

Forestry Statistics 2023

Chapter 4: Carbon

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The Research Agency of the
Forestry Commission

Forest Research is the Research Agency of the Forestry Commission and is the leading UK organisation engaged in forestry and tree related research.

The Agency aims to support and enhance forestry and its role in sustainable development by providing innovative, high quality scientific research, data, technical support and consultancy services.

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Introduction

This chapter contains information on:

- carbon in forests;
- carbon sequestration;
- the Woodland Carbon Code; and
- public attitudes to forestry and climate change.

Estimates for England, Wales, Scotland and Northern Ireland are included, where possible, in addition to UK totals. International comparisons of carbon stocks are provided in the International Forestry chapter. Further information on the data sources and methodology used to compile the figures is provided in the Sources chapter.

All of the statistics presented in this chapter have been previously released.

A copy of all carbon tables can be accessed in spreadsheet format from the [Data Downloads](#) page.

In addition to the statistics presented here, information on UK forests and climate change is available from [Combating Climate Change: a role for UK forests](#) (The Read Report), an independent assessment of the science published in November 2009.

Key findings

The main findings are:

- The total carbon stock in UK forests is estimated to have increased, from around 3.2 billion tonnes of carbon dioxide equivalent in 1990 to 4.0 billion tonnes of carbon dioxide equivalent in 2020, of which 2.8 billion tonnes of carbon dioxide equivalent are in soils, 0.9 billion tonnes of carbon dioxide equivalent are in living woody biomass and the remainder is in deadwood and litter.
- Around one half (51%) of the total UK forest carbon stock in 2020 is in Scotland (2.0 billion tonnes of carbon dioxide equivalent), 36% in England (1.5 billion tonnes), 8% in Wales (0.3 billion tonnes) and 4% in Northern Ireland (0.2 billion tonnes).
- The net annual rate of carbon dioxide accumulation by UK forests is projected to fall from around 18 million tonnes CO₂ in total in 2020 to around 10 million tonnes CO₂ by 2040.
- A total of 451 projects had been validated to the Woodland Carbon Code in the UK at 31 March 2023, covering over 24 thousand hectares and projected to sequester 8.5 million tonnes of carbon dioxide over their lifetime.
- Around four fifths (7.1 million tonnes) of projected carbon dioxide sequestration by Woodland Carbon Code projects is in Scotland, 1.2 million tonnes in England, 0.3 million tonnes in Wales and 11 thousand tonnes in Northern Ireland.

4.1 Forest carbon stock

Forest carbon stock is the amount of carbon that has been sequestered from the atmosphere and is now stored within the forest ecosystem, mainly within living biomass and soil, and to a lesser extent also in dead wood and litter.

Table 4.1a presents modelled estimates of UK forest carbon stock that were compiled for submission to international organisations. The total carbon stock stored within UK forests is estimated to have increased, from around 3.2 billion tonnes of carbon dioxide equivalent in 1990 to 4.0 billion tonnes of carbon dioxide equivalent in 2020 (Table 4.1a). The carbon stored in forest soils accounts for around 70% of total forest carbon stock.

Table 4.1a Forest carbon stock, UK, 1990 to 2020

Carbon stock	million tonnes of carbon dioxide equivalent ¹				
	1990	2000	2010	2015	2020
Carbon in above-ground biomass	376	482	586	630	674
Carbon in below-ground biomass	135	174	211	227	242
Carbon in dead wood	130	138	143	147	149
Carbon in litter	165	175	182	188	190
Soil carbon ^{2,3}	2,366	2,533	2,629	2,726	2,761
Total forest carbon	3,172	3,502	3,750	3,918	4,016

Source: Forest Research

Notes

1. To convert tonnes carbon dioxide equivalent (CO₂e) to tonnes carbon (C), multiply by 12/44.
2. Carbon in soil to a depth of 0 to 100 cm.
3. Changes in soil carbon stocks over the period can be attributed to changes in UK forest area.

These figures are outside the scope of National Statistics. For further information see the Sources chapter.

Around one half (51%) of the estimated total UK forest carbon stock in 2020 is in Scotland (2.0 billion tonnes of carbon dioxide equivalent), 36% in England (1.5

billion tonnes), 8% in Wales (0.3 billion tonnes) and 4% in Northern Ireland (0.2 billion tonnes).

Table 4.1b Forest carbon stock by country, UK, 2020

million tonnes of carbon dioxide equivalent¹

Carbon stock	England	Wales	Scotland	Northern Ireland	UK
Carbon in above-ground biomass	338	64	259	13	674
Carbon in below-ground biomass	122	23	93	5	242
Carbon in dead wood	61	14	68	5	149
Carbon in litter	80	18	85	7	190
Soil carbon ²	864	217	1,545	134	2,761
Total forest carbon	1,465	337	2,050	165	4,016

Source: Forest Research

Notes

1. To convert tonnes carbon dioxide equivalent (CO₂e) to tonnes carbon (C), multiply by 12/44.
2. Carbon in soil to a depth of 0 to 100 cm.

These figures are outside the scope of National Statistics. For further information see the Sources chapter.

4.2 Carbon sequestration

Forest carbon sequestration is the process of increasing the carbon content of the forest through processes that remove carbon dioxide from the atmosphere (i.e., photosynthesis). Once sequestered the carbon is stored in the forest within living biomass, soil and litter and contributes to the forest carbon stock. The forest carbon sink describes the natural reservoir that accumulates and stores sequestered carbon. The forest carbon sink is dynamic and can gain (e.g., sequestration by photosynthesis) and lose (e.g., emission by forest fires) carbon. The forest carbon sink is quantified as the net annual accumulation of carbon (carbon sequestration) by living biomass, soils and litter in forests.

The figures presented in Table 4.2 and Figure 4.2 represent the net annual accumulation of carbon dioxide by UK forests, taking into account carbon emissions due to timber harvesting, forest wildfires and deforestation. The figures in Tables 4.2 and 4.3 are restricted to woodland only. Carbon stored in harvested wood products (HWPs) is not included in these figures. However, carbon associated with HWPs is included in the [UK's greenhouse gas inventory statistics](#) and [energy and emissions projections](#).

The net annual rate of carbon dioxide accumulation by UK forests is projected to fall from around 18 million tonnes CO₂ in total in 2020 to around 10 million tonnes CO₂ by 2040 under a central scenario (Table 4.2 and Figure 4.1).

The projected decline in carbon accumulation from the 2010s to 2040s results from the age composition of UK forests (Figure 4.1). Many of the trees currently in UK forests were planted in the 1970s and 1980s (Figure 1.6) and are reaching economic maturity and being felled (and restocked). Since then, tree planting rates have fallen, resulting in an uneven age distribution today.

This uneven age distribution results in peaks and troughs in the level of carbon sequestration in UK forests over time, due to a changing balance between restocked young woodlands (following timber extraction) which grow relatively

more slowly, and more established woodlands which grow relatively more quickly during their active growth phase.

As a result, timber availability is forecast to increase over this period, and so the capacity of UK forests to sequester carbon dioxide is set to decline.

Table 4.2 Net annual change in forest carbon stocks (CO₂ equivalent)¹, UK, 1990 to 2050

million tonnes of carbon dioxide equivalent²

Year³	England	Wales	Scotland	Northern Ireland	UK
1990	6.1	1.5	6.8	0.6	15.0
1995	7.0	1.6	7.4	0.6	16.5
2000	7.9	1.6	8.1	0.6	18.2
2005	8.2	1.6	8.5	0.6	19.0
2010	8.5	1.6	8.7	0.6	19.5
2015	8.3	1.2	8.0	0.6	18.2
2020	8.2	1.2	7.6	0.6	17.5
2025	7.6	1.3	6.2	0.5	15.6
2030	6.8	1.3	4.1	0.5	12.8
2035	5.9	1.5	2.9	0.5	10.8
2040	5.0	1.6	2.6	0.6	9.8
2045	4.2	1.7	3.3	0.6	9.8
2050	3.8	1.6	4.6	0.5	10.6

Source: UK Greenhouse Gas Inventory (2020).

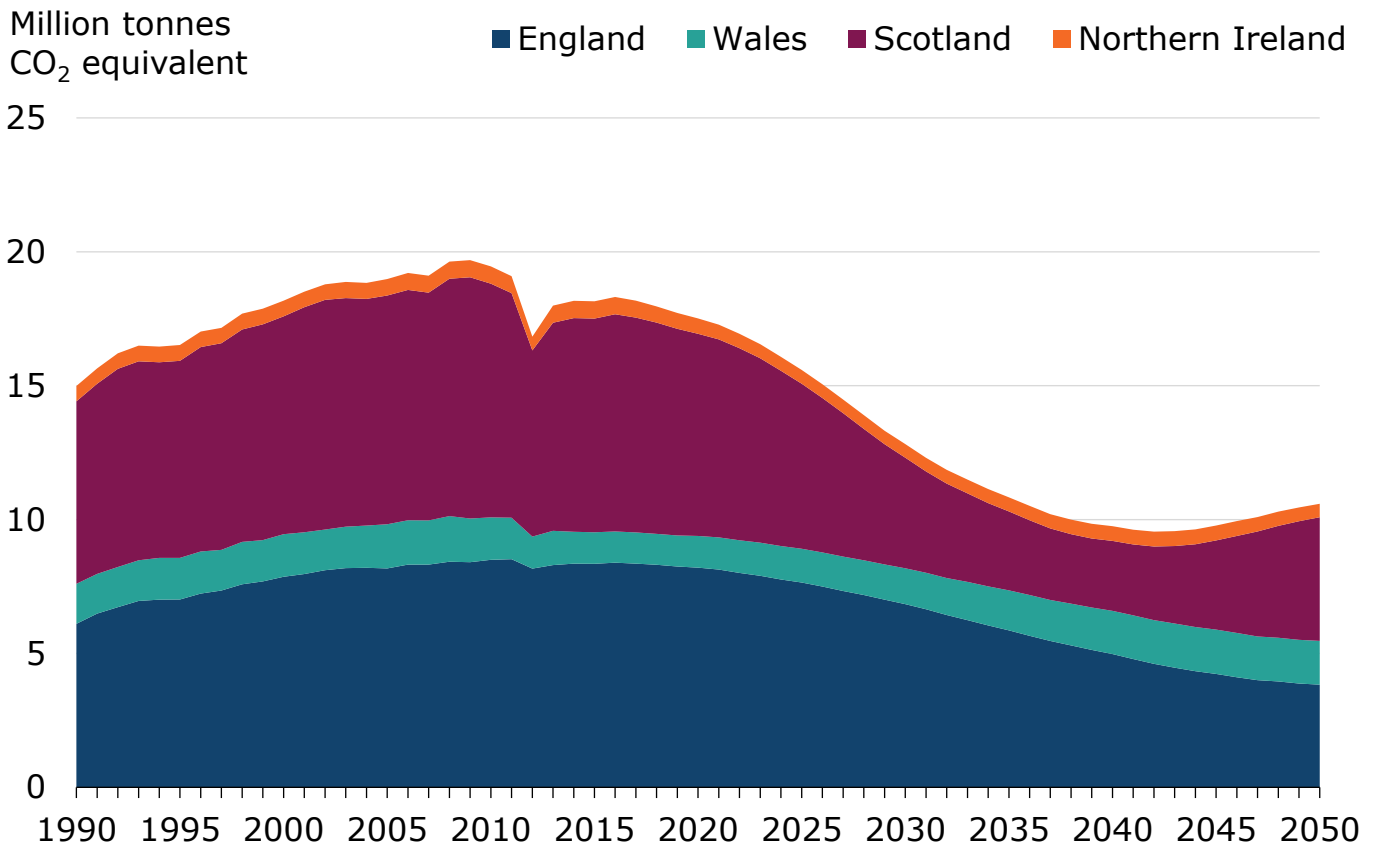
Notes:

1. Net annual accumulation of carbon in forests by woody biomass, soils and litter. Adjusted for losses from deforestation and forest wildfires. Excludes changes in UK harvested wood products.
2. Emissions and sequestration can be presented as tonnes carbon or tonnes carbon dioxide (CO₂). To convert from tonnes CO₂ to tonnes carbon multiply by 12/44.
3. Future predictions of carbon uptake assume that commercial conifer plantations will be replanted when felled. Planting of new woodland follows [a central projection](#) whereby current planting is

maintained to 2021 (2024 in England), after which it is assumed grant-aided planting is reduced to 10% of this rate for the remainder of the period to 2050. The central scenario is based on confirmed policies and funding that was in place in June 2019 continuing at the same rate into the future, which may no longer be representative of current policy.

These figures are outside the scope of National Statistics. For further information see the Sources chapter.

Figure 4.1 Net annual change in forest carbon stocks (CO₂ equivalent), UK, 1990 to 2050



Source: UK Greenhouse Gas Inventory (2020), National Atmospheric Emissions Inventory.

Notes:

1. Net annual accumulation of carbon in forests by woody biomass, soils and litter. Adjusted for losses from deforestation and forest wildfires. Excludes changes in UK harvested wood products.
2. Emissions and sequestration can be presented as tonnes carbon or tonnes carbon dioxide (CO₂). To convert from tonnes CO₂ to tonnes carbon multiply by 12/44.
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These figures are outside the scope of National Statistics. For further information see the Sources chapter.

4.3 Woodland Carbon Code

The Woodland Carbon Code is a voluntary standard, introduced in July 2011, for woodland creation projects that make claims about the carbon they sequester (take out of the atmosphere).

All projects must be placed on the [UK Land Carbon Registry](#). Their claims about potential carbon sequestration are validated by an independent certification body. Validated projects are then verified on a regular basis to confirm the progress of carbon sequestration.

Further information on Woodland Carbon Code projects is provided in the Sources chapter.

Table 4.3a provides annual data on projects registered under the Woodland Carbon Code. The table provides information on the cumulative number of projects, area of woodland covered by the projects and the total projected carbon sequestration over the lifetime (up to 100 years) of the projects.

A total of 451 projects had been validated (including those that had also been verified) to the Woodland Carbon Code at 31 March 2023, covering over 24 thousand hectares and projected to sequester 8.5 million tonnes of carbon dioxide over their lifetime (Table 4.3a).

A total of 1,916 projects were registered under the Woodland Carbon Code at 31 March 2023, covering around 70 thousand hectares of woodland and projected to sequester 22.9 million tonnes of carbon dioxide (Table 4.3a).

Table 4.3a Cumulative number, area and projected carbon sequestration of Woodland Carbon Code projects¹, UK, 2019 to 2023

	Verified ¹	Validated only ¹	Awaiting validation	Total
Number of projects				
March 2019	70	117	79	266
March 2020	88	151	124	363
March 2021	94	208	406	708
March 2022	119	247	1,168	1,534
March 2023	124	327	1,465	1,916
Area of woodland (hectares)				
March 2019	2,404	5,856	9,134	17,394
March 2020	2,633	9,372	2,962	14,967
March 2021	2,841	12,281	16,662	31,785
March 2022	4,416	14,128	40,905	59,449
March 2023	4,640	19,703	46,055	70,399
Projected carbon sequestration² (thousand tonnes of carbon dioxide equivalent)				
March 2019	1,093	2,331	2,760	6,184
March 2020	1,207	3,480	1,121	5,809
March 2021	1,299	4,442	5,368	11,109
March 2022	1,927	4,927	11,860	18,714
March 2023	2,015	6,525	14,408	22,948

Source: Provisional Woodland Statistics 2023

Notes:

1. Projects can be validated/verified individually or come together as part of a group. The statistics presented here show the number of projects validated or verified whether they were put through the process individually or as part of a group.
2. Figures for carbon sequestration indicate the total projected sequestration of the projects over their lifetime of up to 100 years, and include the amount claimable by a project plus the amount allocated to a shared "buffer" in case of unanticipated losses.

Awaiting validation: when a project or group is undergoing assessment by a certification body.

Validated: the initial evaluation of a project or group against the requirements of the Woodland Carbon Code. Upon completion a project/group will receive a 'Validation Opinion Statement'. The project/group will then be certified for a period of up to 5 years.

Verified: Verification is the evaluation of a project as it progresses to confirm the amount of CO₂ sequestered to date as well as that it continues to meet the requirements of the Code.

These figures are outside the scope of National Statistics. For further information see the Sources chapter.

Together, all validated (including verified) projects were predicted to sequester 7,060 thousand tonnes of carbon dioxide in Scotland, 1,193 thousand tonnes in England, 276 thousand tonnes in Wales and 11 thousand tonnes in Northern Ireland over their lifetime (Table 4.3b and Figure 4.2).

Table 4.3b Number, area and projected carbon sequestration of Woodland Carbon Code projects¹, UK, 31 March 2023

	England	Wales	Scotland	Northern Ireland	UK
Number of projects					
Awaiting validation	596	220	523	126	1,465
Validated only	77	30	218	2	327
Verified	46	6	71	1	124
Total validated ²	123	36	289	3	451
Total	719	256	812	129	1,916
Area of woodland (hectares)					
Awaiting validation	6,742	2,101	36,377	835	46,055
Validated only	1,659	592	17,438	15	19,703
Verified	705	131	3,796	9	4,640
Total validated ²	2,364	723	21,234	23	24,344
Total	9,106	2,824	57,611	858	70,399
Projected carbon sequestration³ (thousand tonnes of carbon dioxide equivalent)					
Awaiting validation	2,775	736	10,539	359	14,408
Validated only	808	207	5,501	8	6,525
Verified	384	69	1,559	3	2,015
Total validated ²	1,193	276	7,060	11	8,540
Total	3,967	1,012	17,599	370	22,948

Source: Provisional Woodland Statistics 2023

Notes:

1. Projects can be validated/verified individually or come together as part of a group. The statistics presented here show the number of projects validated or verified whether they were put through the process individually or as part of a group.
2. All validated projects, including those that have also been verified.
3. Figures for carbon sequestration indicate the total projected sequestration of the projects over their lifetime of up to 100 years, and include the amount claimable by a project plus the amount allocated to a shared "buffer" in case of unanticipated losses.

Awaiting validation: when a project or group is undergoing assessment by a certification body.

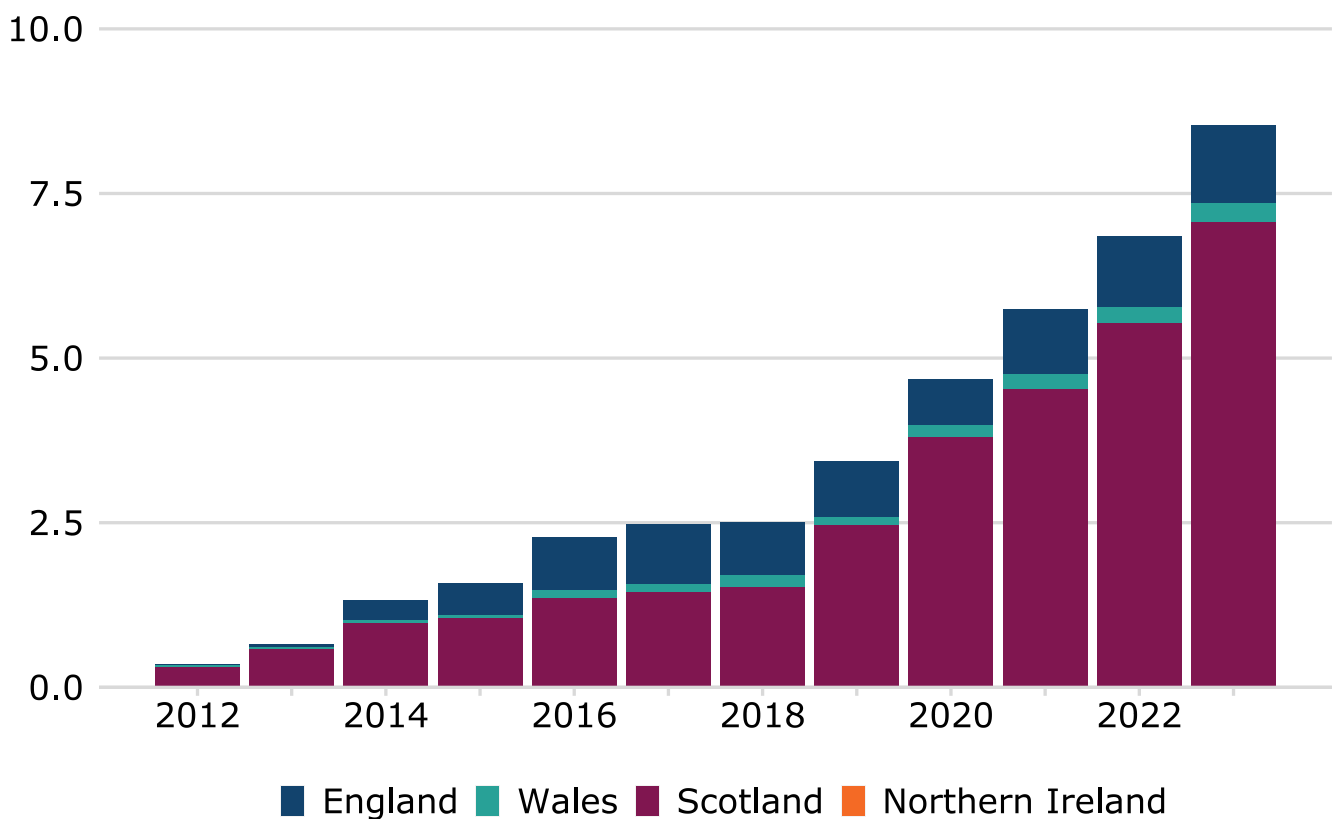
Validated: the initial evaluation of a project or group against the requirements of the Woodland Carbon Code. Upon completion a project/group will receive a 'Validation Opinion Statement'. The project/group will then be certified for a period of up to 5 years.

Verified: Verification is the evaluation of a project as it progresses to confirm the amount of CO₂ sequestered to date as well as that it continues to meet the requirements of the Code.

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Figure 4.2 Cumulative projected carbon sequestration¹ of validated Woodland Carbon Code projects^{2,3} by country, UK, 2012 to 2023

Million tonnes of carbon dioxide equivalent (CO₂e)



Source: Provisional Woodland Statistics 2023

Notes:

1. Figures for carbon sequestration indicate the total projected sequestration of the projects over their lifetime of up to 100 years, and include the amount claimable by a project plus the amount allocated to a shared "buffer" in case of unanticipated losses.
2. Projects can be validated/verified individually or come together as part of a group. The statistics presented here show the number of projects validated or verified whether they were put through the process individually or as part of a group.
3. All validated projects, including those that have also been verified.

Awaiting validation: when a project or group is undergoing assessment by a certification body.

Validated: the initial evaluation of a project or group against the requirements of the Woodland Carbon Code. Upon completion a project/group will receive a 'Validation Opinion Statement'. The project/group will then be certified for a period of up to 5 years.

Verified: Verification is the evaluation of a project as it progresses to confirm the amount of CO₂ sequestered to date as well as that it continues to meet the requirements of the Code.

4.3 Public attitudes to climate change issues

Forest Research has conducted surveys of public attitudes to forestry and forestry-related issues every two years since 1995. The most recent [Public Opinion of Forestry surveys](#) were conducted in 2023.

In the UK survey in 2023, questions were asked to gauge the public's agreement on climate change issues, including on the management of UK forests in response to the threat of climate change (Table 4.4). Some of the public views presented below do not reflect expert opinion.

There were high levels of agreement (respondents stating that they agreed or strongly agreed) with the statements:

- "A lot more trees should be planted", supported by 84% of the UK public in 2023; and
- "Different types of trees should be planted that will be more suited to future climates", supported by 72% in 2023.

Conversely, there were much lower levels of agreement with the statements:

- "No action is needed", supported by 9% in 2023; and
- "Trees should not be felled under any circumstances, even if they are replaced", supported by 25% in 2023.

Table 4.4 Respondents views on the management of forests in response to the threat of climate change, UK, 2015 to 2023

percent of respondents who agree or strongly agree

Statement	2015	2017	2019	2021	2023
A lot more trees should be planted	80	84	88	83	84
Different types of trees should be planted that will be more suited to future climates	67	76	78	72	72
Trees should not be felled in any circumstances, even if they are replaced	25	26	29	36	25
No action is needed	22	24	26	30	9

Source: Public Opinion of Forestry 2023: UK Survey.

Base: Results for 2015, 2017 and 2023 are based on all respondents: 1,804 (2015), 2,113 (2017), 11,055 (2023). Results for 2021 are based on respondents who visited woodland in the last few years (3,557).

Notes:

1. Given the change in base, the results from the 2021 survey are not directly comparable with other years.
2. The range of uncertainty around any result should be no more than $\pm 3.5\%$ for surveys with around 2,000 respondents, no more than $\pm 2.5\%$ in 2021 and no more than $\pm 1.4\%$ in 2023.
3. To compare results over time, a difference of at least 5 percentage points is required to indicate that there is a significant difference.
4. In earlier surveys, the "No action is needed" option was given as "No action is needed, let nature take its course".

These figures are outside the scope of National Statistics. For further information see the Sources chapter.

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