

# UK natural capital accounts methodology guide: 2024

Methods to calculate natural capital ecosystem service accounts that estimate habitat extent, ecosystem services and asset value in the UK.

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# 1 . Introduction

This article describes the methodology used to develop the UK's natural capital ecosystem service accounts. This explains the broad approach to valuation and the overarching assumptions involved. This is followed by a more detailed description of the specific methodologies used to value the individual components of natural capital, and physical and monetary data sources.

The methodology we use to develop these estimates remains under development. The estimates reported are labelled as official statistics in development and should be interpreted in this context. Until September 2023, these were called experimental statistics. Read more about the change in our [guide to official statistics in development](#). We publish official statistics in development to involve customers and stakeholders in their development and as a means of building in quality. We welcome feedback on any of our approaches to [natural.capital.team@ons.gov.uk](mailto:natural.capital.team@ons.gov.uk).

We have implemented several methodological changes in our [UK natural capital accounts: 2024 release](#):

- asset valuations to remove the current year from the calculation for all ecosystem services estimated using a net present value approach, except for noise regulating
- asset value calculations to use five-year rolling averages for timber and fish provisioning
- conversion factors to estimate physical flows for coal provisioning
- projections for pollutant sulphur dioxide (SO<sub>2</sub>) to hold the latest data constant until 2030 for air pollution regulating
- habitat categories for greenhouse gas regulating to match the Territorial Emissions Statistics sectors
- new data sources for recreation and aesthetics (house prices) to extend the time series and produce a more complete estimate for each property
- tourism and recreation (expenditure) and recreation (health benefits) to include data from the People and Nature Survey for Wales for the first time

As a result of changing methods and an expanding portfolio of ecosystem services measured, this latest account cannot be compared with previous accounts on a like-for-like basis. We apply the latest methods developed across all years in the latest accounts, giving a consistent time series.

We use a wide variety of data sources and compile these in line with the guidelines recommended by the [United Nations \(UN\) System of Environmental-Economic Accounting - Ecosystem Accounting \(SEEA EA\) \(PDF, 5.33MB\)](#), and [the UN SEEA Experimental Ecosystem Accounting](#). We also published the [Principles of UK natural capital accounting: 2023 methodology](#), summarising the principles we apply when interpreting guidance and developing practical methodologies in the UK context.

Our [UK natural capital accounts: 2024](#) present data for the:

- size of the seven broad terrestrial habitats (extent)
- quantity and value of services supplied from the ecosystem services on an annual basis (physical and monetary ecosystem service flow accounts)
- value of the ecosystem services as an asset, which represents the stream of services expected to be provided over the lifetime of the asset (monetary asset account)

## 2 . Habitat extent

We use the broad habitat classifications from the [2011 UK National Ecosystem Assessment](#) to categorise habitats. The mapping data for these habitats are from the UK Centre for Ecology and Hydrology's (UKCEH) [Land Cover Maps](#).

Each of the 21 Land Cover Map habitat classes are assigned to the following eight broad habitat classes.

### Enclosed farmland

This includes the Land Cover Map categories of arable, horticulture and improved grassland. Annual crops, perennial crops such as berries and orchards, freshly ploughed land, and higher productivity grasslands.

### Woodland

This includes managed plantations as well as ancient, semi-natural woodlands, and includes both coniferous and broadleaf (deciduous) woodland.

### Mountains, moorland, and heath

This includes heather, heather grassland and inland rock. These are mountainous, open, and rugged habitats.

### Semi-natural grassland

Includes acid grassland, calcareous grassland (where the geology below is composed of calcium carbonate), and neutral grassland. These are acidic, alkaline, and neutral habitats, respectively, with low levels of plant species diversity.

### Urban

This includes suburban and urban habitats, consisting of built structures and other infrastructure.

### Freshwater, wetlands, and floodplains

This includes fen, bog, and freshwater. Freshwater bogs are partly drained habitats, including ericaceous (acidic composition) and herbaceous mosses that form over peat-rich soils.

### Coastal margins

This includes saltmarsh, littoral rock, littoral sediment, supralittoral rock, and supralittoral sediment. Littoral areas are on the shoreline with supralittoral areas being the splash zone above the high-tide mark.

### Marine

This broad habitat is saltwater. In this UK account, we only show total extent of the remaining seven broad terrestrial habitats. Marine is included to show the change of habitats between 1990 and 2021, where a terrestrial habitat has become marine or a marine habitat has become terrestrial.

## 3 . Annual ecosystem service flow valuation

Ecosystem services estimate the contribution of natural assets in the UK to the economy and society. To do this, we calculate annual service flows using a physical measure of its output in units appropriate to the good or service, and then apply a valuation. We multiply an estimate of physical quantity by a price for: fish and timber provisioning; greenhouse gas, air pollution, noise and urban heat regulating; and recreation (health benefits), and recreation and tourism (expenditure). The price we use satisfies one of two accounting conditions:

- It relates, as closely as possible, to contributions provided by the ecosystem to the economy
- where no market exists, imputing a price that an ecosystem could charge for its services in a theoretical market

These conditions are necessary to integrate and align ecosystem services with services in the national accounts. For example, in the national accounts, woodland timber is an input to the timber sector.

For agricultural biomass, water, minerals and metals, oil and gas, coal, and renewable electricity provisioning, we use a residual value resource rent approach.

We assign the value of each ecosystem service to the habitat where the value is derived. This is described in detail for each service in [Section 6: Methodology by service](#).

## 4 . Resource rent definition and assumptions

The resource rent can be interpreted as the annual return stemming directly from a natural capital asset. This is the surplus value accruing to the extractor or user of a natural capital asset calculated after all costs, including opportunity costs, have been considered.

We apply variations of this approach depending on the category of natural capital under assessment. The steps involved in calculating the resource rent are as follows:

- gross operating surplus (System of National Accounts basis) is calculated as output minus operating costs (intermediate consumption plus compensation of employees plus other taxes on production) plus other subsidies on production
- gross operating surplus (resource rent derivation) is calculated as gross operating surplus (System of National Accounts basis) minus specific subsidies on extraction plus specific taxes on extraction
- resource rent is calculated as gross operating surplus (resource rent derivation) minus user costs of produced assets (consumption of fixed capital and return to produced assets)

For the UK, we get this data from the [supply and use tables](#). We calculate return to produced asset estimates using industry-based net capital stocks from our [Capital stocks and fixed capital consumption, UK: 2023 bulletin](#), and the Bank of England's [10-year government bond yield](#). These are deflated using the gross domestic product (GDP) deflator to produce the real yield. The government bond yield is relatively conservative compared with rates expected in certain markets and could therefore overstate the resulting resource rent estimates.

We source Scottish estimates of gross operating surplus and taxes less subsidies from the [Scottish Government's Supply, Use and Input-Output Tables](#). As these tables run a year behind the UK input-output supply and use tables, we use data from Scotland's [Quarterly GDP](#) to produce estimates to the same timeframe. The estimates for the latest years are therefore subject to greater uncertainty than those for which we have balanced supply and use tables.

In our [UK natural capital accounts, 2024 release](#), this data source has resulted in inconsistencies across the UK and Scotland for renewable electricity provisioning. Therefore, we have removed nation breakdowns for the year 2021 for this service.

As capital stocks statistics are not produced for Scotland, the ratio of intermediate consumption from supply-use tables for Scotland to UK values is applied to UK values to derive the net capital stock and consumption of fixed capital.

For England, Wales and Northern Ireland, complete supply and use tables are not available. To provide estimates for these nations, we use data from our Annual Business Survey in our [Non-financial business economy, regional \(Annual Business Survey\) Statistical bulletins](#). To enable us to apportion by country using the best data available, we deduct estimates for Scotland from the UK total, and the remainder is split across England, Wales, and Northern Ireland according to proportions of gross operating surplus.

## 5 . Asset valuation

Natural capital asset values measure the stock, or the stream of services of that natural resource in terms of future expected supply and use over a reasonably predictable time horizon.

The net present value (NPV) approach is recommended by the System of [Environmental Economic Accounting Ecosystem Accounting \(PDF, 5.33MB\)](#) and is applied for all ecosystem services to estimate the asset value, except for recreation and aesthetics (house prices). The NPV approach estimates the stream of services that are expected to be generated over the life of the asset. These values are then discounted back to the present accounting period. This provides an estimate of the capital value of the asset relating to that service at a given point in time.

There are three main aspects of the NPV method, which are:

- pattern of expected future flows of services
- asset life – the period over which the flows of values are expected to be generated
- choice of discount rate

For our [UK natural capital accounts, 2024 release](#), we have made a change to how we calculate the asset value to remove the current year, in line with System of Environmental Economic Accounting (SEEA) guidance.

This change affects all ecosystem services estimated using a net present value approach, except noise regulating as this service was calculated as part of a [scoping study](#) conducted by Economics For The Environment Consultancy Ltd (eftec), so we cannot alter the methods used.

### Pattern of expected future flows of services

An important factor in the valuation of natural capital is determining the expected pattern of future flows of services using future expected levels of services in physical terms or future unit prices. When this information is not available, our default assumption is that the current value of the service is constant over the asset lifetime. This is based on averages over the last five years of data.

### Asset life

The asset life is the expected time over which the services from a natural resource are expected to be provided. An estimate of the asset life is an important component in the NPV model because it determines the expected term over which the service flows from an asset should be discounted.

For non-renewable natural capital assets, a 25-year asset life is assumed unless a sufficient level of information on the expected asset lives is available, in which case this is applied in the calculations.

Renewable natural capital assets are assumed to have a 100-year asset life.

For more information on the accounting asset lifespan see the following sections and in our [Principles of UK natural capital accounting: 2023 methodology](#).

## Choice of discount rate

A discount rate is required to convert the expected stream of monetary flows into a current period estimate of the overall value. A discount rate expresses a time preference – the preference for the owner of an asset to receive income now rather than in the future. It also reflects the owner's attitude to risk. The use of discount rates in NPV calculations can be interpreted as an expected rate of return on the environmental assets.

The Office for National Statistics (ONS) and the Department for Environment, Food and Rural Affairs (Defra) use the social discount rate set out in the [HM Treasury's Green Book \(PDF 1.489KB\)](#). In line with the guidance, estimates presented assume a 3.5% discount rate for flows projected out to 30 years, then declining to 3.0%, then further to 2.5% after 75 years, as discussed in our [Principles of UK natural capital accounting methodology](#).

The discount rates applied to air pollution regulation, noise regulation and recreation (health benefits) employ the health discount rates as detailed in HM Treasury's Green Book, because of the health-based nature of these ecosystem services. This is because the future utility benefits associated with these service provisions are unlikely to be characterised by high rates of diminishing marginal utility.

## 6 . Methodology by service

The following section provides an explanation of the data sources and methods used to calculate the physical and monetary values for each ecosystem service.

### Agricultural biomass provisioning

Agricultural biomass estimates the value of crops, fodder and grazed biomass provided to support agricultural production. In theory, cultivated biological resources should be excluded from the UK natural capital accounts (Principle D2 of our [Principles of UK natural capital accounting](#)). Farmed animals are considered produced rather than natural assets, but we are unable to exclude them from our monetary estimates because of limitations in the granularity of industry data.

Defra publishes agricultural statistics in its [Agriculture in the United Kingdom datasets](#). Grazed biomass calculations are based upon livestock numbers and livestock annual roughage requirements provided in the [Eurostat Economy-wide material flow accounts \(EW-MFA\) questionnaire \(PDF, 3.0MB\)](#). Regional physical flows are taken from Defra's [Provisional cereal and oilseed production estimates for England](#) and are only included for barley, oats, oilseed rape and wheat.

We use input-output supply and use tables for the UK and Scotland for the gross operating surplus and taxes less subsidies variables in the resource rent calculations. For Scotland, the UK net capital stock for Standard Industrial Classification (SIC) 01 is apportioned based on the ratio of consumption of fixed capital between the UK and Scotland, using data from [Scottish Government's Total Income from Farming Estimates](#) and [Defra's Total income from farming in the UK](#). We use agricultural accounts for each nation to apportion the remainder of the resource rent, once Scotland has been deducted, based on the gross operating surplus.

We assign estimates to the habitat of enclosed farmland. There may be some value that can be attributed to semi-natural grassland, but we currently do not have data available to separate this.

## Coal provisioning

Coal production statistics are available from the Department for Energy Security and Net Zero (DESNZ), in the [Digest of UK Energy Statistics \(DUKES\)](#). Northern Ireland ceased coal production in 1970 so has no value for this service.

For the valuation, we use a residual value resource rent approach based upon our [Input-output supply and use tables](#) and capital stocks data for the SIC division: Mining of coal and lignite (SIC 05). Because of the small size of this industry across the UK, the proportions from the Annual Business Survey are too volatile to use here. Instead, we use total production to apportion the remaining UK data across England and Wales once Scotland has been deducted.

Previously, we used a fixed conversion factor to convert physical flows from tonnes to "tonnes of oil equivalent". From this year we use a dynamic coal conversion factor supplied to us by DESNZ, which is an annual weighted average of the conversion factors of various types of coal produced that year, such as coke.

We assign estimates to the habitat of mountains, moorland, and heath. Inland rock is included in mountains, moorland, and heath as one of the UKCEH landcover map classifications. As we do not have a subterranean habitat class, the assumption is that mountains, moorland, and heath cover the locations of most extraction sites.

## Fish provisioning

Fish provisioning estimates the value of marine fish taken from mainland UK waters. We remove aquaculture or farmed fish from estimates as farmed fish are viewed as a produced asset rather than a natural asset (Principle D2 shown in our [Principles of UK natural capital accounting methodology](#)).

We source physical data on marine fish capture (live weight) from the rectangle-level landings data published annually in Marine Management Organisation's (MMO) [UK Sea Fisheries Statistics](#) and the EU Commission's Joint Research Centre Scientific, Technical and Economic Committee for Fisheries as part of the [Fisheries Dependent Information](#) data call. Live weight is the weight of a product when removed from the water.

To calculate marine fish capture from UK waters, exclusive economic zone (EEZ) MMO statistical rectangle factors are used. For more detail on how fish capture in UK waters is estimated, see the [UK commercial sea fisheries landings by Exclusive Economic Zone of capture report 2019, published on GOV.UK](#) and associated publications.

Valuations are calculated by multiplying annual net profit per tonne (landed weight) by tonnes of fish captured (live weight) for a specific species. We calculate net profit per tonne (landed) estimates for marine species by marine areas, provided by Seafish, using Seafish's economic estimates for fleet segments and MMO data on landings by stocks (landed value and landed weight) and landings by stocks and species (in cases where species are not managed by total allowable catches). Landed weight is the weight of a product at the time of landing, regardless of the state in which it has been landed. Landed fish may be whole, gutted and headed, or filleted.

We aggregate data for overall annual valuations of fish provisioning from the four nations and the UK EEZ. A notable limitation of the fish capture provisioning valuation methodology is that landed weight net profits are multiplied by live weight fish capture. Based on MMO data on live and landed weights of UK vessel landings into the UK, aggregate landed weight is around 7% less than live weight. Additionally, the economic data are based on UK fleet data, which we also apply to EU vessels that may face different costs and prices.

Net profit per tonne is not available for all fish species so not all of the physical flow is valued. The valuation of fish capture from UK waters is therefore likely to be an underestimate.

In our [UK natural capital accounts: 2024 release](#), we have updated the asset value calculation to use the five-year average annual value, rather than the annual value for a single year, as per the principles set out in our [Principles of UK natural capital accounting: 2023 methodology](#). Average annual values are calculated by species and area, so asset values are available at this level of granularity for the first time this year.

For all of the fish species across UK waters, we estimate the sustainability of fishing using the [International Council for the Exploration of the Sea's stock assessments](#). These do not include wider externalities from fishing, such as plastic pollution.

Those species estimated to be sustainable are valued using an asset lifetime of 100 years, while those estimated to be unsustainable or unknown are valued over 25 years.

We assign fish provisioning estimates to the marine habitat.

## Minerals and metals provisioning

The British Geological Survey (BGS) provide physical estimates of mineral extraction. Up to and including 2014, mineral extraction is based on the annual minerals raised inquiry, but since 2015, BGS have attempted to obtain data from alternative sources, including Mineral Products Association and the British Ceramics Confederation. Estimates for the four nations will not always sum to UK totals because of data limitations.

Estimates are grouped under the following categories.

### Construction minerals

- sand and gravel
- silica sand
- gypsum
- slate
- chalk
- igneous rock
- limestone
- dolomite
- sandstone

### Clay minerals

- fireclay
- china clay
- ball clay
- talc
- clay and shale

### Fertiliser minerals

- barytes
- fluorspar
- polyhalite

### Salts

- salts
- potash

## Metals

- tin
- tungsten
- lead
- gold
- silver

Monetary estimates are based on the residual value resource rent approach calculated from the SIC subdivision class: Other mining and quarrying (SIC 08) and Mining of metal ores (SIC 07). Other mining and quarrying includes extraction from a mine or quarry, but also dredging of alluvial deposits, rock crushing and the use of salt marshes. The products are used most notably in construction, such as stone and aggregates, manufacture of materials, such as clay and gypsum, and manufacture of chemicals. This SIC division excludes some aspects of the processing of the minerals extracted. However, crushing, grinding, cutting, cleaning, drying, sorting, and mixing are not excluded. This may inflate the resource rents associated with the pure natural provisioning service.

An important limitation of the resource rent approach is the inability to account for different profits and costs across the types of minerals and metals. As a result, we are unable to assign monetary values across habitats and all the monetary value is assigned to mountains, moorland, and heath.

We assign physical estimates to both marine habitats and mountains, moorland, and heath habitats. Inland rock is included in mountains, moorland, and heath as one of the UKCEH landcover map classifications. As we do not have a subterranean habitat class, the assumption is that mountains, moorland, and heath cover the locations of most extraction sites.

## Oil and gas provisioning

Physical estimates of oil and gas production are available from the [North Sea Transition Authority](#) (NSTA).

Monetary estimates follow a residual value resource rent approach calculated from the [income and expenditure](#) on UK upstream oil and gas exploration, operating and decommissioning activities, published by the NSTA, and net capital stock and consumption of fixed capital data for SIC subdivision class: Extraction of crude petroleum and natural gas (SIC 06) from our capital stock data.

We estimate Scottish oil and gas provisioning using [Scottish Government oil and gas statistics](#), comparable with the UK NSTA's data. Consumption of fixed capital and cost of capital is estimated through an apportionment of our capital stocks data for SIC 06, using relative operating expenditure reported by the NSTA and Scottish Government, respectively.

For Wales and Northern Ireland, oil and gas provisioning are assumed to be zero. Therefore, we calculate the estimate for England to be the remainder once the value for Scotland is deducted from the UK total.

Infrastructure for the extraction of oil and gas must be decommissioned and the costs are incurred at the end of an asset's lifetime. This distortion of the cost profile has a downward impact on the resource rents in later years. We adjust decommissioning costs, so they vary according to total income generated in each year, while maintaining the total value of the costs. The distribution of these costs mirrors total income as it changes over time and results in a smoother time series.

For the asset valuation, we use the NSTA's [annual production and expenditure projections](#). For Scottish and English estimates, we apportion the UK projections based upon the relative five-year average of oil and gas production from 2018 to 2022. Annual five-year averages of "unit resource rent" (average resource rent divided by average production) are applied to production projections.

We assign estimates to the marine habitat.

## Renewable electricity provisioning

Electricity generated by renewable sources is published by DESNZ in the [Digest of UK Energy Statistics](#). Bioenergy is excluded to avoid valuation double counting with timber removals and agricultural biomass.

Monetary estimates begin with SIC 35.1: Electricity power generation, transmission, and distribution. We apportion these data using turnover from our Annual Business Survey (ABS), published in our [Non-financial business economy, UK dataset](#), to derive SIC 35.11: Production of electricity.

For Scotland, the ratio of Scotland and the UK's total installed capacity is used to apportion the UK's net capital stock and the resource rent for Scotland's SIC 35.1 is calculated, before we apportion to SIC 35.11 using turnover from the regional ABS.

For England, Wales and Northern Ireland, we deduct the value for Scotland for SIC 35.11 from the value for the UK and the remainder is apportioned across the nations using the gross operating surplus for SIC 35.11 from the regional ABS.

We then further apportion values for the four nations using the percentage of electricity generation that comes from renewable sources from [electricity generation and supply](#). This provides a final estimate for the value of the production of electricity from renewable sources.

An important limitation is the lack of data reflecting the profits and cost for electricity generation from renewable sources, as opposed to other electricity generation.

We calculate the UK valuation for this service by summing the estimates for the four nations to accurately reflect the value derived from renewable energy provision across the UK.

We assign estimates for renewable energy provisioning to habitats based on technology:

- hydroelectric to freshwater, wetlands, and floodplains
- solar photovoltaic (PV) to enclosed farmland; semi-natural grassland; mountains, moorland, and heath; and urban, using mapping data from DESNZ's [Renewable Energy Planning Data](#) and [UKCEH 2021 landcover maps](#)
- wave and tidal to marine
- offshore wind to marine
- onshore wind to enclosed farmland; mountains, moorland, and heath; and semi-natural grassland, using data from DESNZ's [Renewable Energy Planning Data](#) and [UKCEH 2021 landcover maps](#)

## Timber and woodfuel provisioning

We take removals estimates from [Forest Research timber statistics](#) and convert them from green tonnes to cubic metres (m<sup>3</sup>) overbark standing, using a [conversion factor](#) of 1.222 for softwood and 1.111 for hardwood.

The stumpage price is the price paid per standing tree, including the bark and before felling, from a given land area. Stumpage prices are sourced from the [Forest Research Coniferous Standing Sales Price Index in the Timber Price Indices publication \(2024\)](#). We generate annual flow values by multiplying the stumpage price and the physical amount of timber removed.

Asset valuations use [Forest Research forecasts of timber availability](#) to estimate the pattern of expected future flows of the service over the asset lifetime. For our 2024 data, published in our [UK natural capital accounts, 2024 bulletin](#), we have updated the asset value calculation to use the five-year average stumpage price, rather than the stumpage price for a single year, as per the principles set out in our [Principles of UK natural capital accounting: 2023 methodology](#).

The timber data contain all uses of timber including woodfuel. To separate out woodfuel provisioning, we source data from [Forest Research UK roundwood deliveries](#) and deduct this from the timber value, to ensure no double counting occurs. Data for woodfuel are only available from 1994, so prior to this date, timber estimates include some woodfuel provisioning.

We assign estimates for timber and woodfuel provisioning to the woodland habitat.

## Water provisioning

The service of water provisioning estimates the value of public water supply. This maintains UK-wide consistency, as industry data are not available for Scotland, and avoids double counting of the valuation of hydropower.

We source physical data for water provisioning from Scottish Water, the [Drinking Water Inspectorate](#), Natural Resources Wales, and [Northern Ireland Water](#).

Monetary estimates are based on the residual value resource rents calculated for the SIC subdivision class: Water collection, treatment and supply (SIC 36). A limitation of this approach is that the calculated resource rent is not purely related to water supply, but also includes the process of treating the water and rents made in industrial applications.

We assign estimates to the freshwater, wetlands, and floodplains habitat.

## Air pollution regulating

Air pollution regulation estimates have been supplied in consultation with the UK Centre for Ecology and Hydrology (UKCEH), with a full methodology available in the [report published in July 2017](#).

Physical flows use the European Monitoring and Evaluation Program Unified Model for the UK (EMEP4UK) atmospheric chemistry and transport model to generate pollutant concentrations directly from emissions and dynamically calculate pollutant transport and deposition, considering meteorology and pollutant interactions.

Air pollution removal by UK vegetation has been modelled for the years 2007, 2015 and 2019 and then scaled based on previous modelling to create values for 2030. For remaining years, where government concentration data are available through the UK's Automatic Urban and Rural Network (AURN), figures are fed into the model to generate estimates for changes in air pollutant concentrations caused by vegetation. When no pollution concentration data are available, we assume concentrations fall by a constant rate until they reach 2030 values for all pollutants except SO<sub>2</sub>. For SO<sub>2</sub>, the current concentrations are already lower than the 2030 estimates, so we instead hold the latest data constant until 2030.

Health benefits are calculated from the change in pollutant concentration to which people are exposed. Damage costs per unit of exposure are then applied to the benefiting population at the local authority level for the following avoided health outcomes:

- respiratory hospital admissions
- cardiovascular hospital admissions
- loss of life years, in terms of long-term exposure effects from particulate matter 2.5 (PM2.5) and nitrogen dioxide (NO2)
- deaths, in terms of short-term exposure effects from ozone (O3)

For the method of how damage costs are calculated, please see the [Air Quality damage cost update 2019 report \(PDF, 1.13MB\), published by Defra](#).

We assign estimates to habitats based on the rates of deposition for different habitat types.

## Greenhouse gas regulating

Greenhouse gas regulating estimates the value of the removal of greenhouse gases, in carbon dioxide equivalent (CO2e), from the atmosphere by habitats in the UK. Estimates presented represent net values and so our greenhouse gas regulating reflects both storage and removal of greenhouse gases as a single service. Full details about what is measured in the service and why, can be found in our [Principles of natural capital accounting paper in Section 5, under Climate change gas flux](#).

Physical data come from the [UK National Atmospheric Emissions Inventory \(NAEI\) Greenhouse Gas Inventory](#). This contains data relating to carbon exchange in the Land Use, Land Use Change and Forestry (LULUCF) sector. We also aim to estimate the gross carbon sequestration benefits of nature, but this is not possible with current inventory data.

The capacity for habitats to remove greenhouse gas from the air depends upon the habitat type and extent. Local greenhouse gas regulating estimates are produced through local authority modelling of national estimates and are not specific to the land management of each authority.

To estimate the annual value, we multiply the physical flow by a carbon price. The carbon price used in calculations is based on the projected non-traded price of carbon schedule. This is contained within data table 3 of the [Green Book supplementary guidance, published on GOV.UK](#). Carbon prices are available from 2020 to 2050. Prices prior to 2020 and beyond 2050 are deflated or inflated respectively by 1.5% annually, based on advice from DESNZ.

In their latest release, DESNZ stated that the Territorial Emissions Statistics (TES) sectors will replace the National Communication (NC) sectors in all their publications, starting with the [Final UK greenhouse gas emissions national statistics: 1990 to 2022](#). DESNZ have provided the [Mapping table comparing the National Communication \(NC\) and Territorial Emissions Statistics \(TES\) sectors](#) to show how the categories compare across NC and TES sectors. We have updated our habitat categories to match the TES sectors published by DESNZ. Data limitations mean these habitat mappings may include some additional activities compared with previous versions of the Accounts, for example, the TES sector of Forestry includes both afforestation and deforestation, but we are not currently able to differentiate between these, so all are mapped to woodland. Previous NC sectors, new TES sectors and their habitat mapping from the Department for Energy, Security and Net Zero:

## Previously used NC Sectors

### Habitat mapping: Other

- 4. Land Use, Land-Use Change and Forestry

### Habitat mapping: Enclosed farmland

- B. Cropland

### Habitat mapping: Woodland

- A. Forest Land
- G. Harvested Wood Products

#### **Habitat mapping: Semi-natural grassland**

- C. Grassland

#### **Habitat mapping: Freshwater, wetlands, and floodplains**

- D. Wetlands

#### **Habitat mapping: Urban**

- E. Settlements

### **Updated Territorial Emissions Statistics (TES) sectors**

#### **Habitat mapping: Other**

- Other Land use, land use change and forestry

#### **Habitat mapping: Enclosed farmland**

- Bioenergy crops
- Cropland mineral soils under LUC

#### **Habitat mapping: Woodland**

- Forestry

#### **Habitat mapping: Semi-natural grassland**

- Grassland mineral soils under LUC

#### **Habitat mapping: Freshwater, wetlands, and floodplains**

- Peatland

#### **Habitat mapping: Urban**

- Settlement

## Noise regulating

Noise regulating estimates the value of vegetation that acts as a buffer against noise pollution, such as from road traffic.

Defra's [Noise mapping](#) study is used alongside spatial population data and a [UKCEH landcover map](#) to determine the number of buildings located near vegetation that would provide a reduction in the volume of noise. The health impacts and nuisance associated with noise are used alongside the number of buildings to create an annual value.

A single year of data from 2014 is carried forward to create a time series. We deflate this value to match the latest price year.

For a detailed methodology on how noise mitigation estimates were produced, please see [Scoping UK Urban Natural Capital Account – Extending noise regulation estimates – NR0170, published by Defra](#). Further work would be required to develop this methodology.

We assign estimates to the urban habitat. However, we could also assign these estimates to woodland, as urban woodland habitats provide the vegetation that acts as a buffer.

## Urban heat regulating

Urban heat regulating estimates the value of green (for example, parks) and blue (for example, lakes) spaces that can cool urban environments on hot days. The benefits of this include limiting loss of labour productivity and reducing air conditioning use.

Data are available for 11 city regions, with coverage across England, Wales and Scotland. These do not create a full picture of the UK's urban heat regulation.

The cooling effect of green and blue spaces reduces the loss of productivity because of heat, which is determined per industry type, and by the extent of green and blue space per city region. To create an annual value, for each city region, we multiply the number of hot days (28 degrees Celsius and above) by the productivity saved and the gross value added of each industry.

For a detailed methodology on how urban heat regulating estimates were produced, please see [Scoping UK Urban Natural Capital Accounts – Extension to develop temperature regulation estimates – NR0172, published by Defra](#).

We assign estimates to the urban habitat. However, these estimates could also be attributed to the habitats that provide a cooling affect, such as woodlands or freshwater, wetlands, and floodplains.

## Recreation and tourism (expenditure)

Recreation and tourism (expenditure) estimates the amount spent to enable visits to the natural environment, such as transport, car parking and admission costs. In the absence of a ticket to access a public beach, buying a bus ticket represents the cost of the trip and this is taken as a proxy for the value of accessing the site.

The estimates combine separate estimates of nature-based tourism and outdoor recreation. Tourism estimates include day visits longer than three hours in duration, overnight trips and visits from international travellers visiting the UK. To avoid double counting, estimates of recreation include only day visits three hours or shorter in duration.

Estimates use survey data across multiple surveys covering England, Wales, Scotland, and Northern Ireland.

Recreation data for England are taken annually from Natural England's [Monitor of Engagement with the Natural Environment](#) (MENE) survey between 2009 and 2018, and the [People and Nature Survey](#) (PaNS) between 2020 and 2022. Because of differences in the level of reported expenditure between the two surveys, we use the [Living Cost and Food survey](#) (LCF) as a proxy series to join the surveys without a step change. This involves linking LCF spend items to PaNS expenditure items and using the LCF growth rates between 2019 and 2020 to impute a 2020 expenditure value for PaNS. PaNS data are applied as growth rates to the imputed 2020 value, generating a consistent timeseries. Non-expenditure data do not feature a step change. However, changes to survey design and mode means that MENE and PaNS are not directly comparable across all variables.

In Scotland, we use data from two surveys to produce estimates of outdoor recreation:

- [Scottish Recreation Survey \(ScRS\)](#) from 2003 to 2012
- [Scotland's People and Nature Survey \(SPANS\)](#) for 2013 to 2014, 2017 to 2018, and 2019 to 2020

Unlike ScRS, SPANS excludes questions relating to respondent expenditure during their last outdoor recreation visit. To produce estimates of Scottish outdoor recreation expenditure beyond 2012, we created a statistical model. Using comparable MENE and ScRS data, this model examines the relationship between English and Scottish per-visit expenditure on a habitat basis. We use linear interpolation to produce estimates of Scottish recreation from 2014 to 2019. Data from PaNS are used as a proxy series to impute missing years from 2020 onwards.

In Wales, we use data from the [Welsh Outdoor Recreation Survey](#) (WORS) for 2014 to 2015, followed by recreation-based questions asked in the [National Survey for Wales](#) (NSW) for 2016 to 2017, and 2018 to 2019. The [People and Nature Survey Wales](#) (PaNSW) provide data for 2021 to 2022. In Northern Ireland, estimates of outdoor recreation are compiled from the [People in the Outdoors Monitor for Northern Ireland](#) (POMNI). This survey ran for the first time in 2020 to 2021. For both nations, we use data from MENE and PaNS as a proxy series to impute missing years and generate a full timeseries from 2009 onwards.

We use four surveys to generate estimates of nature-based tourism. This includes Visit Britain's [Great Britain Day Visits Survey](#) (GBDVS) and [Great Britain Tourism Survey](#) (GBTS). Both surveys collect annual data from 2011 to present, with a pause in 2020. The LCF is used as a proxy series to impute expenditure estimates in 2020. We also use the [International Passenger Survey](#) (IPS), which collects data annually for international visitors; as well as [Northern Ireland annual tourism statistics](#).

A limitation of the GBDVS data we use to generate tourism expenditure estimates is that we need to make some assumptions on how to correctly apportion spend between activities. This is because respondents' spending is attributed to all types of activities they have completed, leading to a multiplication of expenditure.

We apportion by using data from ad hoc questions added to a single round of the GBDVS, which asked respondents about the importance of different activities within broader visit categories. We apply these one-off proportions to avoid the multiplication and double counting of spend between activity types.

Changes made to the GBDVS between 2019 and 2021 have led to a reduction in the amount of this double counting within their estimates. As our proportions are unchanged, the survey data have become subject to more double counting removal than they now require, leading to lower estimates.

Because of this, there is more uncertainty around our estimates from 2021 onwards, and these may be an underestimate of tourism expenditure in nature. We are looking to update our tourism methodology to adapt the approach to apportioning to activities in future, to more accurately reflect the categories present within updated surveys.

For a detailed methodology on how our tourism estimates were produced, please see [Tourism values for Natural Capital Accounts – NR0176, published by Defra](#) and [UK natural capital accounts: Tourism - methodology](#).

We assign estimates equally to habitats based on the types of natural places visited by respondents within their survey responses. Habitat disaggregated estimations may not sum to overall totals. This is because the habitat-visited question may be asked less frequently compared with other questions, resulting in smaller sample sizes. Estimations can differ depending on sample sizes.

For broad habitat classifications by country, please see Section 2: Habitats in our [Health benefits from recreation methodology, natural capital, UK](#).

For the asset valuation of outdoor recreation, we implement projected population growth calculated from population statistics in our [Principal projection – UK summary dataset](#) into the estimation. These assumptions project the annual value to increase over the 100-year asset lifetime.

Many outdoor recreation visits have no expenditure as people take local visits, such as walking to a local park. Therefore, we acknowledge that the expenditure-based method provides an underestimation of the value provided by visits to the natural environment. Other services, recreation (house prices) and recreation (health benefits) aim to capture some of this additional value.

## Recreation (health benefits)

Recreation (health benefits) estimates the number of people gaining health benefits from regular recreation, and the monetary value associated with this. This service attempts to value the positive effect on health and well-being because of trips in natural environments by estimating the avoided health costs associated with these visits.

We calculate the number of people gaining these benefits using the recreation-based surveys discussed in recreation and tourism (expenditure). The monetary value of health benefits from recreation are derived from the work of Claxton and others (2015) in their article [Methods for the estimation of the National Institute for Health and Care Excellence cost-effectiveness threshold](#). This cost-saving approach concluded that £13,000 of NHS resources adds one [Quality Adjusted Life Year \(QALY\)](#) to the lives of NHS patients (2008 prices).

The methodology underpinning the health benefits gained from recreation can be found under Section 2: Exposure to nature in our [Health benefits from recreation methodology, natural capital, UK](#). Since this methodology, we have undertaken further work to implement the "exposure to nature" approach.

We assign estimates equally to habitats based on the types of natural places visited by respondents within their survey responses.

## Recreation and aesthetic (house prices)

Recreation and aesthetic values for house prices include the additional expenditure on houses that are near to green (land) and blue (water) spaces, enabling people to make free trips to the natural environment, as well as the value added to a property by a view of a green or blue space. Using current data and modelling approaches, the effect of greenspace proximity and visual amenity cannot be separated. Estimates relate to urban properties only, defined as built-up areas with a population of 5,000 or greater.

We use data from the Valuation Office Agency (VOA), HM Land Registry (HMLR) and Ordnance Survey to estimate the effect of proximity to public green space on house prices. Updated data from HMLR now allows us to produce estimates up to 2022. A unique house-level dataset is produced by linking data, and machine learning techniques are then applied to flexibly model house prices. To obtain an estimate of the average effect of green and blue spaces on house price, we estimate the difference between the predicted price based on the real data and the predicted price if there were no green and blue spaces. We calculate this value for all houses with property information from the VOA, not just those that have sold, to produce an asset value.

To simulate a "no-nature" scenario, we set the area of private gardens and functional greenspace, other natural land, and blue space within a 500 meter radius to zero. We also set the distance to functional greenspace to the average distance to functional greenspace in the region and the distance to the sea to a capped maximum value of 2,000 meters. These are combined to give an aggregated "effect of nature". We also estimate the effect of private gardens and public nature.

The annual value in house prices is based on the average percentage increase in house prices from nature multiplied by ONS imputed rental data.

A limitation of this method is that HMLR data are only available for England and Wales. UK, Scotland, and Northern Ireland are estimated using property transaction data between 2011 and 2022 in England and Wales. A future development would be to extend this modelling to include data from Scotland's Land Information Service.

We assign these estimates to the urban habitat.

## 7 . Cite this methodology

Office for National Statistics (ONS), released 8 November 2024, ONS website, methodology, [UK natural capital accounts methodology guide: 2024](#)