

D1. Biodiversity and ecosystem services

D1b. Removal of greenhouse gases by UK forests

Type: Benefit indicator

Summary

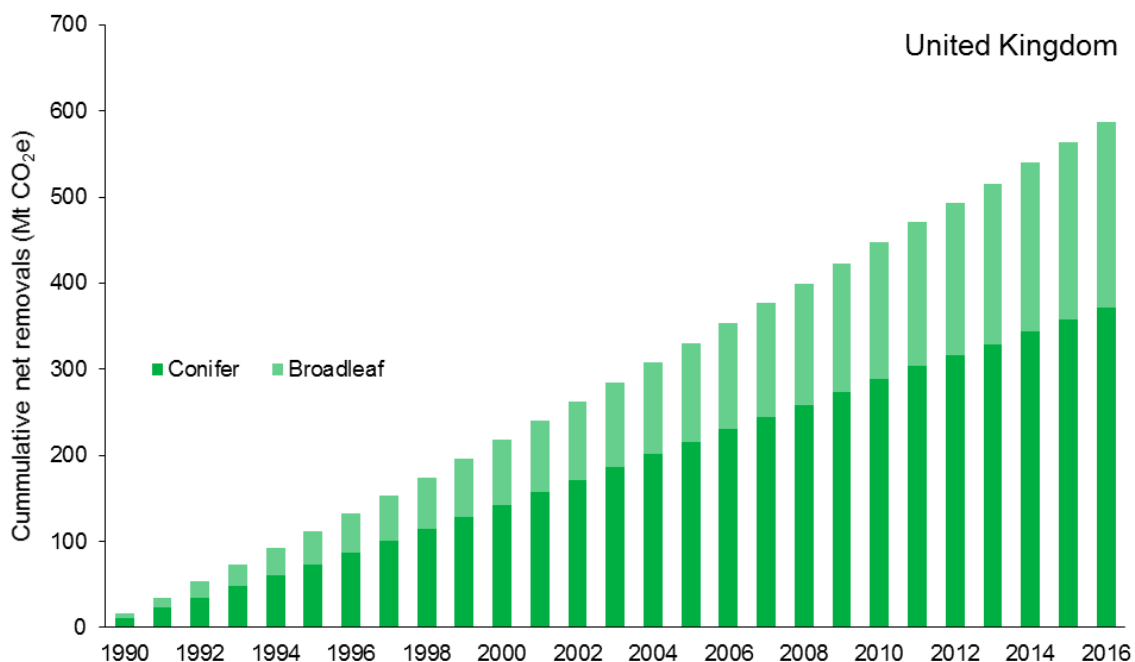
In 2016, forests in the UK are estimated to have removed the equivalent of 23.9 million tonnes (Mt) of carbon dioxide (CO<sub>2</sub>) from the atmosphere (Figure D1bii). Cumulatively, since 1990, the equivalent of 587 Mt of CO<sub>2</sub> has been removed by UK forests (Figure D1bi).

The proportion of removals by broadleaf woodland has increased since the time series began, accounting for 41% (9.8 Mt) of the estimated removals in 2016 compared to 34% (5.9 Mt) of the removals in 1990 (Figure D1bii).

Indicator Description

Forests are a large store of carbon and also act as an active carbon 'sink', removing carbon dioxide (CO<sub>2</sub>), a greenhouse gas, from the atmosphere and storing it as carbon in living biomass, leaf litter and forest soil. This sequestration of CO<sub>2</sub> is an essential ecosystem service. This indicator shows the cumulative net removal of greenhouse gases from the atmosphere by UK forests since 1990. It is split between type of woodland (coniferous and broadleaf). Showing greenhouse gas removals by type of woodland is interesting from a biodiversity perspective as it allows a clearer presentation of the contribution made to greenhouse gas removals by broadleaf woodland, most of which constitutes priority habitat.

Figure D1bi. Cumulative net removals of greenhouse gases by UK forests, 1990 to 2016.





Notes:

1. The bar graph shows the cumulative net removals of greenhouse gases (carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)) from the atmosphere by forests in the UK, expressed as million tonnes of CO<sub>2</sub> equivalent (Mt CO<sub>2</sub>e).
2. Revised in 2015 to reflect improved modelling of greenhouse gas emissions and removals.
3. Revised in 2017 due to improvements made to the forestry sector of the 1990 to 2015 Land Use, Land Use Change and Forestry greenhouse gas inventory.

- Revised in 2018 due to improvements in the 'CARBINE' model used to calculate the forest carbon stock figures for the 1990 to 2016 Land Use, Land Use Change and Forestry greenhouse gas inventory (see background section for more details). These results are therefore not directly comparable with those in previous publications.

**Source:** BEIS Land Use, Land Use Change and Forestry greenhouse gas inventory.

Assessment of change in cumulative net removal of greenhouse gases			
	Long term	Short term	Latest year
Cumulative net removal of greenhouse gases by forests	 1990–2016	 2011–2016	Increased (2016)

### Indicator description

The data presented here are from the UK's Land Use, Land Use Change and Forestry (LULUCF) greenhouse gas inventory, which provides estimates of the annual rate of emissions and removals of greenhouse gases (carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)) from the atmosphere by forests in the UK between 1990 and 2016 (Figures D1bi and D1bii). LULUCF emissions and removals are given in terms of carbon dioxide equivalent (CO<sub>2</sub>e). The CO<sub>2</sub>e of a mixture of greenhouse gases is the quantity of CO<sub>2</sub> that would have the same global warming potential.

### Relevance

The benefits that humans receive from the environment have become more widely recognised. The Millennium Ecosystem Assessment and the more recent UK National Ecosystem Assessment both highlighted that ecosystems and the services they deliver underpin our very existence. We depend on them to produce our food and timber, regulate water supplies and climate, and breakdown waste products. We also value them in less obvious ways: contact with nature gives pleasure, provides recreation and is known to have a positive impact on long-term health and happiness. Measuring the status of ecosystem services is therefore a critical aim of the indicator set. Greenhouse gas removal is a regulating service that contributes to reducing the scale and future impacts of climate change (climate change mitigation).

### Background

National Inventories of human-induced sources and sinks of greenhouse gases are submitted by Parties, including the UK, to the United Nations Framework Convention on Climate Change (UNFCCC) every year. This system was set up to meet the reporting obligations of the Convention and is used to report on progress in meeting Kyoto Protocol commitments. The Kyoto Protocol, which entered into force in 2005, obliges industrialised countries that have ratified the accord to reduce their emissions of 6 greenhouse gases, the major contributors being CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O. The LULUCF greenhouse gas inventory covers emissions and removals of these 3 greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities. The LULUCF estimates are compiled for the Department of Business, Energy & Industrial Strategy (BEIS) by the Centre for Ecology & Hydrology (CEH) and Forest Research (FR).

The forestry figures in the 1990 to 2016 LULUCF inventory have been revised and therefore figures presented here are not directly comparable to those in previous publications. These

revisions are due to improvements in the 'CARBINE' model used for calculating changes in forest carbon stocks that include:

- The inclusion of in-year turnover of standing tree carbon (e.g. fine roots);
- An improvement to the soil and litter model that now assumes there is a quantity of litter input to the soil from non-tree vegetation when the forest canopy is not fully closed;
- An adjustment to the soil model to incorporate all the organic matter transfer to the soil in order to avoid over-estimates of soil carbon accumulation if decomposition losses to the atmosphere are omitted; and
- The inclusion of roots in the litter/dead carbon pool.

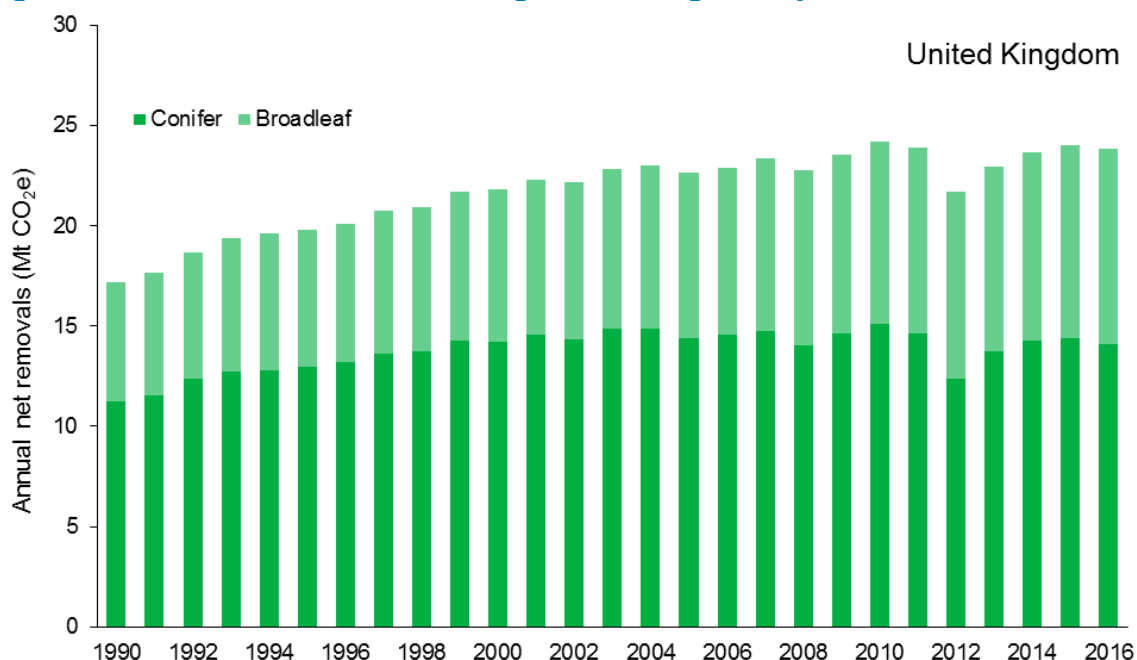
The area of recent afforestation has also been updated to bring it more in to line with the new planting statistics - small woods and some of the main National Forest Inventory areas are now assumed to be older than previously thought.

The result of these model changes is an increase in both the broadleaf and coniferous forest sinks for all years between 1990 and 2015. More specifically, increases to the broadleaf sink were more pronounced in the earlier years of the time series, whereas increases to the coniferous sink were more pronounced in later years.

Figure D1bii shows the annual breakdown of the cumulative removals shown in Figure D1bi. Although the indicator is assessed as improving in both the long term and short term since cumulative greenhouse gas removals have continued to increase, it should be noted that annual rates of removal have remained relatively static in recent years. It is also worth noting that the proportion of removals attributed to broadleaf woodland has been steadily increasing since 2007.

Showing greenhouse gas removals by type of woodland is interesting from a biodiversity perspective as it allows a clearer presentation of the contribution made to greenhouse gas removals by broadleaf woodland, most of which constitutes priority habitat.

**Figure D1bii. Annual net removals of greenhouse gases by UK forests, 1990 to 2016.**



**Notes:**

1. Annual net removals of greenhouse gases (carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O)) from the atmosphere by forests in the UK, expressed as million tonnes of CO<sub>2</sub> equivalent (Mt CO<sub>2</sub>e).

2. The step change in 2012 arises from modelling challenges in matching estimates of wood production. The National Forest Inventory has a base year of 2011 and prior to this the felled area is constrained based on wood production. After the base year the felled area is driven by rotation lengths and the assumed percentage of forest managed for no-thin or no-fell. One of the aims for the next inventory is to develop a robust methodology to smooth these transitions.
3. Revised in 2015 to reflect improved modelling of greenhouse gas emissions and removals.
4. Revised in 2017 due to improvements made to the forestry sector of the 1990 to 2015 Land Use, Land Use Change and Forestry greenhouse gas inventory.
5. Revised in 2018 due to improvements in the 'CARBINE' model used to calculate the forest carbon stock figures for the 1990 to 2016 Land Use, Land Use Change and Forestry greenhouse gas inventory (see background section for more details). These results are therefore not directly comparable with those in previous publications.

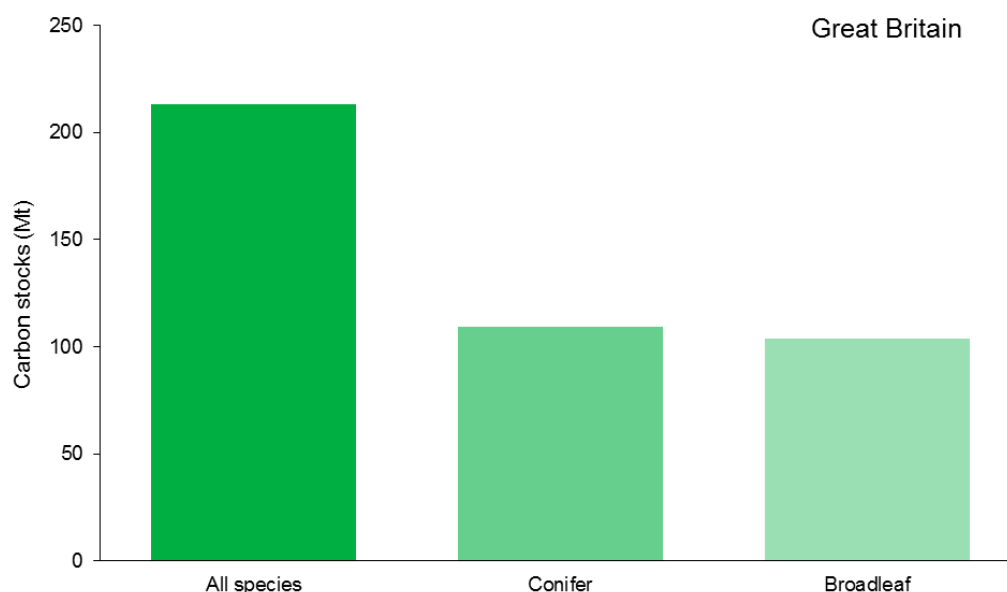
**Source:** BEIS Land Use, Land Use Change and Forestry greenhouse gas inventory.

### National Forest Inventory

The estimated carbon stock of trees in Great Britain (GB) can be used as a complementary measure of carbon storage. Information on current carbon stocks of forests in GB was first calculated in 2014 using [National Forest Inventory](#) (NFI) data, based on a sample of woodlands equal to or greater than 0.5 hectares in size.

The total carbon stock of all species of tree within forests in GB, at 31 March 2011, was estimated to be 213 million tonnes (Mt) of carbon, which is equivalent to 780 Mt of carbon dioxide (MtCO<sub>2e</sub>). Coniferous trees, with an estimated carbon stock of 109 Mt, are responsible for a slightly greater proportion of the total GB carbon stock than broadleaved trees, which are estimated to have a total stock of 104 Mt (Figure D1biii). This difference reflects the fact that in GB, the total 'growing stock volume' (as opposed to the total area) of coniferous woodland covered by the NFI is slightly greater than that of broadleaved woodland.

**Figure D1biii. Total carbon stocks in living coniferous and broadleaved woodland trees in Great Britain, as at 31 March 2011.**



**Note:** Total carbon in all living trees within woodlands of England, Scotland and Wales.

**Source:** National Forest Inventory (Forestry Commission).

Fieldwork for the current NFI began in 2009 and is being conducted on a 5 year cycle. The assessment of woodland carbon stocks from this inventory has formed a new baseline for carbon accounting within British forests and woodlands. Estimates of carbon stocks are determined by the total growing stock volume of woodland; a function of:

- Woodland area; and
- Woodland characteristics (e.g. number of trees, tree height and tree diameter) within this area.

Table D1bi shows a comparative representation of the estimated amount of carbon in living woodland trees in GB and in each of the 3 individual countries. England is estimated to have a total of 105 Mt of carbon in living trees (49% of the total for GB); Scotland is estimated to have 85 Mt (40% of GB); and Wales is estimated to have 22 Mt (10% of GB).

**Table D1bi. Total carbon stocks in coniferous and broadleaved woodland trees in England, Scotland, Wales and Great Britain as at 31 March 2011 (million tonnes of carbon)**

Species	England	Scotland	Wales	Great Britain
All conifers	27.7	70.0	11.5	109.2
All broadleaves	77.7	15.6	10.6	104.0
All species*	105.4	85.4	22.1	213.0

\* Totals may not add due to rounding.

These estimates of forest carbon stock are due to be updated by the Forestry Commission later in 2018. The current NFI fieldwork cycle began in 2015 and will run until 2020. The NFI assessment of woodland carbon stocks was used in the development of the reporting on [LULUCF emissions and removals](#). However, as there are differences in both the scope and the data sources used for LULUCF (sequestration) and NFI (stock) figures, they are not directly comparable. More information can be found in the [Forest Research Report](#) (PDF, 1.29Mb).

### Goals and targets

#### Aichi Targets for which this is a primary indicator

**Strategic Goal D.** Enhance the benefits to all from biodiversity and ecosystems.



**Target 14:** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.



**Target 15:** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

#### Aichi Targets for which this is a relevant indicator

**Strategic Goal B.** Reduce the direct pressures on biodiversity and promote sustainable use.



**Target 7:** By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

#### Web links for further information

Reference	Title	Website
Forestry Commission	Carbon in live woodland trees in Britain: National Forest Inventory Report	<a href="https://www.forestryresearch.gov.uk/documents/2726/FCNFI113.pdf">https://www.forestryresearch.gov.uk/documents/2726/FCNFI113.pdf</a> (PDF, 1.29 Mb)
	Understanding the carbon and greenhouse gas balance of forests in Britain	<a href="https://www.forestryresearch.gov.uk/documents/953/FCRP018.pdf">https://www.forestryresearch.gov.uk/documents/953/FCRP018.pdf</a> (PDF, 7.24 Mb)
Millennium Ecosystem Assessment	Millennium Ecosystem Assessment Reports	<a href="http://www.millenniumassessment.org/en/index.html">http://www.millenniumassessment.org/en/index.html</a>
National Atmospheric Emissions Inventory	LULUCF Greenhouse Gas Inventory	<a href="https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1804191054_ukghgi-90-16_Main_Issue1.1_UNFCCC.pdf">https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1804191054_ukghgi-90-16_Main_Issue1.1_UNFCCC.pdf</a> (PDF, 4.53Mb)
UK National Ecosystem Assessment	Home page	<a href="http://uknea.unep-wcmc.org/">http://uknea.unep-wcmc.org/</a>

Download [Datasheet](#)

**Last updated:** July 2018

**Latest data available:**

Greenhouse gas removals by UK forests (LULUCF) – 2016

Carbon stocks of forests in Great Britain (NFI) – 2011