Derbyshire Natural Capital Strategy – Appendix 7

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Appendix 7 – Natural Capital accounting methodology

Benefit methodologies

This appendix describes the approach to quantifying and valuing the benefits provided by the natural capital assets in the Derbyshire accounting boundary. The analysis covers the physical and monetary flows of the benefits in the account. The section starts by giving an overview of the Physical and Monetary Flow Account and the Natural Capital Asset Account. This section should be read in conjunction with the Excel™ natural capital account workbook developed by eftec (Derbyshire_NCA_041122.xlsx).

Physical and Monetary Flow Account

The Physical Flow Account shows the level of benefits provided by natural capital in physical terms, while the Monetary Flow Account shows the value of benefits provided by natural capital in monetary terms. An overview of the physical flow and monetary valuation metrics used for each benefit in scope is provided in Table 1.

Table 1: Overview of benefits that are quantified and monetised in the accounts

Ecosystem service	Benefit	Physical flow measure	Monetary valuation metric
Agricultural output	Arable crops produced for human consumption; Meat (cows, sheep) and dairy (cows) produced for human consumption	Tonnes of arable crops produced for food (tonnes/yr); Number of livestock heads (heads/yr)	Gross margins or producer price by crop type (£/tonne); Gross margins by livestock type (£/head)
Timber	Timber removed for further processing	Softwood removals (m^3/yr)	Conifer/softwood stumpage price (£/m^3)
Water supply	Industrial, agricultural and public water supply uses	Surface and groundwater abstraction (m^3/yr)	Resource rent value; ecosystem provision value (£/m^3)
Renewable energy	Energy services	Electricity generation from onshore wind (MWh/yr); Electricity generation from hydropower (MWh/yr)	UK unit resource rent (£/MWh)
Minerals	Minerals for various industrial uses and energy services	Volume of sand and gravel extracted (tonnes/yr)	UK unit ex-works sales value of sand and gravel (£/tonne)
Carbon sequestration	Mitigating climate change	Carbon sequestered in each habitat type (tCO_2e/yr)	Marginal abatement cost (£/tCO_2e)
Air quality regulation	Reduced health impacts and associated cost of treatment and productivity and welfare loss	PM2.5 removed by woodland (kg/yr)	Avoided cost (treatment and productivity) plus welfare value (£/ha)
Flood regulation	Reduced flood damage to properties	Number of properties at risk of flooding (properties/yr)	Avoided property damage cost (£/property)
Recreation	Welfare to individuals visiting outdoor recreational sites	Number of recreational visits (visits/yr)	Total welfare value generated by recreation (£/visit)
Physical health (through recreation)	Reduced health impacts and associated cost of treatment and productivity and welfare loss	Total active visits (which result in Quality-adjusted Life years QALYs[2] saved) (active visits/yr)	Avoided treatment costs per visit (based on costs saved per QALY) (£/active visit)

Ecosystem service	Benefit	Physical flow measure	Monetary valuation metric
Education	Cost of educational visit	Educational visits (days/yr)	Resource cost (£/pupil visit) as proxy for value
Volunteering	Labour savings	Volunteering effort (days/yr)	Resource cost (£/day) of unskilled and skilled labour
Tourism	Expenditure attributable to nature	Total overnight stays (visits/yr)	Expenditure by domestic overnight stays attributed to nature (£/trip)
Water quality	Welfare gain from maintaining the Water Framework Directive (WFD) quality status of waterbodies	Length (km) and area (km^2) of WFD waterbodies by status	WTP for avoided deterioration from NWEBS (£/km)

Natural Capital Asset Account

The asset values estimated are reported in the Natural Capital Asset Account, separated into benefits to businesses and benefits to the rest of society. Asset values are calculated by summing the expected future annual flow of benefits over 60 years, discounted according to HM Treasury Green Book Guidance (2022a) to express in present value terms. Where possible, future values take into account expected trends in the quantity and/or value of the benefit. Where this information is not available, benefits are assumed to be constant over time.

Private Benefits

Agricultural output

Agricultural output comprises both arable and livestock outputs and is a significant sector in the region. The benefit is measured based on the marketed production from the sector at the market prices. The account's Asset Register provides the area of crops and Defra (2022) indicates the number of livestock (cattle and sheep) within commercial landholdings for local authorities in 2016. Records from 2021 are assumed to be representative of current and future years.

To estimate arable production, average yield (tonnes/ha) is estimated based on a selection of representative cereal crops. It is assumed that spring milling wheat, spring malting barley and spring oats are representative cereal crops across all of Derbyshire. Yield for these crop types is sourced from Redman (2018; 2019; 2020) and estimated as a three-year average to smooth out any volatility in output. The area of cereal crops makes up approximately 95% of the total cropland area in Derbyshire, therefore other types of crops were not included in the account. Total arable output, in tonnes, is calculated by multiplying the estimated arable area by the estimated average arable yield. Livestock production within each reporting area is set equal to the number of cattle and sheep recorded in Defra (2022) for the administrative boundaries and PDNP. For the national character areas, the number of livestock is from Defra (2022), and is scaled down based on the ratio of livestock numbers between Derbyshire county and the total for the national character areas that fall within Derbyshire. An assumption of the number of beef and dairy cattle within each reporting area is made based on livestock data for the Derby & South and West Derbyshire and East Derbyshire areas

reported in Defra (2022).

For the monetary values of agricultural produce, the John Nix gross margins for each crop and livestock output has been collated to produce a three-year average estimate based on 2019, 2020 and 2021 figures (Redman, 2018; 2019; 2020). A rolling average figure is used to adjust for any potential volatility in agriculture markets. To estimate the arable and livestock farm income, the average gross margin unit value (£/tonne or £/head) is multiplied by the estimated arable and livestock production figures (e.g., tonnes of wheat; number of beef cows) in each reporting area. For arable crops, the average gross margin of spring milling wheat, spring malting barley and spring oats is applied to the estimated arable output. For livestock, gross margins for upland spring lamb, spring calving upland sucklers are applied to the number of breeding ewes and beef cattle respectively, whilst all-year-round calving Holstein gross margin is used for dairy cattle. The average unit gross margin figures are assumed to be constant over time.

Timber

This benefit has been estimated using the data from the Forestry Research (2021a; 2021b) for the volume of timber at the market value. The account uses the average figures and does not differentiate between species. Data used to estimate the area of commercial woodland within each reporting area is taken from the account Asset Register.

In 2021, the volume of softwood removals in England was estimated as 2 million cubic meters based on estimates of removals from the Forestry Commission Timber statistics (Forest Research, 2021a)[1]. Dividing this by the Forestry Research (2021a) estimated area of coniferous woodland in England (roughly 342 thousand hectares), gives an estimate for the volume of softwood timber removals per hectare in England of 7.2 m^3/ha/year. This is multiplied by the area of commercial woodland within each reporting area. It is assumed that over time timber yields are harvested sustainably, with the volume of removals per hectare remaining constant.

The value of softwood timber production is based on the Forestry Commission coniferous standing sales price index (Forest Research, 2021b). The stumpage price used in the account is estimated as the average of prices recorded in September 2020, March 2021 and September 2021, roughly £33/m^3 overbark. This monetary unit value is then applied to the estimated volume of softwood removals. It is also assumed that the unit value remains constant over time.

Water supply

The benefit of water supply from the natural environment is estimated by the quantity of water (abstracted in each reporting area). Monetary values are calculated using estimates of the value of providing water supply from alternative sources.

[1] Forestry Commission removal statistics provide volume estimates in green tonnes. This has been converted to cubic metres using a conversion factor of 1.222 as recommended by Forest Research (2019b) and is consistent with the approach used in the ONS (2020) woodland natural capital account.

The volume of water abstracted within the Derbyshire region is based on Environment Agency internal records of supply over the last five-years. Five-year average abstraction volumes have been estimated for each sub-area. Only consumption abstractions (i.e., supply in each sub-area) are monetised as this reflects the benefit of water use. Average abstraction volumes for production (i.e., from sub-area source) are included as a physical quantity (2017 to 2021).

To value water abstraction in each region, the volume of water abstracted needs to be disaggregated by water source (i.e., groundwater, surface or tidal) and by purpose. To disaggregate by water source, data requested from the Environment Agency on water returns by source has been used to estimate proportions of total actual abstractions by each water type. The EA data represents actual abstractions, rather than licensed abstractions which is recorded in Defra (2019) for the Midlands EA regional charge area. Table 2 shows how these proportions may vary depending on the dataset used, which could lead to substantially different estimates of abstraction in the Derbyshire area. The proportions based on actual abstractions are multiplied by the five-year average abstraction volume provided by the client. It is assumed that these proportions do not vary across sub-areas.

Table 2: Comparison of % of total water abstractions by water source

Water source	Defra (2019) licensed abstractions	Actual abstractions in Derbyshire (Environment Agency)
Surface water	70%	98%
Tidal water	13%	0%
Groundwater	16%	2%

Defra (2019) present the quantity of water abstraction per year in England for the period between 2000 and 2017. This covers the number of licenses held, and the estimated average abstraction in million cubic metres for non-tidal (surface waters and groundwater) and tidal waters estimated for eight purposes in each Environment Agency regional charge area. Across all types of water use in the Midlands area, 43% of all water abstracted is for public water supply, 0.8% is for spray irrigation, 34% is for electricity supply, 21% is for other industry, 0.6% is for fish farming, cress growing, and amenity ponds and 0.5% is for 'other' abstraction purposes. Other uses, such as agriculture and private water supply, are estimated compose approximately 0% of total water abstraction in the Midlands charge area. For this account boundary, estimates from the Midlands region can be selected, however further disaggregation (i.e., catchment level or local authority) is not possible using this dataset[2]. Using this dataset, the proportion of total licensed abstractions can be estimated by source and purpose. These proportions are assumed to be representative of current and future years. They are used to divide the estimated water abstractions by each water source, by purpose (e.g., agricultural irrigation vs public water supply).

Data is not available for the PDNP or national character areas.

Value of surface waters for public water supply

Using ONS (2019) figures, cited in ENCA (Defra, 2020a), an indicative five-year average unit resource rent value has been estimated as £0.56 per cubic metre in 2021 prices. In the ONS accounts (2019), private water sources, supply to industry and water abstracted from groundwater sources are not valued. Therefore, in the Derbyshire account, this unit value is

[2] Further details on the methodology behind these statistics is available upon request from Defra.

applied to the total water abstracted for public water supply from surface waters in each reporting area in Derbyshire. In theory, this reflects the return to the ecosystem, not to water treatment and supply infrastructure, and is treated as a private value to businesses (i.e., water companies[3]). The monetary unit value is assumed to remain constant over time.

Water supply value of groundwater

Stantec (2019), based on values from the EA's groundwater appraisal guidance, provide monetary unit values for abstraction from all water sources across a variety of sectors. Low, central, and high unit values are provided for three ecosystem service sub-categories: drinking, agriculture, and energy/industry, and further sub-divided by final ecosystem service benefit. The value of groundwater for hydropower generation is excluded from this assessment as it would double-count with the estimated resource rent value of renewable energy generation.

[3] Note that a different, internally calculated, resource rent was used in UU's Corporate Natural Capital Account in 2017 – see Section **Error! Reference source not found.**.

Table 3**Error! Reference source not found.** shows which unit values from Stantec (2019) have been applied to which purpose/sector.

Table 3: Groundwater unit values inflated to 2021 prices (Stantec, 2019)

Applied purpose (based on Defra, 2019)	Low	Central	High	Unit
Public water supply	0.44	0.53	0.61	£/m^3
Private water supply	0.44	0.53	0.61	£/m^3
Spray irrigation	0.00	1.27	0.00	£/m^3
Agriculture (excl. spray irrigation)	0.21	0.26	0.45	£/m^3
Agriculture (excl. spray irrigation)	0.21	0.26	0.45	£/m^3
Fish farming, cress growing, amenity ponds	0.00	0.00	0.00	£/m^3

For this assessment, the low (and lower bound[4]) values are applied to the estimated abstraction of water for each purpose from groundwater sources. This produces an estimate of ecosystem provision of groundwater abstracted and is treated as a value to businesses. The monetary unit values are assumed to remain constant over time.

Renewable energy

The renewable energy benefit is estimated by the amount of energy generated (in megawatt hours MWh) from hydroelectricity and onshore wind valued using the national average resource rent[5].

BEIS (2021a) provides an estimate for the volume of renewable electricity generation in MWh by energy type for each administrative boundary within Derbyshire. Renewable energy statistics are available from the Department of Business, Energy & Industrial Strategy (BEIS, 2021a), and reflect the generation, of electricity by renewable energy source in the UK in 2019. It is assumed that 2019 is representative of the baseline year of 2020, and that electricity generation is constant over time.

The monetary value of electricity produced from renewable energy sources is estimated following the approach used by ONS (2021) that estimates the annual resource rent of renewable energy provisioning equal to £1.36 billion in 2020 prices, with associated generation of 82.2 million MWh in 2019. Dividing these figures and adjusting for inflation produces an average unit resource rent value of £16.5/MWh/year, in 2021 prices. This is then applied to the estimates of renewable energy generated by hydro power and onshore wind within each administrative boundary and is attributed to businesses. It is assumed that the monetary unit value remains constant over time.

The quantity and value of renewable energy has not been disaggregated to PDNP or national character areas.

[4] Lower bound estimates of unit values are used as the areas included in the accounting boundary are not under serious water stress.

[5] Calculated as gross value minus costs of production.

Minerals

The benefits associated with minerals extraction include sand and gravel, coal measures, limestone, sandstone, and millstone grit. The quantity extracted (tonnes) is valued using the UK average ex-works sales value of sand and gravel, and an average of the 2019 production value (£/tonne). UK mineral production and value estimates are reported on a national basis (British Geological Society, 2021). Note that Derby City has a separate mineral planning authority from Derbyshire for which extraction data could not be accessed.

The quantity of extracted minerals within each administrative boundary has been provided by the Derbyshire County Council. The volume of mineral outputs in tonnes is set equal to the estimated average annual extraction tonnage for all active extraction licenses in the Derbyshire area.

Minerals are a non-renewable resource, and therefore mineral extractions are not assumed to remain constant across the accounting period (i.e., 60-years). As land-bank years[6] are reported at the county level, this is assumed to be representative for all quarry sites within Derbyshire. Derbyshire County Council (2021) reports that remaining land-bank years for sand and gravel and crushed rock are approximately 10 and 60+ years, respectively. The production of sand and gravel is assumed to last 10 years, while coal measures, and all other mineral (Sandstone, Permian limestone, Carboniferous limestone, Sherwood sandstone, Millstone grit) are assumed to last 60 years.

The monetary value of mineral production is estimated using the UK Minerals Yearbook to produce an average unit production value for sand and gravel and coal measures. Due to the aggregation for production and sales figures for limestone and dolomite, igneous rock, sandstone, and chalk in the UK Minerals Yearbook, this aggregate value is applied to all minerals extracted in the Derbyshire area except sand and gravel and coal measures (Sandstone, Permian limestone, Carboniferous limestone, Sherwood sandstone, Millstone grit) (British Geological Survey, 2021). This is then applied to the estimates the volume of sand and gravel, coal, and all other minerals produced within each reporting area and is treated as a value to businesses. It is assumed that the monetary unit value remains constant over time.

The quantity and value of minerals has not been disaggregated national character areas.

Public Benefits

Carbon sequestration

Carbon sequestered in habitats and emitted by habitats

Carbon sequestration rates have been estimated for two different natural capital assets within the accounting boundary - woodland and hedgerows. This benefit is estimated using the sequestration rates for each habitat (tonnes CO_2 equivalent per hectare) and the non-traded price of carbon.

[6] Land-bank years represent the remaining stock of sand and gravel or crushed rock within a county and is assumed to be representative for all quarries in the county.

Carbon sequestration and emission rates were taken from the Natural England report Gregg et al (2021) NERR094 entitled Carbon storage and sequestration by habitat: a review of the evidence (second edition). This review considered the scientific evidence for carbon sequestration by semi-natural habitats, in relation to their condition and/or management. This new report updates and expands previous work by Natural England on 'Carbon storage by habitat' published in 2012 NERR043. Where evidence was lacking a gap analysis was included showing areas where research was needed. Where research projects were underway, new evidence was obtained under the Natural England 'Spatial Prioritisation of Land Management for Carbon, (in press), where this was lacking evidence from northern Europe was utilised to fill any final gaps in data.

The total amount of CO_2 equivalent sequestered and emitted is estimated by multiplying these per hectare rates with the total hectares of the respective habitat type, as recorded in the Asset Register. The amount of CO_2e sequestered is then valued following the BEIS (2021b) for the non-traded central price, £245 per tonne of CO_2e in 2021. This is multiplied by the estimated tonnes of CO_2e sequestered. Future flows of carbon are valued using the BEIS (2021b) carbon values series until 2050. Following BEIS (2021b) advice, a real annual growth rate of 1.5% is then applied starting at the most recently published value for 2050 and into the future.

Carbon emitted by livestock

The account estimates the volume and value of carbon emissions from livestock. Note that this calculation does not account for emissions from all farm operations (e.g., electricity, fuel from vehicles, fertiliser and pesticide use) and is therefore an underestimate of the carbon emitted from farming activities.

Table 4 shows the per head carbon emission rates for cattle and sheep that are used within this account. The emission rate for cattle is derived by summing the total volume of emissions produced by both beef and dairy cattle in England as reported in Jones et al. (2019) and dividing this value by the estimated total number of livestock in England (Defra, 2020b). Emission rates are assumed to remain constant over time.

Table 4: Livestock emission rates

Livestock type	Emission rate
Cattle (all types)	1.76 tCO_2e/head/yr
Sheep	0.2 tCO_2e/head/yr

Source: Defra (2020b) and Jones et al. (2019)

The total amount of CO_2 equivalent emitted is estimated by multiplying the per head rate for a given livestock type by the corresponding number of heads in a reporting area. The number of cattle and sheep has been estimated using Defra agricultural statistics for each district and borough council within the Derbyshire region (including PDNP) (Defra, 2021). The amount of tCO_2e emitted is then valued following the same approach as for tCO_2e sequestered in habitats and in accordance with the BEIS (2021b) guidance.

Air quality regulation

Air quality benefit arises from the ability of different types of vegetation to remove pollutants from the air. This benefit is estimated for the amount of PM2.5 removed by woodland (which

makes up more than 70% of this benefit in the UK (Jones et al., 2017) and the human health benefits of this removal.

Jones et al. (2017) modelled this benefit for the UK national accounts reflecting the variety of different levels of PM2.5 concentration, types and extent of vegetation and density of human population across the country. An update to this study has produced estimates of PM2.5 removal per hectare of woodland by local authority. The kilograms PM2.5 removed by hectare of woodland (eftec and CEH, 2019) is multiplied by the total woodland area in a given local authority in each reporting area. For the national character areas and the PDNP, the total woodland area is broken down by local authority to allow the local authority specific PM2.5 removal rate to be applied. The PM2.5 removal per ha of mature (i.e., existing) woodland is falling over 2015-2030 based on the assumption about emissions and concentrations falling over time.

The economic value of this service is estimated through the resulting avoided healthcare cost at local authority level (eftec and CEH, 2019). The account shows the benefits as the result of: £ per ha of woodland (in terms of avoided health care cost due to PM2.5 removed, in 2021 prices) for a given local authority area (eftec and CEH, 2019), which is multiplied by the total woodland area in that area (as produced by further GIS analysis). This produces the annual value of PM2.5 removal by woodland. For the national character areas and the PDNP, the total woodland area is broken down by local authority to allow the local authority specific value of PM2.5 removal rate to be applied.

Future benefits decline in line with lower emission / concentration assumption mentioned above but are discounted at lower levels using the lower health discount rates (HM Treasury, 2022b).

Recreation

Recreational benefit is measured in terms of number of visits to accessible greenspaces, and the average welfare value associated with these visits.

The ORVal[7] tool is used to estimate the number and welfare value of visits to the accessible open spaces in the account boundary. ORVal also breaks down the estimated number of visits and associated welfare value by socio-economic group. Estimates can be produced for various spatial breakdowns including local authorities and Middle Layer Super Output Area (MSOA). The number of visits and value for each national character area and the PDNP are derived by summing the visits/value in each MSOA within the national character area.

It should be noted that the data from ORVal takes into account the location of the recreation asset, surrounding population, habitat type(s) and local alternatives, but makes the assumption that accessible green space is in average condition for its type. Where this is not the case, green space with better/ worse condition than average will likely have higher/lower values for number and welfare value of visits. Similarly, as the model underlying ORVal is based

[7] ORVal is a spatial model that shows the recreational sites, number of visits and the benefit to visitors using data from mapping tools, Monitor of Engagement in Natural Environment (MENE) survey and economic valuation literature. University of Exeter (2018) ORVal v2.0 - The Outdoor Recreational. https://www.leep.exeter.ac.uk/orval/

on MENE data[8], it does not take into account visits by children or overseas visitors to the UK.

Therefore, as ORVal captures all domestic visits by adults, there is a risk of double counting with domestic tourism visits, in particular day visits[9]. To adjust the visit numbers to reflect recreation visits under three hours, the MENE cross-tabulation viewer was used to determine the number of visits across England that were over and under 3 hours (Natural England, n.d.)[10]. 78% of visits across England were under three hours, this percentage is applied to the estimated total annual visits in each reporting area. The annual visits under three hours are multiplied by the estimated average welfare value per visit for that reporting area (ranges between £3.2-£4.3 per visit in 2021 prices). The unit monetary value (i.e., £ welfare value per visit) is assumed to remain constant over time.

ORVal does not distinguish on-water recreation. This is estimated through the values for maintaining WFD status from the National Water Environment Benefits Survey (NWEBS)[11]. ORVal is based on the MENE survey which asks respondents about the types of activities they undertake during their recreational visits, including fishing and water sports as broad categories (Natural England, 2018a). Therefore, there is a risk of double-counting if both ORVal and separate on-water recreation valuation are used. Consequently, the estimated value of on-water recreation within the NWEBS data, estimated as part of the method described in Section A.1.3.8, is not included in the account to avoid double-counting.

Physical health

In addition to improving the general welfare of visitors, if people are active during their visits, recreation can also have measurable physical health benefits. White et al. (2016) estimate that 51.5% of recreation visits[12] are 'active', where an 'active visit' is defined as those who met recommended daily physical activity guidelines either fully, or partially, during visits.

The White et al. (2016) proportion of active visits is applied to the annual visits to greenspaces within the account boundary[13], producing the number of annual active visits which is assumed to remain constant over time.

The benefit is valued as the health benefits of active recreation (in terms of improvements in Quality Adjusted Life years – QALYs[14]) and the economic value of health improvement (in terms of the avoided health cost due to improvement in QALY). Beale et al. (2007) analysed Health Survey for England data, estimating that 30 minutes a week of moderate-intense physical exercise, if undertaken 52 weeks a year, would be associated with 0.0106768 QALYs per individual per year. Beale et al. (2007) assume this relationship between physical activity and QALYs is both cumulative and linear. Claxton et al. (2015) estimate a cost-effectiveness threshold of a QALY to be roughly £12,900/QALY in 2008 prices. This figure is used as a proxy

[8] See: https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results
[9] A day visits is any leisure visit that is at least 3-hours (round-trip).
[10] This is based on the Year 7 (2015/16) MENE survey weighted base results for "Question 3: How long did this visit last altogether."
[11] See Section A.14 for water quality methodology.
[12] Refers to recreation visits that are under three hours, as reflected in the recreation method.
[13] As described in the recreation method.
[14] QALY is a health measurement used widely in health and health economics research. QALY of zero denotes death, and 1 denotes full health.

for health costs, reflecting the avoided health costs when QALY is improved by one unit. Based on this information, the avoided health cost is estimated as £3.41 in 2021 prices. The monetary unit value is assumed to remain constant over time.

Tourism

Domestic tourism is measured in terms of the number of day visits (i.e., visits that are more than three hours but do not include an overnight stay) and the number of domestic overnight trips and the associated expenditure of these visits and trips that are attributable to natural capital. The Great Britain Day Visitor Survey (Kantar, 2019a) and the Great Britain Tourist Survey (Kantar, 2019b) produce annual figures for Great Britain, but also three-year average visit and trip numbers and associated expenditure by local authority and national parks. The latter has been used in this assessment to allow for subdivision across the administrative boundary. The day visits (i.e., over three hours) and overnight trips are treated as additional to the recreation visits (i.e., those under three hours). Note that some district and borough councils within the Derbyshire area provided data on tourism activities, but they could not be used due to difficulties reconciling differences in the several datasets received. Reporting for different time periods (before, during and after the Covid-19 pandemic), as well as differences in the tourism visit estimation methodology used, indicated that a single, consistent, data source would be preferable and yield more reliable estimates.

Total domestic tourism visits for a reporting area are the sum of the estimated annual day visits and domestic overnight trips. For each visitor group, the average expenditure per visit is estimated at the local authority and national park level. The average expenditure (£/visit) for a given reporting area is then multiplied by the estimated number of day-visits and overnight trips to that area within a set reporting area. The sum of day-visits and overnight trip expenditure provides an estimate of the total expenditure that supports the local economy.

The proportion of visits and trips and their associated expenditure that are attributable to natural capital are estimated using ONS (2021) tourism and leisure natural capital account for the UK. Based on this work, it is estimated that nature's average contribution to total expenditure on tourism and outdoor leisure related activities within GB is approximately 8%. This proportion is applied to both the number of total visits (day and overnight) and their associated total expenditure, to produce an estimate of the natural capital attributable visits and expenditure within each reporting area. Both visits and expenditure are assumed to remain constant over time.

The quantity and value of tourism has not been disaggregated to the national character areas.

Volunteering

The benefits to an individual of volunteering are many and varied, including for example physical and mental health benefits, as well as a sense of contribution to wider society. The number of days should relate to nature-based volunteering only. The number of volunteer days are valued based on the value of employing volunteers by various skill levels used by the Heritage Lottery Fund (HLF, 2017). Note that data on volunteer effort (i.e., days) are high-level estimates provided by Derbyshire County Council for Lowland Derbyshire, therefore the

estimates produced are partial and do not represent the total across the County.

An estimated 36,900 hours of volunteering were undertaken in Lowland Derbyshire between 2004 and 2011 (Lowland Derbyshire Biodiversity Partnership 2011, 2011), which is estimated to be 6,150 hours per year. This value has been converted to days by assuming one day equates to 7.5 hours. It is assumed that all volunteer effort is nature related. The number of volunteer days is assumed to remain constant over time.

The value of volunteer effort is calculated using the value of skilled and unskilled labour per day, from the Heritage Lottery Fund (HLF, 2017). The value of the volunteer input ranges between £55 to £165 per day, in 2021 prices. It is assumed that volunteer effort is evenly divided between unskilled and skilled volunteer inputs. Then the number of volunteer days is multiplied by the appropriate input value. The monetary unit value is assumed to remain constant over the accounting period.

The quantity and value of volunteer is only provided for the entirely of Derbyshire; it has not been disaggregated to the administrative boundaries, national character areas or Peak District National Park.

Education

The natural environment can be an important resource in education in terms of improving health and wellbeing and learning attainment of students. The number of education visits are valued using the average value per educational visits from Natural England's CNCA for National Nature Reserves (Clark, 2017). Only South Derbyshire provided an estimate of the number of educational visits within their reporting area. This value is likely only partial and is not reflective of the total number of educational visits attributable to natural capital within the Derbyshire area. The number of educational visits is assumed to remain constant over time.

The educational visits are valued using evidence from the National Nature Reserve CNCA (Clark, 2017) which used the price charged by other providers (e.g., RSPB, Wildlife Trusts)[15]. The values range between £2.08 and £6.90 per visit and vary based on user type (e.g., public, half school day or higher education) and the level of involvement from Natural England staff and volunteers. However, an average value of £3.31 per visit[16] is used in the Derbyshire account. After accounting for inflation, the average value per educational visit is £3.66, which is applied to the number of education visits reported by the protected landscapes. It is assumed that the monetary unit value remains constant over time.

The quantity and value of education is only provided for the entirely of Derbyshire; it has not been disaggregated to the administrative boundaries, national character areas or Peak District National Park.

[15] A summary of the values is available in Clark (2017).
[16] It is assumed this average value is in 2017 prices, which is the same price year as the NNR account.

Water quality

Maintaining the quality of water in the environment could have financial benefits for businesses (e.g., avoided water treatment costs) and welfare benefits to the public as proxy for many ecosystem services provided. The approach taken here is the latter and the welfare benefits are linked to maintaining the Water Framework Directive (WFD) quality status of the of waterbodies as reported in the natural capital Asset Register.

The physical change is estimated by a given status (i.e., change in the WFD status from Good to Moderate). The economic value is based on the National Water Environment Benefits Survey (NWEBS) values (NERA Economic Consulting 2007; Metcalfe, 2012). The NWEBS values provide low, central and high estimates of values for coastal and transitional water bodies, in 2012 prices. NWEBs values have been inflated to 2021 prices using the HM Treasury (2022b) GDP deflator.

The NWEBS values represent survey respondents' willingness to pay (WTP) for six equally weighted ecosystem components (Defra, 2015, p.69):

- Fish;
- Other animals such as invertebrates;
- Plant communities;
- The clarity of water;
- The condition of the river channel and flow of water; and
- The safety of water for recreational contact.

Therefore, to avoid potential double-counting with recreation estimates, one sixth of the estimated total value is deducted from the account values. It should be interpreted with caution as it has not been possible to disaggregate the impact of water quality on other benefits valued in the account.

This assessment uses the central value estimates for avoiding the deterioration of lakes and water bodies and for rivers in the Humber and North West River Basin Districts. Estimates are produced for lakes (i.e., annual £ value per km^2) and for river water bodies (i.e., annual £ value per km). Using the central estimates, the total annual value of avoiding the deterioration of the current water quality across all identified water bodies in Derbyshire is estimated using the relevant river basin district values for each reporting area. Where sub boundaries fall within Humber and North West River Basin District, the average value of these Districts are applied.