Step 4. Cells are a calculation of the area in favourable or recovering condition. e.g. C17 = C4*C11

Step 6. Column F is a sum of the percentage in favourable or recovering condition. e.g. F21 = Sum (B21:E21)

Step5. Cells are a calculation of the proportion of the UK area in favourable or recovering condition, by taking the area in favourable condition and dividing by the total area for a site type in the UK. e.g. B24 = B18/F4. Note that for rows 21 and 22 a slight alteration to the formula is used to account for Wales not having provided SSSI condition results: the total used for the division is the total area of A/SSSIs in England, Scotland and Northern Ireland, i.e. excluding Wales e.g. B21 = B15 / (F3-E3)