Scotland natural capital accounts: 2023 Methodology

How the Scottish natural capital ecosystem service accounts are measured and developed, including the specific methods used to value individual components of natural capital and physical and monetary data sources.

1. Overview of Scotland natural capital accounts methodology: 2023

The methodology we use to develop these estimates remains under development. The estimates reported in our Scotland natural capital accounts: 2023 are experimental and should be interpreted in this context.

Experimental Statistics are those that are in the testing phase, are not yet fully developed and have not been submitted for assessment to the UK Statistics Authority. We publish Experimental Statistics to involve customers and stakeholders in their development and as a means of building in quality at an early stage.

This methodology article describes the methodology used to develop Scotland's natural capital accounts. The broad approach to valuation and the overarching assumptions made are explained in this methodology article.

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 methodologies used largely align with those used in our UK natural capital accounts: 2022 bulletin, except the provisioning service of oil and gas production where we have improved our methodology. For more information on the methodologies used, please see our UK natural capital accounts methodology guide: 2022. For comparability, updated UK totals and values for oil and gas provisioning have been provided in our Natural capital accounts, Scotland, supplementary tables.

Where data for Scotland are not available, we use apportioning methods to disaggregate UK estimates. Apportioning has been used for agricultural biomass,

water abstraction, mineral extraction, oil and gas production, coal production and renewable services. Further detail is provided in the following sections.

We have used a wide variety of data sources to produce Scotland's natural capital accounts. These sources have been compiled in line with the guidelines recommended by the United Nations (UN) System of Environmental-Economic Accounting (SEEA) Central Framework and SEEA Experimental Ecosystem Accounting principles, which are in turn part of the wider framework of the System of National Accounts.

As UN SEEA guidance is still under development, the Office for National Statistics (ONS) and the Department for Environment, Food and Rural Affairs (Defra) published the Principles of UK natural capital accounting: 2023, which is a summary of the principles underlying the accounts.

We welcome feedback on any of our approaches to natural.capital.team@ons.gov.uk.

2. Habitat extent

Our methodology uses the broad habitat classifications as defined by data from the Land Cover Maps produced by the UK Centre for Ecology and Hydrology (UKCEH). We use raster data from UKCEH Land Cover Maps to estimate habitat extent.

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

Enclosed farmland

Most enclosed farmland is managed for cereal, cattle, and sheep production. Improved grassland is nutrient-rich and is often used as pastures for livestock.

Woodland

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

Mountain, moorland, and heath

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

Semi-natural grasslands

Includes acid grassland, calcareous grassland, 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 floodplain

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

Coastal margins

This includes saltmarsh, littoral rock, littoral sediment, supralittoral rock, and supralittoral sediment. Details of these habitat types can be found in Appendix 2 of the Land Cover Map 2021 documentation (PDF, 1.9MB).

Marine

This broad habitat is saltwater.

3. Annual ecosystem service flow valuation

Broadly, two approaches are used to value the annual service flows. For fish capture, timber, carbon sequestration, air pollution removal, noise mitigation, urban cooling, recreation, and tourism, an estimate of physical quantity is multiplied by a price. The price we use satisfies two accounting conditions:

1. Identifying a price that relates, as closely as possible, to contributions provided by the ecosystem to the economy.
2. 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 to services elsewhere in the national accounts. For example, in the national accounts woodland timber is an input to the timber sector.

For agricultural biomass, water abstraction, minerals, fossil fuels, renewable, and electricity generation we use a residual value resource rent approach.

4. Resource rent definition and assumptions

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

Variations of this approach are applied depending on the category of natural capital under assessment; the variations are explained in the individual ecosystem service methodology. The steps involved in calculating the resource rent are as follows:

- gross operating surplus (System of National Accounts basis) equals 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) equals gross operating surplus (System of National Accounts basis) minus specific subsidies on extraction plus specific taxes on extraction
- resource rent equals gross operating surplus (resource rent derivation) minus user costs of produced assets (consumption of fixed capital and return to produced assets)

Most of the data used in resource rent calculations are available from the Scottish Government's Supply, Use and Input-Output Tables. Return to produced asset estimates are calculated using industry-based net capital stocks published in our Capital stocks and fixed capital consumption, UK: 2021 bulletin, and the nominal 10-year government bond yield published by the Bank of England. These are then deflated using the gross domestic product (GDP) deflator to produce the real yield. The government bond yield rate is relatively conservative compared with those expected in certain markets and could overstate the resulting resource rent estimates.

Technical guidance on System of Environmental-Economic Accounting (SEEA) Experimental Ecosystems Accounting (page 107) (PDF, 2.9MB) acknowledges that the use of the resource rent method may result in very small or even negative resource rents.

In their National Accounting and the Valuation of Ecosystem Assets and Their Services article, Obst, Hein and Edens (2015) conclude that:

"resource rent type approaches are inappropriate in cases where market structures do not permit the observed market price to incorporate a reasonable exchange value for the relevant ecosystem service. Under these circumstances, alternative approaches, for example, replacement cost approaches, may need to be considered".

If the residual value approach produces implausible estimates for subsoil assets and provisioning services, alternative methods should be explored.

Finally, where unit resource rents can be satisfactorily derived, care still needs to be taken by users in applying these at a disaggregated level. Even for abiotic flows, the extraction or economic costs could vary spatially, and hence national unit resource rents could be misleading for specific regions.

5. Asset valuation

The net present value (NPV) approach is recommended by the System of Environmental Economic Accounting (SEEA) and is applied for all ecosystem services to estimate the asset value. 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 values
- asset life – the period over which the flows of values are expected to be generated
- choice of discount rate

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. These paths are not observed and hence assumptions concerning the flows must be made, generally as a projection of the latest trends.

One way to estimate the expected flows is to assume that the current flow, averaged over recent years, is constant over the asset life. In some cases, more information is available on future expected levels of services in non-monetary terms or future unit prices. Where there are readily available official projections, these have been considered but otherwise our default assumption is that the value of the services is constant over time.

Where the pattern of expected service values is assumed to be constant, this is based on averages over the latest five years of data, up to and including the reference year in question.

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.

Following our Principles of natural capital accounting methodology, this article takes one of three approaches when determining the life of a natural capital asset.

Non-renewable natural capital assets: where a sufficient level of information on the expected asset lives is available this asset life is applied in the calculations. Where this is not available, a 25-year asset life is assumed.

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

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.

Based on the Discounting for Environmental Accounts Report for the Office for National Statistics November 2016 by external consultants from Chantry Educational Services (PDF, 453KB), 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 guidance set out in the document, estimates presented in this article assume a 3.5% discount rate for flows projected out to 30 years, declining to 3.0% thereafter and 2.5% after 75 years. The rationale for this approach is discussed further in the Principles of natural capital accounting methodology, published by the ONS and Defra.

The discount rates applied to air pollution removal services and health benefits from recreation have been updated to employ the health discount rates as detailed in HM Treasury's Green Book. The rationale for this lies in the health-based nature of the ecosystem service and the resulting health benefits derived by society. The future utility benefits associated with these service provisions differ from typical consumption goods, in that they are unlikely to be characterised by high rates of diminishing marginal utility, therefore lower rates of discounting are appropriate.

6. Methodology by service

The following section provides an explanation of the data sources and methods used in each service.

Agricultural biomass

Agricultural biomass relates to the value of crops, fodder and grazed biomass provided to support agricultural production.

Agricultural statistics are published by the Department for Environment, Food and Rural Affairs (Defra). 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, 3,0334KB). This approach is also used in our UK Material flow accounts: 2023 dataset.

Estimating the proportion of agricultural production that can be attributed to nature rather than modern intensive farming practices is challenging. Modern farmers heavily manage and interact with the natural services supplied on their land. For example, sowing, irrigation, fertiliser spreading, pesticide use, and livestock management are all industrial practices applied to the land. Very intensive farming may even take place entirely indoors without soil or natural light. At the other extreme, livestock may be allowed to roam freely over semi-natural grassland with very limited human intervention.

As with the principles applied to the UK natural capital accounts, we draw the line between the farmland ecosystem and the economy at the point at which vegetable biomass is extracted (Principle D.2 in our Principles of natural capital accounting methodology). Conceptually, this means farmed animals should not be included in these estimates as they are considered produced rather than natural assets, however this exclusion is not currently possible given data limitations. Grass and

feed that livestock eat are regarded as ecosystem services and so are included. This is also consistent with the boundary between the environment and the economy used in our Material flow accounts: 2023 dataset.

For the Scotland natural capital accounts: 2023, physical flows of agricultural biomass were derived from the Scottish agriculture: economic reports, which contains data on a wide variety of crops, cereals, fresh fruit and vegetables production levels.

In generating agricultural biomass valuation estimates, input-output supply and use tables for Scotland were used to source values for the gross operating surplus and taxes less subsides variables that feature in the resource rent calculations. The UK net capital stock for Standard Industrial Classification (SIC) 01 was apportioned based on the ratio of consumption of fixed capital between the UK and Scotland, with data pulled from the Total Income from Farming Estimates: 2018 to 2020, published by the Scottish Government and Total income from farming in the UK, published by Defra, respectively.

While residual value resource rent approaches can be used for valuing provisioning services in the first instance, top-down industry level estimates present difficulties in establishing clear ecosystem service logic chains and disaggregation. Condition indicators, or even physical flows of agricultural biomass, cannot readily be related to the estimated valuation of the service. We are working to develop valuation approaches using the highest data resolution of good or service production available and appropriate to the level of variation in that good or service (Principle M6).

In future accounts we hope to further develop the agricultural biomass service valuation. Alternative approaches include total farm income and farm rental methods that generate more stable estimates of the value of this service and provide the potential for low-level disaggregation. The ambition being to ultimately link these with indicators of condition. For more information about farm rental, see our UK natural capital accounts: 2019 bulletin.

Fish capture

We rely on a range of external sources that all involve known issues. For instance, Norwegian and Faroese landings of fish captured in the UK are excluded from our estimates because of limited data coverage. The economic data are based on UK fleet data, which we also apply to EU vessels that may face different costs and prices.

Aquaculture or farmed fish have been removed from estimates as farmed fish are viewed as a produced asset and not a natural asset.

Physical data on marine fish capture (live weight) are sourced from the rectangle-level landings data published annually by the EU Commission's Joint Research Centre Scientific, Technical and Economic Committee for Fisheries as part of the Fisheries Dependent Information data call (deep sea).

To calculate marine fish capture in the UK, exclusive economic zone (EEZ) Marine Management Organisation International Council for the Exploration of the Sea statistical rectangle factors were used. The overall fish capture provisioning service physical flow presented in this article represents landings (tonnage) from Scottish waters. UK boundaries do not perfectly align with the geographical areas of fish capture statistics. 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 using net profit per tonne (landed) estimates, provided by Seafish, for different marine species by marine areas. Net profit per tonne is calculated using Seafish economic estimates for fleet segments and Marine Management Organisation 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). Annual net profit per tonne (landed weight) is multiplied by tonnes of fish captured (live weight) for a specific species. The data are aggregated for overall annual valuations of fish provisioning from the UK EEZ.

Landed weight is the weight 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. Live weight is the weight of a product when removed from the water.

A notable limitation of the fish capture provisioning valuation methodology is that landed weight net profits were multiplied by live weight fish capture. Based on Marine Management Organisation data on live and landed weights of UK vessel landings into the UK, aggregate landed weight is around 7% less than live weight.

Net profit per tonne was not available for all fish species so not all the physical flow is valued. We can estimate a net profit valuation for 85% of the fish capture tonnage on average between 2015 and 2020. The provisioning service valuation of fish capture from Scottish waters is therefore likely to be an underestimate.

For all 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. For each stock, we check that fishing pressure is at or below levels capable of producing maximum sustainable yield. We also check if each stock's spawning biomass is at or above the level capable of producing the maximum sustainable yield. Since 2014, we can determine stock sustainability for 76% of the fish capture tonnage, leaving 24% as unknown.

We can determine if the level of fishing for a specific stock is sustainable, but this approach does not consider the knock-on effects of unsustainable fishing to the wider ecosystem. For instance, if a fish species that forms a significant part of other fish species' diets is managed unsustainably, it risks affecting the sustainability of other fish stocks higher up the food chain.

Timber

The method used to value the provisioning services related to timber supply requires two inputs: the stumpage price and the physical amount of timber removed. Annual flow values are then generated by multiplying the two factors together.

Timber provisioning service asset valuations used Forestry Commission forecasts of timber availability to estimate the pattern of expected future flows of the service over the asset lifetime.

Removals estimates are taken from Forestry Commission timber statistics and converted from green tonnes to cubic metres (m3) 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 Forestry Commission Coniferous Standing Sales Price Index in the Timber Price Indices publication (2021). The Coniferous Standing Sales Price Index monitors changes in the average price received per cubic metre (overbark) for timber that the Forestry Commission or Natural Resources Wales sold standing where the purchaser is responsible for harvesting.

Water abstraction

Physical data for water abstraction are sourced from Scottish Water, Defra, Natural Resources Wales, and Northern Ireland Water. No industry water data are available for Scotland, so only data for public water supply are included to maintain UK-wide consistency. Removing industry data also avoids double counting of the valuation of hydropower.

Monetary estimates are based on resource rents calculated for the SIC subdivision class: Water collection, treatment and supply (SIC 36). The definition of this industry subdivision, from our UK SIC 2007 main volume (page 145) (PDF, 1.3MB) states: "the collection, treatment and distribution of water for domestic and industrial needs. Collection of water from various sources, as well as distribution by various means is included". A limitation of this approach, therefore, 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. A limitation of this approach, therefore, 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.

For the Scotland natural capital accounts: 2023 water abstraction provisioning valuation, Scottish input-output supply and use tables were used to source values for the gross operating surplus, taxes less subsides and intermediate consumption variables that feature in the resource rent calculations. The UK net capital stock for SIC 36 was apportioned based on the ratio between intermediate consumption, as sourced from Scotland and the UK’s supply and use tables.

Further work is required to value the services relating to other uses of the water provisioning services, and to explore the roles of different ecosystem types in providing clean water.

We are exploring alternative methods used to value water provisioning services, with the aim to look at the short-term cost and certainty, and long-term sustainability of Scotland's water supply. Our aim is to capture the impact of the changing demand for water, and of climate change on Scotland's water supply by reporting on:

- current and projected demand and water abstraction levels
- weather forecasts and costs of ecologically excessive abstraction
- water movements by truck
- restrictions on supply

Because of increasingly severe fluctuations in weather conditions, such as drought and heavy rainfall affecting regions in Scotland differently, effectively managing water supply is becoming increasingly important.

According to the Assessing Climate change impacts on the water quality of Scottish standing waters report (PDF, 6573KB), published by Scotland's Centre of Expertise for Water, rising air temperatures will affect the temperature of water bodies in Scotland, precipitating changes in water quality through factors such as the extent of algal blooms. It is estimated that by 2040, all standing water bodies in Scotland will be exposed to climate change-related risks.

Minerals

Physical estimates of mineral extraction are provided by the British Geological Survey.

Monetary estimates are based on the residual value resource rent approach calculated from the SIC subdivision class: Other mining and quarrying (SIC 08). This division 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, and manufacture of materials, such as clay and gypsum, and manufacture of chemicals. This 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.

For the Scotland natural capital accounts: 2023 mineral provisioning valuation, Scottish input-output supply and use tables were used to source values for the gross operating surplus, taxes less subsides and intermediate consumption variables that feature in the resource rent calculations. The UK net capital stock for SIC 08 was apportioned based on the ratio between intermediate consumption, as sourced from Scotland and the UK's supply and use tables.

Oil and gas production

Physical estimates of oil and gas production are available from the North Sea Transition Authority.

Monetary estimates of oil and gas follow a residual value resource rent approach calculated from the Income from and expenditure on UK upstream oil and gas exploration, development, operating and decommissioning activities – 1970 to 2022, published by the North Sea Transition Authority 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.

Scottish oil and gas provisioning is estimated using Scottish Government oil and gas statistics, comparable with the UK North Sea Transition Authority 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 North Sea Transition Authority and Scottish Government, respectively.

For the asset valuation of fossil fuels, we use annual projected UK oil and gas production figures from the North Sea Transition Authority. For Scottish, and therefore English estimates, the UK projections were apportioned based upon the relative five-year average of oil and gas production, respectively, from 2017 to 2021.

To estimate valuations in future years, annual five-year averages of "unit resource rent" (average resource rent divided by average production) are applied to production projections.

Coal production

Coal production statistics are available from the department formerly known as Business, Energy and Industrial Strategy (BEIS), now the Department for Energy Security and Net Zero (DESNZ), in the Digest of UK Energy Statistics (DUKES). For the valuation of coal, a residual value resource rent approach is used. This is based upon our Input-output supply and use tables and capital stocks data for the SIC division: Mining of coal and lignite (SIC 05).

For the Scotland natural capital accounts: 2023 coal provisioning valuation, Scottish input-output supply and use tables were used to source values for the gross operating surplus, taxes less subsides and intermediate consumption variables that feature in the resource rent calculations. The UK net capital stock for SIC 05 was apportioned based on the ratio between intermediate consumption, as sourced from Scotland and the UK's supply and use tables.

Renewable generation

Energy generated by renewable sources is published by BEIS (now 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: Electricity, gas, steam and air conditioning supply.

These data are apportioned using turnover from our Annual Business Survey (ABS) to derive SIC 35.1: Electric power generation, transmission and distribution.

For the Scotland natural capital accounts: 2023 renewable provisioning valuation, the ratio of Scotland and the UK's total installed capacity was used to apportion the UK's net capital stock. The resource rent was then calculated using Scottish supply and use tables, this was further apportioned using regional ABS data to calculate SIC 35.11: Production of electricity.

To estimate the renewable provisioning valuation, data were finally apportioned using the renewable proportion of Scotland's total energy generation from BEIS data.

Carbon sequestration

Estimates relate to the removal of greenhouse gases, in carbon dioxide equivalent (CO2e) from the atmosphere by habitats in Scotland. However, because of a lack of data we are unable to include the marine habitat, including those intertidal areas such as saltmarsh.

The carbon sequestration data come from the UK National Atmospheric Emission Inventory (NAEI) Greenhouse Gas Inventory. This contains data relating to carbon change in the Land Use, Land Use Change and Forestry (LULUCF) sector.

A presentation of natural capital accounts based on the impacts from nature acting naturally would include sequestration from ancient woodland but might exclude that from plantation forests. Emissions from damaged green spaces would not be included, as this can be viewed as a form of human-driven pollution, though emissions from a volcano erupting would.

Another view of natural capital is that all natural habitats are somewhat modified. Usually, human intervention is required to capture value and so the possibility of valuing many natural services (notably renewable energy) as if they were separate from human action is impossible.

We have opted for a combined nature and human approach, where greenhouse gas emissions from poorly-managed peatland are included.

This is an area of research we will consider further as our accounts develop. The net carbon sequestration values presented align with 2019 NAEI data for the LULUCF sector. We also aim to estimate the gross carbon sequestration benefits of nature, but this is currently not possible with inventory data.

To estimate the annual value, we multiply the physical flow by the 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, following advice from DESNZ, formerly BEIS.

Air pollution removal by vegetation

Air quality regulation estimates have been supplied in consultation with the UK Centre for Ecology and Hydrology (UKCEH). A brief overview of the methodology follows, with more detailed explanation in the full methodology report published in July 2017.

Calculation of the physical flow account uses the European Monitoring and Evaluation Program Unified Model for the UK (EMEP4UK) atmospheric chemistry and transport model. This model generates pollutant concentrations directly from emissions and dynamically calculates pollutant transport and deposition, considering meteorology and pollutant interactions.

Air pollution data removal by UK vegetation have been modelled for the years 2007, 2015 and 2019. We have then scaled this based on previous modelling to create values for 2030. For 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. We then apply linear interpolation for future years where no government concentration data are available.

The health benefits were calculated from the change in pollutant exposure from the EMEP4UK scenario comparisons, that is, the change in pollutant concentration to which people are exposed. Damage costs per unit exposure were 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)

Damage costs were updated in February 2019. For the method of how these are calculated, please see the Air Quality damage cost update 2019 report (PDF, 1.13MB), published by Defra.

Noise mitigation by vegetation

For a detailed methodology paper on how noise mitigation estimates were produced, please see Scoping UK Urban Natural Capital Account – Extending noise regulation estimates – NR0170, published by Defra.

Urban cooling

For a detailed methodology on how urban cooling estimates were produced, please see Scoping UK Urban Natural Capital Accounts – Extension to develop temperature regulation estimates – NR0172, published by Defra.

Recreation and tourism

In our Scotland natural capital accounts: 2023, health benefits from recreation in nature have been included for the first time. The impact and methodology of this new service are discussed within our Health benefits from recreation, natural capital, UK: 2022 bulletin.

Previous years' changes to the cultural service account structuring are discussed in our UK natural capital accounts: Tourism and recreation methodology.

Recreation

The recreation estimates are adapted from the "simple travel cost" method developed by Ricardo-AEA in the methodological report Reviewing cultural services valuation methodology for inclusion in aggregate UK natural capital estimate. This method was originally created for use on the Monitor of Engagement with the Natural Environment (MENE) Survey, which covers recreational visits by respondents in England.

The method looks at the expenditure incurred to travel to the natural environment and some expenditure incurred during the visit. This expenditure method considers the market goods consumed as part of making the recreational visit (that is, fuel, public transport costs, admission charges and parking fees). This expenditure is currently assumed as a proxy for the value of accessing the site.

Estimates for the cultural service of outdoor recreation in this publication use survey data across seven surveys covering England, Wales, Scotland and Northern Ireland. The questions used from these surveys can be broadly summarised as:

- how many visits to the outdoors for leisure and recreation have you made in the last four weeks?
- on the last visit to the outdoors, what type of habitat did you go to?
- what was the main means of transport used on this last visit?
- how far did you travel to get to and from the main destination of this visit?
- how long was the visit, in terms of time (including travel time)?
- how much did you spend on (spending category)?

In Scotland, data from two surveys are used to produce estimates of outdoor recreation. From 2003 to 2012, data from the Scottish Recreation Survey (ScRS) were used. The ScRS was undertaken through the inclusion of a series of questions in every monthly wave of the TNS Omnibus survey, the Scottish Opinion Survey (SOS). In every month of the SOS, around 1,000 face-to-face interviews are undertaken with adults in Scotland aged 16 years and over.

Replacing the ScRS, Scottish Natural Heritage commissioned the Scotland's People and Nature Survey (SPANS) for the first time in 2013 to 2014, then again in 2017 to 2018. 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 examined the relationship between English and Scottish per visit expenditure on a habitat basis. Linear interpolation was used to produce estimates of Scottish recreation from 2014 to 2016.

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, projected population growth calculated from population statistics in our Principal projection – UK summary dataset and an income uplift assumption, were implemented into the estimation. The income uplift assumptions are 1%, declining to 0.75% after 30 years and 0.5% after a further 45 years. These assumptions project the annual value to increase over the 100 years.

It is acknowledged that the expenditure-based method provides an underestimation of the value provided by visits to the natural environment. Primarily, this is because there are several benefits that are not accounted for, including aesthetic, scientific and educational interactions. Currently, there is no method in use that incorporates these considerations. Additionally, the time spent by people in the natural environment is not itself directly valued because of the accounting and methodological challenges involved.

A significant number of outdoor recreation visits have no expenditure as people take local visits, such as walking to a local park. The value of local recreation and the aesthetic benefit from living near green and blue spaces is estimated through house prices.

Health benefits from recreation

The Scotland natural capital accounts: 2023 include a new recreation account for the first time. The recreation-based surveys discussed in this section of the report have been further used to generate the number of people gaining health benefits from regular recreation, and the monetary value associated with this. The monetary value of health benefits from recreation have been derived from the work of Claxon 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 values).

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, further work has been undertaken to implement the "exposure to nature" approach.

Recreation and aesthetic value in house prices

For a detailed methodology note on how the recreation and aesthetic value in house prices was produced for the UK accounts, please see our article, Urban green spaces raise nearby house prices by an average of £2,500. Please note that there are two significant differences for consideration when assessing house price values for Scotland.

First, we were unable to include data on schools in Scotland: Education Scotland inspect a sample of schools, and educational establishments are not given an overall inspection outcome in the same way as Ofsted (for England) and Estyn (for Wales). Since there is a strong correlation between house prices and proximity to school, this lack of data reduces the accuracy of the model for Scotland. Future work might hope to use alternative data sources on the quality of schools in Scotland.

Second, it is possible that our sample of urban property prices are underestimates of actual urban property prices in Scotland. We source property price data from Zoopla, which uses the advertised price rather than the selling price. However, Scottish properties are marketed with either a fixed price or "offers over" the minimum offer accepted by the seller. As bidding for "offers over" houses can drive up the selling price of properties, our data on advertised prices could underestimate the actual selling price.

7. Cite this methodology

Office for National Statistics (ONS), released 15 June 2023, ONS website, methodology, Scotland natural capital accounts methodology: 2023