A North West Regional Natural Capital Account

Final report

United Utilities

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Disclaimer

Document evolution

Interim report	02/04/2020	Reviewed by Ece Ozdemiroglu
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This report is based on eftec's Version 2 – January 2020 report template.

Summary

This is the final report for the project to develop a North West Region natural capital account for United Utilities. The scope of this account is all the natural capital assets in the region, and assessment of the benefits from them, which aligns with the scope of the UK's national ecosystem accounts. The results give a consistent picture of the region's natural capital: the extent and condition of natural capital assets and the benefits they provide to businesses in the region and the rest of the society. The results can input to both United Utilities' business strategy and operations, and decision-making across the region.

The methods used in the project are based on published evidence from Government and robust academic sources. Their application in the region, including identification of material benefits to include in the account, was informed by discussion with stakeholders at a workshop in Manchester in March 2020.

The account covers the North West region as defined by the maximum extent of the political boundaries, operational catchments, and the United Utilities service area. The asset and benefit assessments are also presented for six county/city-regions, and for example catchments in Cumbria allowing comparisons at different scales within the region. An outline of the accounting process is provided in Figure S1. Spatial data are used to build the asset register, from which benefits are assessed using further data from Government and robust academic sources. Physical and monetary values of benefits are calculated.

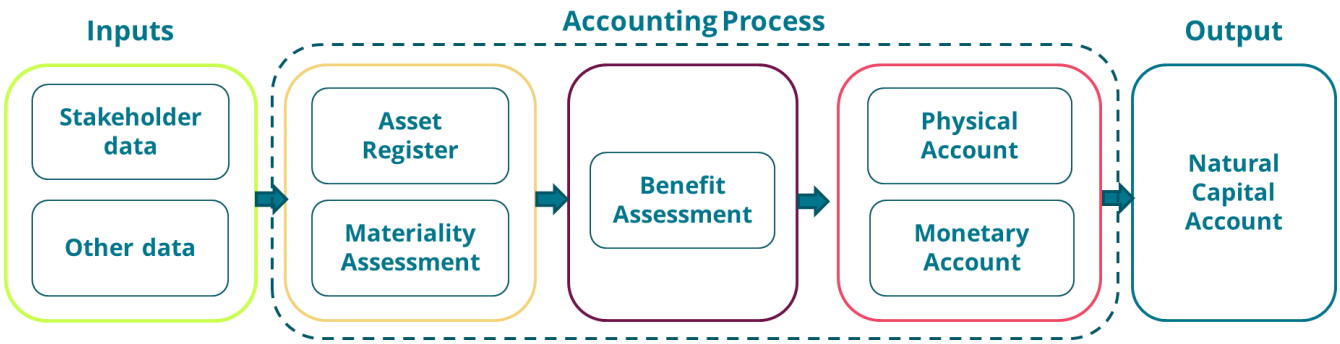
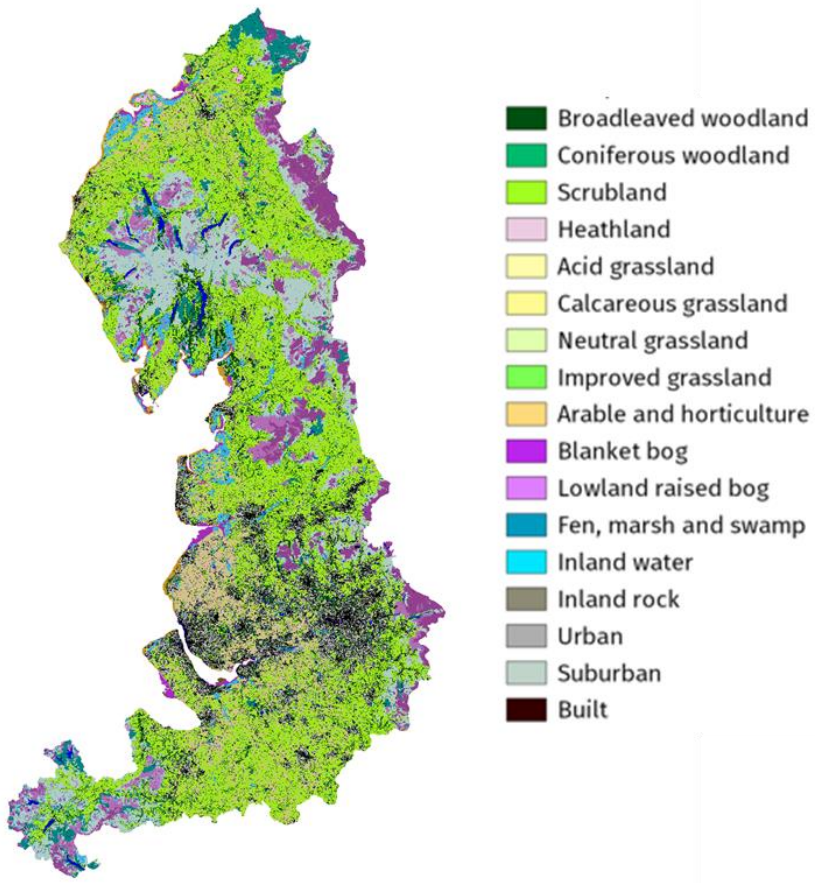


Figure S1: Outline of accounting process

Account Results

The NW region account results in Figure S2 and Table S1 quantify assets in detail and measure and value a wide range of benefits – this is believed to be one of the most complete natural capital accounts developed in the UK, in terms of the fine scale spatial mapping, large regional area covered, and range of benefits valued. The results identify that large benefits from natural capital to wider society that are nearly as large as the direct benefits to business.



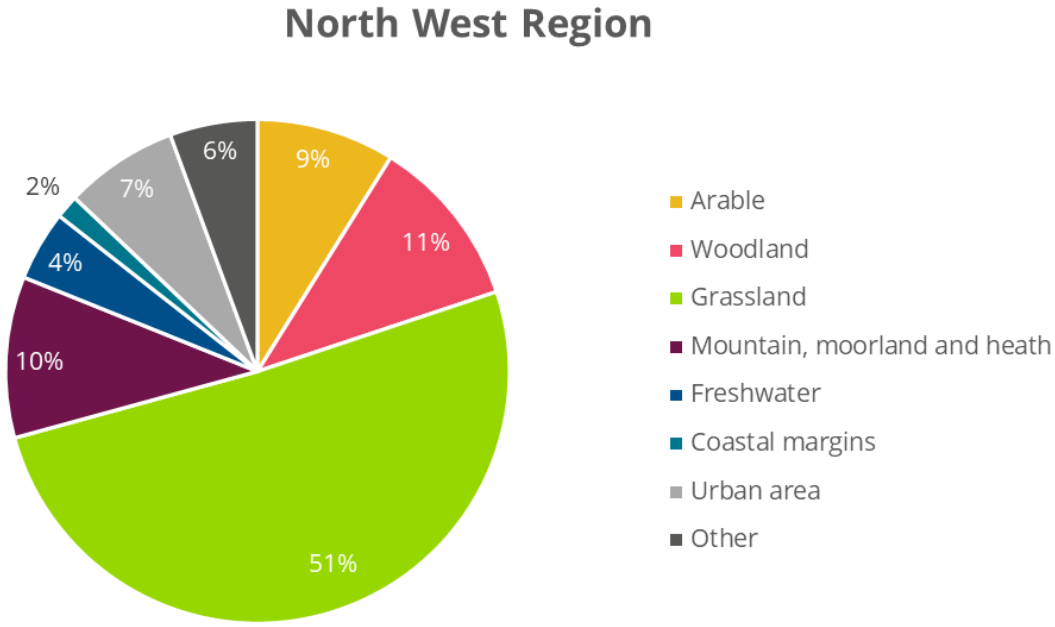


Figure S2: North West Regional extent account

Table S 1: North West Region natural capital balance sheet, PV60 £m

At May 2021	Valuation metric	Value to Businesses	Value to the rest of society	Total
Asset values (monetised)				
Food provision	Arable income	2,542		**2,542**
	Livestock income	7,080		**7,080**
Fishing (commercial)	Value of landings by vessels 10m and under	0.01		**0**
Timber	Value of softwood removals	317		**317**
Renewable energy	Resource rent value of hydropower	7		**7**
Water availability	Resource rent value of tidal and surface water abstractions for public water supply	653		**653**
	Groundwater used for public and private drinking water and agriculture use	96		**96**
Minerals	Ex-works sales value of sand and gravel	569		**569**
	Ex-works sales value of crushed rock	4,008		**4,008**
Tourism	Domestic tourism expenditure attributed to natural capital	70,104		**70,104**
Air quality regulation	Value of PM2.5 removal by woodland		4,509	**4,509**
Carbon sequestration	Value of CO_2e sequestered in woodland, saltmarsh, and improved grassland		7,208	**7,208**
Recreation	Adult recreation welfare value (under 3 hours)		23,432	**23,432**
Physical health	Avoided medical treatment costs due to active physical recreation in nature		12,291	**12,291**
Water quality	Welfare benefit of avoiding deterioration in rivers		3,824	**3,824**
	Welfare benefit of avoiding deterioration in lakes		20	**20**
	Total gross asset value	**85,376**	**51,284**	**136,660**
Asset values (non-monetised)				
Water supply	Total water abstraction at source (i.e., production): 658 million m^3			
Flood risk management	Volume of water held back by woodland: just over 37 million m^3			
Recreation	Total children recreation visits (under 3 hrs): 68 million visits			
Biodiversity	Total SSSI area: 217,500 hectares			
Education				
Volunteering				
Mental health				

The data for the NW region can be broken down to generate accounts for sub-areas of the region. Six reporting areas, based on country and city boundaries, are used in the account, and example catchment accounts are also provided. These sub-regional and illustrative catchment results are reported, in a similar layout, in the accompanying MS PowerPoint™ file (NW NCA Draft Account Outputs 100521.ppt). These data demonstrate how the account allows comparisons between different parts of the region, and between smaller areas nested within a regional context.

Account results for other reporting areas in the region can be efficiently generated from the spatial data and account calculation processes developed. The detailed spatial mapping of habitats and land uses prepared for the project mean that the asset register can also be

generated and inputted into the account for other spatial boundaries within the region. Some benefits calculations then occur automatically, whereas others require manual data processes.

The regional results can be compared to the natural capital account for UU's land (which makes up 3% of the regional account area) from 2017. However, the regional account uses the best available methods, several of which are updated or newly developed since 2017, so the comparison could be improved by an update to the UU land account. Interpretation of the regional account would also be improved through better understanding of the current spending to manage natural capital in the region. This data is not routinely gathered, but methods are now available to do so.

Further work

The results are considered to provide a robust and detailed baseline of natural capital evidence for the North West region. Further engagement with stakeholders is recommended to discuss how to share, use, update and manage the account results going forward. However, there are still details in the methods that could be improved by:

1. Expanding data to cover:
   - Upland and lowland areas;
   - Management of drought events;
   - Value of intra-regional transfers of water in the North West;
   - Sources of hydroelectricity in local authorities, and
   - Condition indicators for areas of recreational greenspace, AONBs and National Parks.
2. Assessing the cost of maintaining natural capital assets
3. Further research into:
   - Adaptation to climate change;
   - Assessment of natural flood management benefits;
   - Educational visits to natural areas, cultural resources and social benefits;
   - Social capital: for example valuing UU involvement in catchment partnerships;
   - The benefit of carbon storage and sequestration;
   - Mental health benefits;
   - Biodiversity, and
   - Employment supported in key sectors.
4. Updating the UU corporate natural capital account, which can be done efficiently by linking to spatial and benefit data in the account.

Contents

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Abbreviations & Acronyms

AONB	Areas of Outstanding Natural Beauty
BEIS	Department for Business, Energy, and Industrial Strategy
CNCA	Corporate Natural Capital Account
CO_2e	Carbon dioxide equivalent
Defra	Department for Environment, Food and Rural Affairs
DWWMP	Drainage and Wastewater Management Plans
EA	Environment Agency
ELM(S)	Environmental Land Management (Scheme)
ENCA	(Defra) Enabling Natural Capital Approach
MMO	Marine Management Organisation
MWh	Megawatt hour
kWh	kilowatt hour
MENE	Monitor of Engagement with the Natural Environment
NCA	Natural Capital Account
NE	Natural England
NEVO	Natural Environmental Valuation Online
NWR	North West Region
ONS	Office for National Statistics
ORVal	Outdoor Recreation Valuation
PM2.5	Particulate Matter less than 2.5 microns in diameter
SSSI	Sites of Special Scientific Interest
SUDS	Sustainable Urban Drainage System
UU	United Utilities
WFD	Water Framework Directive

1. Introduction

This is the final report for the development of a NW Region natural capital account for United Utilities (UU). It reports the work undertaken to produce the baseline account for the region. The methods used and results for the region are presented here, and other sub-regional outputs from the account are reported in the tables and diagrams in the accompanying MS PowerPoint™ file (NW NCA Draft outputs 100521.ppt). The detailed calculations, assumptions and data sources used are laid out in a bespoke accounting MS Excel™ spreadsheet (NW-NCA-final-100521-reissuedOct21.xls) provided to United Utilities, and that can be shared with regional stakeholders.

The purpose of this project is to prepare a baseline natural capital account for the North West of England. This report covers the development and results of :

- A regional account that maps the extent and condition of natural capital assets, and measures and values of the benefits that they produce to the businesses in the region and the rest of the society;
- A refined accounting method that can provide results for the region and in selected sub-regional breakdowns; and
- Engagement with key stakeholders on the approach and data used.

The account makes the same baseline data about natural capital assets and benefits available to stakeholders at the regional and sub-regional spatial levels. This is intended to aid collaborative and consistent decision making in contexts like the following:

- For United Utilities
  - Business strategy and operations, and wider stakeholder discussion for current activities (e.g., management of UU's own estate);
  - Appraisal of individual investment options (e.g., in catchment management approaches);
  - Regional outcome scenarios (e.g., of environmental net gain);
  - Biodiversity enhancements by putting United Utilities land in context of regional resources;
- Sharing consistent natural capital data between environmental regulators and environmental management delivery bodies in the North West;
- Sustainable Urban Drainage System (SUDS) and urban green infrastructure investments to promote greater recreation and wellbeing;
- Agricultural interventions through greater knowledge of the land use types and agricultural sub-sectors in the region;
- Local governance in city regions (e.g., Liverpool/Manchester), smaller local authorities, Areas of Outstanding Natural Beauty (AONB) and National Parks, and
- Natural capital investments by a range of groups within the region (e.g., Local Economic Partnerships, Private Estates).

For example, United Utilities is making, or considering, natural capital investments in the North West, much of which could be outside of land it owns. The account will inform how and where to make such investments to improve natural capital in the North West. For example, in the drainage and wastewater management

plans (DWWMP), UU already has a commitment to enhance natural capital by 10%; the natural capital account will inform the delivery of this target.

Stakeholder needs naturally evolve over time with changing environmental and socio-economic conditions. Therefore, further discussions of how to use this baseline account, and subsequent account updates, are expected.

2. Approach

The approach to preparing a natural capital account has been informed by feedback from United Utilities and stakeholders. This natural capital accounting is a systematic approach to put together different environmental, financial, and socio-economic data to answer the following key questions to unpick our dependencies on natural capital[1]:

I. What assets do we have?
II. What benefits do they provide and to whom?
III. What are these benefits worth?
IV. What does it cost to maintain the assets?
V. How do costs compare to benefits over time?

The outputs in this report relate to Steps I – III and as such has a similar scope to the UK national natural capital accounts[2], than an organisational account.

This approach was then refined and adapted to the North West through engagement with United Utilities and stakeholders. Further work is planned to share the baseline account with regional stakeholders, obtain feedback to improve the analysis (e.g., through better data collation), and explore processes for giving access to the information in the account and repeating production of the account in future years, and/or other objectives to be determined.

This structure of the account allows the benefit assessment to be designed so that some of the benefits are automatically calculated when asset register information is inputted, for others, asset and benefit data need to be linked manually. These calculations link data on the extent and condition of the assets identified in the asset register, to value data on flows of ecosystem services, through the process shown in Figure 2.1. The product of quantity and unit value gives an estimate of annual value. Asset values are calculated by summing the expected future annual values of benefits over 60 years, discounted according to HM Treasury Green Book Guidance. 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.

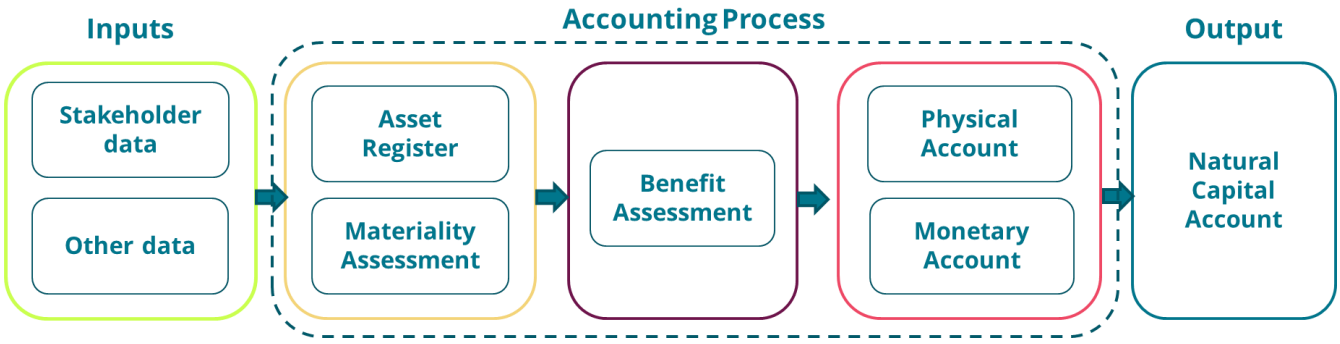

Figure 2.3: Outline of accounting process

[1] These questions are based on the Corporate Natural Capital Accounting (CNCA) framework published by the Natural Capital Committee in 2015 (eftec, RSPB and PWC, 2015).

[2] Natural Capital - Office for National Statistics (ons.gov.uk)

The benefits calculations are described in more detail in Section 6. The data sources and assumptions for these calculations are laid out and referenced in the account spreadsheet. In general methods use recognised government data sources and large scale modelling sources for quantities of benefits and unit values.

The advantages of this natural capital accounting approach are that it:

- Considers long-term value of natural capital assets, so encouraging the monitoring and sustainable management of natural capital;
- Identifies both private and public values provided by natural capital assets;
- Provides a framework within which you can measure changes in natural capital assets over time, relative to an 'baseline year'. It can also be the basis of scenario analysis to test future changes in the extent and condition of natural capital assets; external factors like climate change; and outcomes of decisions by the stakeholders, and
- Measures changes in value of natural capital benefits by cause (i.e., by extent and condition of natural capital assets, beneficiaries, external factors, and effect of decisions).

The specific methods to measure and value individual assets and benefits are described in the relevant sections on the asset register and the assessment of benefits.

Interpretation of the regional account would also be improved through better understanding of the current spending to manage natural capital in the region (Step IV above), which would allow production of a regional 'natural capital balance sheet' (V). This spending data is not routinely gathered in the UK, but methods are now available to do so – this is one of a number of potential next steps, discussed in Section 7.

3. Stakeholder engagement

Stakeholder engagement was undertaken early in the project to help design the accounting framework, identify data, identify material benefits, and make outputs decision-useful for as many stakeholders as possible.

The methods and scope of the account were discussed at a stakeholder workshop in Manchester in March 2020. A range of organisations engaged in the workshop, and their inputs are an important factor in developing the account, either as contributors of data, users of the results and/or stakeholders in the resulting United Utilities' investment decisions. Relevant stakeholders invited to the workshop from a long list developed by eftec, Countryscape and United Utilities (UU) on the basis of existing networks and knowledge of the region.

A small number of stakeholders from this list with an existing knowledge of natural capital accounting were contacted in advance of the workshop to gauge key views on the accounting process and aims (e.g., for farming, property, city regions). Workshop attendees are summarised in Table 3.1.

Table 3.1: Number of March 2020 workshop attendees by organisation type

Organisation	Number
Project team (eftec and Countryscape)	3
United Utilities	3
Public Sector	4
NGO/ Other	5
Private Sector	3
Total	**18**

The following summarises key feedback from the stakeholder engagement.

Purpose

The natural capital account must not try to present a solution to everything. We should consider where it can add value (e.g., filling knowledge gaps in current information, providing baseline information or supporting scenario analysis) and what scale of decisions it is intended to support (i.e., at strategic, catchment or project level). A recommendation was made that the account should have a high impact for a few users rather than try to meet everyone's needs (risk of trying to satisfy all users resulting in compromises). Regional organisations and local authorities will be key users of the tool, with the capability to consider potential habitat change from existing uses (e.g., restoring peatland instead of use for cropping). Key questions to determine the shape of the account specification are:

- Who is the end user and for what purpose will the results be used?
- Will the account be used to suggest and generate solutions? If so, what decisions will it influence?
- How does it link to potential funding streams?

Mapping

In terms of mapping and spatial breakdown, key feedback was:

- Operational catchment level is the lowest level of catchment required. Local authority splits are needed too. The chosen habitat classification is at the correct level of detail;
- The proposed scale at 5m resolution is sufficiently detailed – although it is recognised that the Asset Register will aggregate this data for larger geographical areas;
- Further work is possible to give additional mapped detail of urban areas, and water resources, and
- The project needs its own mapping approach using consistent data across the region, but needs to acknowledge, and could link to, the different local mapping efforts in the region including Merseyside, Cheshire East, and Greater Manchester.

Benefits

The list of benefits covered was discussed, and feedback was used to identify the list of material benefits (see Section 4.2). There was also a suggestion that the levels of employment supported in key industries could be a useful output (agriculture, forestry, tourism, and the visitor economy). This is noted as a potential future addition to the account in Section 7.

Presentation of Results

The workshop session on data sharing and access provided ideas on the account interface design. Key points were:

- Fine scale spatial data allowing zooming and search for local data;
- Layers can be clicked on and off for Assets and Benefits;
- Show contextual data including boundaries, landmarks and biodiversity;
- Ability to show layers that give understanding of the location of beneficiaries – e.g., population density or businesses;
- Click on the map to display statistics, opportunities, confidence, demographics, and
- Case study examples would help to illustrate the usefulness of the tool and information available.

Data & Governance

- The best available data is proprietary, and while generally accessible to the public sector, it is not accessible to all stakeholders. So there is a risk of creating a system in which partner organisations have unequal access to data/ results.
- The choice of data also needs to consider the frequency of updates to that data, and how this can support updates to the account. This links to overall governance of the account and responsibility to maintain data.

It was suggested that the work could benefit from an advisory group which would also help long-term engagement with the project. The group could also aim to make data sharing easier, by sharing processes and uses of the data across the region. It could also make the results more independent of UU – while not hiding the fact that its development has been sponsored by the company.

4. Scope of the account

Scoping of the account defines the spatial boundary of the account, the natural capital asset and the benefits covered and presentation of results.

4.1 Spatial boundaries and asset register

The suggested spatial boundary for the account is based on the United Utilities service area (area within which UU provides services to its customers). The boundary is set as the outer limit of the following three boundaries (shown in Figure 4.1):

- United Utilities service area;
- North West Region, and
- Welsh Catchments (including Dee and Vyrnwy) from which UU abstracts water.

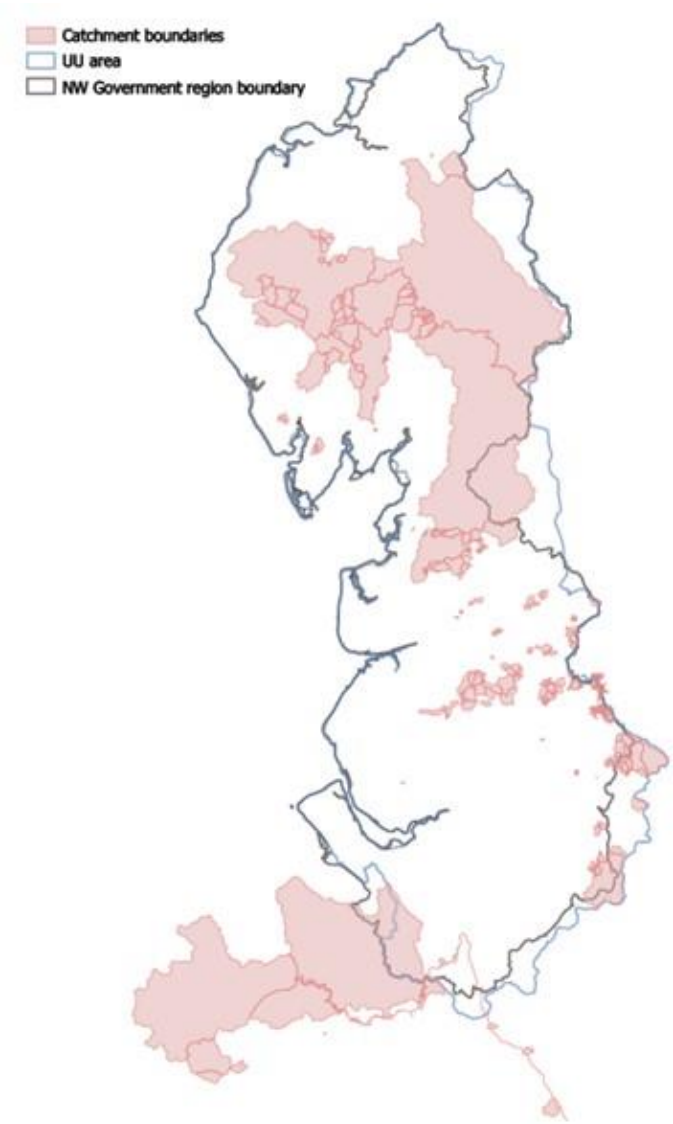

Figure 4.1: Boundary of the North West Regional account

This boundary includes the North West River Basin District and the Eden catchment. This 'North West' boundary excludes some important water resources for the region, for example from North Wales. However, the transfer of water into the region, and transfers within the region (e.g., Cumbria to Manchester) are explicitly included in the account. Alternative options for the spatial boundary include the North West River Basin District or the North West Government Region.

It is also possible to include inshore waters (possibly to 3km) in the boundary of the account. This would help recognise the input from these areas to benefits such as coastal recreation and inshore fisheries. However, the allocation of marine assets to sub-areas of the region is not straightforward, so this has not been undertaken. As stated above, the account also includes benefits from coastal habitats and inshore waters. In addition, the account includes

numbers of designated bathing waters in the asset register. Dividing them to sub-areas of region would be arbitrary, and not necessarily a good basis for assessing how these assets generate benefits.

The natural capital assets are defined by the extent and condition of habitats and land use types within he account boundary. Biodiversity is reflected in the detailed mapping data, but in the asset register is covered only through data on specific habitats and designated sites. Many benefits are from services that are provided by a combination of assets. Further details of the asset register area in Section 5.

When interpreting the asset register, it should be borne in mind that there are different local natural capital mapping efforts in the region including Merseyside, Cheshire East, and Greater Manchester, which may provide additional local data. The sensitivity of results to different mapping approaches would benefit from testing with relevant stakeholders.

4.2 Benefits

The list of material benefits the account aims to cover was developed at the stakeholder workshop:

- Food provision
- Fishing (commercial)
- Timber
- Renewable energy (hydro only)[3]
- Water supply
- Minerals
- Air quality regulation
- Carbon sequestration
- Flood risk management
- Recreation
- Physical health from active recreation
- Tourism
- Water quality
- Flood risk management
- Biodiversity
- Education
- Volunteering
- Mental health

The methods used to assess these benefits are described in Section 6. The calculations are linked to the location, extent, and condition of natural capital assets, as identified in the asset register, described in Section 5. Monetary valuations are prioritised in the accounts, but are not possible for all the material benefits. Note other metrics are available, such as ECOSERV[4], which measure different aspects of the benefits quantified in the accounts, which have already been used for some sub-areas of the NW region.

It is important to recognise the benefits coastal and inshore habitats support, including carbon sequestration in saltmarshes, commercial fishing landings to ports along the North West coast, and coastal and marine recreation. However, renewable energy from offshore wind is not included in the account, as they are an offshore asset rather than part of the terrestrial/inshore area of the account. Also, BEIS (2019) data allocate offshore wind electricity generation to the local authority where the cables come ashore, so mapping the data to regional sub-areas is impractical.

[3] Renewable energy only reflects hydropower sources after discussions with UU this was deemed to be most dependent on natural capital assets in the region.

[4] https://ecosystemsknowledge.net/ecoserv-gis

4.3 Presentation of results

Information inputted into and benefit assessment results from the accounting can be presented for different spatial areas and for different beneficiaries. There are many potential spatial area breakdowns within the chosen North West region. For the account, results are broken down by Counties and/or City regions. Given the detailed mapping work and accounting framework developed, other sub-areas could be supported, such as for management catchments, local authorities, operational catchments, or groups of private estates.

Benefits by beneficiaries are shown in two main groups: 'Businesses' (i.e. where the value identified is a financial return to a business) and 'the rest of the society' (i.e. public benefits to wider society). The distribution of values across business sectors can be readily extracted from the accounts, for several benefits:

- Hydropower sector - renewable energy resource rent;
- Agriculture – arable and livestock income;
- Forestry – softwood removals value; and
- Tourism and Outdoor Leisure – domestic tourism spending (note this excludes spending in trips of under 3 hours durations, but this spending is known to be very small compared to overall tourism spending (eftec et al, 2019)); and
- Water supply – value of groundwater abstraction is estimated separately for public and private water supply, and agricultural uses. The value of tidal and/or surface water abstraction is estimated for public and private water supply and valued using a resource rent value for water abstracted (ONS, 2019). These values can be added to the relevant sector values above to better show the benefits to those sectors from natural capital in the region.

For licensing reasons, mapping outputs are constrained to image downloads with associated data tables as opposed to interactive mapping outputs. It is important to be clear and manage stakeholder expectations on this in the project.

Users of the account should be aware of other natural capital accounting work in parts of the North West Region. This account was developed to provide results for the whole region, and to allow comparison of sub-areas of the region. Accounts specific to parts of the region can adopt different mapping, list of benefits and analysis approaches specific to local data and issues. The natural capital account(s) that is most applicable to the specific decisions should be used in each case.

5. Asset register

The asset register is a registry of all natural capital assets within the boundary of the account. It forms the foundation of the account and records both the extent and condition of the assets.

5.1 Natural capital extent

The extent account records the size and location of the areas of natural capital assets, based on identifiable habitats and land uses. The construction of the asset register aligns to the UK Habitat Classification (UKHab), utilising data from several sources:

- Ordnance Survey MasterMap;
- UKCEH Land Cover Map 2015;
- Natural England Priority Habitat Inventory, and
- OpenStreetMap.

By combining data from these multiple sources, the mapping provides a more accurate estimate of land cover area to include in the asset register. Where there are data conflicts, a judgement has been made of which dataset should be used depending on the land category. The Natural England Priority Habitat Inventory is preferred to MasterMap for most land categories, with several exceptions, for instance in the case of open water habitats where MasterMap provides greater detail. These judgements are recorded and explained in the account spreadsheet[5].

The land use classification used is based on the UK Habitat Classification (UKHab) as shown in Table 5.1.

Table 5.1: Land classification for the North West Regional Account

Broadleaved woodland	Rivers and streams
Coniferous woodland	Canals
Scrub	Inland rock
Heathland	Coastal unvegetated
Acid grassland	Saltmarsh
Calcareous grassland	Intertidal unvegetated
Neutral grassland	Open access recreation sites*
Improved grassland	Outdoor sports facilities*
Arable and horticulture	Cemeteries and religious grounds*
Blanket bog	Allotments*
Lowland raised bog	Private gardens*
Fen, marsh, and swamp	Amenity greenspace*
Lakes and ponds	Development

* Remaining unclassified areas, principally urban greenspace, and some areas around buildings in the countryside.

This classification supports combining the flows of benefits from different assets. Being based on UKHab, it is part of a nested system, so that habitat analysis can be disaggregated if higher detail is required. The use of UKHab also facilitates links to data sets with more or fewer categories, including those used in other

[5] See worksheet 'Habitat Classifications' in accompanying accounting workbook.

parts of the region (e.g., mapping of natural capital in the Liverpool Combined Authority), at a national scale (e.g., the Broad Habitats used by the Natural Capital Committee) and to other assessment frameworks (e.g., the Defra biodiversity metric). Figure 5.1 shows the distribution of habitats across the North West Region. Note that the habitat types have been simplified from Table 5.1 (but are still based on UKHAB), and unclassified land are not included in the map. In addition to these habitats, the extent of assets also records data on mineral resources in the region.

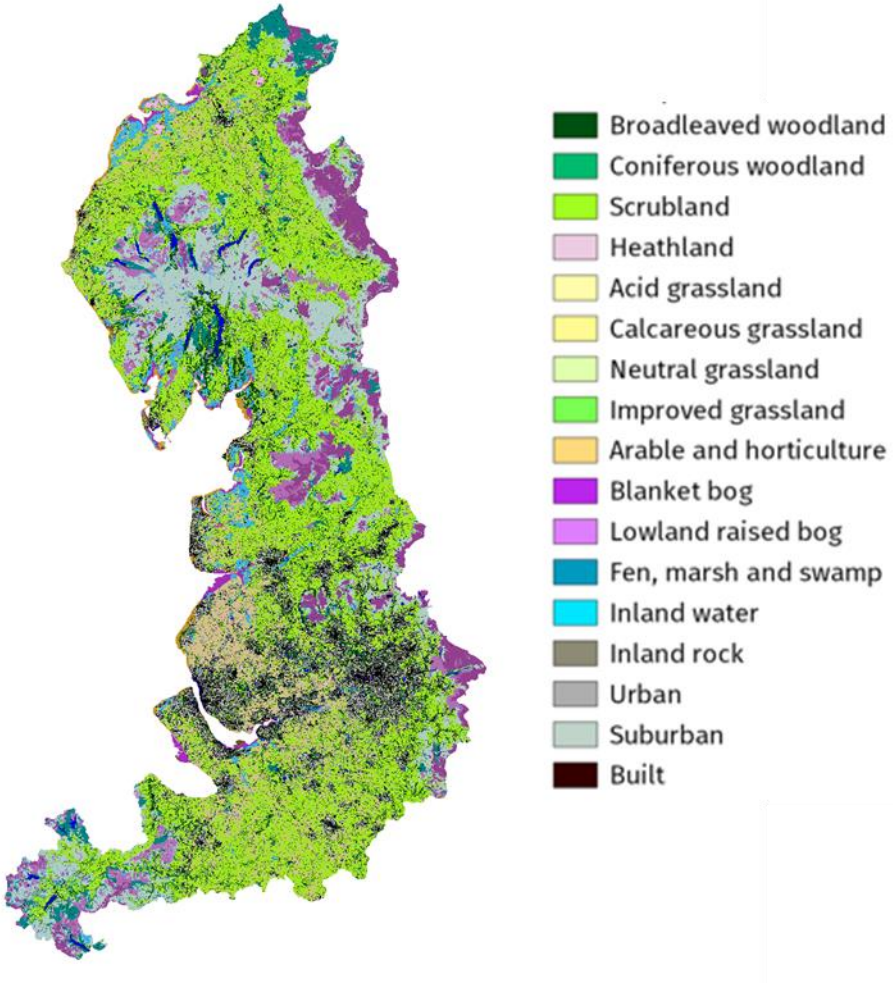

Figure 5.1: North West region habitat extent map

5.2 Natural capital condition

The type and size of benefits provided by natural capital assets are determined by the extent (quantity) and condition (quality) of those assets. Therefore, the natural capital asset register also includes data on condition. Such data needs to be collected through establishing indicators of condition such as different land use, existing monitoring data and designations. These include recreation land (parks), open access land, and specific designations such as Sites of Special Scientific Interest (SSSI), National Parks and Areas of Outstanding Natural Beauty (AONB).

These categories are generated separately and will overlap with habitat areas. For example, for a given area of woodland, the specific area of which is designated as SSSI or Ancient Woodland can also be recorded.

In addition, the asset register presents condition data on the water environment including Water Framework Directive status (number and length of water bodies by status) by each sub-area and Bathing Water status for the North West Region.

Data on the extent and condition of assets in the asset register forms the basis of the benefits assessments methods, which combine it with unit value and other context data, as described in Section 6.

6. Benefit assessment methods

This section describes our approach to quantifying and valuing the benefits provided by natural capital assets in the North West region. The analysis covers the physical and monetary flows of the benefits listed in Section 4.2. In future iterations of the account, other benefits can be added.

The baseline year for the analysis is 2020. Monetary values published in earlier price years are inflated to 2020 values using the latest HM Treasury (2021) GDP deflators. Asset values are estimated using HM Treasury Greenbook (2020) guidance following a declining discount rate and a 60-year assessment period.

The methods described in this section relate to the results for the North West region. The same methods are used whenever possible for other reporting areas, bit not all can be applied at finer spatial scale, often due to a lack of spatial data on natural capital assets. The account results include data for six reporting areas based on political boundaries and three example three catchments. Where necessary, it is noted when a variation in the approach has been applied to produce estimates for the three selected catchment areas. Further detail on the methods for the catchments are in Appendix A.

Results for other spatial boundaries can be readily generated using the accounting process developed. The detailed spatial mapping of habitats and land uses mean that, for any spatial boundary, the asset register can be generated and inputted into the account. This inputs to benefits calculations in a structured and efficient manner. Some calculations are semi-automated, others require bespoke extraction of input data from specified sources (e.g., for recreation or local water quality values). This input data entered feeds into calculation formulas that automatically generate account results.

6.1 Food provision

Food provision 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 distinction was raised by stakeholders between business and societal benefits of food provision. Business benefits refer to net income to farmers, which can be proxied by gross margin.

To estimate the value of agricultural production, the assessment relies on the Natural Environment Valuation Online (NEVO) tool, which is a map-based tool providing spatially disaggregated estimates of the volume and value of agricultural production across England and Wales, alongside some other ecosystem services (University of Exeter, 2019b). The agricultural model in NEVO "*predicts the decisions made by profit maximising farmers about how to allocate their agricultural land between arable and grassland, and within these uses, what crops and livestock to produce*" (University of Exeter, 2019a, p.2). The model takes into account environmental characteristics of the agricultural land such as soil type and quality, the environmental sensitivity of the area and climate data. The model also considers output prices, fertiliser prices, distance to markets, environmental characteristics, and climate to predict how land is split between crop and livestock production (ibid.). The model covers a 40-year time period (2020 – 2060). NEVO's agricultural model makes use of the following data sources:

- Farm Business Survey (2005-2011) and June Agricultural Census data for agricultural land use and production;

- John Nix Pocketbook, for farm prices; and
- UKCP09 for future climate and output price projections.

NEVO provides the total arable area by crop type[6], total grassland[7] area used for grazing and corresponding agricultural output estimates for arable food production by crop type (tonnes per year) and livestock production[8] (heads per year). NEVO outputs are produced for each local authority area within the accounting boundary. As NEVO produces annual decadal averages until 2059, production estimates are linearly interpolated between decades, assuming a decadal span is from 0-9 (i.e., '2020-2030' refers to 2020 until 2029). After 2059 production is assumed to be constant.

The estimated area of arable land and grassland used for agricultural use in NEVO differs from the account asset register. Therefore, to use NEVO within the account, unit values of production per hectare are estimated as well as the proportion of arable crop areas. In doing so, it is assumed that the distribution of crops (i.e., % share of total arable land) estimated by NEVO for a given local authority is representative of the current activity. To produce estimates for the six reporting areas, for a given crop, the average proportion of arable area used (e.g., for wheat), is estimated and multiplied by the total area of arable and horticulture land recorded in the asset register for that reporting area. These areas are then multiplied by the estimated average arable production of each crop per hectare across the local authorities within the reporting area.

To estimate livestock production in each reporting area, a grassland area adjustment factor is calculated based on the area of improved grassland in the asset register divided by the total area of grassland used for agriculture from NEVO. The estimated number of livestock heads (e.g., beef cows) is then produced by multiplying the grassland adjustment factor by the number of livestock heads predicted by NEVO for each reporting area.

For the monetary values of 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; Redman, 2019; Redman, 2020). Such 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 potatoes; number of beef cows) in each reporting area. The average unit gross margin figures are assumed to be constant over time.

6.2 Fishing (commercial)

The coastal natural capital assets in the account contribute to commercial fisheries yields by providing habitats and supporting the ecosystems that the lifecycles of commercial fish species depend on. The benefit of commercial fishing is estimated by the volume of landings at ports within the account boundary and the associated market value of landings. The value of fisheries productivity by intertidal habitats is only captured in the account to the extent that it supports landings of fish from inshore waters of the region.

[6] Reflects wheat, sugar beet, oil seed rape, winter barley, summer barley and potatoes.
[7] Reflects permanent grassland, temporary grassland and rough-grazing combined.
[8] Livestock production reflects beef cows, dairy cows, and sheep.

The fisheries productivity of saltmarsh has been measured (e.g., Colclough, 2013), but there is not yet a suitable average productivity per hectare estimate for this service. The saltmarsh and other habitats in the study boundary are likely to provide some of the stock from which commercial landings are taken. Therefore, valuing fisheries productivity would risk double-counting with the commercial fish landings. However, not valuing this service should not stop it being recognised as part of the assets underpinning commercial fisheries.

The Marine Management Organisation (MMO, 2021) provides tonnage data for live weight and landed weight of pelagic, demersal and shellfish, as well as the value of landings by ports aggregated to NUTS2[9] Regions. Data can be disaggregated further to reflect the length of fishing vessels, either under 10 metres, over 10 metres or 'unknown'. The focus of this benefit is inshore fishing, which can be proxied by the volume and associated value of landings by vessels under 10 metres. Therefore, vessels over 10 metres or those grouped as unknown are excluded from the assessment.

The latest data from the MMO reflects 2020 figures (MMO, 2021). Catches are estimated from data for 10 ports[10] falling within the reporting areas of Cumbria, Lancashire+ and Liverpool City Region. Note that this data represents catches by port of landing rather than actual fishing location, but given the smaller size of vessels (with limited range) the catches are likely to have been from within the NW region. These estimates are assumed to continue sustainably into the future, due to lack of data on the status and future fishing pressure on stocks which preclude a more dynamic assessment over time.

Note that since the selected example catchments (i.e., Eamont, Eden Upper and Eden Lower) do not have any commercial fishers, this benefit does not apply to them and is not included in the accounting workbook.

6.3 Timber

This benefit has been estimated using the data from the Forestry Commission (2018) and the ONS (2019; 2020) for the volume of timber at the market value. The account uses the average figures and does not differentiate between species.

In 2018, the volume of softwood removals in the UK was estimated as 13.8 million cubic meters based on estimates of removals from the Forestry Commission Timber statistics (Forest Research, 2019a)[11]. Dividing this by the Forestry Commission (2019) estimated area of coniferous woodland in the UK (roughly 1.6 million hectares), gives an estimate for the volume of softwood timber removals per hectare in the UK of 8.5 m^3/ha/year. This is multiplied by the area of coniferous woodland, all of which is assumed to be used for timber production, within each reporting area[12]. This approach is considered to be fairly accurate, as the large majority of timber output is likely to be from conifers, and while conifer production could be overestimated (because some areas of conifer will not be commercially harvested), other production is

[9] Statistical regions of the UK: NUTS Level 2 (January 2018) Names and Codes in the United Kingdom | Open Geography Portal (statistics.gov.uk)

[10] Barrow, Maryport, Silloth, Whitehaven, Workington, Fleetwood, Lytham St Annes, Morecambe, Hoylake, and Liverpool.

[11] 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.

[12] Results currently reflect the assumption that all coniferous woodland in the asset register is used for timber.

underestimated (because harvest from deciduous woodland is excluded). 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, 2020). The stumpage price used in the account is estimated as the average of prices recorded in March and September 2020, roughly £25/m^3 overbark in 2020 prices. 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.

6.4 Renewable energy (hydro only)

The renewable energy benefit is estimated by the amount of energy generated (in megawatt hours MWh) from hydroelectricity valued using the national average resource rent[13]. Currently, the estimates reflect hydroelectricity generated in local authorities that fully lie in the accounting boundary[14]. Therefore, the resulting estimate for the North West region does not capture the Northern Wales reporting area as it is not possible to identify where within the local authority or catchment boundary the hydro sites are.

Renewable energy statistics are available from the Department of Business, Energy & Industrial Strategy (BEIS, 2020), and reflect the generation, installed capacity and load factors by renewable energy source in 2019. These estimates are produced by region and can be further disaggregated to local authorities (BEIS, 2020). Based on this data, the generation of electricity from hydroelectricity sources in 2019 measured in MWh, can be produced for each local authority that lies within the NW Region boundary. 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 (2019) that estimates the annual resource rent of renewable energy provisioning equal to £686 million, with associated generation of 98.7 million MWh in 2017. Dividing these figures produces an average unit resource rent value of £8.93/MWh/year, in 2020 prices. This is then applied to the BEIS (2019) estimates of renewable energy generated by hydro power within the study boundary and is attributed to businesses. It is assumed that the monetary unit value remains constant over time.

6.5 Water supply

The benefit of water supply from the natural environment is estimated by the quantity of water (available in and transferred to the region). Monetary values are calculated using estimates of the value of providing water supply from alternative sources.

The volume of water abstracted within the North West region is based on United Utilities internal records of consumption and supply over the last five-years. Five-year average abstraction volumes have been estimated for each sub-area, with High Peak District estimated separately. 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.

[13] Calculated as gross value minus costs of production.
[14] This refers to 59 local authorities across the six sub-regional reporting areas.

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 North West EA regional charge area. Table 6.1 shows how these proportions may vary depending on the dataset used, even though there is minimal difference in the estimates. The proportions based on actual abstractions are multiplied by the five-year average abstraction volume from UU. It is assumed that these proportions do not vary across sub-areas.

Table 6.1: Comparison of % of total water abstractions by water source

Water source	Licensed abstractions (Defra, 2019)	Actual abstractions (Environment Agency)
Surface water	37%	32%
Tidal water	60%	65%
Groundwater	2%	3%

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[15] in each Environment Agency regional charge area. For this account boundary, estimates from the North West region can be selected, however further disaggregation (i.e., catchment level or local authority) is not possible using this dataset[16]. 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).

6.5.1 *Value of tidal and surface waters for public water supply*

Using ONS (2019) figures, cited in ENCA (Defra, 2020), an indicative five-year average unit resource rent value has been estimated as £0.41 per cubic metre in 2020 prices. In the ONS accounts (2019), private water sources, supply to industry and water abstracted from groundwater sources are not valued. Therefore, in the NW account, this unit value is applied to the total water abstracted for public water supply from tidal and surface waters in the North West region and six sub-areas. 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[17]). The monetary unit value is assumed to remain constant over time.

6.5.2 *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

[15] Uses include public water supply, spray irrigation, agriculture (excl. spray irrigation), electricity supply industry, other industry, fish farming, cress growing, amenity ponds, private water supply and other.

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

[17] Note that a different, internally calculated, resource rent was used in UU's Corporate Natural Capital Account in 2017 – see Section 7.2.1.

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 (see Section 6.4). Table 6.2 shows which unit values from Stantec (2019) have been applied to which purpose/sector.

Table 6.2: Groundwater unit values inflated to 2020 prices (Stantec, 2019)

Applied purpose (based on Defra, 2019)	Low	Central	High	Unit
Public water supply	0.44	0.53	0.62	£/m^3
Private water supply	0.44	0.53	0.62	£/m^3
Spray irrigation	0.00	1.28	0.00	£/m^3
Agriculture (excl. spray irrigation)	0.21	0.27	0.45	£/m^3
Agriculture (excl. spray irrigation)	0.21	0.27	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[18]) values for 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.

6.6 Minerals

The benefits associated with minerals extraction include sand and gravel, and crushed rock. The quantity extracted (tonnes) is valued using the UK average ex-works sales value of sand and gravel, and crushed rock (£/tonne). UK mineral production and value estimates are reported on a national basis (British Geological Society, 2020).

The quantity of extracted minerals for sub-areas in England is based on the sales volumes for sand and gravel and crushed rock. This is available for the North West (North West AWP, 2019) broken down by the following counties: Cumbria, Lancashire, Cheshire East and West, and Greater Manchester, Merseyside and Halton and Warrington. These county groups do not fully align with the six NW account sub-areas, so minerals data is not broken down to all of them. Annual sales are available for 2018, which are assumed to be representative of 2020.

For the Welsh sub-area (i.e., North Wales) the quantity extracted is estimated using the new annualised apportionment of mineral extractions (tonnes/yr) for each local planning authority in Northern Wales

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

(North Wales AWP, 2019) and for Powys (South Wales AWP, 2019). In the North Wales AWP, extraction volumes from Conwy are aggregated with Snowdonia which needed to be adjusted as the latter is not included in the NW region. Volume figures are adjusted based on the number of quarries by mineral type (i.e., crushed rock and sand and gravel) in Conwy relative to the total number of quarries in both Conwy and Snowdonia. This proportion is then multiplied by the annualised apportionment for each mineral type.

As the Welsh sub-area quantity of minerals extracted is an annualised apportionment (i.e., annualised figure based on land-bank years), this reflects the annual value in future years, whilst for the English sub-areas future flows are set equal to the local aggregates assessment/emerging or adopted local plan rate (tonnes/yr) for each mineral.

Since 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[19] are reported at the county level, this is assumed to be representative for all quarry sites within a given county. Land-bank years are adjusted to reflect 2020 estimates by reducing the number of years remaining for extraction by the number of years since the latest report (i.e., 2019). This is then used to represent the remaining asset life of quarries within the reporting area.

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 crushed rock respectively (British Geological Survey, 2020). This is then applied to the estimates the volume of sand and gravel produced within the study boundary and is treated as a value to businesses. It is assumed that the monetary unit value remains constant over time.

6.7 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. 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 2020 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

[19] 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.

GIS analysis). This produces the annual value of PM2.5 removal by woodland.

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, 2020).

6.8 Carbon sequestration

Three different natural capital assets within the accounting boundary, namely, woodland, saltmarsh and improved grassland areas sequester carbon. This benefit is estimated using the sequestration rates for each habitat (tonnes CO_2 equivalent per hectare) and the non-traded price of carbon.

Note that peatland has not been included in this assessment as current evidence would represent avoided future emissions (by restoring degraded peatlands that are currently a carbon source) rather than current carbon sequestration. Further, the condition of peatland across the North West region cannot be easily assessed, and would therefore rely on national data to estimate current condition.

Table 6.3: Carbon sequestration rates by habitat type

Habitat	Sequestration rate	Source
Woodland	5.7 tCO_2e/ha/yr	ONS (2019) and Forestry Commission (2017)
Saltmarsh	5.2 tCo_2e/ha/yr	Cannell et al. (1999)
Improved grassland	0.6 tCO_2e/ha/yr	Soussana et al. (2010)

Table 6.33 shows the per hectare carbon sequestration rates for woodland, saltmarsh and improved grassland that are used within this assessment. The unit sequestration factor for woodland covers both coniferous and broadleaved woodland. For saltmarsh, Cannell et al. (1999, p.514)[20] provide an average carbon sequestration rate for British saltmarshes of 1.4 tonnes of carbon per hectare per year (based on range of 0.64 to 2.19 tonnes of carbon per hectare per year). Improved grassland is estimated as 0.18 tonnes of carbon sequestered per hectare (Soussanna et al., 2010). The rates for saltmarsh and improved grassland have been converted to tonnes CO_2e using a conversion factor of 3.67 (IPCC, 2018). Sequestration rates are assumed to remain constant over time.

The total amount of CO_2 equivalent sequestered 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 (2018) for the non-traded central price, £75 per tonne of CO_2e in 2020. This is multiplied the estimated tonnes of CO_2e sequestered.

BEIS (2018) carbon values were last updated in December 2018 when the UK had an 80% carbon reduction commitment and are currently under review to reflect the UK government's net zero policy target. Latest advice (update March 2020) is to use the non-traded 2018 central value in calculations, and the high value (£112 per tonne of CO_2e in 2020) for sensitivity analysis (BEIS, 2020).

[20] This range is also cited in the ONS (2016) scoping study on coastal margins in the UK.

6.9 Flood risk management

The account measures the flood risk management benefit based on an estimate of the additional water storage capacity of woodland following methods from Forest Research (2018).

Forest Research (2018) provide Great Britain average cubic metre per hectare (m^3/ha) unit values based on estimated flood water storage due to woodland water use and floodplain woodland hydraulic roughness. In the NW region account, it is assumed that the Great Britain average is representative of the region. The unit value for the annual average additional woodland soil water storage capacity is applied to the total area of woodland in the North West region and each sub-area, and catchment.

6.10 Recreation

6.10.1 Adult 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[21] 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. For a given local authority in a reporting area, the estimated number of visits and associated welfare value produced by ORVal is multiplied by the proportion of the local authority area that lies within the reporting area boundary.

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 on MENE data[22], 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[23]. 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.)[24]. 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-£3.4 per visit).

[21] 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/

[22] See: https://www.gov.uk/government/collections/monitor-of-engagement-with-the-natural-environment-survey-purpose-and-results

[23] A day visits is any leisure visit that is at least 3-hours (round-trip).

[24] This is based on the Year 7 (2015/16) MENE survey weighted base results for "Question 3: How long did this visit last altogether."

The unit monetary value (i.e., £ welfare value per visit) is assumed to remain constant over time, whilst the number of annual visits is profiled both with and without population growth. The latter assumes the number of annual visits over time is constant, and the former assumes the number of recreation visits rises proportionately with annual population growth forecasts from ONS (2020). This rise in visits is assumed to be within the carrying capacity of the green spaces and open areas and hence does not cause damage to this natural capital asset. This is an assumption that will need to be tested. The results present a broad estimate of likely current benefits, and an indication of the value that can be maintained (if sites are already average or better) or achieved (if sites are below average and can be improved).

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)[25]. 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 6.13, is not included in the account to avoid double-counting.

6.10.2 Children recreational visits

Using the resulting estimates from the approach described in Section 6.10.1, the estimated visits numbers can be expanded to cover visits by children based on MENE survey responses indicating visits were made with dependents. Since the ORVal estimates form the basis of this calculation, MENE data can be applied to Welsh recreation visits, despite the survey only representing England. This is because the Welsh visit numbers have been calibrated to align with MENE as part of the background modelling to ORVal (Day and Smith, 2018).

To calculate the number of visits that children make to recreational greenspaces, an assumed ratio of under-16 visits to the total number of adult visits is estimated based on national figures from MENE (Natural England, n.d.). Children recreational visits can occur with or without an adult present, the former is estimated by dividing the number of children per adult visit (0.4) and the number of adults per adult visit (1.9) and multiplying the resulting quotient by the estimated number of adult recreation visits that are under 3 hours in each sub-area. It is assumed that the number of children per visit is the same regardless of visit duration and that the UK averages are representative of the North West region.

Children recreational visits without an adult are estimated using the frequency of 'number visits taken with no adult present' (83%) (Natural England, 2019) divided by the estimated number of children recreational visits taken with an adult. The number of children recreational visits is estimated as the difference between the estimated recreational visits and the estimated quotient (i.e., visits with adults/83%). The proportion applied is assumed to remain constant over time and space.

[25] See Section 6.13 for water quality methodology.

6.11 Physical health from active recreation

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[26] 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[27], producing the number of annual active visits. As with the number of annual recreation visits, two scenarios are used: active visit numbers remain constant over time or they increase in line with population growth forecasts from ONS (2020).

The benefit is valued as the health benefits of active recreation (in terms of improvements in Quality Adjusted Life years – QALYs[28]) 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 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 2020 prices. The monetary unit value is assumed to remain constant over time.

6.12 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. The latter has been used in this assessment to allow for subdivision across the six reporting areas. 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).

The number of day visits per year and the number of overnight trips per year for each reporting area are estimated by multiplying the total visits[29] in a local authority by the proportion of that local authority area that falls within the reporting area boundary. Total domestic tourism visits for a reporting area are the sum of the estimated annual day visits and domestic overnight trips. The same proportional approach is applied for the three-year average expenditure for each visitor type, in each local authority across the six reporting areas. This provides an estimate of the total expenditure that supports the local economy.

[26] Refers to recreation visits that are under three hours, as reflected in Section 6.10.

[27] As described in Section 6.10.

[28] QALY is a health measurement used widely in health and health economics research. QALY of zero denotes death, and 1 denotes full health.

[29] A day visit is treated as equal to an overnight trip, therefore visit = trip.

The proportion of visits and trips and their associated expenditure that are attributable to natural capital are estimated using eftec's work for ONS to estimate the scale of natural capital dependent spending in the UK (eftec et al., 2019). This data is disaggregated at the devolved nation and the nine Government Operation Regions in England but cannot currently be disaggregated at a sub-regional level with sufficient accuracy. For this assessment, the proportion of total expenditure that can be attributed to ecosystems (i.e., natural capital, as shown in Table 6.44) for the North West of England and Wales, where relevant, are applied to the total domestic tourism visits and total domestic tourism expenditure in each reporting area.

Table 6.4: Domestic tourism expenditure and estimated proportion of total expenditure

	North West England		England		Wales	
	£bn	% of total	£bn	% of total	£bn	% of total
Total expenditure	9.4	-	74.9	-	12.1	-
Activity expenditure	3.4	36%	25.9	35%	4.2	35%
Ecosystem attribution (i.e., natural capital)	2.0	21%	15.5	21%	2.7	23%

Table note: Estimated proportions of total expenditure based on regional estimates of expenditure from eftec et al. (2019). Price year of eftec et al. (2019) expenditure is 2017.

6.13 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 2020 prices using the HM Treasury (2021) 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, as discussed in Section 6.9, 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, coastal and transitional water bodies and for rivers in the catchments relevant to the account boundary: Humber, Northumbria, North West, Solway Tweed, Severn, Dee and Western Wales River Basin Districts. Estimates are produced for lakes, coastal and transitional water bodies (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 the North West Region is estimated using the relevant river basin district values for each reporting area.

The quality of bathing waters is reflected in the natural capital asset register using the Bathing Water Directive quality classification. The benefit of recreation in bathing waters is not valued separately as it is assumed to be adequately covered by the ORVal data described in Section 6.9.

6.14 Key non-monetised benefits

The following are recognised as material benefits from natural capital in the North West, but currently cannot be reliably measured or valued at the regional scale. They can be recognised through relevant KPIs (e.g., SSSI condition) and listed as 'key non-monetised benefits' in the account summary.

Water supply (i.e., water transfers): The accounting boundary includes some catchments in Wales to include an assessment of water supply benefits of water transfers from sources in those catchments, as well as transfers between sub-regional areas (e.g., between counties). This is reflected in United Utilities recorded production abstraction volumes (i.e., from source). Although not monetised, this is a useful indicator that reflects the distribution of assets providing water supply benefits in the region.

Flood risk management: The account measures the flood risk management benefit provided by woodland based on evidence from Forest Research (2018) – see section 6.9 for further details. This benefit is not monetised, as the flood water storage replacement cost[30] approach used by Forest Research (2018) is not considered robust to apply across the North West region.

Recreation (children visits): The number of children recreational visits is included in the account, but it is not easy to establish the value of a child's time as a proxy of welfare benefits, and there are some risks of double counting with the value that has been attributed to adult visits. Hence this benefit has only been included as quantitative information (number of visits) within the NW account (i.e., non-monetised benefit). See section 6.10.2 for further details on approach.

Biodiversity: The monetary valuation of wildlife and habitat is complex and, in many contexts, contentious. A portion of this value is indirectly captured in the biodiversity indicators presented in the account for SSSI condition, as well as through the value of other benefits to which biodiversity contributes.

[30] Reflects the replacement cost of building a reservoir to retain the same volume of water, which is not necessarily the least cost option.

6.14.1 Unquantified benefits

Education: visits to nature can be valued based on the costs of providing outdoor learning activities (see ENCA (Defra, 2020) for further guidance). However, it is uncertain if data can be gathered on the total number of such visits by schoolchildren per year across the region. This would be better assessed specific to sites with nature-education facilities that encourage learning in the natural environment.

Volunteering: Value of time (at average wage) can be used as a proxy to value the benefits of volunteer activities in nature (e.g., from Heritage Fund[31]). As with education, this would be difficult to capture at the regional level but may be more evident at the site-level.

Mental health: Following current ENCA guidance (Defra, 2020), only physical health benefits are valued in this report as there is currently insufficient evidence to value mental health benefits in general terms. While the evidence for mental health benefits from green space is strong, it is context dependent and not readily generalisable for the purposes of accounting and policy analysis.

6.15 Results for North West Region

The physical and monetary estimates for each benefit are given a confidence rating which is described in Table 6.55. The estimated annual physical and monetary values, and present value of benefits over the 60 years, are summarised in Table 6.66.

The results are shown 'with trends', meaning that where available the calculation of present value (PV) factors in known trends over time in the quantity or value of benefits. Where no data on trends is available, benefits are assumed to remain constant.

Table 6.5: Assessing data quality

Level of confidence	Symbol	Description
Low	🔴	Evidence is partial and significant assumptions are made so that the data provides only order of magnitude estimates of value to inform decisions and spending choices.
Medium	🟡	Science-based assumptions and published data are used but there is some uncertainty in combining them, resulting in reasonable confidence in using the data to guide decisions and spending choices.
High	🟢	Evidence is peer reviewed or based on published guidance so there is good confidence in using the data to support specific decisions and spending choices.
No colour	⚫	Not valued

[31] Heritage Fund. (n.d.). How to calculate volunteer time. [online]. Available at: https://www.heritagefund.org.uk/discussions/how-calculate-volunteer-time

Table 6.6: Baseline natural capital assessment for North West Region: physical and monetary value of benefits

At May 2021	2019/20	Quality	Physical flow quantity (unit/yr)	2019/20	Quality	Monetary value (£m/yr)	PV 60 (£m)
Key monetised benefits							With trends
Food provision	934,939	●	Arable food production (tonnes)	92	●	Arable income	2,542
	2,798,514	●	Livestock production (no. heads)	293	●	Livestock income	7,080
Fishing (commercial)	114	●	Landed weight landings by vessels 10m and under (tonnes)	<0.01	●	Landings by vessels 10m and under	0.01
Timber	483,885	●	Volume of softwood removals (m^3)	12	●	Value of softwood removals	317
Renewable energy	31,491	●	Electricity generated by hydropower (MWh)	0.3	●	Resource rent of hydropower	7
Water supply	60,682,837	●	Tidal and surface water abstraction for public water supply (m^3)	25	●	Resource rent of tidal and surface water abstractions for public water supply	653
	8,562,785	●	Groundwater abstraction for public and private water supply (m^3)	4	●	Ecosystem provision of groundwater for public and private drinking water and agriculture	96
Minerals	3,863,000	●	Volume of sand and gravel extracted (tonnes)	54	●	Ex-works sales of sand and gravel	569
	14,575,500	●	Volume of crushed rock extracted (tonnes)	177	●	Ex-works sales of crushed rock	4,008
Air quality regulation	1,053,704	●	PM2.5 removal by woodland (kgPM2.5)	173	●	PM2.5 removal by woodland	4,509
Carbon sequestration	1,537,838	●	CO2e sequestered in habitats (tCO_2e)	115	●	CO_2e sequestered in habitats	7,208
Recreation	267,481,356	●	Adult recreation visits (under 3 hours) (visits)	893	●	Adult recreation welfare (under 3 hours)	25,008
Physical health	137,752,898	●	Active visits (active visits)	469	●	Avoided medical treatment costs	13,117
Tourism	77,528,697	●	Day visits and overnight trips attributed to natural capital (visits)	2,673	●	Domestic tourism expenditure attributed to natural capital	70,104
Water quality	8,015	●	Length of WFD rivers (km)	146	●	Welfare of avoiding deterioration in rivers	3,824
	100	●	Area of WFD lakes (km^2)	0.8	●	Welfare for avoided deterioration in lakes	20
			Total value	**5,125**	●	**Mix of values**	**136,662**
Key non-monetised benefits							
Water supply	657,919,205	●	Total water abstraction at source (i.e., production) (m^3/yr.)	-	●	-	Not valued
Flood risk management	37,184,896	●	Annual average additional woodland soil water storage capacity (m^3/yr.)	-	●	-	
Recreation	67,817,370	●	Total children recreation visits (under 3 hours) (visits/yr.)	-	●	-	
Biodiversity	217,461	●	Total SSSI area (ha)	-	●	-	

7. Results and Next Steps

This Section shows the regional account results and examples of comparisons for sub-areas of the North West region. The accompanying workbook (NW-NCA-final-100521-reissuedOct21.xls) facilitates comparisons across the six reporting regions and Eamont Catchment through a drop-down function. Further results are presented in the accompanying MS PowerPoint™ file (NW NCA Draft Account outputs 070421.ppt).

7.1 Regional baseline account

The results of the NW Region Account are shown in Figure 7.1 and Table 7.1.

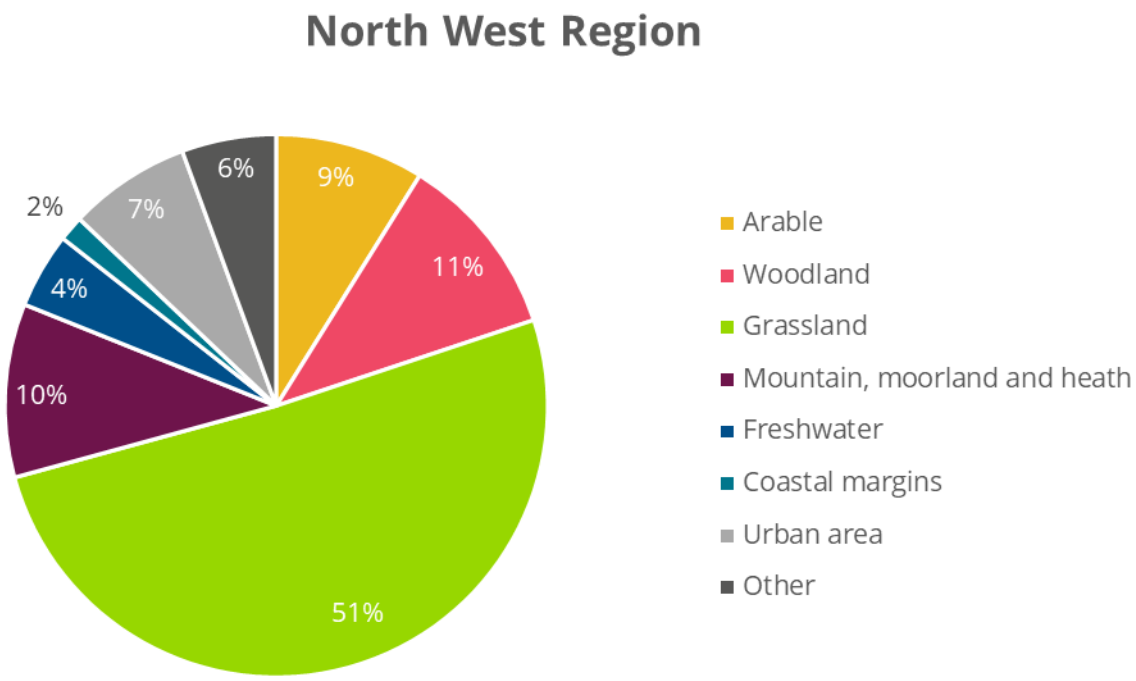

Figure 7.1: North West region habitat breakdown

Table 7.1 shows that the overall value from the environment to wider society nearly as large as the values arising directly to business.

Table 7.1: North West Region natural capital balance sheet

	Valuation metric	Value to businesses	Value to the rest of society	Total
Asset values (monetised)				
Food provision	Arable income	2,542		**2,542**
	Livestock income	7,080		**7,080**
Fishing (commercial)	Value of landings by vessels 10m and under	0.01		**0**
Timber	Value of softwood removals	317		**317**
Renewable energy	Resource rent value of hydropower	7		**7**
Water availability	Resource rent value of tidal and surface water abstractions for public water supply	653		**653**
	Groundwater used for public and private drinking water and agriculture use	96		**96**
Minerals	Ex-works sales value of sand and gravel	569		**569**
	Ex-works sales value of crushed rock	4,008		**4,008**
Tourism	Domestic tourism expenditure attributed to natural capital	70,104		**70,104**
Air quality regulation	Value of PM2.5 removal by woodland		4,509	**4,509**
Carbon sequestration	Value of CO_2e sequestered in woodland, saltmarsh, and improved grassland		7,208	**7,208**
Recreation	Adult recreation welfare value (under 3 hours)		23,432	**23,432**
Physical health	Avoided medical treatment costs due to active physical recreation in nature		12,291	**12,291**
Water quality	Welfare benefit of avoiding deterioration in rivers		3,824	**3,824**
	Welfare benefit of avoiding deterioration in lakes		20	**20**
Total gross asset value		**85,378**	**51,284**	**136,662**
Asset values (non-monetised)				
Water supply	Total water abstraction at source (i.e., production): 658 million m^3			
Flood risk management	Volume of water held back by woodland: 37 million m^3			
Recreation	Total children recreation visits (under 3 hrs): 68 million visits			
Biodiversity	Total SSSI area: 217,500 hectares			
Education				
Volunteering				
Mental health				

7.2 Comparisons of accounting results and methods

The following provides some initial observations from comparing the accounting results for different spatial areas and methods.

7.2.1 Comparing the North West Region account to the United Utilities Corporate Natural Capital Account

Table 7.2 compares the approaches applied in the North West Regional account to those used in the United Utilities CNCA. Overall, the general principles of the methods applied for the six benefits included in the UU CNCA are the same, but due to the scale of the NWR account, the data used varies. Text in red indicates points of difference in:

- Benefits that are included as well as differences in monetary value input data:
  - Several benefits are included in the regional account, but do not feature in the UU account. Values for air quality and water quality could now be calculated due to progress with methods.
  - Other benefits, including minerals and tourism, were not relevant or not possible to quantify for UU land.
  - (e.g., farm tenancy income and private sales values).
- The UU account is in 2017 prices and used a 25-year time horizon to calculate the present value of assets. Whereas the North West Region account is in 2020 prices and relevant benefit values have been re-estimated using a 25-year time horizon.

7.2.2 Comparing the North West Region account to the EA tool and Defra ENCA

Table 7.3 compares the methods used in the North West Region account with:

- Defra's 'Enabling a Natural Capital Approach' (ENCA) (2020); and
- The Environment Agency's Natural Capital Register and Account Tool.

The data sources used are generally the same across the three documents. There are some differences, which are shown in red which refer to specific data sources, e.g., use of the John Nix gross margin unit values in the NWR account. The NWR account also includes minerals and tourism, two benefits that are not included in the current versions of ENCA nor the EA tool.

Table 7.2: Comparison of NWR methods with UU CNCA 2016/17

Benefits	North West Region		UU CNCA	
	Physical flow metric	Monetary value metric	Physical flow metric	Monetary value metric
Food provision	Tonnes of arable crops produced for food	Gross margins by crop type (Redman, 2018; Redman, 2019; Redman, 2020)		
	Number of livestock heads	Gross margins by livestock type (Redman, 2018; Redman, 2019; Redman, 2020)	Number of livestock heads (sheep and cattle)	Wider society: Total food production value (sheep, cattle, farm costs) and agri-environment income Private: Farm tenancy income
Timber	Softwood removals (m^3/yr) (Forest Enterprise, 2019 and ONS, 2020)	Conifer/softwood stumpage price (£/m^3) (Forest Enterprise, 2019)	Total timber production (m^3/yr)	Timber sales value
Renewable energy	Electricity generation from hydroelectricity (MWh/yr) (BEIS, 2020)	Estimated UK average unit resource rent (£/MWh) (ONS, 2019)	Annual energy generation from hydro (MWh/yr)	Energy production value (tariffs, operating costs, and capital costs)
			Annual energy generation from solar, wind (MWh/yr)	
Water supply	Regional quantity of water abstraction by source and purpose (Defra, 2019); UU average annual volume of water abstracted – consumption (2015/16-2019/20)	Resource rent (ONS, 2019) or replacement cost (Stantec, 2019)	UU Average annual volume of water abstracted (2013/14-2015/16)	Net asset value of water produced
	UU average annual volume of water abstracted – production (2015/16-2019/20)			
Carbon sequestration	Carbon sequestered in woodland, saltmarsh, and improved grassland (tCO_2e/yr)	Non-traded central carbon value BEIS (2018) £/t/CO_2e	Carbon sequestered in woodland and grassland (tCO_2e/yr)	Non-traded central carbon value BEIS (2017) £/t/CO_2e.
			Carbon emitted by peatland (tCO_2e/yr)	
			GHG averted by renewables (tCO_2e/yr)	
Recreation	Adult recreational visits under three hours	Associated welfare value	Number of recreational visits (ORVal v1.0)	Welfare values using developer version of ORVal
	Children recreational visits under three hours			
				Private income from recreational activities

Table 7.3: Comparison of NWR methods with ENCA and EA NC Account Tool

Benefit	North West Region		ENCA	EA tool
	Physical flow metric	Monetary value metric		
Food provision	Tonnes of arable crops produced for food and number of livestock heads (NEVO based estimate)	Gross margins by crop type and livestock type (Redman, 2018; 2019; 2020)	Y – Physical N- £	N – Physical (Doesn't use NEVO) Y - £
Fishing (commercial)	Landed weight of fish landings (t/yr) (MMO, 2021)	Value of landings (MMO, 2021)	Y - Also reference resource rent approach	Y – Physical N - £ Estimate net average profit/ tonne/ yr based on ONS account (2019)
Timber	Softwood removals (m^3/yr.) (Forest Enterprise, 2019 and ONS, 2020)	Conifer/softwood stumpage price (£/m^3) (Forest Enterprise, 2019)	Y Both broadleaved and conifers	Y Both broadleaved and conifers
Renewable energy	Electricity generation from hydroelectricity (MWh/yr.) (BEIS, 2020)	Estimated UK average unit resource rent (£/MWh) (ONS, 2019)	Y	Y Only hydropower
Water supply	Regional quantity of water abstraction by source and purpose (Defra, 2019); Average annual water abstraction – consumption (UU)	Resource rent (ONS, 2019) or replacement cost (Stantec, 2019)	Y - Abstracted water by purpose and resource rent (ONS accounts)	Y - Abstracted water by purpose and mix of values
	Average annual water abstraction – production (UU)	Not valued	Not publicly available data	
Minerals	Volume of output (t/yr.) (Regional Aggregate Working Party reports)	Ex-works sales value (BGS, 2020)	Not included	Not included
Air quality regulation	PM2.5 removed by woodland (kg/yr) (eftec and CEH, 2019)	Reduced health costs (£/ha) (eftec and CEH, 2019)	Y	Y Also includes SO_2, NO_2 and O_3
Carbon sequestration	Carbon sequestered in each habitat type (tCO_2e/yr)	Non-traded central carbon value BEIS (2018) £/t/CO_2e.	Y Includes rates for other habitats	Y - Estimated as net: sequestration by habitats and emissions from peatlands
Recreation	Adult recreational visits under three hours (Day and Smith, 2018)	Associated welfare value (Day and Smith, 2018).	Y	Y
	Children recreational visits under three hours (Day and Smith, 2018; MENE)	Not valued	Not included	Y
Physical health	Active visits (ORVal and White et al., 2016)	Avoided medical treatment costs per year (Claxton et al., 2015)	Y	Y
Tourism	Ecosystem attributed domestic tourism and leisure visits (Latest GBDVS, GBTS and eftec et al., 2019)	Ecosystem attributed domestic tourism and leisure expenditure (Latest GBDVS, GBTS and eftec et al., 2019)	Not yet included	Not included
Water quality	Length (km) and area (km^2) of WFD waterbodies by status	WTP for avoided deterioration from NWEBS (£/km or £/km^2) (Metcalfe, 2012; NERA Economic Consulting, 2007)	Y	Y

7.2.3 Influence of including population growth on future benefits

Future benefits can change for a variety of reasons: the way the assets are managed by the stakeholders involved; external factors such as climate change and population growth that are outside the control of the stakeholders; and updates of data such as emission or sequestration rates and unit monetary values.

In this report, we have used changes in monetary values for the escalating price of carbon (BEIS, 2020) and population growth for some benefits. Table 7.4 shows the influence of including the population growth trend, using ONS population projections, in the recreation values for the regional account. Note that the pressure on land, landscape and other resources from increasing population growth and visits could be significant and need to be included in decision making but are not captured in these estimates.

Table 7.4: Comparison of recreation present values with and without population growth

Recreation PVs (£m)	Greater Manchester	Cumbria	North West Region
Constant, PV60	6,929	1,659	23,432
With population growth, PV 60	7,312	1,695	25,008
Constant, PV25	4,506	1,079	15,240

Other factors (in particular land management and use decisions and climate change) should be included in future iterations of the baseline account or as alternative scenarios to feed into decision making.

7.2.1 Variations in Sub-area values

Many of the benefits vary in proportion to the size (spatial area) of assets and the population receiving the benefits. The latter factor means that Manchester and Liverpool city regions have a higher level of benefit in relation to their spatial area. Cumbria has a higher tourism benefit relative to recreation benefits than Manchester, as shown in Table 7.5. In Manchester, air quality benefits are three times greater than carbon sequestration benefits, whereas Cumbria the reverse is the case, as shown in Table 7.6. Both results are as expected given the types of benefit.

Table 7.5: Tourism and recreation comparison (£ million)

Assuming constant benefits over 60 years	Adult recreation		Tourism	
	2020 value	PV60	2020 value	PV60
Cumbria	63	1,659	361	9,466
Lancashire+	192	5,026	492	12,899
Greater Manchester	264	6,929	916	24,011
Liverpool City Region	200	5,253	419	10,998
Cheshire and Warrington	138	3,625	378	9,918
North Wales	36	941	107	2,812
North West Region	**893**	**23,432**	**2,673**	**70,104**
Eamont Catchment	3	68	7	184
Eden Upper Catchment	4	113	12	303
Eden Lower Catchment	3	90	21	551

Table 7.6: Air quality regulation and carbon sequestration in woodland comparison (£ million)

Assuming constant benefits over 60 years	Air quality regulation		Carbon sequestration	
	2020 value	PV60	2020 value	PV60
Cumbria	38	964	35	3,144
Lancashire+	22	585	12	1,313
Greater Manchester	56	1,477	7	537
Liverpool City Region	32	831	3	245
Cheshire and Warrington	19	504	10	1,056
North Wales	6	148	12	914
North West Region	**173**	**4,509**	**81**	**7,208**
Eamont Catchment	0.1	2	2	123
Eden Upper Catchment	0.1	3	4	219
Eden Lower Catchment	0.1	4	4	248

Due to intra-regional water transfers, there are differences in water supply benefits from sub-areas within the region, as shown in Table 7.7. For example Cumbria accounts for 8% of the total water consumed within the region but represents 36% of total water abstracted by UU. This indicates that Cumbria is a key exporter of water whilst Greater Manchester is the main importer.

Table 7.7: Comparison of water consumption and water production abstractions by UU

WSZ by NC area	North West region account areas	% of total average consumption	% of total average abstraction for production
Cumbria	Cumbria	8%	36%
Lancashire	Lancashire+	19%	20%
Greater Manchester	Greater Manchester	53%	9%
Merseyside	Liverpool City Region	5%	2%
Cheshire	Cheshire and Warrington	14%	3%
Wales	North Wales	0%	27%
High Peak District	Overlaps with Greater Manchester and, Cheshire and Warrington	0%	3%
North West Region		**100%**	**100%**

7.3 Future uses of natural capital accounting

Overall the project has been successful in developing a detailed regional natural capital accounting process that can generate results for sub-regions and comparison of these results using consistent approach and data. The range of benefits measures, valued and spatially disaggregated is extensive.

The accounting process has taken significantly longer than anticipated. This is partly due to the COVID19 pandemic (which generated delays in obtaining data), and the time taken to complete the detailed mapping of natural capital across the region. However, this detailed mapping now supports a system of accounting that allows data to be generated quickly to provide consistent comparisons of natural capital data for different sub-areas of the region.

The outputs of the North West region account and sub-regional reporting area accounts are complimentary to on-going work in different parts of the region. This regional account provides an understanding of the overall scale and significance of benefits provided by natural capital assets. Its alignment with the Green Book (HM Treasury, 2020) provides data can be used to make a business case to central government for support and funding to invest in natural capital. However, different data may best inform different scales of decision-making. For example, determining how investment should be prioritised and distributed should also use data from within sub-regions of the North West (e.g., mapping of natural capital and ecosystem services in the Liverpool Combined Authority; Greater Manchester Combined Authority natural capital investment plan).

The results presented here will benefit from ongoing engagement with stakeholders and testing of use in decision-making. While this account focused on key (material) benefits and made the best of readily available data, the following are the areas that could be improved:

- Preparing separate asset registers, and some benefits estimates (e.g., agricultural output) between upland and lowland areas;
- Managing drought events: data could be used to quantify the reservoir and groundwater sources that act as back-up to the supply system. Further research is needed to determine how to value these sources - based on the avoided cost of needing alternative capacity, or the benefit of avoided supply disruption to customers. This service is expected to become increasingly important with the impacts of climate change;
- Data is included in the account on the quantity of intra-regional transfers of water in the North West. However, how to value this use of water in the accounts for those sub-regions requires further development;
- Further research is required to identify sources of hydroelectricity in local authorities partially included in the accounting boundary (e.g., Craven District, High Peak District and Welsh local authorities in North Wales reporting area), and
- Expand condition indicators to include areas of recreational greenspace, AONBs and National Parks.

These are in order of priority coming from the accounting process. However, ultimate priority depends on the benefits, data and future changes that will be most useful for decision-makers and hence this list should be consulted on with the stakeholders.

7.3.1 Assessing the cost of maintaining natural capital assets

As described in Section 2 and applied in the natural capital accounting method used to develop the account for UU's land, a complete natural capital account would include an assessment of current and planned spending on maintaining the extent and condition of the natural capital assets providing the benefits assessed. Maintenance can be understood in the broadest sense of including restoration, maintenance, and enhancement. This enables comparison of expected costs and benefits, and consideration of whether enough resources are being put into the right actions to ensure those benefits and the natural capital assets that provide them are sustained over time.

At an organisational level, data on such costs is relatively easy to gather. Linking the maintenance actions

to provision / maintenance of benefits over time is a difficult task. However, at the regional (or national) level, the data on such costs is not routinely gathered, but methods are now available to do so (Natural England, 2021). These methods could be applied to the North West region, but doing so would require a separate project, with buy-in from key public and private stakeholders who manage the majority of relevant spending and their willingness to provide such data.

7.3.2 Further research

Further issues that cannot be included in the account due to data and/or method limitations, and would require research to determine if there are ways to robustly include them in the account include:

- Adaptation to climate change. For both flood risk and drought resilience, a key factor in the account is factoring in future changes in the frequency of events. This can draw on available science, such as in the UK Climate Change Risk Assessment[32], but requires further work. As well as elements of climate change risk and hazard like floods and droughts, there are also links to the condition of natural capital assets. Improving the condition of an asset reduces its vulnerability to pressures, including climate change. Therefore, future iterations of the accounts could be used to measure the benefit of natural capital based adaptation measures for all relevant climate change risks in the region.
- Assessment of natural flood management benefits. However, this is one of the most complex benefits to measure and value:
    - Regulation of flood events: data from Forest Research (2018) is assessed as a way of quantifying water storage by woodland. If this can be linked to flood risk reduction, then it can be valued in monetary terms using national guidance: by estimating the physical damage avoided through protection and the economic value of that avoided damage.
    - Coastal flood hazard regulation is provided by vegetated intertidal habitats (e.g., saltmarsh) absorbing wave energy, thereby reducing the risks of flooding during extreme events, and/or reducing the costs of constructing and maintaining flood risk management infrastructure. This service is of greatest function and value for intertidal areas that face the open sea, and therefore subject to a longer wave fetch – this would need to be assessed in accounting area.
    - Fluvial and surface water flooding can be mitigated by natural capital; habitats with greater roughness generally slow flows, and afforestation and storage of water in upper catchments can help reduce flood peaks in small catchments (Stratford et al., 2017). Evidence for larger catchments remains indeterminate.
- Educational visits to natural areas, cultural resources and social benefits: bottom-up data collection is required to quantify these on a regional scale, so it is suggested these are discussed with regional stakeholders;
- Social capital: for example valuing UU involvement in catchment partnerships;
- The benefit of carbon storage and sequestration: it is possible, with assumptions to estimate the carbon stored in some habitats (e.g., woodland, saltmarsh, grasslands), but not others (e.g., arable) and therefore further work is needed to represent storage within the asset register and link it to sequestration benefits.
- Identifying income from shooting within the tourism and leisure benefit.
- Mental health benefits: This is considered to be a significant omission even though part of this

[32] https://www.ukclimaterisk.org/

benefit may be captured within the physical health benefits measured.

- Biodiversity: the Defra Biodiversity metric[33] is designed for scoring biodiversity units (BU) at a site level. It can theoretically be applied at a larger spatial scale, but requires assessment of habitat condition, which often can only be established through site survey work. An expected market value per BU is estimated[34], but applying this to existing stocks of biodiversity has significant uncertainties.
- Employment supported in key sectors (agriculture, forestry, tourism and the visitor economy) could be a useful addition to account outputs for strategic decision making. Work would be needed on how to represent employment with direct (e.g., agricultural) and indirect (e.g., food processing) dependency on the region's natural capital.

Further research would also inform interpretation of the account by assessing the sensitivity of results to different mapping approaches (such as those used in other natural capital accounts in the region). This would benefit from testing in partnership with relevant stakeholders.

7.3.3 Updating the UU corporate natural capital account

An update to the UU Estate's Corporate Natural Capital Account would enable a significantly better comparison between benefits from the Estate and the wider region. Such an update could be done efficiently and quickly using the information gathered for this regional account by:

- Linking regional mapping to the UU Estate, using a GIS layer for the Estate;
- Linking UU data into account calculation methods for benefits flows and values, and
- Updating data on UU's natural capital maintenance costs.

[33] https://consult.defra.gov.uk/natural-england/the-biodiversity-metric-2-0/ the revised metric (v3) was published subsequently.
[34] The Defra Biodiversity Net Gain Impact Assessment gives as expected value of £11,000 per BU (range £9,000 – £15,000).

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Appendix A - Eamont Catchment pilot NCA

The proposed methods for producing the account have been tested on a pilot area of the North West Region. The Eamont Catchment was selected to demonstrate the accounting methodologies described in Section 6. The catchment lies within Eden local authority area in Cumbria, in the North West. The catchment area overlaps with the Lake District National Park, and contains upland, lowland and urban areas, providing a good test of the accounting process. The baseline year for the analysis is 2020. Monetary values published in earlier price years have been inflated to 2020 values using the latest HM Treasury (2021) GDP deflators. Asset values are estimated using HM Treasury Greenbook (2020) guidance following a declining discount rate and a 60-year assessment period.

Results for this pilot were presented at the 12th March 2020 workshop to enable discussion, with updates to the values and approaches updated for the Interim Report (April, 2020). Updates to the Eamont Catchment pilot NCA since then include:

- Alignment of methods used to estimate food provision and recreation to those described in Sections 6.1 and 6.9.
- Extension of the assessment to include tourism and flood risk management.

A.1 Asset register

An asset register has been prepared following the method set out in Section 5, assessing both extent and condition. Table A. 1 shows that the total area of Eamont Catchment is roughly 40,800 hectares. The area is primarily acid grassland (40%) and improved grassland (29%), but a variety of additional habitats are present.

Table A. 1: Eamont Catchment extent

Habitat	Area (ha)	%
Broadleaved woodland	2,212	5%
Coniferous woodland	1,037	2%
Scrubland	81	<1%
Heathland	2,053	5%
Acid grassland	16,165	40%
Calcareous grassland	238	<1%
Neutral grassland	44	<1%
Improved grassland	11,967	29%
Arable and horticulture	756	2%
Blanket bog	2,291	6%
Fen, marsh and swamp	895	2%
Lakes and ponds	1,425	4%
Rivers and streams	183	<1%
Inland rock	48	<1%
Development	941	2%
Unclassified	500	1%
Total	**40,836**	**100%**

A total of 22 WFD waterbodies are located within Eamont Catchment: 15 rivers and seven lakes. Of these, 19 are classed as having 'moderate' WFD overall status, two are 'poor' and only one is classed as 'bad' (Environment Agency, 2020). The breakdown of WFD status by waterbody type is shown in Table A. 2.

Table A. 2: WFD waterbody status by waterbody type

WFD overall status	River	Lake	Total
Good	0	0	0
Moderate	12	7	19
Poor	2	0	2
Bad	1	0	1
Total	**15**	**7**	**22**

A.2 Benefits assessment

Of the 13 benefits described in Section 6, nine have been estimated for Eamont catchment:

- Food provision
- Timber
- Air quality regulation
- Carbon sequestration
- Flood risk management
- Recreation
- Physical health
- Tourism
- Water quality

As most of the input data described in Section 6 provides local authority level data, where figures for Eamont Catchment could not be identified, figures for Eden District have been used and adjusted based on total area.

A.3 Summary

The estimated annual physical and monetary values, and present value of 60 years, of benefits are summarised in Table A. 3. The data are given a confidence rating which is described in Table 6.5.

As shown in Table A. 3, the total value of natural capital benefits is estimated to be roughly £21 million per year in the baseline year. The majority of the value is driven by tourism (30% of total annual value) and recreation (27%). The total present value of natural capital assets, over 60-years, is estimated as £676 million assuming a constant baseline for most benefits (i.e., without trends).

Table A. 3: Baseline natural capital assessment for Eamont Catchments

	2019/20	Quality	Physical flow quantity (unit/yr)	2019/20	Quality	Monetary value (£m/yr)	PV 60 (£m)
Key monetised benefits							With trends
Food provision	3,30	●	Arable food production (tonnes)	0.3	●	Arable income	10
	56,552	●	Livestock production (no. heads)	4.4	●	Livestock income	12
Fishing (commercial)	No benefit provision	●	Landed weight landings by vessels 10m and under (tonnes)	No benefit provision	●	Landings by vessels 10m and under	No benefit provision
Timber	8,116	●	Volume of softwood removals (m^3)	0.2	●	Value of softwood removals	5
Renewable energy	Not assessed	●	Electricity generated by hydropower (MWh)	Not assessed	●	Resource rent of hydropower	Not assessed
Water supply	Not assessed	●	Tidal and surface water abstraction for public water supply (m^3)	Not assessed	●	Resource rent of tidal and surface water abstractions for public water supply	Not assessed
	Not assessed	●	Groundwater abstraction for public and private water supply (m^3)	Not assessed	●	Ecosystem provision of groundwater for public and private drinking water and agriculture	Not assessed
Minerals	Not available	●	Volume of sand and gravel extracted (tonnes)	Not available	●	Ex-works sales of sand and gravel	Not available
	Not available	●	Volume of crushed rock extracted (tonnes)	Not available	●	Ex-works sales of crushed rock	Not available
Air quality regulation	18,002	●	PM2.5 removal by woodland (kgPM2.5)	0.1	●	PM2.5 removal by woodland	2
Carbon sequestration	26,296	●	CO_2e sequestered in habitats (tCO_2e)	2.0	●	CO_2e sequestered in habitats	123
Recreation	853,792	●	Adult recreation visits (under 3 hours) (visits)	2.6	●	Adult recreation welfare (under 3 hours)	70
Physical health	439,703	●	Active visits (active visits)	1.5	●	Avoided medical treatment costs	40
Tourism	127,360	●	Day visits and overnight trips attributed to natural capital (visits)	7.0	●	Domestic tourism expenditure attributed to natural capital	184
Water quality	216	●	Length of WFD rivers (km)	2.5	●	Welfare of avoiding deterioration in rivers	65
	13	●	Area of WFD lakes (km^2)	0.1	●	Welfare for avoided deterioration in lakes	2
			Total value	**21**	●	**Mix of values**	**613**
Water supply	Not assessed	●	Total water abstraction at source (i.e., production) (m^3)	-	●	-	Not valued
Flood risk management	537,060	●	Annual average additional woodland soil water storage capacity (m^3)	-	●	-	
Recreation	216,471	●	Total children recreation visits (under 3 hours) (visits)	-	●	-	
Biodiversity	6,020	●	Total SSSI area (ha)	-	●	-	

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