

# 9. Biodiversity and ecosystem services: terrestrial

**Type:** Benefit indicator

## 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.

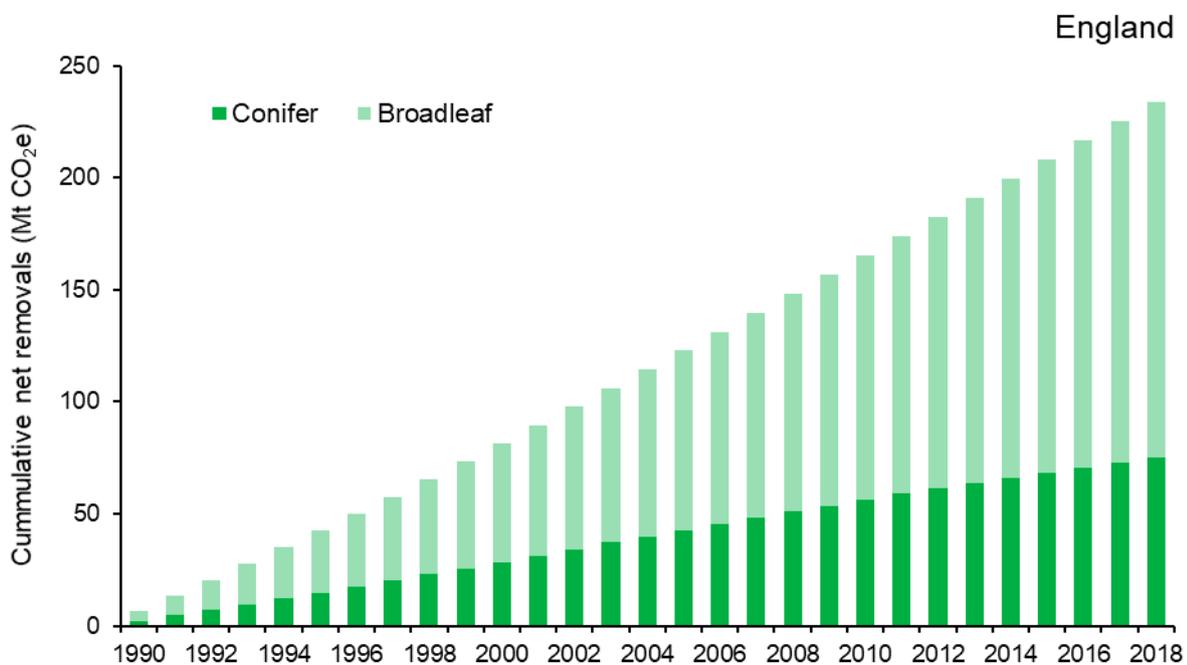
This indicator shows the cumulative net removal of greenhouse gases from the atmosphere by forests in England since 1990. It is split between type of woodland (conifer and broadleaf). Showing greenhouse gas removals by type of woodland is interesting from a biodiversity perspective as it allows a clearer presentation of the contribution made to greenhouse gas removals by broadleaf woodland, most of which constitutes priority habitat.

## Removal of greenhouse gases by forests in England

It is estimated that since 1990, forests in England have (cumulatively) removed the equivalent of 234 million tonnes of carbon dioxide (MtCO<sub>2</sub>e) from the atmosphere (Figure 9.1). In 2018, English forests are estimated to have removed 8.6 MtCO<sub>2</sub>e (Figure 9.2).

The proportion of greenhouse gasses removed from the atmosphere by broadleaf woodland has increased since the time series began; accounting for 75% (6.4 MtCO<sub>2</sub>e) of the estimated annual removals in 2018 compared to 65% (4.3 MtCO<sub>2</sub>e) of removals in 1990 (Figure 9.2).

**Figure 9.1: Cumulative net removals of greenhouse gases by forests in England, 1990 to 2018**



## Notes:

- Estimated 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).

- Revised in 2015 to reflect improved modelling of greenhouse gas emissions and removals.
- There were revisions to the forest category of LULUCF between the 1990 to 2017 and 1990 to 2018 inventories (see background section for more detail).
- Revised in 2019 and 2020 due to further improvements in the CARBINE model and forest planting and harvesting statistics (see background section for more details).
- These results are therefore not directly comparable with those in previous publications.

**Source:** Department of Business, Energy & Industrial Strategy (BEIS) – Land Use, Land Use Change and Forestry (LULUCF) greenhouse gas inventory.

## Indicator assessment

### Assessment of change in cumulative net removal of greenhouse gases by forests:

**Long term (1990 to 2018): Improving; Short term (2013 to 2018): Improving; Latest year (2018): Increased.**

**Note:** Long and short-term assessments are based on a 3% rule of thumb. The base years for these assessments use a 3-year average. See [Assessing Indicators](#).

## 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 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 2018 (Figures 9.1 and 9.2). 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 ecosystem service that contributes to reducing the scale and future impacts of climate change (that is climate change mitigation).

The indicator is relevant to outcomes 1 and 1c in [Biodiversity 2020, the strategy for England's wildlife and ecosystem services](#) (PDF 2.66 MB). The indicator is also relevant to international goals and targets (see Annex A and B of the aforementioned publication).

## Background

English forests are a large store of carbon and also act as an active carbon 'sink', removing 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.

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 for Business, Energy and Industrial Strategy (BEIS) by the UK Centre for Ecology & Hydrology (UKCEH) and Forest Research (FR).

The forestry figures in the 1990 to 2018 LULUCF inventory have been revised and therefore the figures presented here are not directly comparable to those in previous publications. The explanation of the changes can be found on p354 to 357 of the latest [National Inventory Report](#).

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

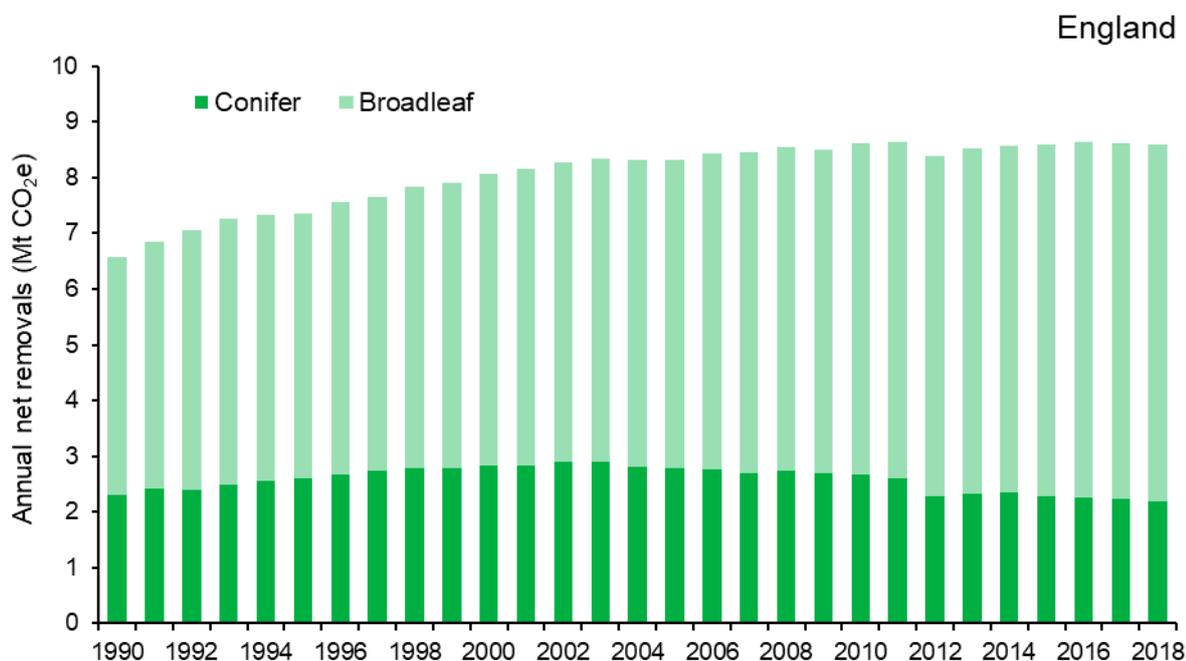
- Corrections to the double counting of litter and deadwood inputs;
- Correction of deadwood on deforested land not being reported; and
- Improvement to the foliage decay function;
- Improvement to the soil model.

There have also been improvements to the process for allocating forest management activities. These improvements have led to changes in assumptions about the proportions of forest area allocated to new planting and felling (harvesting) over time.

The result of these (and earlier) model changes is a decrease in both the broadleaf and conifer forest sinks for all years between 1990 and 2018. More specifically, decreases to the conifer sink were of a greater magnitude than those to the broadleaf sink and decreases to both sinks are more pronounced in the later years of the time series.

Figure 9.2 shows the annual breakdown of the cumulative removals shown in Figure 9.1. 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 over the last 16 years. It is also worth noting that the proportion of removals attributed to broadleaf woodland has been increasing since the time series began in 1990.

**Figure 9.2: Annual net removals of greenhouse gases by forests in England, 1990 to 2018**



**Notes:**

- Estimated 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 England, expressed as million tonnes of CO<sub>2</sub> equivalent (Mt CO<sub>2</sub>e).

- 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.
- Revised in 2015 to reflect improved modelling of greenhouse gas emissions and removals.
- Revised in 2017 due to improvements made to the forestry sector of the 1990 to 2015 Land Use, Land Use Change and Forestry (LULUCF) 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 LULUCF greenhouse gas inventory.
- Revised in 2019 and 2020 due to further improvements in the CARBINE model and forest planting and harvesting statistics (see background section for more details).
- These results are therefore not directly comparable with those in previous publications.

**Source:** Department of Business, Energy & Industrial Strategy (BEIS) – Land Use, Land Use Change and Forestry (LULUCF) greenhouse gas inventory.

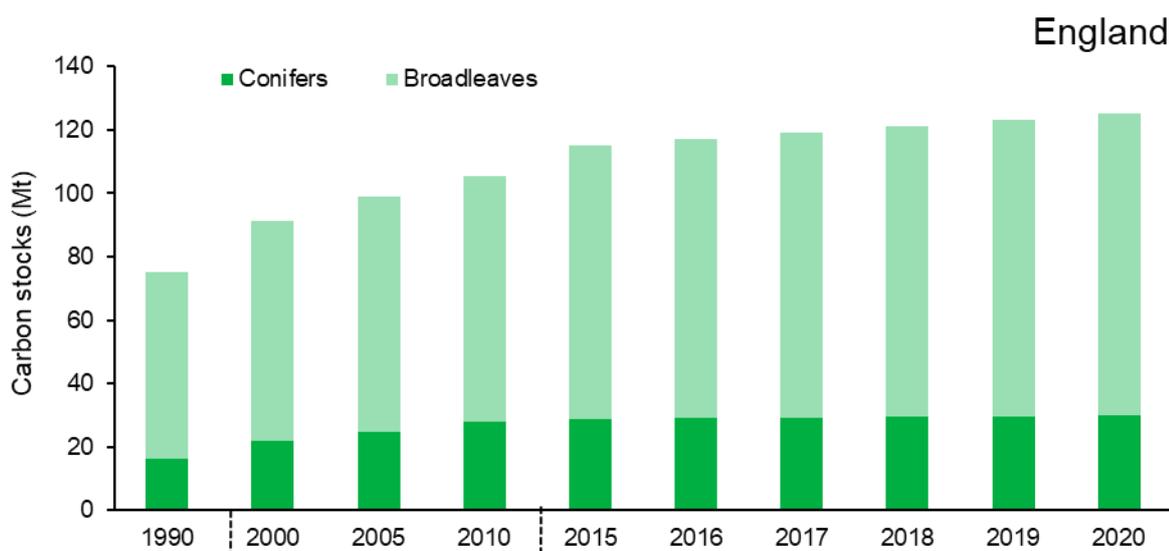
Showing greenhouse gas removals by type of woodland is interesting from a biodiversity perspective as it allows a clearer presentation of the contribution made to greenhouse gas removals by broadleaf woodland, most of which constitutes priority habitat.

### National Forest Inventory

The estimated carbon stock of trees in England can be used as a complementary measure of carbon storage. Information on current carbon stocks of forests in England 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 English forests as at 31 March 2020, is estimated to be 125 Mt of carbon (459 Mt CO<sub>2</sub>e) (see Figure 9.3). Broadleaf trees, with an estimated carbon stock of 95.5 Mt (350 Mt CO<sub>2</sub>e) are responsible for a greater proportion of the total England carbon stock than conifer trees, which are estimated to have a total stock of 30 Mt (109 Mt CO<sub>2</sub>e). This difference reflects the fact that in England, the total 'growing stock volume' (and area) of broadleaved woodland covered by the NFI is greater than that of conifer woodland.

**Figure 9.3: Total carbon stocks in living conifer and broadleaved woodland trees in England, 1990 to 2020**



**Notes:**

- Estimated total carbon in all living trees within woodlands of England.

- The time series is non-linear (indicated by the dashed vertical lines on the x axis).

**Source:** National Forestry 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.

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).

### Web links for further information

Forestry Commission: [Carbon in live woodland trees in Britain: National Forest Inventory Report](#) (PDF, 1.29 Mb)

Millennium Ecosystem Assessment: [Millennium Ecosystem Assessment](#)

National Atmospheric Emissions Inventory: [https://naei.beis.gov.uk/reports/reports?report\\_id=998h](https://naei.beis.gov.uk/reports/reports?report_id=998h)

UK National Ecosystem Assessment: [UK National Ecosystem Assessment](#)

**Last updated:** October 2020

**Latest data available:**

Greenhouse gas removals by forests in England (LULUCF) – 2018;

Carbon stocks of forests in England (NFI) – 2020