

Great Ouse

Natural capital register and account

2025



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Executive Summary

Natural capital refers to the elements of the natural environment that provide valuable goods and services to people [1]. These include food, water, flood alleviation, thriving wildlife and places to enjoy. Natural capital underpins our wellbeing and economic prosperity, providing multiple benefits to society.

This Natural Capital Baseline Report provides an assessment of the natural capital assets within the Great Ouse catchment¹. The report highlights the importance of natural capital in supporting economic activity and human wellbeing through the provision of ecosystem services. The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) and includes both quantitative and qualitative analysis undertaken through desk-based research, spatial analysis using Geographical Information Systems (GIS) and engagement with key stakeholders.

The catchment comprises 220,000 hectares (ha) of terrestrial, coastal and freshwater habitats, including coastal margins; enclosed farmlands; freshwater habitats; mountains, moorlands and heaths; urban land; and woodland. The catchment also contains local, national and international designated sites such as the Ouse Washes, Fenland, Wicken Fen and Aspoll Close.

The key ecosystem services from natural assets in the catchment can be categorised into provisioning, regulating, cultural and supporting / bundled services, the estimated natural capital values of these are summarised below:

- Water supply, agriculture, renewable energy generation and timber are key **provisioning services**. Water supply alone contributes an estimated £321 million annually, while agriculture is valued at nearly £188 million per year.
- Climate regulation, air quality improvement, hazard regulation and pollination are critical **regulating services**. Woodlands and enclosed farmland play a significant role in carbon sequestration and climate regulation, which sequesters an estimated 64,573tCO₂e/yr² in the catchment. Conversely, the peatland in the catchment is likely to be in a degraded condition and consequently emits approximately 1,080,000tCO₂e/yr.
- Recreation, physical health, and aesthetic value are important **cultural services**. Despite being predominantly agricultural in land-use, it is estimated that the catchment attracts approximately 18.6 million visitors annually to open spaces, with an estimated value of £22.9 million annually³. This contributes to natural capital value through improvements to physical and mental health (welfare) and can boost the local economy.

¹ The Great Ouse catchment is not strictly a hydrological catchment as there are movements of water both into and out of the area defined, that are not being considered in this report. However, the term 'catchment' has been used throughout the dialogue with the Environment Agency during establishment of the study areas and these areas are being defined for water management purposes. Therefore, the term catchment is used to describe the study area.

² Tonnes of carbon dioxide equivalent per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases

³ Open spaces considered within ORVal include publicly accessible green spaces within the catchment, for example, public parks, doorstep greens and nature reserves.

- **Supporting / bundled ecosystem services** in the catchment include water quality and biodiversity, which allow other ecosystem services to function and often involve multiple services or non-use values. The catchment hosts a large number of designated sites that support biodiversity conservation, for example, approximately 1.80% (3,960ha) of the catchment is internationally designated as a Special Protection Area, Special Area of Conservation (SAC) or Ramsar Site. Other statutory sites for nature conservation in the catchment include 46 Site of Special Scientific Interests, seven National Nature Reserves and ten Local Nature Reserves (LNR).

Ecosystem services that have not been valued but are important for the catchment include pollination and seed dispersal; control of pests and diseases; regulation of soil quality and erosion; biodiversity; and cultural services through the contribution of ecosystems to aesthetics, the historic environment, and a sense of place.

Other ecosystem services that have not been valued include volunteering and education. These ecosystem services have not been included due to a lack of information available, or because they are too complex to accurately determine with the information available. Since there is no marine habitat within the catchment study area, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. It should also be noted that the estimated value for agricultural activities does not include the negative impacts it can have on the other ecosystem service (for example water quality, carbon sequestration, hazard regulation and biodiversity) through pollution, biodiversity loss, erosion and peat degradation. Figure 1 provides an overview of the natural capital value within the catchment.

The natural capital assets in the catchment are at risk, which in turn creates risks for the delivery of ecosystem services. Broadly, the risks identified include climate change; land-use change; resource extraction; population growth; pollution; and invasive species. If not managed, these risks will degrade the quantity and quality of natural capital assets in the catchment and prevent the provision of ecosystem services that our societies economy and wellbeing rely on.

Conversely, there are many opportunities to enhance natural capital assets in the catchment, thereby increasing the provision of ecosystem services, and boosting local and global natural capital value. These opportunities include restoration of natural habitats including peatland, woodland and wetland; habitat creation and growth; implementing nature-based solutions (NbS); adopting sustainable practices in agriculture and water management; regenerative farming; and strengthening policy and governance that enables the conservation of natural capital assets and supports sustainable development. These interventions would deliver multiple benefits across a range of ecosystem service types.

The report highlights the critical role of natural capital in supporting the local community's resilience and wellbeing in the catchment, and the value of considering natural capital in strategic decision-making. Through addressing the identified risks and leveraging the opportunities, the Fens2100+ programme, and future investment projects should look to sustainably manage existing natural capital assets and look for opportunities to enhance ecosystem service delivery for future generations.

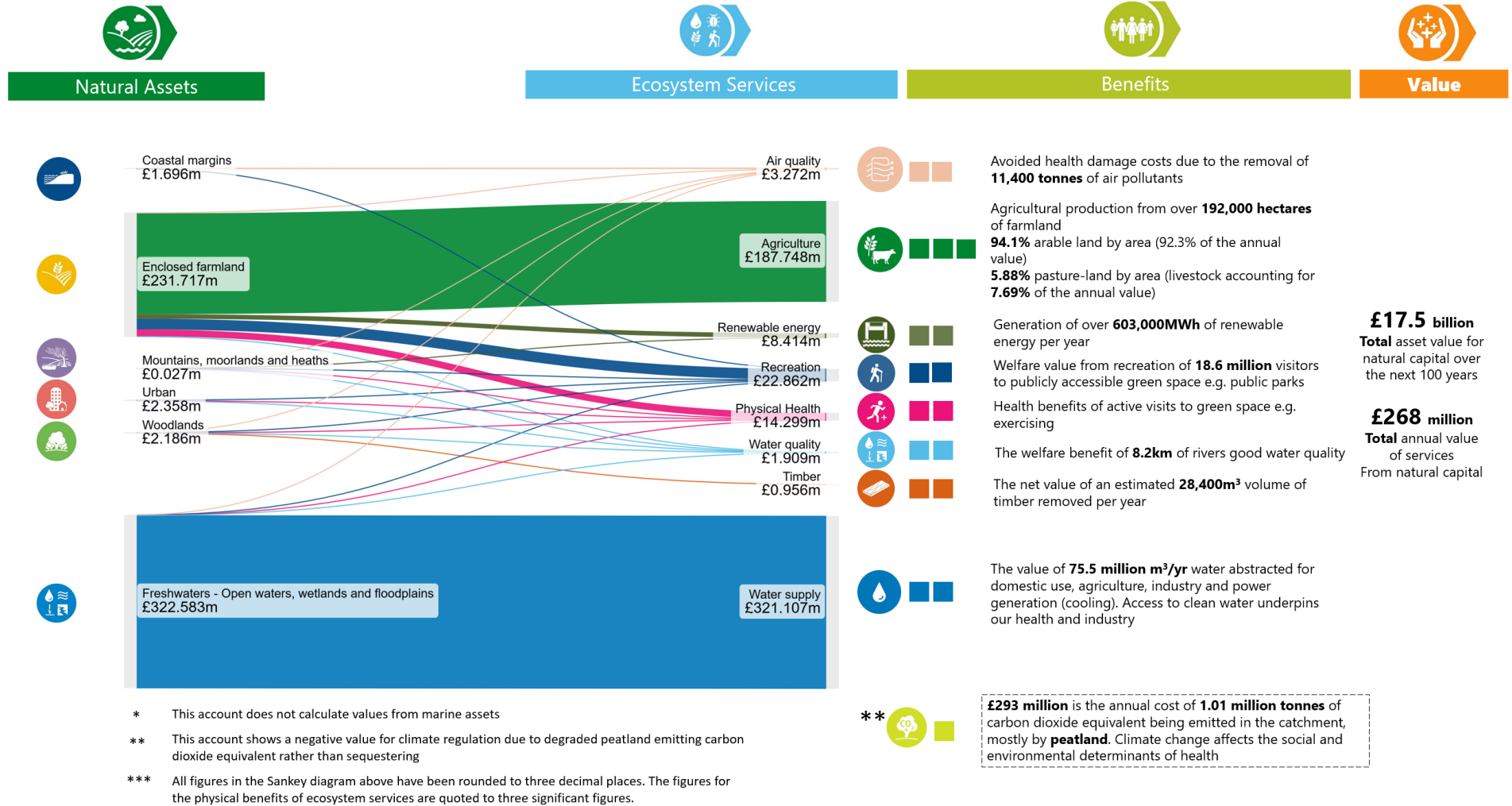


Figure 1: Summary of the NCRAT results for the catchment, showing the flow of ecosystem services and their benefits from natural assets

1. Introduction

1.1 Aim and purpose of this document

This report presents a catchment-scale natural capital baseline for the Fens2100+ Great Ouse catchment (hereafter referred to as the 'catchment')¹. It provides an insight into the provision of ecosystem services by natural capital assets across the catchment, highlighting the wider benefits this has on society, such as the importance of natural capital in supporting economic activity and human wellbeing, as well as the risks and opportunities. It aims to provide decision makers with evidence to support future choices, investments and actions for the Fens2100+ programme.

The assessment was conducted using the Environment Agency's Natural Capital Register and Account Tool (NCRAT) suite of tools⁴ and includes an estimated total quantifiable natural capital value (£m) in the catchment, supported by qualitative evidence and analysis. More information on the importance of using a natural capital approach is provided in Section 2.2.

1.2 Usage statement

This report should be read alongside the Great Ouse baseline evidence report and the Great Ouse environmental and agricultural baseline appendix. This document provides a proportionate level of detail required for a strategic catchment-scale baseline. A detailed baseline analysis may be required at project level to align with the Environment Agency's Minimum Technical Requirements or Environmental Impact Assessment.

1.3 Catchment context

The catchment covers approximately 219,600ha (2,196km²) across Cambridgeshire, Norfolk and Lincolnshire. The catchment extends along the River Great Ouse from the Earith Sluice to the outlet of the Tidal River Ouse into the Wash at King's Lynn. To the south-east the catchment is bordered by the low clay hills of the Huntingdonshire Uplands. In the north-west the natural catchment boundary sits along the edge of the Whittlesey Washes and the River Nene, as shown in Figure 2.

Other watercourses in the study area include the Hundred Foot River (also known as New Bedford River), the Old Bedford River, Ely Ouse, Wissey, Lark and Cam. Water enters the river network from field ditches which are connected to larger drains managed by Internal Drainage Boards (IDBs).

The Environment Agency have permissive powers to carry out flood and coastal risk management activities on Main Rivers. In addition, the Environment Agency are responsible for producing a national strategy for Flood and Coastal Erosion Risk Management (FCERM). The latest strategy published in 2020 contains 'Measure 1.5.4'. This requires development of a long-term plan for managing future flood risk in the Fens. IDBs play a vital role in managing water levels and drainage across the catchment for agricultural and environmental purposes. The IDB's are responsible for managing the

⁴ Environment Agency NCRAT includes: Environment Agency Natural Capital Register and Account Tool version 1.2, Workbook; and Environment Agency natural capital scorecard version 1.2

complex network of drains that feed into Main Rivers by pumps. They also regulate water levels on non-Main Rivers (ordinary watercourses).

There are 48 IDBs operating within the catchment. These IDB's are grouped into consortiums within the catchment including the Middle Level Commissioners, Ely Group of IDB's, Downham Market Group of IDB's, the Whittlesey Consortium of IDB's, Ramsey IDB and the King's Lynn IDB.

The catchment topography is flat and low-lying with 32% of the study area lying below mean sea level, and 62% lying below 2.5m AOD (metres Above Ordnance Datum). The lowest area sits 4m below sea level in the proximity of the A1 near Brampton. A branched network of drainage channels with numerous water level management structures allow the low-lying catchment to be drained.

The catchment is dominated by arable crops, with some occasional pasture and priority habitats including coastal and floodplain grazing marsh and fens (upland and lowland). It is a highly productive agricultural area with 41.8% of the land classified as Grade 1 agricultural land.

The majority of the catchment is located within the National Character Area (NCA) 46 'The Fens' [2]. The NCA 88 Bedfordshire and Cambridgeshire Claylands, NCA 87 East Anglian Chalk, NCA 85 The Brecks and the NCA 76 North West Norfolk also intersect with small portions of the catchment boundary. The Fens is a distinctive, historic and human influenced wetland landscape lying to the west of The Wash, the largest estuarine system in the UK. The NCA is notable for its large-scale, flat, open topography with extensive vistas to level horizons.

Eleven local authorities intersect with the catchment, including King's Lynn and West Norfolk (33.9% of the catchment area), East Cambridgeshire (21.9%), Fenland (18.3%), Huntingdonshire (12.5%), South Cambridgeshire (6.1%), West Suffolk (5.3%), South Holland (1.09%) and Breckland (0.9%). The other three local authorities (Peterborough, North Northamptonshire, and Cambridge) cover just 0.1% of the catchment combined.

March, Chatteris, Soham, Downham Market, Ely and King's Lynn are the main centres of population in the catchment. Wisbech lies just outside the catchment boundary to the west, and Cambridge and Huntingdon are large settlements located close to the catchment to the south.

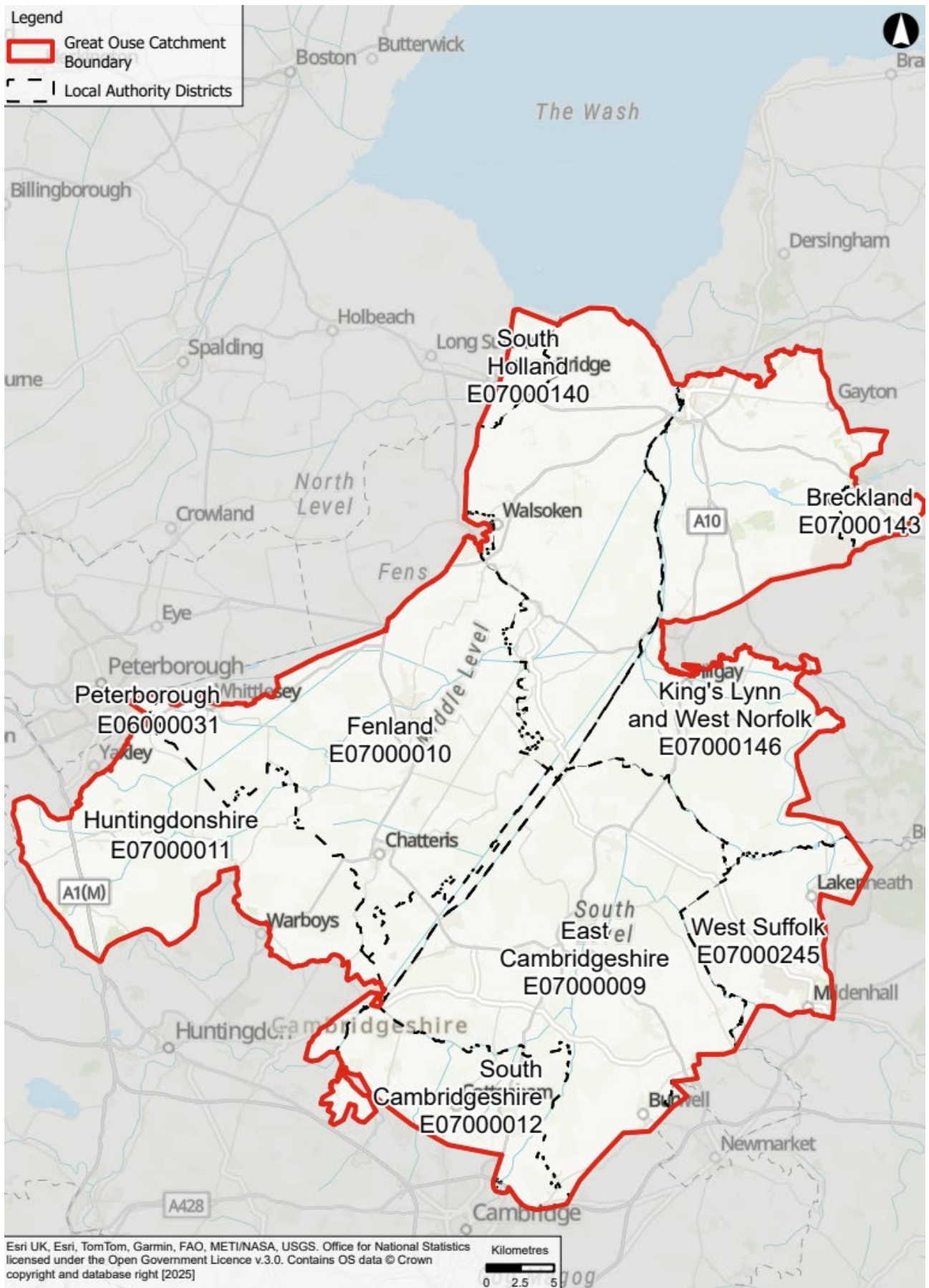


Figure 2: Great Ouse catchment outline

2. Understanding natural capital

2.1 An introduction to natural capital

Natural capital refers to the renewable and non-renewable natural resources that combine to provide valuable goods and services to people [1]. All aspects of the natural environment - including soils; geological formations; habitats; and ecosystems - are natural capital assets which provide ecosystem services, from which flow benefits to society.

There is a growing awareness of the role of natural capital in delivering quality of place, and in enhancing health and wellbeing. Some benefits of natural capital can be measured and valued, but many are difficult to define and quantify. Taking a natural capital approach facilitates comparability between environmental and economic costs and benefits and can help organisations, planners and policy makers assess needs, identify dependencies on natural assets, and translate this into relevant information for decision-making, which can in turn facilitate better design and achievement of policy, strategies, programmes and projects.

A natural capital framework

A natural capital framework, such as that shown in Figure 3, provides a coherent, comprehensive and consistent mechanism to analyse key ecosystem services and benefits provided by nature and is recognised by the HM Government's Green Book as a way to improve appraisal of a range of environmental benefits and effects [3].

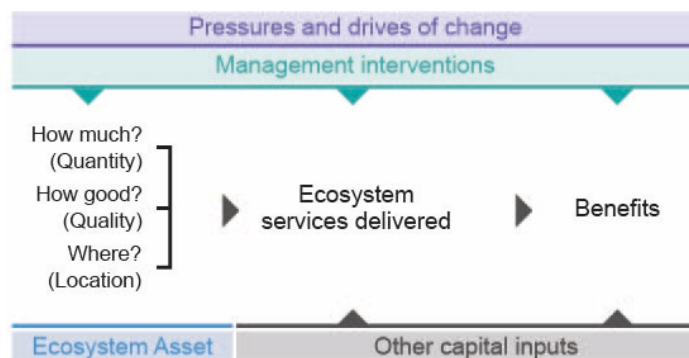


Figure 3: A Natural Capital Framework, adapted from Enabling a Natural Capital Approach Guidance [4]

Natural capital / ecosystem assets

Natural capital assets are aspects of the natural environment. This includes but is not limited to:

- Habitats that serve as natural environments for living organisms such as woodland, heathland, marine and intertidal habitat, scrub, agricultural land, hedgerows, semi-natural grassland and urban trees;
- All living organisms including animals, plants, fungi, and bacteria;
- Green infrastructure, which comprises multifunctional green spaces such as parks and green walls;
- Geological features and processes including rocks, soils and minerals; and
- The water environment, including rivers, lakes, aquifers, and oceans.

The quality, quantity, location and connectivity of these natural capital assets impacts the ecosystems services and benefits they provide. These in turn can be affected by background pressures, management practices and drivers of demand, therefore impacting their natural capital value.

Ecosystem Services

The benefit and contribution of nature to our society is a product of the various ecosystem services it provides, which can be grouped into four categories [5]:

- **Provisioning:** Material outputs from nature (e.g., seafood, water, fibre, genetic material);
- **Regulating:** Indirect benefits from nature generated through regulation of ecosystem processes (e.g., mitigation of climate change through carbon sequestration, water filtration by wetlands, erosion control and protection from storm surges by vegetation, crop pollination by insects);
- **Cultural:** Non-material benefits from nature (e.g., spiritual, aesthetic, recreational, and others); wellbeing gains from sites and areas are often derived from a combination of the heritage, biodiversity and geodiversity aspects; and
- **Supporting/bundled services** [5]: Fundamental ecological processes that support the delivery of other ecosystem services (e.g., nutrient cycling, primary production, soil formation). Bundled services may include: Amenity, Biodiversity, Soil Quality, Water Quality, Landscape and non-use benefits.

Benefits

Ecosystem services provide a wealth of benefits to society and the economy, for example:

- Improved physical health through the supply of clean air, water and food; as well as regulation of temperature and flood protection;
- Improved mental health through provision of green and blue space for recreation; and
- Improved economy through the availability and quality of commercial activities such as arable farming, aquaculture, timber production, and pastoral farming.

Each ecosystem service will have numerous benefits to society and the economy. For example, erosion control benefits human physical health by reducing the risk of dangerous landslides; mental health by improving access to nature; and benefits the economy by improving soil health for agriculture and reducing the cost of repairing infrastructure after a landslide. Sometimes, other economic inputs are required to enable ecosystem services to provide a benefit to society. For example, the health and wellbeing benefits of recreation requires providing accessibility, including functional gateways and path maintenance.

Value

The value of the benefits provided from ecosystem services in an area can be estimated using quantitative and qualitative information about the quantity, quality and location of natural capital assets, as well as information on how local natural assets are used by society – both locally and globally, and for private and public sectors.

Quantitative valuation is best used to provide information on the marginal value of incremental changes in impacts or dependencies, either at a point in time or over a given period and is usually monetised in units (£). It can also be used to estimate the economic value of a range of ecosystem services that affect economic performance and human

wellbeing - some of which are commonly unpriced and not considered in economic metrics such as Gross Domestic Product (GDP).

Qualitative valuation, describing the natural capital impacts, is therefore also important as it can be used to take into account the importance, worth, or usefulness of the impact and/or dependency by taking into account the context, to give equal values to any monetary figures presented.

Where products are directly or indirectly linked to ecosystem services and are traded in markets, valuation can be carried out using market prices - this is often the case for provisioning services such as timber production [4]. For other services that are not typically traded in markets, such as improved water quality or climate regulation, non-market based approaches are used. These typically involve measuring the price individuals are willing to pay to secure positive impacts or avoid negative impacts, through stated preference, revealed preference or cost-based approaches [4].

It should be noted that the representation of natural capital in monetary accounts will only ever be partial as a number of ecosystem services remain difficult to quantify and value. Some are highly location specific, for example water flow and impact on flood risk, and some are intangible or difficult to even place a monetary value on, for example cultural services, such as aesthetic experiences and sense of place.

Through valuing natural capital benefits, their importance to society and the economy can be better represented and accounted for in decision-making about future place-based planning and investment.

2.2 The importance of considering natural capital within flood risk and water management infrastructure investment

The concepts of natural capital and ecosystem services are widely supported; the challenge, however, is in implementing the approach and embedding it in working practices, so that the value from the natural environment becomes an integral component of investment decision-making. This is recognised in the State of Natural Capital Report for England 2024 [6], which explores the relationship between natural capital and infrastructure. Two key outcomes of the report that highlight the importance of natural capital include:

- Infrastructure, such as flood risk and water management infrastructure can deliver benefits for natural capital, such as through the provision of protected natural habitats and connecting corridors for species along linear infrastructure. In addition, the environment affects infrastructure as changes in the environment such as the climate emergency can increase the costs of infrastructure (e.g. cost of damages caused by flooding). In some cases, natural capital approaches may reduce the demand for hard engineered infrastructure, such as coastal defences, by supporting the use of green engineering or NbS.
- There are significant risks to natural capital that must be considered. The degradation of natural capital can lead to the loss of ecosystem services that are vital for human well-being and economic stability. For instance, the destruction of wetlands can increase the risk of flooding, while deforestation can exacerbate climate change by reducing carbon sequestration. Ignoring these risks can result in increased costs for disaster management and recovery, loss of biodiversity, and diminished quality of life.

The consideration and implementation of natural capital approaches in planning future flood risk and water management infrastructure investment can provide a wide range of benefits [7]:

- Reducing risk of not fully considering the value of the natural environment (whether monetised or not) in decision-making;
- Enabling a holistic cost to benefit analysis and risk assessment;
- Identifying how economic and social activity is dependent on the natural environment;
- Facilitating an innovative approach to identifying policy solutions and managing risk;
- Helping to identify priorities for investment; and
- Providing a basis for systematic accounting of changes to natural capital assets over time.

2.3 Key accounting methods

2.3.1 Natural capital accounting

Natural capital accounting is an approach that can be used to provide a systematic and repeatable exercise to collate information on natural capital, the ecosystem services that they provide and the associated market value (if appropriate) [4]. These accounts can be used to measure, value, monitor and communicate the stock and condition of natural assets and the flows of services that they provide. By understanding the state of natural capital this can help ensure that the value of natural assets is considered as part of the decision-making process.

There are a variety of approaches that can be used in natural capital accounting depending on the scale and purpose of the exercise, however the key considerations in each are the extent, condition, physical flow, monetary flow and asset accounts.

2.3.2 Environment Agency Natural Capital Register and Account Tool

The Environment Agency NCRAT was developed to help estimate the flow of services from natural assets and understand the value and benefits that the natural environment provides.

NCRAT requires information on the habitat extent and condition to be provided alongside other local data and uses this information to calculate flows of services and associated monetary values. This information is then summarised in a benefits statement showing the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Figure 4 outlines the types of input data that is required, process that are undertaken and outputs that are provided by the NCRAT [8].

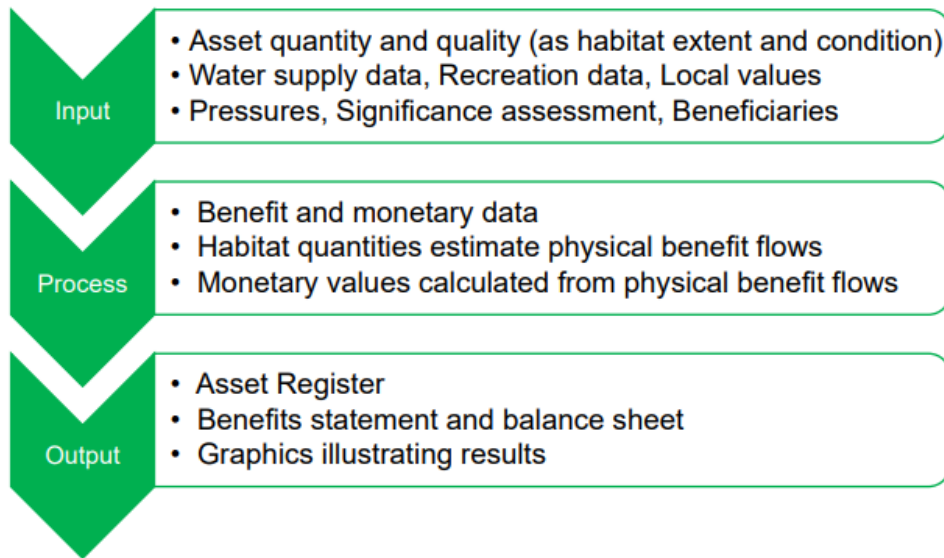


Figure 4: NCRAT Flow Chart

The NCRAT does not include valuation of supporting services (such as nutrient cycling) as this has the potential to lead to double counting as they underpin cultural, provisioning and regulating services. There are also ecosystem services that are not captured by the current version of the NCRAT due to a lack of robust data. This includes pollination, noise mitigation and soil quality and erosion. Where ecosystem services have been identified as being important, but are not captured by NCRAT, qualitative commentary has been provided to ensure that key benefits are captured.

3. Our approach to understanding the benefit and value of natural capital

3.1 Developing our evidence base

This section outlines the methodology used to assess the baseline natural capital value within the catchment.

3.1.1 Methodology

The natural capital assessment was conducted in six distinct stages, broadly aligned with the Natural Capital Protocol [9] and guidance set out within the Enabling a Natural Capital Approach guidance [4]:

1. Desk-based research on natural capital assets, ecosystem services, benefits and plans.
2. An initial materiality assessment to scope in/out relevant ecosystem services based on the wider context of the catchment, use of resources and how people interact with habitats (see Section 3.1.3 for more information).
3. Baseline analysis using the Environment Agency's Natural Capital Register and Account Tool (NCRAT), qualitative analysis of additional ecosystem services not quantified within the NCRAT assessment, and spatial GIS analysis.
4. Natural Capital Scorecard and associated narrative (including ecosystem services and benefits that were not assessed in the NCRAT but were scoped in during the materiality assessment).
5. Presenting outcomes of spatial analysis, and natural capital assessment. Contextualisation of results by incorporating outcomes of stakeholder engagement and spatial analysis. Qualitative narrative on wider ecosystem services not assessed in monetary or biophysical terms to provide a holistic perspective on natural capital value generated.
6. Interpret results and identify limitations in the assessment.

3.1.2 Desk-based research: Data Sources

The data sources used for the desk-based assessment of natural capital assets and ecosystem services are listed below.

- Corine Land Cover 2018 [10]
- Statutory Main Rivers [11]
- OS Open Rivers [12]
- OpenStreetMap Waterways [13]
- National Forest Inventory woodland [14]
- England Peat Status GHG and C Storage [15]
- Ancient Woodland Inventory [16]
- Priority Habitat Inventory [17]
- Water Environment Regulations (WER) / Water Framework Directive (WFD) catchment data – waterbody classifications and extent (rivers, surface waters and groundwaters) [18]

- WER / WFD waterbody extent (rivers, surface waters, transitional and coastal waterbodies, lakes and groundwater bodies) [19] [20] [21]
- Felling Licence Applications [22]
- Surface Water Availability for Water Resource Charging [23]
- Groundwater Management Units coloured according to water resource availability [24]
- Bathing waters data [25]
- Sites of Special Scientific Interest [26]
- Special Protected Areas [27]
- Special Area of Conservation [28]
- Ramsar Sites [29]
- National Nature Reserves [30]
- Local Nature Reserves [31]
- Natural England Green Infrastructure Map [32]
- Outdoor Recreation Valuation Tool (ORVal) [33]
- NCRAT Data Support Package⁵

3.1.3 Materiality assessment

The NCRAT requires a range of local information to be entered into the tool to support the assessment. There are instances where the level of effort required to gather the data for a specific input is disproportionate to the scale of the study and relevance of the data to the scheme. In these instances, the information is excluded from the tool. There are also ecosystem services that are not quantified or given a monetary value by the NCRAT but that may be of importance in the catchment (e.g. pollination or soil erosion/ retention) and therefore require additional analysis to capture the potential benefits and provide a more well-rounded account.

An initial materiality assessment was undertaken to determine which ecosystem services are of direct relevance to the catchment and should be considered as part of the baseline natural capital account (e.g. the ecosystem services that are provided currently). The list of ecosystem services outlined in the Natural England Accounting for National Nature Reserves report [34] was used as the basis to scope services in/out of the assessment.

The results of the materiality assessment, including an overview of the ecosystem services that have been scoped in/out, is provided in Section 4.1.1.

3.1.4 NCRAT

The Environment Agency's NCRAT has been used to develop a baseline of the condition and extent of natural capital assets and help understand and quantify the value and benefits that they provide to society. The NCRAT has been selected as it provides a consistent methodology to develop natural capital registers and accounts for each of the catchments within the Fens2100+ project. The NCRAT is also best suited for use at the strategic scale (above 10,000ha) and therefore is most suitable for the size of catchments that are considered as part of Fens2100+. An overview of the NCRAT is provided in 2.3.2 and further guidance on the tool can be found in The Natural Capital Register and Account Tool, Version 1.2 – Technical Report [8].

3.1.5 Confidence Ratings

The NCRAT considers thirteen key ecosystem services as shown below in Figure 5.

⁵ This package was provided by the Environment Agency and is not publicly available.



Figure 5: Ecosystem services quantified and valued in the NCRAT © Environment Agency [7]

A natural capital register and account will only ever reveal a partial value of nature, however the benefits statement provides an overview of the flows of ecosystem services from assets and the calculated monetary values of selected services including present value over time. Monetary values have been provided for annual flows and for asset value over a 100-year period (minimum and maximum values also provided where data is available).

Confidence ratings have then been assigned to the monetary values presented for each of the ecosystem services to highlight where the data used to calculate a monetary value is considered to be of greater quality or more appropriate. These confidence intervals are assigned based on a Red-Amber-Green (RAG) rating in line with the NCRAT methodology and are illustrated in Table 1 [8].

As highlighted in Section 3.1.1, the number of ecosystem services and benefits provided by a place vary, and not all of them can be quantified. This means that not all services are currently represented within NCRAT.

Table 1: Confidence rating definitions

Confidence rating	Definition
Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed or based on sources that are not specifically tailored to this context. Some assumptions or estimations may be open to question. Accuracy is expected to be better than plus or minus 50%.
Red	Low confidence in results. Input data and/or parameters from a single source and low level of transferability from original context. It is expected that estimate is in the right order of magnitude. Order of magnitude implies that, for example, for an estimate of 5 the 'real' figure is within the range 0.5 to 50.
White	It is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.

Confidence rating	Definition
Grey	These ecosystem services are not valued by the NCRAT, either due to a lack of data or because they are too complex for the scope of this assessment.

3.1.6 Stakeholder Engagement

Stakeholder engagement is valuable to help determining the input data and interpreting the results from the register and account. Other organisations and local stakeholder groups such as The Wildlife Trusts may be able to provide (or have access to) locally specific data, as well as providing different perspectives to qualitative assessments such as risks, pressures, and the significance of benefits in a place.

The qualitative aspects of the assessment, such as the significance assessment, have been based on professional judgement and understanding of the catchment. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression.

3.1.7 Limitations and assumptions

The following assumptions should be noted, in addition to those provided in the NCRAT [7].

- All values within the analysis were expressed in 2024 prices and British Pound (GBP).
- The 'Risk Register', 'Significance Assessment,' and 'Beneficiaries Assessment' tabs in the NCRAT spreadsheet tool have been completed without detailed stakeholder engagement having been undertaken. It is recommended that this be refined through engagement with stakeholders as part of any future update and project progression. However, the inputs for these assessments do not impact the overall natural capital value calculated for the study area.
- Statutory main river widths are assumed to be 39m and ordinary watercourses, which are mapped using both the OS Open Rivers and OpenStreetMap datasets, are assumed to be 10m and 5m wide, respectively⁶. It should be noted that there are a large number of man-made drainage ditches and channels across the catchment that are not accounted for in this analysis. Additionally, water resource availability within the catchment not only supports users within the catchment, but also in areas beyond it, via the Ely Ouse-Essex Transfer Scheme, which moves excess water from the Great Ouse Fens to supply reservoirs in Essex. However, the volume of these water transfer values are not available, therefore the wider ecosystem service benefits from watercourses within the catchment have not been directly attributed.
- Woodland areas under management are assumed to be areas with a felling licence expiry dated after 31st March 2015, this is based on the Forest Commission's definition of 'Woodland area under management' having had a felling licence in the

⁶ Based on a sample of 15 river widths taken from across the catchment boundary. Measured using aerial imagery using ArcGIS.

past ten years, being owned by government organisations, or having a management plan [35].

- Peatland condition classifications are assigned based on the estimated rate of GHG flux (named 'newghgr' in the 'England Peat Status GHG and C storage dataset') and the closest emission factor provided in the Peatland Code Field Protocol [36].
- To calculate input values for water supply and renewable energy, local authority data was used and adjusted in proportion to size of the catchment. This assumes that the distribution of renewable energy and water supply is even across the local authority.
- To estimate the number of recreational visits in the catchment and the associated value of this, ORVal data was used for each of the Middle layer Super Output Areas (MSOAs) in the catchment. Where an MSOA is only partially within the catchment, the number of visits and associated value was scaled down relative to the area within the catchment – this assumes that the distribution of recreational visits for each welfare group is even across the MSOA.
- Groundwater management units that have been identified by the Environment Agency as having water available for consumptive abstraction on a 'case-by-case' basis have been considered as 'water not available for licensing'.
- Surface water operational catchments with less than 1% of their total area intersecting with the catchment area have been excluded from NCRAT calculations.

The following limitations should also be considered:

- Data resolution is generally low; with the majority of habitat data being derived from remote sensing datasets such as CORINE Land Cover or the Centre for Ecology and Hydrology Land Cover Maps being the main data sources for the assessment. Datasets such as the National Forest Inventory, EA Statutory Main Rivers and OS Open Rivers were used to supplement habitat type data and reduce this limitation.
- The provision of biodiversity benefits is currently not quantifiable within the tool (for example, when comparing arable land to more biodiverse semi-natural habitats).
- Since there is no marine habitat in the catchment, the provision of food from fish and shellfish landings has not been included. This is because it is not possible to attribute these benefits to the study area.
- The net carbon sequestration rate for arable land is based on Christie et al. 2011 at $0.107\text{tCO}_2\text{e/ha/yr}^7$, resulting in a sequestration of carbon [37]. More recent data collated in the Natural England report 'Carbon Storage and Sequestration by Habitat 2021 (NERR094)' uses figures from a study by Muhammed et al. 2018 which showed a net emission rate of $0.290\text{tCO}_2\text{e/ha/yr}$ for arable land and a net sequestration rate of $0.360\text{tCO}_2\text{e/ha/yr}$ for improved grasslands [38]. There is variation in carbon fluxes on arable land based on a variety of factors, including production and application of fertilisers, vegetation type, catchment topography, weather, and land use. However, it is likely that the $0.107\text{tCO}_2\text{e/ha/yr}$ figure does not provide an accurate picture of carbon fluxes within the catchment.

⁷ Tonnes of carbon dioxide equivalent per hectare per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases.

- The area of freshwater habitats is likely to be underrepresented in this study due to the large number of drainage channels in the catchment that are not captured in the EA Main River, OS Open Rivers or OpenStreetMap datasets.
- The NCRAT uses national data to calculate the natural capital value for agriculture. This is based on the average of the John Nix Farm management units Editions 49-52, years 2019-2022 [39]. The natural capital value is updated for the 2024 accounting price year which takes account of inflation to the price base. Local deviations from the national average may lead to the value of local agriculture being misrepresented. In the catchment, there is a higher proportion of arable agriculture and fruit / vegetable crops than the national average, meaning that the NCRAT is likely to underestimate the value of food production.
- The NCRAT values water quality based on all the WER/ WFD surface water bodies in the operational catchments that the Great Ouse catchment intersects. There are 76 surface waterbodies within the catchment boundary. Seven of these waterbodies score 'good' for ecological status for the River Basin Management Plan Cycle 2, and Cycle 3, 59 of these waterbodies score 'moderate', eight waterbodies score 'poor' for ecological status and two waterbodies score 'bad' for ecological status.
- The 'England Peat Status GHG and C storage dataset' is expected to be an overestimate of peatland extent in the Fens2100+ study area, based on a comparison with more recent data published by Natural England [2]. This indicates the amount of carbon dioxide emitted as a result of actively eroding or degraded peatland has also been overestimated, so the monetary value of climate regulation in the catchment is expected to be greater than calculated for this baseline.
- It is likely that these limitations lead to an underestimate of the benefits provided by semi-natural habitats, and furthermore underestimate the negative impacts of arable land while overemphasising the wider benefits of arable land, beyond food production.
- This baseline assessment has not been informed or verified by any field surveys or site visits conducted by Arup.
- This baseline assessment is currently limited to the catchment boundary that has been defined for the Fens2100+ project by the Environment Agency. There is no official data boundary that matches the catchment study area.
- The baseline information collated comprises a proportionate level of detail from publicly available data sources and it is reported at the geographical basis relevant to the data availability. Therefore, this report reviews and provides commentary of existing reports written by others. Arup accept no responsibility for any error or omission in this report which is due to an error or omission in the original documentation we refer to. Arup have not independently verified the information and have assumed it to be accurate, complete, reliable, and current as of the date of such information.

4. The natural capital register and account for the catchment

4.1 Materiality Assessment

A summary of ecosystem services to be scoped in/out of the assessment is provided in Table 2. The initial materiality assessment highlighted that the majority of ecosystem services are of significance and should therefore be scoped into the assessment. Of those services that have been scoped out, this is predominantly due to lack of marine habitat (for fish and shellfish) and woodland habitat (for foraging and noise regulation). Of those that have been scoped into the assessment, six are not quantified by NCRAT and require additional qualitative analysis. These are indicated using ‘*’ in Table 2.

Please note:

- Ecosystem services related to wild plants, algae & their outputs, wild animals & their outputs, and aquaculture have been scoped out due to lack of reliable data on gathering rates and/or lack of suitable habitat for these benefits to materialise (e.g. availability of coastal waters for fishing and/or aquaculture, presence of ports that record fish landings, availability of land used for commercial hunting, datasets on foraging rates).
- Noise regulation benefits were scoped out of the assessment, as most approaches to quantifying benefits are based on complex modelling that requires significant collection of location-specific data.

Table 2: Materiality Assessment summary

Scoped in	Scoped out
<ul style="list-style-type: none"> • Materials from plants, animals & algae • Cultivated crops • Water supply • Reared animals & their outputs • Water quality • Air quality • Mass stabilisation and control of erosion rates* • Flood protection • Global, regional & local climate regulation • Pollination & seed dispersal* • Maintenance of nursery populations and habitats* • Pest & disease control* • Global, regional & local climate regulation • Experiential and physical use • Scientific and educational use • Aesthetic* • Spiritual* 	<ul style="list-style-type: none"> • Wild plants, algae and their outputs • Wild animals & their outputs • Aquaculture • Noise regulation

4.2 Natural Assets

4.2.1 Land cover types in the catchment

This section focuses on providing an overview of the quantity, quality and location of natural capital assets within the catchment, which contains approximately 220,000ha of terrestrial, coastal and freshwater habitats (see Figure 6).

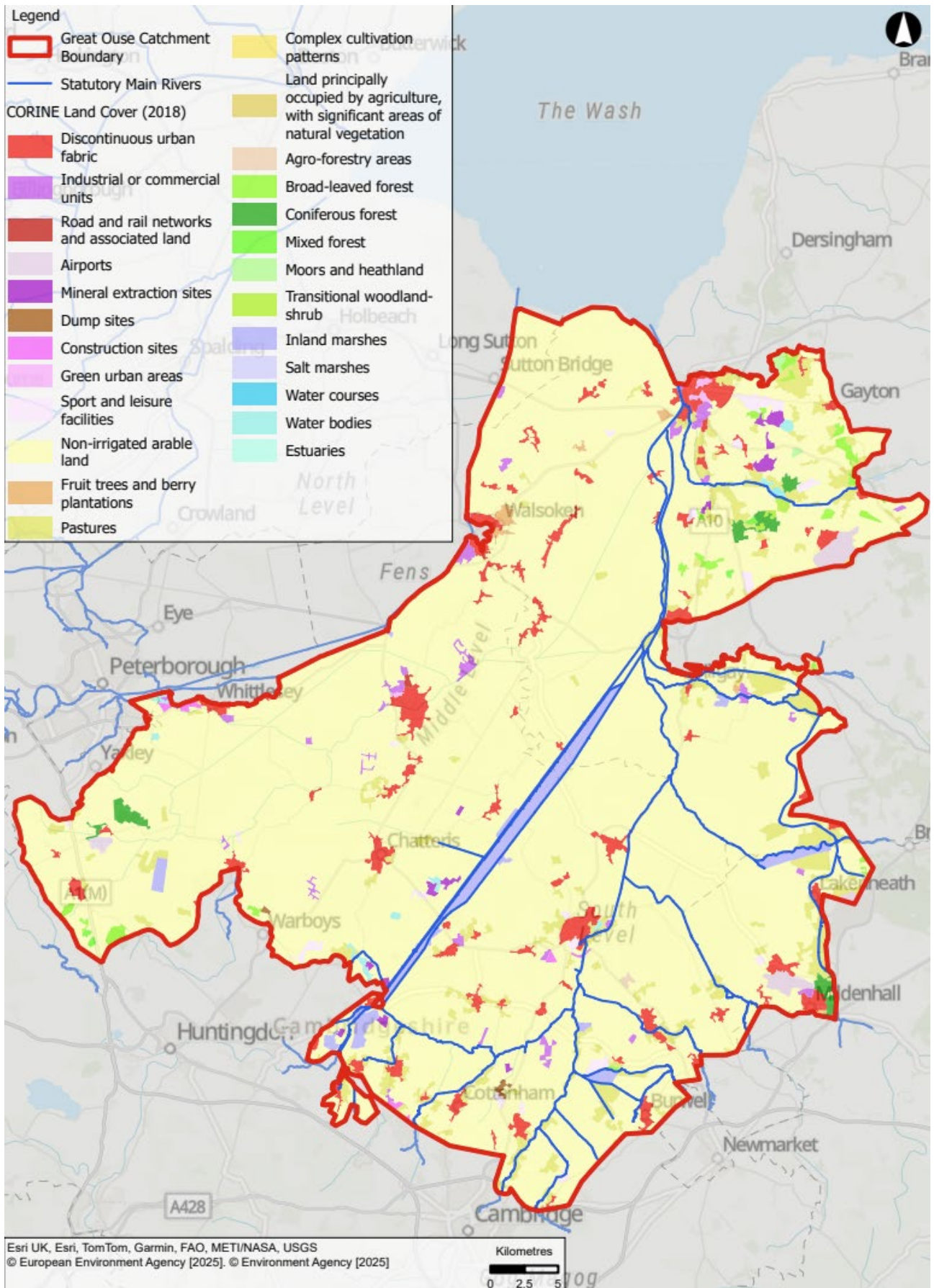


Figure 6: Overview of Corine Land Cover for the catchment

For the purpose of this report, the natural capital assets in the catchment have been grouped according to UK National Ecosystem Assessment (UKNEA) broad habitat types. The quantity of each habitat type in the catchment is shown in Figure 7. The Office for National Statistics UK Natural Capital Accounts methodology guide provides further detail on habitat types and the methods used to estimate habitat extent, ecosystem services and asset value in the UK⁸.

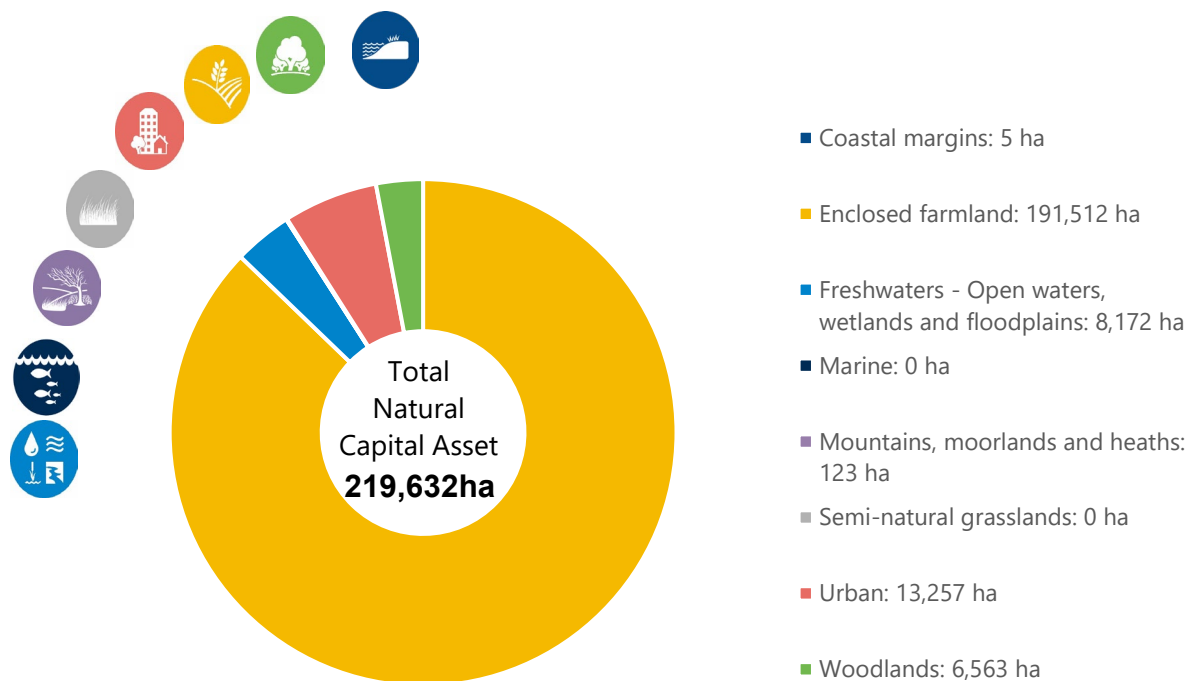


Figure 7: Natural capital asset quantity within the catchment. Based on the UK Natural Capital Ecosystem Assessment broad habitat types / land cover data.

4.2.1.1 Coastal margins

The catchment has approximately 15.7km of coastline along the North Sea and 5,270ha of coastal priority habitats (2.40% of the catchment area). Approximately 0.33ha of the Wash SSSI, Ramsar and SPA, and 11.4ha of the Wash NNR overlaps with the Great Ouse. The site is an intertidal embayment designated as a Ramsar site, Special Protection Area, SAC, and Site of Special Scientific Interest and is of international and national significant importance due to habitats such as sublittoral sandbanks, sandflats, mudflats, shallow inlets and reefs which attract a range of wildlife including wintering waterbirds; passage birds; waders; breeding birds; harbour seal; and shellfish [40] [41] [42].

These coastal margins in the catchment primarily include priority habitat coastal saltmarsh, with a small area of intertidal mudflats [43]. Coastal habitats protect against erosion and flooding by dissipating waves, trapping sediment, and creating buffer zones that store water during storms. Additionally, they provide various ecosystem services, including

⁸ Office for National Statistics. (2024). UK natural capital accounts methodology guide: 2024. Available at: <https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/uknaturalcapitalaccountsmethodologyguide2024/pdf> [Accessed 14 March 2025].

water quality improvement, carbon sequestration, biodiversity, recreation and tourism, cultural and historic value, and serve as nurseries for many commercial fish species.

4.2.1.2 Enclosed farmland

Enclosed farmland or agricultural land is essential for food production and provides local employment. Additionally, it can support a variety of wintering and breeding birds, as well as provide habitat connectivity through hedgerow and ditch networks for a variety of other species.

The Great Ouse Fens is an area of national agricultural importance due to its rich peaty soils. The most abundant land cover type in the catchment is enclosed farmland, covering an area of approximately 191,512ha, or 87.2% of the catchment. Approximately 92,000ha, or almost 42% of the catchment is classified as Grade 1 land, and a further 66,000ha (30%) as Grade 2⁹. Consequently, 72% of the catchments area (which has an Agricultural Land Classification (ALC) [44]) is the best grades of Grade 1 and Grade 2 (see Figure 8) [36].

It should be noted that since 2019 there has been significant change and market disruptions in agriculture and the food supply, notably the Agricultural Transition following UK exit from the EU. The Agricultural Transition includes the phase out of subsidies such as the Basic Payment Scheme, and the introduction of the Environmental Land Management Scheme and associated pilots which are influencing the type and extent of cropping across the catchment and beyond. Additionally, cropping regimes and agricultural output per hectare on an annual basis are extremely variable from crop to crop and farm to farm, with impacts such as climate change and extreme weather also influencing agriculture in the catchment.

⁹ Grade 1 agricultural land is excellent quality agricultural land with no or very minor limitations for growing agricultural and horticultural crops.

Grade 2 agricultural land is very good quality land with minor limitations that affect crop yield, cultivations or harvesting.

Grade 3 agricultural land is good quality land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of other crops including oilseed rape, potatoes and sugar beet.

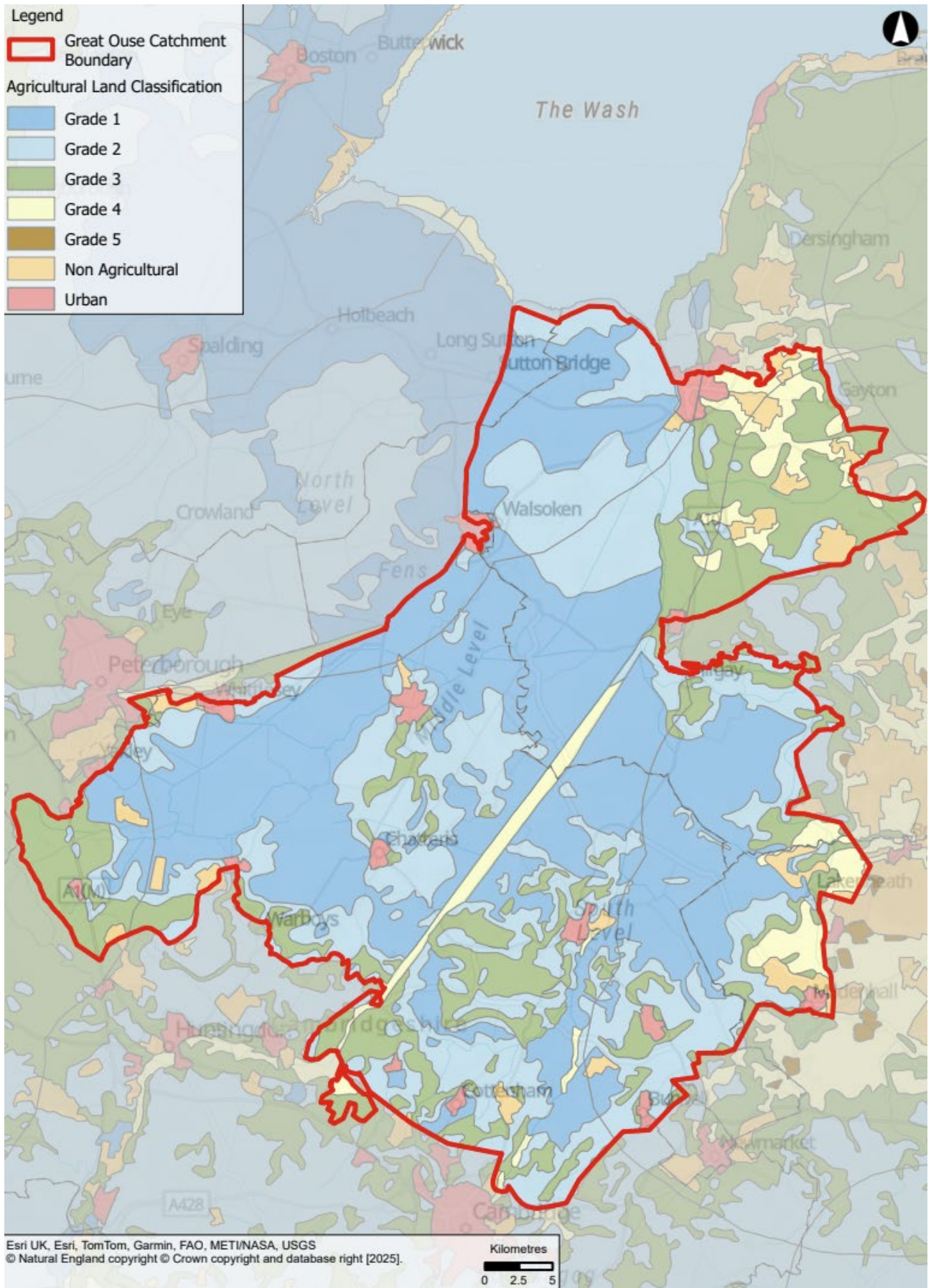


Figure 8: Overview of Agricultural Land Classification within the catchment

According to the 2018 Corine Land Cover, 94.1% (180,000ha) of farmland is used for arable agriculture or horticulture (includes cereal crops, fruit and vegetables and other arable crops), including the significant production of higher value crops such as fresh produce, potatoes, and sugar beet. In 2022, this was estimated to be approximately 77.0% based on estimated land use, crop areas and livestock populations on commercial agricultural holdings [45]¹⁰.

Approximately 5.9% (11,300ha) of farmland is grassland used for the keeping of livestock, with a number of farms producing beef cattle and/or sheep. In 2022, this was estimated to be approximately 13.0% based on estimated land use, crop areas and livestock populations on commercial agricultural holdings [46].

4.2.1.3 Urban areas

Urban land is generally characterised by significant alteration from semi-natural habitats caused by humans. Nonetheless, urban land can contain a variety of natural and/or semi-natural natural capital assets in the form of blue or green urban infrastructure. Most commonly, these consist of parks, urban trees, gardens, and allotments. Certain types of green infrastructure such as parks are generally open to the general public and can be crucial in providing a variety of cultural ecosystem services, such as benefits for health and wellbeing, providing aesthetic value and cultural heritage.

The key urban centres in the catchment consisting of built-up areas and gardens include the city of Ely, and the towns of King's Lynn and villages including Downham Market, Whittlesey, Soham March.

There are a large number of designated heritage assets located within the vicinity of urban areas, and sixty conservation areas designated within in the catchment. For the historic environment, natural capital benefits can be attributed to aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora. Key benefits associated with historic environment assets include amenity, landscape and non-use values, with beneficiaries likely to include local communities and wider society that visit. Additionally, a large number of non-designated heritage assets are present throughout the catchment such as yet undiscovered archaeological remains, which are likely to be particularly well preserved within peat soils.

4.2.1.4 Woodlands

Woodlands are essential for carbon sequestration, biodiversity, recreation, and economic value, significantly contributing to the country's natural capital. They also provide other vital ecosystem services such as soil formation, water regulation, and air purification. These services not only support environmental health but also enhance human well-being by improving air quality and reducing the impacts of climate change. Additionally, woodlands offer recreational opportunities that promote physical and mental health, and they support various economic activities, including timber production and tourism.

The catchment consists of approximately 6,560ha of woodland, predominantly made up of broadleaved woodland (4,610ha). There is approximately 867ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [14]. There is

¹⁰ Refer to section 4.2 of Fens2100+ (2025) Great Ouse Environment and Agriculture Appendix

also approximately 1,070ha of coniferous woodland in the catchment. A small area of ancient woodland (457ha) is present.

4.2.1.5 Freshwaters and groundwaters

Freshwater habitats are crucial for supplying drinking water; managing flood risk; supporting a wide variety of activities that benefit health, wellbeing, and economic activity; and can be a significant carbon sink. The east of England is also particularly reliant on water for the irrigation of crops, particularly in the months between June and August; agriculture in this region accounts for approximately 10% of the total water demand [47].

Freshwater habitats, including rivers and streams, comprise approximately 8,170ha within the catchment, however this is likely to be under representative due to the large number of drainage channels managed by landowners and IDBs that are not captured in the Environment Agency Main River, OS Open Rivers or OpenStreetMap datasets.

The primary watercourse within the catchment is the River Great Ouse, which is the fourth longest river in the UK. As the river enters the catchment study area at Earith it splits, with much of the flow diverted over 31km through the Ouse Washes, and some directed through the adjacent tidal Hundred Foot River which runs parallel to the Washes. From Earith, the course of the river continues in a wide loop down the Old West, becoming the Ely Ouse and then finally the Ten Mile bank, before re-joining the tidal River Ouse at Denver just below the outfall of the Ouse Washes at Welmore Sluice on the tidal Hundred Foot River. The Tidal River Ouse eventually discharges past King's Lynn into the Wash.

Despite an extensive network of drainage infrastructure, the catchment has suffered repeated fluvial and tidal flooding over various areas, including recently. The main sources of flood risk for the catchment are a combination of risk from infrequent extreme storm, fluvial, and tidal events. The tidal limit of the Great Ouse is at Brownhill Staunch, near Earith. Flood risk is managed through an extensive and complex network of assets including 138 pumping stations, 24 sets of sluice gates, 95km of coastal defences and 405km of fluvial embankments.

The catchment is located within the Middle Level, Old Bedford, South Level and Cut-Off Channel, North West Norfolk Rivers, Great Ouse, Cam Lower, Nene Lower, Wissey, Great Ouse Lower and Lark operational catchments, which in turn forms part of the Environment Agency's Witham and Anglian TraC management catchments and Anglian River Basin District (RBD).

The catchment falls within 37 river water body catchments including the 'Middle Level', 'Ely Ouse (South Level)' and 'Old West River'. Approximately 335ha of the catchment intersects with a transitional water body; the Great Ouse bisects the catchment from north east to south west and the Nene forms the north west boundary of the catchment. Section 4.4 of the Fens2100+ Great Ouse: Environment and Agriculture Appendix provides an overview of the Cycle 3 (2022) status classifications for surface water bodies within the catchment. The location and extent of these surface water bodies and catchments are shown in Figure 9.

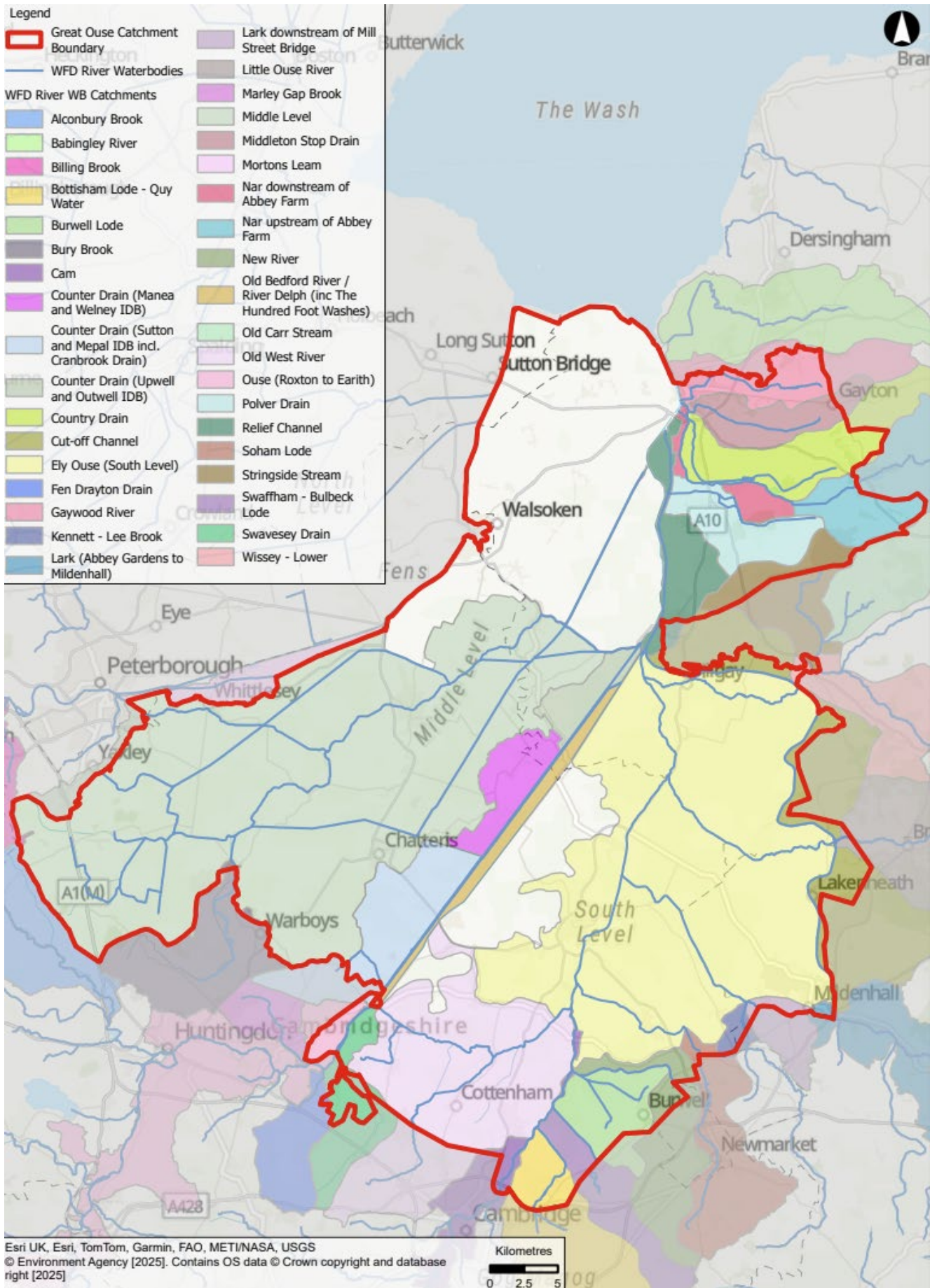


Figure 9: WER surface waterbodies in the catchment

4.2.1.6 Mountains, moorlands and heaths

Mountains, moorlands, and heaths consist of habitats like inland rock, dwarf shrub heath, and dense shrub. In lowland habitats they are dominated by heather and peatland. These areas offer advantages such as carbon storage, flood mitigation, the production of food through sustaining sheep and cattle grazing, air pollutant removal, as well as cultural benefits through opportunities for recreation, education and aesthetic value. Lowland peatland and heathlands are often small, highly fragmented, and influenced by adjacent land uses. The catchment comprises of approximately 104ha of dwarf shrub heath and 19ha of dense scrub.

4.2.2 Peatland in the catchment

Peatlands are wetland areas with a natural layer of peat soils, formed from carbon rich dead and decaying plants under waterlogged conditions, they provide a variety of crucial services to society [48]. Firstly, peatlands represent an important carbon sink globally and have the potential to regulate atmospheric carbon when in a healthy waterlogged condition. However, once peats are in a degraded condition they become carbon sources – this is the case for the majority of peatlands in the UK [49]. Peatlands also provide habitat for a diverse range of species, from *Sphagnum* mosses to butterworts *Pinguicula* to common crane *Grus grus* [48]. Healthy peatlands provide flood management by retaining water and slowing the flow, and provide important sources of high-quality water that can be easily treated for drinking water [48].

According to Natural England’s dataset ‘England Peat Status GHG and C storage’, approximately 119,000ha of peatland is present within the catchment. Corine Land Cover data classifies areas with indicative peat presence as ‘modified grassland’ and ‘arable and horticulture’, which is indicative of peat degradation.

Furthermore, there is uncertainty and inconsistencies in data available on extent and condition across the wider Fens. Holman and Kechavarzi, estimate that less than 32,000ha of peatland (thick peat, peat at depth, or thin peat), was still extant in the Fens as a whole, compared to c.150,000ha identified as such by the peaty soils locations layer [50]. The Fens for the Future report [51] explains how peatland in the Fens has been degraded through drainage for arable cultivation. Once degraded, peatland emits CO₂ and methane; a report on peatland natural capital by the Office for National Statistics estimates that 7,600 kilotons of carbon dioxide equivalents per year (kt CO₂e/yr) are emitted as a result of arable practices on peatland [52].

The baseline condition of this peatland is categorised as ‘drained’ (approximately 91,200ha), ‘actively eroding’ (approximately 28,000ha) or ‘modified’ (approximately 169ha) using the peatlands emission factor (tCO₂e/ha/yr), in accordance with the Peatland Code Field Protocol [36] (see Section 3.1.7 for limitations of this method). For peatland, in an ‘actively eroding’ condition, the assumed emission factor is 23.8 tCO₂e/ha/yr; for peatland in ‘drained’ condition, the assumed emission factor is 4.54 tCO₂e/ha/yr and for peatland in ‘modified’ condition, the assumed emission factor is 2.54 tCO₂e/ha/yr.

Natural England recently released the 2025 England Peat Map [2]. This provides a more accurate and detailed picture of the current state of peatland when compared to the ‘England Peat Status GHG and C storage’ dataset [15] that has been used for this Natural Capital Baseline. The new peat map has been developed using machine learning, satellite imagery, LiDAR, and updated field surveys to detect peat soils that were previously unmapped or misclassified. The new 2025 peat map shows both gains in mapped extent (due to better detection) and losses or degradation (due to environmental change).

The 2025 England Peat Map suggests that the peatland extents used in this baseline (based on the 2008 England Peat Status dataset) are an overestimation. The new peat map shows approximately 78,000ha of deep peaty soils across all catchments in the Fens2100+ study area, whereas the 2008 dataset shows approximately 155,000ha. There is approximately 70,000ha of intersecting peatland extents between the two datasets, highlighting that the new peat map has identified roughly 8,000ha of previously unmapped peatland across the Fens2100 study area. For climate regulation, this indicates the amount of carbon dioxide emitted as a result of actively eroding peatland has also been overestimated, so the value of climate regulation is expected to be greater than calculated for this baseline.

As the Natural Capital baseline assessment uses the 2008 'England Peat Status GHG and C storage' dataset, percentage coverages of peat are not directly comparable with the catchment summary report (which uses the 2025 England Peat Map).

4.2.3 Protected areas for biodiversity

There are 81 statutory internationally, nationally or locally designated nature conservation sites within or partially within the catchment, some of which overlap with other designations. These include:

- **Breckland** – SPA and SAC;
- **Fenland** – SAC;
- **Nene Washes** – SPA, SAC, Ramsar site and SSSI;
- **Norfolk Valley Fens** – SAC;
- **Ouse Washes** - SPA, SAC, Ramsar site and SSSI;
- **Roydon Common** – SAC (Roydon Common & Dersingham Bog), Ramsar site, SSSI and NNR;
- **The Wash** – SPA, Ramsar Site and SAC (The Wash & North Norfolk Coast);
- **Wicken Fen** - Ramsar site, SSSI and NNR;
- **Woodwalton Fen** - Ramsar site, SSSI and NNR;

A full list of designated nature conservation sites is found in the Great Ouse Environment and Agriculture appendix¹¹.

The location of each designated site is shown in Figure 10, and a summary of each internationally designated site provided in Sections 4.2.3.1 to 4.2.3.9.

¹¹ Fens2100+ (2025) Great Ouse: Environment and Agriculture Appendix

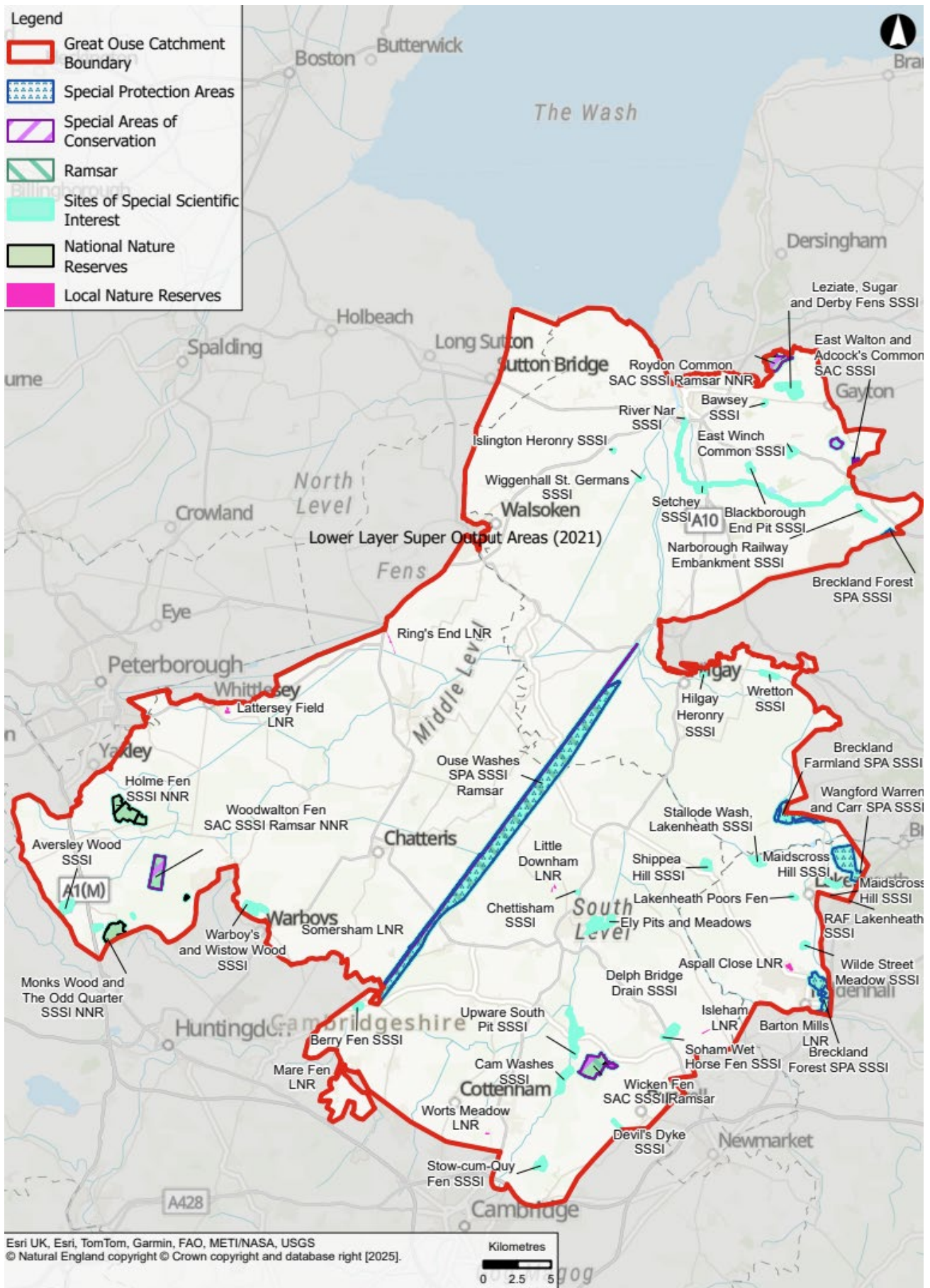


Figure 10: Overview of Designated sites for nature conservation within the catchment

4.2.3.1 Breckland (SAC and SPA)

Breckland SAC is approximately 7,540ha with diverse habitats, including inland water bodies, bogs and marshes. Key habitats include inland dunes with open *Corynephorus* and *Agrostis* grasslands, natural eutrophic lakes and European dry heaths. The site supports rare species such as grey hair-grass, perennial knawel, and great crested newt.

Breckland SPA is approximately 39,400ha, characterised by sandy soils of glacial origin. The site supports dry heath and grassland communities, with remnants of these habitats providing breeding grounds for heathland birds. Key species include stone curlew, nightjar, and woodlark.

4.2.3.2 Fenland (SAC)

Fenland SAC is 619ha with diverse habitats, including inland water bodies, bogs and marshes. Key habitats are *Molinia* meadows and calcareous fens, which are crucial for conserving rare and distinctive fen-meadow types in East Anglia. The site supports species like black bog-rush, tormentil and meadow thistle.

4.2.3.3 Nene Washes (Ramsar site, SAC, SPA and SSSI)

Nene Washes Ramsar Site is approximately 1,520ha, of seasonally flooded wet grassland. The site also contains a substantial network of drainage ditches that remain wet throughout the year. Nationally scarce plants include fringed water-lily, hairlike pondweed, and marsh dock. The site supports a relict invertebrate fauna, including the aquatic snail, the water beetle and the dragonfly. It also holds a notable assemblage of breeding water birds, such as gadwall, garganey and shoveler. The site supports internationally important numbers of wintering water birds, including Bewick's swan.

Nene Washes SAC, covering 82.6ha, is designated for the Annex II species spined loach, which is a primary reason for the site's selection. This site is one of only four known outstanding localities for spined loach in the United Kingdom.

The Nene Washes SPA is an area of seasonally flooding grassland and grazing marsh. It supports an internationally important wintering population of Bewick's swan and nationally important breeding populations of migratory species such as gadwall, garganey and shoveler. Additionally, it supports nationally important wintering populations of wigeon, teal and gadwall. The site is important for a diverse assemblage of breeding birds of wet grasslands, including redshank, snipe and lapwing. It also hosts a notable assemblage of wintering waterfowl and a wide range of raptors throughout the year.

The Nene Washes SSSI, covering approximately 1520ha, represents one of the country's few remaining areas of washland habitat. This site is notable for its diverse plant and animal life within its network of dykes and supports large numbers of wintering wildfowl, including species such as wigeon, teal and pintail. Additionally, it provides important breeding grounds for wetland birds like snipe and redshank.

4.2.3.4 Norfolk Valley Fens (SAC)

Norfolk Valley Fens SAC, covering 616ha, comprises valley-head spring-fed fens, which are rare in the lowlands, and supports a rich flora including grass-of-Parnassus, common butterwort, and marsh helleborine. It is also home to strong populations of narrow-mouthed whorl snail and Desmoulin's whorl snail.

4.2.3.5 Ouse Washes (SSSI, SPA, SAC and Ramsar)

Ouse Washes Ramsar is a significant wetland characterised by seasonally flooding washlands, holding high conservation value for many plants and animals. It supports

nationally rare plants like small water pepper, whorled water-milfoil, and greater water parsnip, as well as rare invertebrates such as the large darter dragonfly and the rifle beetle. The site is crucial for internationally important populations of wintering waterfowl, including Bewick's swan, gadwall, and pintail.

The Ouse Washes SAC supports populations of spined loach. This site is one of only four known outstanding localities for spined loach in the United Kingdom.

Ouse Washes SPA is a wetland of major international importance, comprising seasonally flooded washlands managed traditionally. It provides crucial breeding and winter habitats for wetland bird species, particularly wildfowl and waders and supports significant populations of ruff, Bewick's swan and whooper swan, among others.

Ouse Washes SSSI is a 2400ha site that plays a crucial role in land drainage and flood water storage. This extensive washland habitat supports large numbers of wildfowl and waders, especially during winter, including teal, pintail and wigeon. The grassland communities feature reed and floating sweet-grass, reed canary-grass, and marsh foxtail, along with various sedges, rushes, and herbs.

4.2.3.6 Roydon Common (SAC, Ramsar site, SSSI and NNR)

Roydon Common Ramsar is an area of lowland mixed valley mire surrounded by heathland. The site supports nationally important flora such as bog orchid, mossy stonecrop, and narrow-leaved marsh orchid, as well as lower plants like marsh fern, *Lophozia capitata*, and *Kurzia sylvatica*. It also hosts a range of nationally rare and scarce invertebrates, including the buckleria moth, fungus gnat and the hoverfly.

Roydon Common and Dersingham Bog SAC, covering 353ha, represent the largest and best examples of M16 *Erica tetralix* – *Sphagnum compactum* wet heath in East Anglia. This diverse mire supports many rare plants, birds, and insects, including the dragonfly *Sympetrum scoticum*, European nightjar and hen harrier.

Roydon Common SSSI, spanning 194ha, is one of Britain's finest examples of a lowland mixed valley mire. This site features a complex series of plant communities transitioning from wet acid heath through valley mire to calcareous fen, supporting many rare and locally uncommon plants. The area also includes nationally important dry *Calluna* heath on acidic sands, and is of significant ornithological and entomological interest.

Roydon Common NNR is a glorious relic of the vast heaths, bogs, and commons that once spanned Norfolk. The reserve features diverse habitats, including heathland, acid bog, wet carr woodland, and grassland. It is home to many rare species, such as the black darter, round-leaved sundew, and bog asphodel, and supports breeding populations of woodlark and nightjar.

4.2.3.7 The Wash & North Norfolk Coast (SAC, SPA, Ramsar Site)

The Wash and North Norfolk SAC, covering approximately 108,000ha, is one of the largest marine areas in the UK, featuring extensive subtidal sandbanks, mudflats, and sandflats. The site supports diverse benthic communities, including brittlestars, sand-mason worms, and tellins, and provides important nursery grounds for commercial fish species like plaice, cod, and sole. The area is also home to the largest colony of harbour seals in the UK.

4.2.3.8 Wicken Fen - Ramsar site, SSSI and NNR

Wicken Fen Ramsar is a remnant of the original peat fenland of the East Anglian basin, preserved as a flood catchment area with controlled water levels. The site features a mosaic of habitats, supporting a diverse range of species including sedges, rushes and

spike rushes. Notable species include fen violet, fen ragwort, and milk parsley, along with wildfowl such as mallard, teal, and wigeon.

Wicken Fen NNR, is one of Europe's most important wetlands, home to over 9,000 species including booming bitterns, cuckoos and rare orchids in summer, as well as hen harriers and short-eared owls in winter. The fen's habitats, such as reedbeds and wet grasslands, provide crucial breeding grounds for species like the great crested newt and various warblers, including the chiffchaff and Cetti's warbler.

Wicken Fen SSSI, covering 254ha, is a small remnant of the East Anglian peat fens and one of the best surviving examples, unique in Cambridgeshire. The site supports a range of characteristic fenland communities and is notable for its diverse fauna and flora, particularly the invertebrate fauna and relic fen flora. The northern part of the site features original peat fen with carr and sedge communities, while the southern part includes rough pasture land, reedbeds, and pools that attract breeding wetland birds and wintering wildfowl.

4.2.3.9 Woodwalton Fen - Ramsar site, SSSI and NNR

Woodwalton Fens is a wetland site, featuring a range of open fen and swamp communities, a relict area of acid peat, and an important network of ditches. The site supports endangered plants like fen violet, fen wood, and fen ragwort, as well as a large number of wetland invertebrates, including 20 British Red Data Book species. Significant habitats include mixed fen, marshy grassland, birch and alder woodland, and fen carr, with species such as purple moor-grass, heather and bog myrtle.

Woodwalton Fen NNR is one of the last fragments of the ancient wild fens, providing a refuge for thousands of species of fen animals and plants. This 209ha reserve is internationally important, hosting rare fen plants like fen wood-rush and fen violet, and supporting a diverse array of invertebrates, including over 1,000 beetle species and 900 species of moths and butterflies. The fen is also home to breeding kingfishers and marsh harriers, making it a paradise for nature lovers and photographers.

Woodwalton Fen SSSI, covering 230ha, holds a range of wetland plant communities once characteristic of large areas of the East Anglian fens. The site features open fen and swamp communities, with key species including purple moor-grass, ling, and bog myrtle. The network of ditches supports many uncommon water plants, such as bladderwort and water violet, while the fen carr includes willow, blackthorn, and guelder rose.

4.2.4 Risk Register

The NCRAT includes a Risk Register that highlights how drivers of environmental change may present risks to the quality and quantity of natural assets in the study area. This can be used to highlight which ecosystem services are under pressure and limited in their capacity to continue to provide future benefits.

The assessment of risk is qualitative and informed by the prevalence of the driver of environmental change, as well as the extent and condition of the natural asset in the study area. The drivers of change assessed in the NCRAT are described in Table 3.

Table 3: The drivers of environmental change considered in the Risk Register

Driver of change	Definition
Land-use change (incl. habitat loss)	This can be the result of a number of drivers including development and coastal erosion as well as hazards (e.g.

	forest fires). Land-use change is usually permanent but it could also be temporary. It is likely to affect the extent of natural capital asset rather than condition.
Climate change	This includes drivers on habitats from changing climatic conditions including temperature, precipitation, soil aridity and storminess. Assessments of the likely impact of climate change over this century are provided in UK Climate Projections ¹² .
Resource extraction (incl. over-exploitation)	Over-exploitation of resources can impact natural assets through both direct physical damage and additional stress on the resources on which they rely (e.g. water availability).
Population growth	Driver which comes from the demands of a higher population on natural resources and the environment. Note that the impact of population growth may be through future land-use change, resource extraction, and pollution.
Pollution	Includes both diffuse sources (e.g. agriculture, urban run-off, atmospheric deposition) and point sources (e.g. sewer overflows, wastewater treatment, abandoned mines).
Invasive species/diseases/pathogens	Invasive species/diseases/pathogens can have significant impacts on ecosystems, threatening the abundance and health of native species.

¹² UK Climate Projections are available at: <https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index>

For this catchment, the natural assets under most pressure are coastal margins; enclosed farmland; freshwaters; and mountains, moorlands and heaths. The primary drivers of this are land-use change (including habitat loss), climate change, resource extraction and pollution. Figure 11 shows which ecosystem services are most at risk due to strain on a natural asset.

Level of pressure categories	Description
High	High likelihood the pressure will affect natural asset(s) and high risk of loss of ecosystem service.
Medium	Medium likelihood the pressure will affect natural asset(s) and medium risk of loss of ecosystem service.
Low	Low likelihood the pressure will affect natural asset(s) and low risk of loss of ecosystem service.
None	The pressure is not expected to affect the natural asset(s) nor ecosystem service.
No data	No data available to assess likelihood of pressure and affect on natural asset(s) nor ecosystem service.
Not assessed	Risk rating not completed
	No viable benefit-asset attribution

Ecosystem Services Group	Natural capital assets (NEA Broad habitat type)							
	Coastal margins	Enclosed farmland	Freshwaters - Open waters, wetlands and floodplains	Marine	Mountains, moorlands and heaths	Semi-natural grasslands	Urban	Woodlands
Agriculture		High			High	None		
Fish and shellfish landings	High			None				
Water supply			High					
Timber								Medium
Renewable energy		High	High		High			
Climate regulation	High	High			High	None		Medium
Air quality	High	High	High		High	None		Medium
Hazard regulation								
Recreation	High	High	High		High	None	Medium	Medium
Physical Health	High	High	High		High	None	Medium	Medium
Education		High	High		High	None	Medium	Medium
Volunteering		High	High		High	None	Medium	Medium
Water quality		High	High		High	None	Medium	Medium

Figure 11: Natural Capital Risk Register

4.3 Ecosystem Services

The type and significance of ecosystem services in the catchment are shown in Figure 12. More information about each of these services is provided in the sections below.

As shown in Figure 12, the most significant ecosystem services in the catchment are water supply, arable agriculture and recreation. The significance is based on a desk-top assessment of the relative provision of ecosystem service and the number of people it will impact. The definition of each significance rating is provided in Table 4.

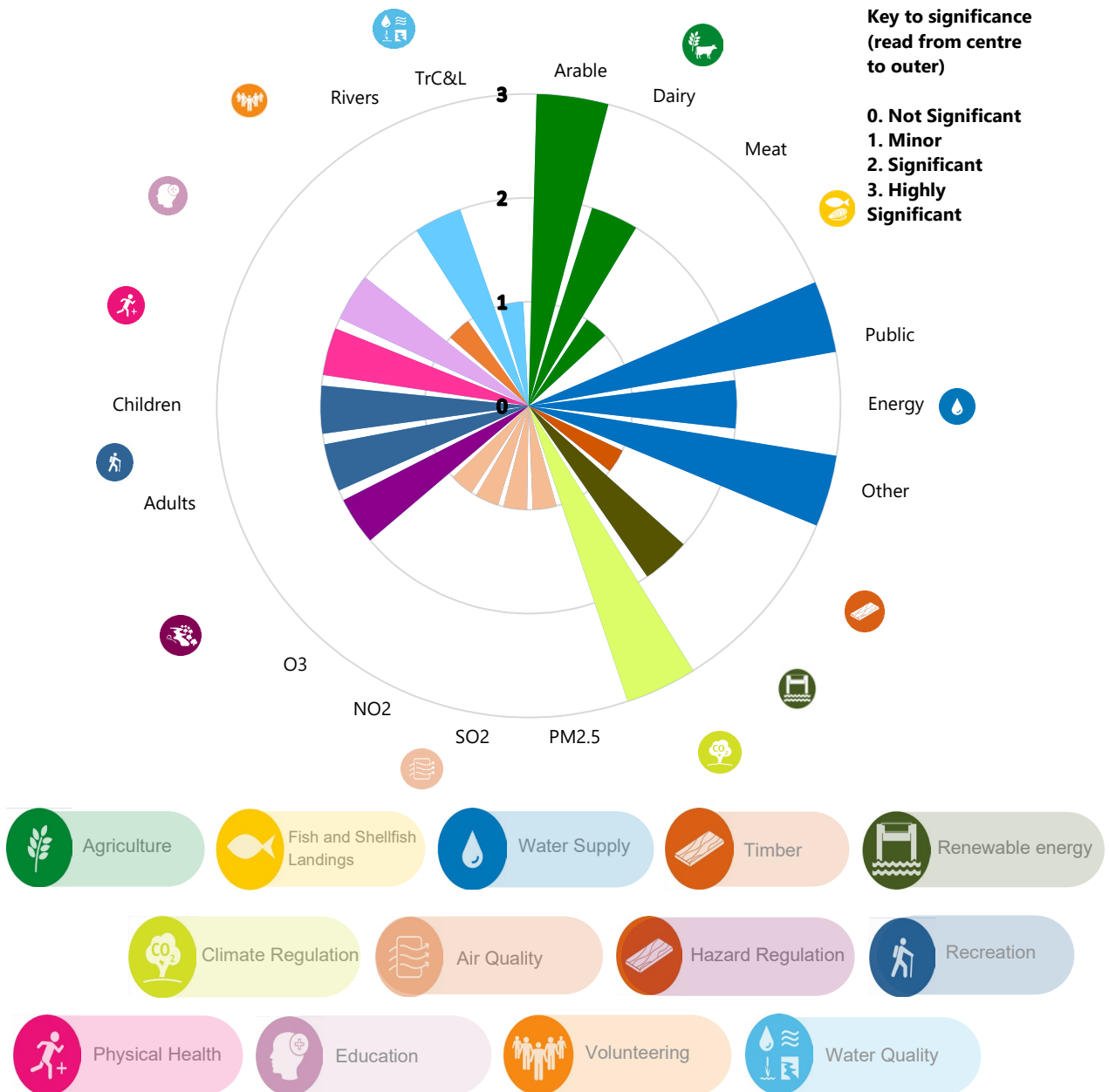


Figure 12: Rose diagram showing the significance of ecosystem services in the catchment.

Table 4: The definition of the ecosystem service significance ratings used in the NCRAT

Significance rating	Definition
Highly significant	The benefit flow is (very) important to the place in relative terms* because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant	The benefit flow is of material importance in relative terms* because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor	The benefit flow is of minor importance in relative terms* because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.

*Relative to the provision of other services/benefits within the catchment.

4.3.1 Provisioning Services

Food production

Agriculture plays an important role as an ecosystem service and land-use in the catchment. The majority of terrestrial habitat is comprised of arable fields and agricultural grasslands. Agricultural practices, such as arable farming and livestock rearing, contribute to national food security and support the local economy.

Water supply

The catchment is included within several abstraction licensing strategy catchments. These include the Cam and Ely Ouse abstraction licensing strategy (ALS) [53], the Old Bedford including Middle Level ALS [54], the North-West Norfolk abstraction licensing strategy [55] and the Nene catchment ALS [56]:

- Cam and Ely Ouse ALS covers the south of the catchment. Notably this ALS area indicates abstraction in the region of 341 million m³, of which 14.6% was for agriculture. Currently in the area of the Great Ouse, the majority of the catchment has water available at Q30 flows¹³ and above, and restricted water available at Q50, whereas at flows lower than these levels the whole catchment has no water available.

¹³ The Environment Agency's Water Resources Geographical Information System provides a snapshot in time on water availability at four flow snapshots. From high to low, these are: Q30 (i.e. the flow of a river which is exceeded on average for 30% of the time, therefore you would expect the river flow to be lower than Q30 on 256 days in an average year, i.e. a higher flow), Q50, Q70 and Q95. These are calculated for each integrated Water Framework Directive waterbody and looks at the balance between the flow in the river, the quantity needed to support the ecology and the water that can be licensed for abstraction.

- The Old Bedford including Middle Level ALS, covers the centre of the Great Ouse Fens. This strategy shows that water is only available for licensing over winter, and that it includes 3 areas, at the Great Fen, adjacent to Denver, and East of Warboys which are environmentally sensitive to abstraction.
- The North-West Norfolk ALC covers the north-eastern part of the Great Ouse Fens, though only provides assessment on the availability of water for the areas east of the River Great Ouse. Water is available in the catchment for: less than 30% of the time near the Polver drain; 30-50% of the time at the upper River Nar; and at least 50% of the time adjacent to the A47 east of King's Lynn.

Given the variability of water abstraction throughout the catchment, and the salinity constraints in the north of the catchment, a number of farmers have invested in on-farm water storage reservoirs in recent decades.

As well as farm reservoirs, there is a proposal for a new Fens Reservoir to the north of Chatteris, and filling from the Middle Level System, and the Dog in a Doublet Sluice, the Anglian Water Fens Reservoir. This reservoir is expected to have a significant impact on the volumes of water which are discharged at the St German's pumping station because it will draw water primarily from the Middle Level system [57].

The catchment has a long history of flooding which impacts both properties and farming. Heavy rain during Storm Babet (2023/2024) caused significant strain to the drainage infrastructure throughout the catchment, leading to widespread localised flooding and waterlogging of lower lying roads and fields.

Flooding has major impacts on crops and to a lesser extent areas of land utilised for livestock grazing. Flood events can restrict the ability to establish new crops, reduce crop yields and quality, or can destroy crops once ready for harvest leading to direct agricultural damages and wider economic consequences for landowners.

Renewable energy

Many natural processes provide a renewable energy source that can be harnessed to produce electricity. Solar power (photovoltaics) and onshore wind generation are the main sources of onshore renewable energy generation in the catchment.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. There is only a relatively small proportion of woodland cover in the catchment, with only approximately 6,560ha of woodland. There are approximately 867ha of commercial woodland that is actively managed with a felling licence valid within the last 10 years [16].

4.3.2 Regulating Services

Climate regulation

Ecosystems regulate a wide range of atmospheric processes that control our climate, including the greenhouse effect, precipitation, the ozone layer, the albedo effect, and atmospheric chemical composition [58]. Locally, this can help reduce urban temperatures and remove air pollutants. Globally, the most significant example of climate regulation by ecosystems is the absorption of greenhouse gases [58].

Woodland and enclosed farmland are the most significant habitats for carbon sequestration in the catchment. A major source of carbon emissions identified in the NCRAT are habitats located on degraded peatland, such as agricultural fields on deep peat soils. These habitats emit more carbon dioxide equivalent than habitats elsewhere in

the catchment can sequester and ongoing soil and water management will likely impact on the future carbon sequestration potential.

Air quality

Most urban areas in England experience significant levels of air pollution which can contribute to adverse health impacts including premature mortality from cardiovascular and respiratory causes. Studies have shown that vegetation can play an important role in removing air pollutants and improving air quality. There are six AQMAs within the catchment; Whittlesey AQMA No.1 (SO₂), Wisbech AQMA No.1 (SO₂), Wisbech AQMA No. 2 (PM₁₀), Wisbech AQMA No.3 (NO₂), Railway Road AQMA (NO₂), and Gaywood Clock AQMA (NO₂). Of these, four are within the Fenland District Council area and have been declared for nitrogen dioxide (NO₂), particulate matter (PM10) and sulphur dioxide (SO₂). Two are located within the King's Lynn and West Norfolk area and were both declared for NO₂.

Air pollution removal occurs through dry deposition, a mechanism by which pollutants are accumulated on leaf surfaces. Gaseous pollutants can also be removed through leaf stomata uptake.

Hazard regulation

Many habitats can act as buffers to reduce the effect of natural hazards, such as flooding. Relative to bare soil or paved surfaces, natural habitats reduce flooding risk to downstream populations by buffering peak rainfall flows entering rivers. Likewise, coastlines with intact seagrass and kelp beds, coastal wetlands or mudflats are better protected from flooding and coastal erosion.

Ouse Washes, a manmade flood storage reservoir, provides 90 million m³ of flood storage and is Britain's largest wash land occupying around 2,500ha.

The coastal habitats present in the catchment dissipate wave energy and provide barriers reducing risk of damage to coastal defences, low lying land, and infrastructure [59]. If unimpeded by coastal development, natural intertidal habitats such as saltmarsh are likely to migrate with rising sea levels predicted under future climate scenarios, thereby providing resilience to future sea level rise.

Disease and pests

Pests can be responsible for agricultural losses and encourage the use of pesticides. Natural pest control, such as by bats and birds, can enhance crop production by reducing herbivorous insects that damage or use parts of crops. Provision of habitats such as semi-natural grasslands and woodlands, can support species which prey on pests. Given the high cover of agricultural land in the catchment natural pest control of infestations is an important regulating service.

Pollination

Semi-natural habitats such as grasslands, woodlands, hedgerows, and scrub support insect populations that pollinate crops growing on agricultural land. Seed dispersal allows plants to colonise new areas where the species may not already be present, ensuring genetic diversity and supporting other species by providing food, shelter, and habitat.

Soil retention and erosion

Soil retention is required for the maintenance of healthy ecosystems and delivery of other ecosystem services such as food and timber production. Soil resources in the catchment

are degraded and eroded due to drainage and tillage of land for agriculture. Tree planting and increased diversity of vegetation structure and cover can help increase soil retention.

4.3.3 Cultural Services

Our cultures, knowledge systems, religious beliefs, social interactions and amenity has been shaped by our interaction with natural ecosystems. Cultural ecosystem services represent a suite of benefits related to amenity and culture, that can have a significant impact on society as a whole and are therefore often difficult to quantify or value.

Recreation

The catchment has approximately 15.7km of coastline, and includes approximately 1,840km of Public Rights of Way, comprising 1,129km of footpaths, 365km of bridleways and 267km of byways. There are approximately 332.3km of National Cycle Network routes within the catchment boundary and the King Charles III England Coast Path National Trail follows the coastline of the catchment.

Based on datasets used for ORVal, the catchment contains a total of 527 recreational sites. The most common type of recreational site is graveyard (85 sites). Other sites include 55 allotments, 67 amenity parks, three amenity woods, 56 cemeteries, three clubs, 11 commons, one country park, two doorstep greens, one Forestry Commission wood, two gardens, 10 golf courses, 40 nature parks, 58 parks, 76 recreation grounds, 10 village greens, and 47 woods. ORVal data also shows the catchment contains 410 paths.

Along with the 2,300 designated heritage sites and the 82 nationally and internationally designated sites for biodiversity in the catchment, these amenities attract a range of visitors to the local area which contributes to the local economy.

Physical health

Approximately half of the visits made to the local area are likely to partake in activities that are beneficial for their physical health [60]. Improvements to health improve the quality of life for individuals and reduce the pressure on healthcare systems.

Education and volunteering

Visits to the catchment for scientific and educational purposes are difficult to quantify, but can create benefits for human society as a whole. The protected areas and heritage sites within the catchment have the potential to enable insights about past and future changes which the area.

The Must Farm, for example, which is located at the very north of the catchment, comprises two unique and internationally important sites, 'Bronze Age River (2011)' and the 'Bronze Age Settlement (2015)'. The project is the first landscape-scale archaeological investigation of the deep Fenland and has revealed unprecedented material and paleoenvironmental data stretching back to the Neolithic and through to the late Bronze Age.

Another example includes Roydon Common SSSI. Spanning 194ha, this is one of Britain's finest examples of a lowland mixed valley mire. This site features a complex series of plant communities transitioning from wet acid heath through valley mire to calcareous fen, supporting many rare and locally uncommon plants. The area also includes nationally important dry *Calluna* heath on acidic sands, and is of significant ornithological and entomological interest.

Designated sites provide an opportunity for public volunteering, which provides benefits to recipient organisations and their stakeholders, to wider society, and to the volunteers themselves [34].

Aesthetic / sense of place

The concept of sense of place in the context of natural capital refers to the emotional and symbolic meaning that the environment holds for individuals or communities. Intrinsically, it is difficult to measure, as it describes how people perceive, feel about, and interact with their environment.

In the context of this study, aesthetic / sense of place benefits of natural capital assets is based on the character of the landscape which comprises a rural agricultural landscape with scattered farmsteads, villages and market towns.

4.3.4 Bundled services

Bundled services are benefits provided by nature that are not easily attributable to specific ecosystem services as they provide multiple types of benefits. Some of the bundled services can also be classified as supporting services, they are crucial to the functioning of ecosystem processes and therefore support the provision of other ecosystem services. Bundled services are typically difficult to quantify as their primary benefit is the underpinning of all other ecosystem services, and therefore do not provide a direct measurable benefit.

Water quality

Ecosystems and vegetation can improve water quality in variety of ways, including through the absorption of excess nutrients; slowing the flow of water which increases water (and pollutant) retention in the soil, helping to prevent sewer overload; providing shade and reducing algae growth; and helping to stabilise river banks and beds with root systems, which reduces sediment runoff [61].

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

As outlined in Section 4.2.1.5, of the of the 76 surface waterbodies within the catchment, seven score 'good' for ecological status, 59 of these waterbodies score 'moderate', eight waterbodies score 'poor' for ecological status and two waterbodies score 'bad' for ecological status for the River Basin Management Plan Cycle 2 and Cycle 3.

Biodiversity

Biodiversity is defined by the Convention of Biological Diversity as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” [62]. Biodiversity is an integral characteristic of stable and resilient ecosystems, and is vital for the continuous delivery of all other ecosystem services.

As described in Section 4.2.3, there are designated sites in the catchment that are highly important for biodiversity. These areas include a variety of rare habitats including fen-meadow types and wet acid heathland; and species such as great crested newt, greater water parsnip and large darter dragonfly.

4.4 Benefits

4.4.1 Natural capital benefits

Figure 13 shows the flow of ecosystem services from natural assets in the catchment. For each of the ecosystem services shown, data on the physical flow of benefits is used to estimate a monetary value. Sections 4.4.2 - 4.4.5 below describe the physical benefits from the ecosystem services in the catchment. It should be noted that the benefits of ecosystem services impact different groups of people differently, depending on the service and location. Often, ecosystem services will deliver direct benefits to local people, for example through improved health, and indirect benefits to the wider population, for example by reducing cost to health services.

The monetary values shown have been calculated from the NCRAT.

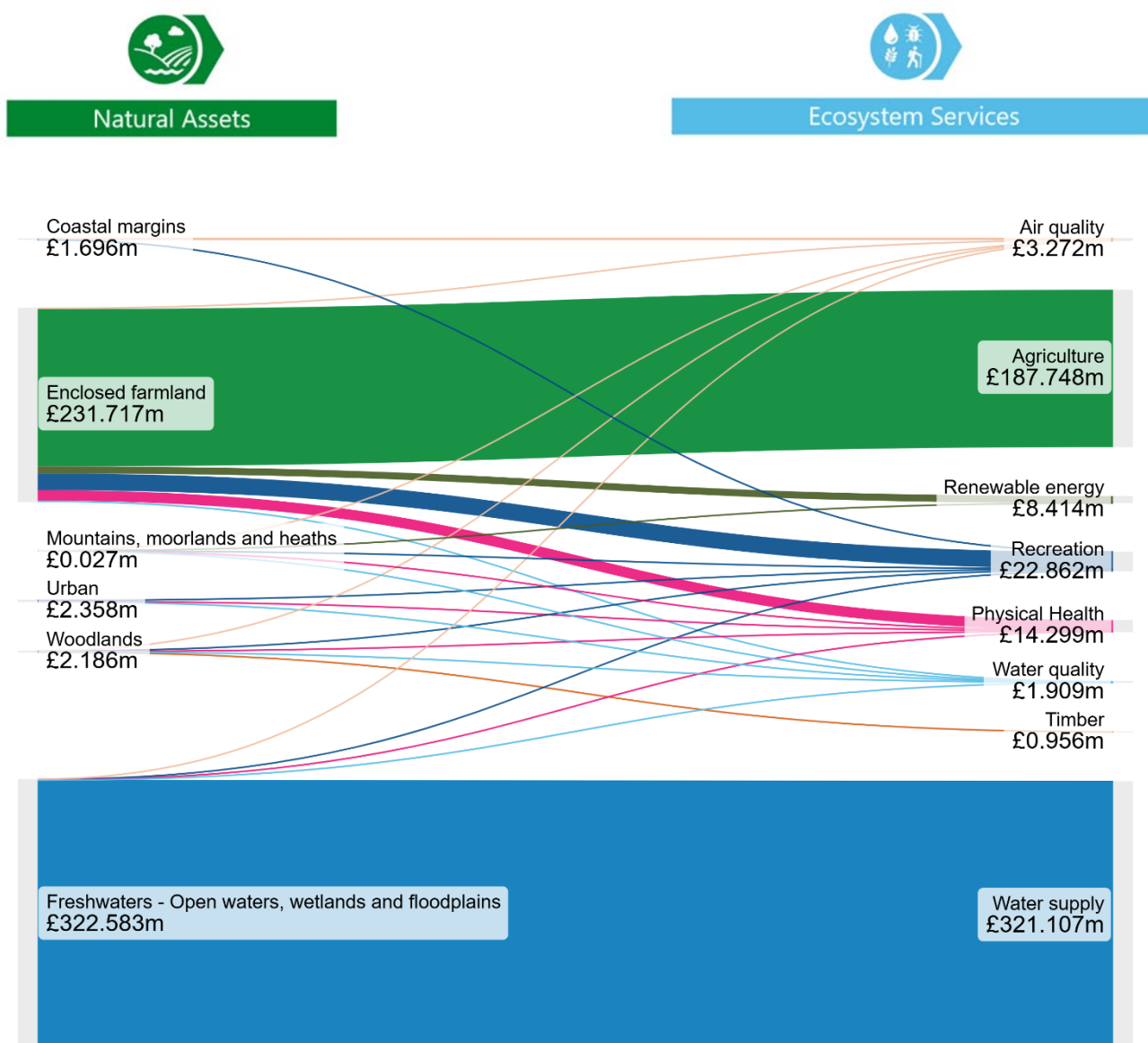


Figure 13: Sankey diagram showing the flow of ecosystem services from natural assets in the catchment.

Some of the benefits that are not included in Figure 13 but are significant to the catchment include:

- Increased pollination and the control of pests and diseases, which promote healthy ecosystems and improve agricultural productivity;
- the cultural, historical and aesthetic value ecosystems provide to places; and
- the provision of all other ecosystem services through biodiversity and biosphere integrity.

These benefits are not assessed with the NCRAT; however, a qualitative assessment of their benefit is provided below.

4.4.2 Provisioning Services

Food production

Agricultural practices, such as arable farming and livestock rearing, contribute significantly to national food security and support the local economy. The estimated annual yields for arable, livestock dairy and meat are approximately 1.55 million tonnes, 95.7 million litres and 3,080 tonnes respectively.

Water supply

In 2018, it is estimated that over 10 billion m³ of water was abstracted from non-tidal surface waters and groundwater in England for public supply, agriculture, industry and energy generation [63]. Overall, the volume of water abstracted from the catchment is approximated to be 75.5 million m³ per year, however, as noted in the assumptions and limitations, this does not consider water transfer out of the catchment via the Ely Ouse- Essex Water Transfer Scheme.

Renewable energy

According to the Department for Energy Security and Net Zero, roughly 0.1 megawatts (MW) electricity was generated from hydro generation, 449MW was generated from onshore wind and 1330MW from solar power in the 11 local authorities that intersect with the catchment in 2023 [64]. In comparison, in 2023 across England it was estimated that 3,094MW of electricity was generated from onshore wind, 43MW from hydro generation and 13,976MW from photovoltaics. Approximate figures for each local authority within the catchment are shown in Table 5.

Table 5: The installed generation capacity of onshore wind and solar power for the Local Authority Districts within the catchment

Local Authority District (LAD)	Proportion of the LAD within the catchment	Installed onshore wind generation capacity (MW)		Installed solar generation capacity (MW)	
		Total capacity in LAD	Estimated capacity within catchment	Total capacity in LAD	Estimated capacity within catchment
East Cambridgeshire	73.9%	0.1	0.1	165.0	122.0
Fenland	73.3%	117.0	85.5	40.9	30.0

King's Lynn and West Norfolk	51.6%	32.4	16.7	116.0	59.8
Huntingdonshire	30.0%	69.9	21.0	151.0	45.4
South Cambridgeshire	14.7%	26.5	3.9	291.0	42.7
West Suffolk	11.3%	0.5	0.1	155.0	17.5
South Holland	3.2%	44.0	1.4	90.2	2.9
Breckland	1.5%	25.9	0.4	91.9	1.3
Peterborough	0.7%	46.1	0.3	38.6	0.3
Cambridge	0.5%	0.0	0.0	16.5	0.1
North Northamptonshire	0.0%	86.3	0.0	170.0	0.0

Since catchment-specific data is not available, the renewable energy generation value for each local authority area has been scaled to the catchment according to the relative size difference (see Table 5). Using this method, it is estimated that approximately 603,000MWh/year is generated in the catchment from renewable sources.

From desk-based research, notable renewable energy projects in the catchment include the following:

- Glass Moor wind farm phase 1 and 2, 28MW;
- Red Tile wind farm, Chatteris, 24MW;
- Sutton Bridge Solar Farm, Sutton Bridge, 49.9MW;
- Burwell Solar Farm, Soham, 49.8MW;
- Goosehall Solar Farm, Soham, 39.5MW; and
- Westry Foods anaerobic digestion plant, March, 5,000 kW.

It is therefore considered that the 603,000MWh/year could be an underestimate of the overall contribution that renewable energy projects the catchment provides to the wider renewable energy provision.

Timber

Woodlands play a fundamental role in providing timber and wood fuel in the UK. Approximately a quarter of the areas of woodland in the catchment have had a management plan or a felling license in the last 10 years or are owned by government organisations. While there are data limitations in relation to actual rates of timber extraction in woodlands within the catchment, national data can be applied to estimate a yearly volume of 28,356m³.

4.4.3 Regulating Services

Climate regulation

Data presented for King's Lynn and West Norfolk District and East Cambridgeshire District Council suggests that land use, land use change and forestry is responsible for 35.9% and 22% of total net emissions in the area, respectively [65] [66].

For the catchment, the NCRAT presents net greenhouse gas fluxes as emitting roughly 1.01 million tCO₂e/yr¹⁴. This is calculated using the extent of different habitat types in the catchment and their average carbon sequestration rates.

The catchment is underlain by approximately 119,000ha of peatland, or 54.3% of the catchment area. This peat is predominantly in a 'drained' condition (76.4% of the total peatland area), with a smaller proportion of 'actively eroding' condition (23.4% of the total peatland area) and 'modified' condition (0.142% of the total peatland area). The volume of carbon emitted by peatland in each of the above condition classes results in a central volume of net emission of approximately 1.08 million tCO₂e/yr.

Woodland, and enclosed farmland in the catchment is calculated to sequester approximately 44,000tCO₂e/yr and 20,500 tCO₂e/yr, respectively. Additionally, the 123ha of mountains, moorlands and 5ha of saltmarsh in the catchment is calculated to sequester approximately 83tCO₂e/yr and 26tCO₂e/yr, respectively.

It is important to note that the NCRAT assumes all agricultural land (i.e. arable and pastoral) is delivering net sequestration, which is likely incorrect (see limitations in Section 3.1.7). At a national scale, agriculture is a net emitter of greenhouse gases and it is likely this pattern is similar in the catchment; in 2021, approximately 48 MtCO₂e were emitted from as a result of agricultural land management across Great Britain.

Air quality

The NCRAT considers the removal of four air pollutants, Particulate matter (PM_{2.5}), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), and Ozone (O₃). Overall, approximately 11,400 tonnes of air pollutants are removed by vegetation each year. The removal of these air pollutants provides health benefits to the local population in the catchment. Much of the catchment is rural with a low population density, but there are several larger urban areas such as King's Lynn, Wisbech and Ely. The health benefits of improved air quality are likely to be most significant in these urban and densely populated areas.

It is important to note that air pollution is likely to be distributed unevenly across the catchment, however the NCRAT assumes an even distribution of air pollutant abatement across the whole catchment rather than modelling variable impact or value across the catchment. Therefore, both the impacts of poor air quality and the benefits of air pollutant removal may vary when measured on the ground.

Hazard regulation

The NCRAT only quantifies and values the cumulative yearly water storage capacity of woodlands in their canopy and soils. The annual volume of potential flood storage within areas of woodland in the catchment is approximately 1.08 million m³ of floodwater.

¹⁴ Tonnes of carbon dioxide equivalent per year. This is a measure of how much carbon dioxide would have to be released to have an equivalent warming impact to the amounts of other greenhouse gases.

Disease and pests

The NCRAT does not quantify benefits relating to disease and pest control. It is estimated that globally 35–40% of potential crop yields are destroyed by pests [67]. Natural pest control, such as by bats and birds, can enhance crop production by reducing herbivorous insects that damage or use parts of crops.

Pollination

The NCRAT does not quantify benefits relating to pollination. Pollination plays a crucial role in promoting healthy ecosystems and supporting the provision of other ecosystem services. Approximately 80% of British wildflower species and 37% of crops grown in the UK benefit from insect pollination, including beans and oilseed rape; additionally, a further 37% of crops grown in the UK, such as carrots and onions, require insect pollination to create viable seeds.

Within the catchment, the crop areas have been estimated based upon commercial agricultural holdings¹⁵ [68] as follows:

- Cereals – 84,100ha (approximately 38.2% of the catchment land use)
- Arable crops (excluding cereals) – 41,700ha
- Fruit and vegetables – 6,530ha

Many cereal and arable crops are wind-pollinated [69], whereas many fruit and vegetable crops (particularly oilseed rape, orchard fruit, soft fruit and field beans) make use of insects to transfer pollen. Without the pollinating insects, these plants would likely have overall reduced quality and yields, resulting in a direct negative economic value impact. They also contribute to the diversity of wild plant species, habitats and wildlife in England, as well as its resilience and natural beauty. Pollination is therefore an essential ecosystem service which maintains biodiversity and supports other vital ecosystem functions, including soil protection, flood control and carbon sequestration.

The quantification of pollination benefits heavily relies on complex modelling, which is outside the scope of this assessment. Currently, the direction and magnitude of changes in pollinator biodiversity, the value and functional relationship of pollinators to agriculture from farm to national scales and how this biodiversity and linked ecosystem service is only partly understood [70].

Soil erosion and retention

The NCRAT does not quantify benefits relating to soil erosion and retention. Soils provide many essential services including an environment for food production, filtering and absorbing water, reducing pollutants, regulating climate and providing habitat for organisms. It is estimated that over 2 million ha of soil are at risk of erosion in England and Wales and almost 4 million ha are at risk of soil compaction. This has implications for water resources, flooding and soil quality and food production [71].

4.4.4 Cultural Services

The NCRAT quantifies and values only four cultural ecosystem services: recreation, physical health, education, and volunteering.

¹⁵ Data based upon the most recent Local Authority data for East Lindsey District Council (2021) and apportioned to land within the Great Ouse catchment.

Recreation

Access to open green spaces can provide a range of benefits to local economies. Based on data from the University of Exeter's ORVal Tool [33], approximately 14.8 million adults visit open green spaces in the catchment every year which supports the growth of local economies. A further 3.8 million children are estimated to visit the catchment each year, but the welfare value can only be calculated for adults aged 16 or older.

Physical health

Of the roughly 18.6 million total yearly visits to open green spaces within the catchment, roughly 7.63 million visitors are likely to partake in activities that are beneficial for their physical health, through visits involving 30 minutes or more of physical activity.

Education and volunteering

For this assessment, education and volunteering benefits were not possible to quantify due to lack of data availability. Although visits to the catchment for scientific and educational purposes are difficult to quantify, they do create benefits for human society as a whole.

Volunteering visits are similarly difficult to quantify, but can provide benefits to recipient organisations and their stakeholders, to wider society and to the volunteers themselves. Volunteering in nature and outdoor activities can have many positive benefits for the participants such as improving physical health, mental health and social connectedness. This not only provides a direct benefit to those participating in the activity but can have follow-on benefits by reducing national health care costs. Mental health improvements include reduced stress and anxiety and increased positive mood, self-esteem and resilience [72].

Aesthetic / sense of place

The aesthetic and sense of place benefits from nature are intrinsically difficult to measure, as it describes how people perceive, feel about, and interact with their environment. One means of measuring this benefit is through house prices, which tend to increase in areas where there is greater access to green and blue space due to improved local aesthetics.

4.4.5 Bundled services

Bundled services may not produce measurable benefits but are essential for ecological processes to function and facilitate the provision of all ecosystem services. Supporting services are typically not assessed on their own, as their importance underpins all individual ecosystem services discussed as part of this assessment.

Water quality

The bundled ecosystem service for water quality entails a range of benefits related to ecosystems functioning to remediate polluted water, the value of good-quality water for economic activities, recreation, education, and for healthy plant and animal populations.

The NCRAT applies non-market valuation approaches to quantify the value of good water quality within the catchment, mainly by applying data on people's willingness to pay for good water quality in combination with the ecological status of inland and coastal waterbodies and 2019 bathing water status. The catchment contains 72 WER / WFD river waterbodies, two lake waterbodies, and two transitional waterbodies – seven of the surface water bodies have a 'good' ecological classification status, 59 have a 'moderate' ecological classification status, eight have a 'poor' ecological classification status and two have a 'bad' ecological classification status.

Biodiversity

The variety of living organisms in the catchment is important at a local level for increasing resilience to pests and diseases and supporting healthy ecosystems. At a global level, it is important for maintaining genetic diversity, which in turn is required for biosphere integrity, one of the nine planetary boundaries [73]. At both a local and a global level, Biodiversity enables the functioning of ecosystem services that are critical to all life on Earth.

While there are some ways to measure aspects or indicators of biodiversity (e.g. through Biodiversity Metrics, indices or indicator species), the NCRAT does not currently include this.

4.4.6 Beneficiaries Assessment

A qualitative Beneficiaries Assessment has been undertaken that explores who benefits from each ecosystem service, either directly or indirectly. The assessment considers who the beneficiaries of each ecosystem service are (i.e. the local population, wider society, public sector or private sector) and whether they are primary, secondary or indirect beneficiaries. The outputs of this are presented in Appendix A: Output - Benefits Statement.

The local population – including local communities and households (residents) – were identified as the primary beneficiary for most ecosystem services except provisioning services such as agriculture, water supply, timber and renewable energy. For these, as well as pollination, they have been identified as the secondary beneficiary.

The wider society – meaning those who live outside of the study area and include non-governmental organisations – has been identified as an indirect beneficiary for the majority of ecosystem services, specifically regulating and cultural services. For provisioning services and bundled services, the wider society is considered a secondary beneficiary. For climate regulation, the wider society is considered a primary beneficiary.

The public sector – referring to national and local government bodies – has been identified as an indirect beneficiary for the majority of ecosystem services, particularly provisioning services. The public sector is considered a secondary beneficiary of climate regulation, hazard regulation, disease and pest regulation, all bundled services and cultural services including recreation, health, volunteering and education. The public sector is considered the primary beneficiary of the mediation of wastes.

The private sector – including commercial enterprises, farming and industry – is considered a primary beneficiary for provisioning services such as agriculture, water supply, timber, and renewable energy as well as the regulation of disease and pests, pollination, soil condition and erosion, and mediation of wastes. The private sector is considered a secondary beneficiary of all bundled services, climate regulation and hazard regulation. For the remaining services, including cultural services and air quality regulation, the private sector is considered an indirect beneficiary.

4.5 Value

4.5.1 Natural capital value

The total natural capital value that has been estimated for the ecosystem services in the catchment is £268.1 million per year, with a 100-year asset value of approximately £17.5 billion. Figure 14 shows how this figure can be broken down into the different benefits from ecosystem services. This value will be an underestimate of the real value of natural capital assets as some benefits have not been valued, including biodiversity which underpins the

functioning of all other ecosystem services. More information on the value of ecosystem service benefits is provided in the subsequent sections. Figure 14 shows the estimated annual value for hazard regulation as £0, however the annual value of flood storage is £548,000. More information about the estimated values of ecosystem services is provided in Section 4.5.

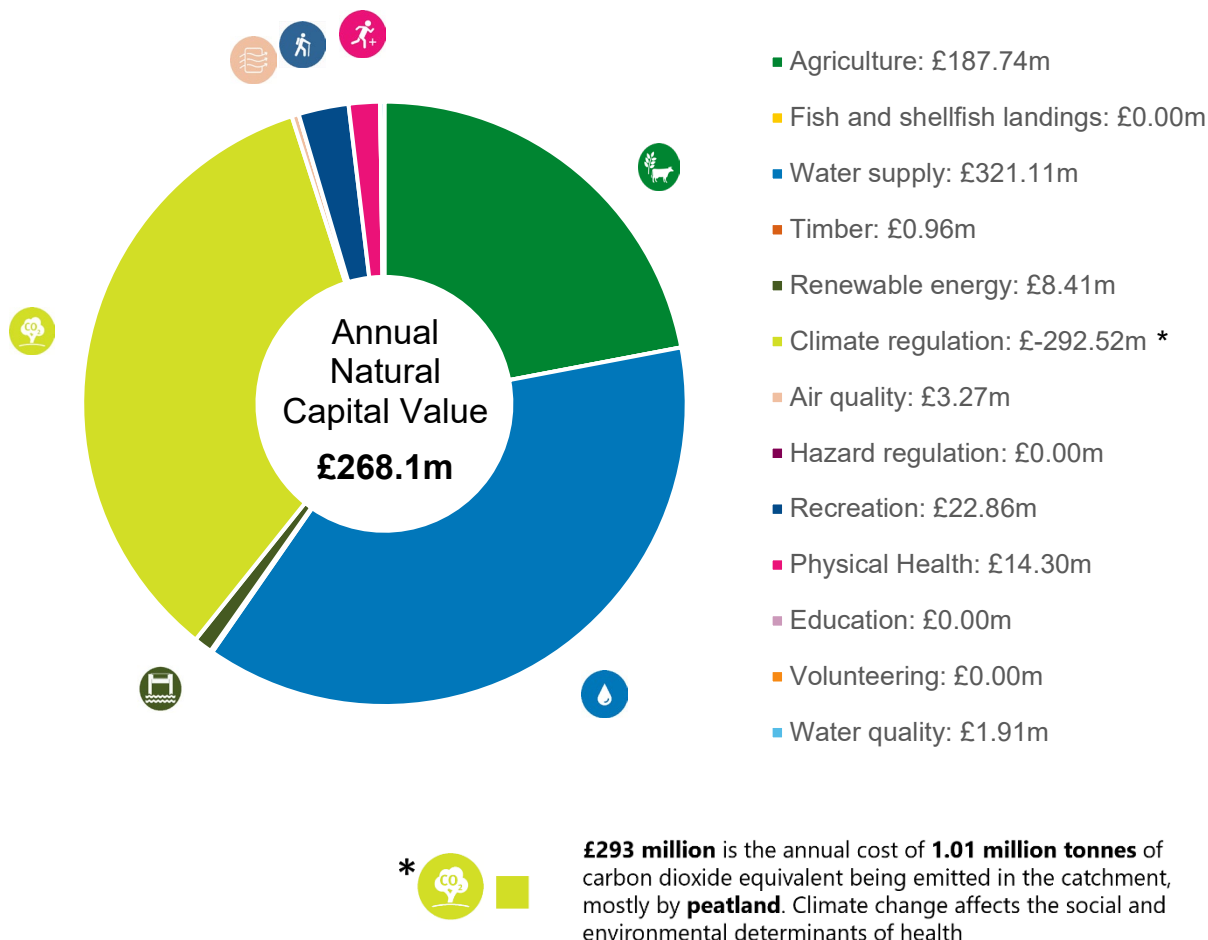


Figure 14: Pie chart showing the natural capital value of different ecosystem services in the catchment (£ million).

Not all ecosystem services have been quantified into a monetary value and so show a value of £0 on Figure 14. Volunteering and education have not been included in the assessment because there is not enough data available to calculate a value. Since there is no marine habitat within the catchment, the provision of food from fish and shellfish landings has not been included as it is not appropriate to attribute these benefits to the study area. The NCRAT does not provide a monetary value for hazard regulation as the valuation methodology is not sufficiently robust. Other ecosystem services not included are those that are particularly hard to quantify, including biodiversity, pollination, regulation of disease and pests, regulation of soil quality and erosion, and cultural benefits relating to amenity, aesthetics and spirituality. Consequently, the total values of assets and services in a natural capital account will always be an underestimate.

4.5.2 Provisioning services

Food production

The estimated annual arable, livestock dairy and meat yields are approximately 1.55 million tonnes, 95,700 kilolitres per year (kL/yr) and 3,080 tonnes respectively, which have a combined worth of approximately £188 million each year. The asset value over the next 100 years for agriculture is approximately £5,600 million. As noted in Section 3.1.7, the natural capital values do not include the potential costs from carbon emissions associated with agricultural activities (e.g. cost of carbon emissions from land management, fertiliser production, machinery etc.).

Water supply

Overall, the volume of water abstracted from the catchment is approximated to be 75.5 million m³ per year, equating to £321 million each year and £9,570 million over the next 100 years – these are the central values. The minimum and maximum annual values for water supply are £38.0 million and £512 million respectively.

Renewable energy

The renewable energy generated within the catchment is estimated to be 603,000MWh per year, which has been valued at approximately £8.41 million a year and £251 million over the next 100 years.

Timber

The national value of timber and fuel extracted from woodlands is estimated at almost £15 billion. National data can be applied to the catchment to estimate a yearly timber production volume of 28,400m³, which is valued at approximately £0.956 million per year. The 100-year asset value of this is £28.51 million.

A key consideration for this figure is that, in order to provide a constant benefit, woodlands need to be managed sustainably. As such, timber harvest rates should not negatively impact the health and therefore the wider ecosystem service provision within a woodland.

4.5.3 Regulating Services

Climate regulation

Based on the extent of habitat types in the catchment, the NCRAT presents the net greenhouse gas fluxes as emitting roughly 1.01 million tCO₂e/yr for a central value, with an annual cost of over £293 million - this has a 100-year asset value of approximately £897 million.

The NCRAT provides maximum and minimum values for climate regulation which should also be considered given the amber confidence interval for climate regulation (see Table 1 for confidence interval definitions) and uncertainty in the results. The central volume of carbon dioxide emitted is 1,014,889 tCO₂e/yr. The minimum annual volume of carbon emitted is approximately 42 tCO₂e/yr (-£12,070 per year) lower than this central value and the maximum is 42 tCO₂e/yr (-£12,070 per year) higher than this central value.

The estimated value for climate regulation is based on the extent of different habitat types in the catchment. The majority of the catchment is agricultural land, which has a relatively low carbon sequestration rate. The value for climate regulation would be higher if the area of woodland, wetlands or saltmarsh was increased, as these have a higher carbon sequestration rate. As explained in section 4.2.2, the peatland in the catchment is

predominately in a 'drained' or 'actively eroding' condition and is a net emitter of carbon, which significantly reduces the value for climate regulation.

Air quality

The removal of roughly 11,400 tonnes of air pollutants by vegetation each year leads to an estimated avoided cost of treatment and productivity loss of approximately £3.27 million per year and £101 million over the next 100 years.

Hazard regulation

In the catchment, an estimated 1.08 million m³ of floodwater is temporarily stored in areas of woodland in Great Ouse. The NCRAT does not provide a monetary value for this benefit, however the cost of creating a flood storage reservoir to store a similar amount of water is estimated at £548,000 per year.

Disease and pests

The NCRAT does not provide a monetary value for the benefits associated with disease and pest control in the catchment. There is not sufficient information to calculate the precise economic impact of pests and disease. The spread of invasive and non-native species more broadly is estimated to cost the UK economy £1.8 billion each year [6].

Pollination

The NCRAT does not provide a monetary value for the benefits associated with pollination in the catchment. Pollination by insects and other animals has been estimated to be worth £500 million annually in the UK [6].

Soil erosion and retention

The NCRAT does not provide a monetary value for the benefits associated with soil erosion and retention in the catchment. As peat is drained it shrinks; becoming lighter, friable and vulnerable to erosion. Production losses due to soil erosion are estimated to cost £40 million per year in England and Wales [6].

4.5.4 Cultural Services

Recreation

The value of roughly 14.8 million visits by adults to open green spaces in the catchment every year is worth approximately £22.9 million each year and has a 100-year asset value of approximately £552 million. The welfare value of a further 3.8 million visits made by children each year cannot be quantified but is likely to be significant.

Physical health

By applying a valuation approach to measuring the improvements in 'quality adjusted life years' (QALYs), the NCRAT estimates that roughly £14.3 million in healthcare treatment costs can be avoided every year due to improved physical health as a result of 7.63 million active visits to green spaces. The 100-year asset value of this is approximately £426 million.

Education and volunteering

Although education and volunteering have been scoped out of this assessment due to lack of data availability, they are valuable ecosystem services. The number of volunteer hours and educational visits can be used to calculate the value of education and volunteering in a catchment. It is likely that the protected areas and heritage sites within the catchment

enable valuable volunteering and educational opportunities. All 141 National Nature Reserves managed by Natural England have a total volunteering value of £1.8 million (for 150,000 hours of work) and a total educational value of £123,000 [72].

Aesthetic / sense of place

The NCRAT does not provide a monetary value for the benefits associated with aesthetics and sense of place. Recreation and aesthetic values are in part captured by house prices as there is value associated with proximity to green and blue spaces for recreation (free trips to nature) and the visual amenity (aesthetic) value provided by being able to view green and blue spaces. In 2021, the combined aesthetic and recreation value of these services was estimated to be worth £4 billion [74].

4.5.5 Bundled services

Water quality

Based on a willingness to pay approach, the river water quality is worth an estimated £1.91 million per year as an alternative to having poorer water quality. This is because only six of the 72 river waterbodies within the catchment meet 'Good' or 'High' ecological status and the NCRAT only provides an annual value of good or high water quality per km. Transitional, coastal and lake waterbody water quality is worth an estimated £1.9 million, based on the same willingness to pay approach. Only one transitional, coastal or water waterbody within the catchment meets 'Good' or 'High' ecological status. The 100-year asset value for rivers, transitional, coastal waters and lakes is £56.9 million.

There are 72 river water bodies across the catchments; two lake waterbodies, and two transitional waterbodies – seven of the surface water bodies have a 'good' ecological classification status, fifty-nine have a 'moderate' ecological classification status, eight have a 'poor' ecological classification status and two have a 'bad' ecological classification status.

The NCRAT accounts for all river waterbodies in every operational catchment that the study area intersects. Therefore, the number of rivers within the catchment is likely to be overestimated; NCRAT considers 72 river waterbodies, whereas there are 30 river waterbodies within the catchment. Therefore, the number of rivers within the catchment that meet 'Good' or 'High' ecological status is also likely to be overestimated; in the Great Ouse catchment there is one river waterbody that meets 'Good' or 'High' ecological status, not the six that the NCRAT has calculated. Therefore, the value of river water quality is overestimated.

Biodiversity

The NCRAT does not assess the value of biodiversity. However, the value of biodiversity to our economy and society should not be overlooked as it underpins the value of all other ecosystem services.

The Dasgupta Review provides a thorough assessment into the value of biodiversity to our economy and society [75]. The Report distinguishes six sources of biodiversity's value including human existence, human health, amenity, the provision of ecosystem services from Nature's goods and services, species existence, and the intrinsic value of nature itself [75].

4.5.6 Monetary value confidence intervals

Table 6 shows a RAG rating of confidence in the monetary values assigned to the annual and 100-year flow of benefits [34]. Definitions for confidence intervals are provided in Section 3.1.4.

Table 6: The natural capital values calculated using the NCRAT colour coded according to the confidence interval

Ecosystem Service	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m
Agriculture - Arable	173.31	-	-	5,166.75
Agriculture - Livestock (dairy)	13.55	-	-	404.06
Agriculture - Livestock (meat)	0.88	-	-	26.35
Fish and shellfish landings	-	-	-	-
Water supply (public)	45.89	-	-	1,368.05
Water supply (energy generation)	-	-	-	-
Water supply (all other)	275.22	-	-	8,204.97
Timber	0.96	-	-	28.51
Renewable energy	8.41	-	-	250.85
Climate regulation	-292.52	896.20	897.37	896.78
Air quality - PM2.5	1.69	-	-	51.60
Air quality - SO2	0.01	-	-	0.56
Air quality - NO2	0.96	-	-	7.93
Air quality - O3	0.60	-	-	41.22
Hazard regulation	-	-	-	-
Disease and pests				
Pollination				

Soil quality / erosion				
Noise mitigation				
Waste remediation				
Recreation (adults)	22.86	-	-	551.86
Recreation (children)	-	-	-	-
Physical Health	14.30	-	-	426.32
Education	0.00	0.00	0.00	0.00
Volunteering	0.00	-	-	0.00
Amenity				
Aesthetic / sense of place				
Spiritual				
Water quality - rivers	1.91	46.71	67.14	56.93
Water quality - transitional, coastal waters and lakes	0.00	0.00	0.00	0.00
Biodiversity				

5. Summary and next steps

5.1 Summary of the NCRAT results for the catchment

The flow of ecosystem services that are derived from natural assets within the catchment were estimated, which was used to calculate the value of the benefits those services provide. This process is summarised in Figure 15. The analysis is not exhaustive and does not include all assets, services and benefits, therefore the natural capital values shown are an underestimate. Figure 15 indicates the confidence in the valuation provided as High (3 coloured squares), Medium (2 coloured squares), or Low (1 coloured square).

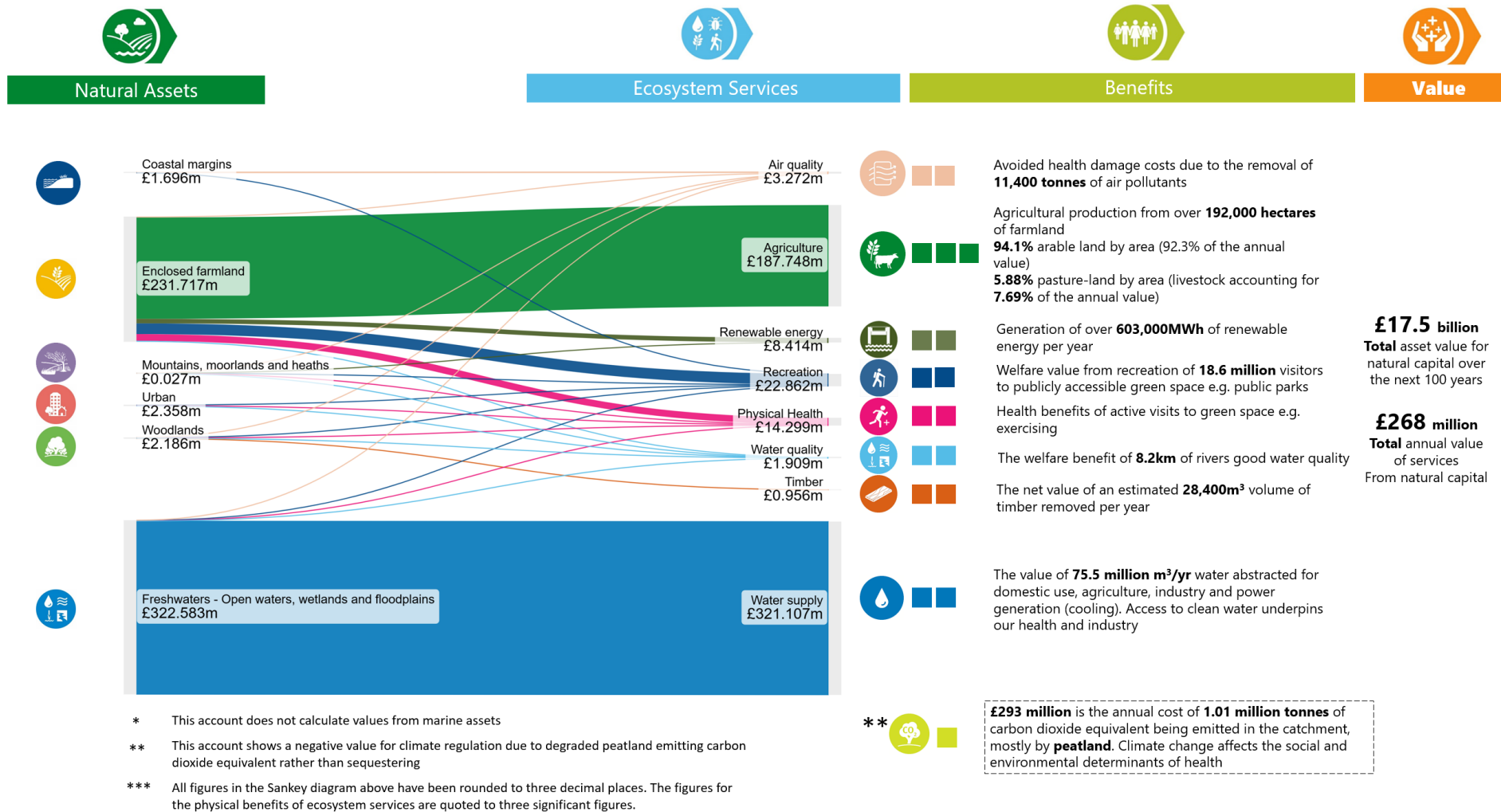


Figure 15: Summary of the NCRAT results for the catchment

5.2 Strengths, weaknesses, opportunities and threats

5.2.1 Strengths

The key natural capital strengths in the catchment include:

- **Water environment:** The catchment contains important surface water and groundwater bodies that are crucial for human water supply and local ecosystem functioning. The main surface waterbody is the River Great Ouse; the groundwater bodies underlying the catchment are the Cam and Ely Ouse Chalk, North west Norfolk Sandringham Sands, Cam and Ely Ouse Woburn Sands, North West Norfolk Chalk. The natural capital value of water supply in the catchment is estimated at £321 million annually.
- **Fertile soil:** The large majority (87%) of the catchment is enclosed farmland; the natural capital value of this land is estimated at £188 million annually through food production. Approximately 192,000ha of arable fields and agricultural grasslands support both arable farming and livestock rearing, producing over 1.55 million tonnes of arable yields, 95.7 million litres of dairy and 3,080 tonnes of livestock yields each year. These activities support food production, provide employment, and help maintain the landscape character of The Fens NCA.
- **Statutory designations:** Approximately 2.49% of the catchment is designated including Breckland (SPA and SAC), Fenland (SAC), Nene Washes (SPA, SAC, Ramsar site and SSSI), Norfolk Valley Fens (SAC), Ouse Washes (SPA, SAC, Ramsar site and SSSI), Roydon Common (SAC (Roydon Common & Dersingham Bog), Ramsar site, SSSI and NNR), The Wash (SPA, Ramsar Site and SAC), Wicken Fen (Ramsar site, SSSI and NNR), Woodwalton Fen (Ramsar site, SSSI and NNR). These designations provide legal protection to critical habitats - ensuring the conservation of valuable natural resources, supporting biodiversity, and protecting the continuous provision of ecosystem services.
- **Renewable energy:** The catchment contains multiple operational wind and solar farms and anaerobic digestion units. The renewable energy generated for the catchment is estimated to be approximately 603,000MWh per year, which has been valued at approximately £8.41 million a year and £251 million over the next 100 years.
- **Woodlands:** Woodlands are highly effective at capturing and sequestering carbon dioxide from the atmosphere; it is estimated that woodland in the catchment sequesters 44,000tCO_{2e} every year. This significant carbon storage capacity not only helps mitigate climate change by reducing greenhouse gas concentrations but also enhances the resilience of coastal ecosystems. By protecting and restoring these coastal habitats, the region can leverage their natural ability to sequester carbon, contributing to both local and global climate goals.
- **Coastal priority habitat:** The catchment includes approximately 5,270ha of coastal priority habitat providing important habitats such as coastal and floodplain grazing marsh, mudflats, littoral sediment and coastal saltmarsh, which attract a range of wildlife including wintering waterbirds; passage birds; waders; breeding birds; harbour seal; and shellfish [40] [41] [42]. These habitats provide crucial ecosystem services, including water quality improvement, carbon sequestration, biodiversity, recreation,

tourism, and protection against erosion and flooding. Additionally, they serve as nurseries for many commercial fish species.

5.2.2 Weaknesses

The weaknesses of natural capital in the catchment are as follows:

- **Climate regulation:** A significant portion (54.3%) of the catchment is comprised of peatland. This peat is in a poor condition, and consequently net emits approximately 1.08 million tCO₂e/yr. When sequestration from other habitat types are also considered, the annual volume of carbon emitted is 1.01 million tCO₂e/yr. The cost of this is approximately £293 million a year. However over the next 100 years, the total value provided by carbon sequestration is valued at £897 million.
- **Environmental degradation:** The vast majority of the catchment is made up of agricultural land, covering 87% of land area. Whilst this is important for food production, intensive agricultural practices can contribute to soil degradation, habitat fragmentation, and pollution. These activities can also lead to the loss of biodiversity, reduced soil fertility, and increased greenhouse gas emissions, impacting ecosystem health and resilience. Additionally, the use of chemical fertilizers and pesticides can contaminate water bodies and groundwater resources, further degrading the quality of natural habitats and affecting aquatic life. The catchment has a relatively low proportion of semi-natural and ancient woodlands, and the condition of peatland has been degraded through drainage. This is likely as a result of historic land use change driven by agricultural intensification.
- **Vulnerability to climate change:** The natural assets in the catchment are at risk from rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns. These changes can lead to habitat loss, reduced biodiversity, and increased vulnerability to coastal erosion and flooding. In addition, it can impact food production through damage to crops and increased soil erosion during extreme weather events, and through unpredictable seasons. The impacts of climate change can also disrupt the balance of marine ecosystems, affecting fish populations and other marine life that are crucial for local fisheries and biodiversity.

Across the catchment, agricultural land and ecologically valuable habitats - including designated sites - are at risk from retreating coastlines, saline intrusion, and coastal flooding. These threats can lead to the loss of valuable farmland, reduced agricultural productivity, and degradation of critical biodiversity areas, directly impacting both economy and ecology of the region, as well as indirectly through the erosion of ecosystem service provision due to habitat degradation.

5.2.3 Threats

Threats to the condition or quality of natural capital assets in the catchment have been identified, including:

- **Climate change:** The catchment is at risk of flooding, both from the sea given its low-lying coastal topography as well as from rivers and drains within the catchment. These changes can lead to habitat loss and reduced biodiversity (e.g. as a result of salination impacts), and increased vulnerability to coastal erosion and flooding.

Rising sea levels, increased frequency of extreme weather events, and changing precipitation patterns increase flood risk and pose significant risks to food production,

and coastal habitats. The catchment has suffered from floods on multiple occasions over the last 50 years, with the most recent extreme event in October 2023, Storm Babet, which caused flooding across Cambridgeshire, with three red warnings issued in the county following the event. The whole catchment was affected, including March and Ely. Storm Henk caused further flooding in the catchment in January 2024, prompting amber flood warnings on the River Great Ouse, Lower River Cam and the Hundred Foot Washes.

Rising sea levels and an increased demand for groundwater abstraction increases the risk of saline intrusion to groundwater and soils. This can lead to a variety of issues such as habitat loss, reduced agricultural productivity and loss of aquifer water quality [76].

- **Agricultural practices:** Intensive farming practices, particularly on arable land, can lead to degradation of soil and peat; reduced soil fertility; and increased greenhouse gas emissions. The condition of any remaining peatland in the catchment is already poor due to decades of drainage and intensive agriculture.

The use of nitrogen and phosphorus-based fertilisers can also contribute to waterway pollution. The Environment Agency's reasons for not achieving Good (RNAG) dataset identifies diffuse pollution from agricultural and rural land management and physical modifications associated with flood defence structures, land drainage operations, and agricultural land use as the current RNAG's for the waterbodies within the catchment.

- **Water resource management:** Over-extraction of water from aquifers and rivers can lead to reduced water availability for ecosystems and human use, including irrigation for arable crops. This can exacerbate the impacts of droughts and reduce the resilience of freshwater habitats. Currently in the area of the Great Ouse, the majority of the catchment has water available at Q30 flows and above, and restricted water available at Q50, whereas at flows lower than these levels the whole catchment has no water available.

The whole of Eastern England has been classified as 'seriously water stressed' by the Environment Agency [47]. The projected water deficit in the Fenland for 2050 is 0-15 megalitres per day, this emphasises the importance of sustainable water management in the local area and the threat of severe water shortage in the future [47].

There are trade-offs between the benefits that are obtained from different ecosystem services, especially if natural assets are not managed sustainably. For example, abstraction of water for water supply to provide drinking water, grow crops and livestock may deplete water resource and have knock on negative implications for other ecosystems that rely on sufficient flows and volumes of water being available. This includes other provisioning services (such as timber) regulating services (such as climate regulation and soil quality), cultural services (such as recreation and amenity) and bundled services (such as water quality and biodiversity).

- **Pollution:** Air and water pollution from agriculture and urban areas can degrade natural habitats and reduce their ability to provide ecosystem services. This includes the accumulation of pollutants in vegetation and water bodies, impacting human health and biodiversity.
- **Invasive species:** The introduction and spread of invasive species can disrupt local ecosystems by outcompeting native species for resources, altering habitat structures,

and introducing diseases. This can lead to a decline in native biodiversity and negatively affect ecosystem functions and services.

- **Urban development:** Expansion of urban areas and infrastructure can lead to habitat fragmentation, loss of green spaces, and increased pollution. This can negatively impact biodiversity and the provision of ecosystem services such as air quality regulation and recreational spaces.

5.2.4 Opportunities

There is opportunity to improve natural capital in the catchment through:

- **Enhancement of asset quality:** Investing in the restoration, enhancement and connection of natural habitats such as chalk streams, fenland rivers, floodplain grassland and reedbeds, can improve their condition and resilience.

Reducing pollution e.g. through farm nutrient management plans and changes to licence conditions, can enhance asset quality, addressing sources of excess nutrients, plastics and other pollutants.

A key opportunity for habitat restoration in the catchment is the Great Fen Restoration Project. This aims to transform 3,700ha of land in Cambridgeshire into a thriving wetland ecosystem, reconnecting Woodwalton Fen and Holme Fen National Nature Reserves. This initiative focuses on habitat restoration to improve biodiversity, climate change mitigation by addressing peat degradation, and supporting local communities through sustainable land management and eco-tourism. Additionally, the project provides social benefits through educational opportunities and improved access to green space with new footpaths, cycleways, and visitor facilities [77] [78]. This is an opportunity for visitors from local communities and beyond to learn, develop awareness, knowledge, attitudes and skills that would support the conservation of local heritage and develop a sense of ownership and an engagement with climate change issues for the catchment.

- **Habitat extension or creation:** Creating new habitats and extension of existing habitats can enhance biodiversity and ecosystem service provision. Implementing measures such as niche habitat restoration including hibernacula built and dead hedging laid, invertebrate-friendly practises, river, lake and riparian habitat restoration, floodplain restoration and reconnection can support habitat and species recovery. There is also the opportunity to introduce keystone species, such as the potential to restore species such as beaver and pine marten. This can also provide new opportunities for recreation, tourism and education, especially when combined with improved recreational access. Given the low topography and high flood risk of the catchment, creating wetland habitat and restoring lowland peatland will be especially important for the future of the catchment to manage flood risk and promote carbon sequestration.

Lakenheath Fen is an example of successful habitat creation in the catchment. Managed by the RSPB, Lakenheath Fen involved converting arable farmland into a large wetland with reedbeds and grazing marshes. This site now attracts numerous bird species such as reed warblers, sedge warblers, bearded tits, and marsh harriers [79].

Another example of habitat creation in the catchment is the Wissey Wetlands Creation project, which includes the creation of reedbed habitat on over 60ha of former agricultural land near the village of Hilgay in west Norfolk. A further 20ha of reed bed and 40ha of grassland and woodland will be created at the neighbouring Methwold site. This project is part of the Wissey Living Landscape scheme and compensates for reedbed habitat lost due to various environmental changes, including increased saline intrusion into freshwater areas [72].

- **Recreation and tourism:** Improving the recreational value of new or existing green space can significantly enhance community well-being, encourage outdoor activity, and promote environmental awareness. This has benefits for natural capital, such as improved human health and education. This can be achieved by improving accessibility to green space through well-maintained and wheelchair-accessible paths, good public transport links and clear signage. Other opportunities to improve the recreational value of natural assets include improving amenities (e.g. benches, bins, lighting and toilet facilities); adding recreational facilities (e.g. playgrounds and sports areas); and by promoting nature engagement through educational signage and community gardens.
- **Use of Nature based Solutions (NbS):** Implementing NbS, such as sustainable agriculture, green engineering, and ecosystem-based adaptation, can deliver multiple benefits. Natural flood management is a type of NbS encompassing a suite of measures which work with natural processes to reduce the risk of flooding. These processes protect, restore, and mimic the natural functions of catchments, floodplains and the coast to slow, spread and store water, and each intervention comes with its own set of multiple benefits. NBS solutions can enhance resilience to climate change, improve water quality, and support biodiversity while providing economic and social benefits.
- **Sustainable land and water management:** Adopting sustainable practices in agriculture and water management can reduce environmental impacts and enhance ecosystem services. This includes practices such as conservation agriculture, agroforestry and integrated water resource management. Planting hedgerows and grassland along the agricultural field margins provides an opportunity to improve biodiversity and connectivity, and will support other ecosystem services such as pollination, water quality, flood management and climate regulation.
- **Regenerative farming practices:** Implementing regenerative farming practices focuses on restoring soil health, increasing biodiversity, and improving water cycles. These practices can lead to more resilient and productive agricultural systems, enhancing ecosystem services and reducing environmental impacts, especially along key watercourses such as the Great Ouse River. There is also opportunity to support appropriate management of salt marshes and grazing marsh, such as restoration of sustainable grazing.
- **Climate change mitigation and adaptation:** Working collaboratively with catchment stakeholders to deliver integrated solutions in order to mitigate the impact of climate change.

Tree planting could be considered in locations where it can deliver biodiversity, flood, water quality, water resources and climate adaptation benefits. Consideration should be given to the fact that poor placement of trees on peatland can actually lead to

further degradation and drying of the peat through water uptake, inadvertently increasing greenhouse gas emissions [80].

The Landscape Recovery Fund is a long-term, large-scale government project fund with a focus on addressing climate change and habitat creation. The Ouse Washes is a Landscape Recovery Project within the catchment that provides an opportunity to improve climate change mitigation and adaptation whilst simultaneously creating and restoring wetland habitat. The project aims to create 1,000ha of target habitat creation and to form a continuous wetland habitat from the Ouse Washes, Fen Drayton, and Ouse Fen to form 1900ha of continuous wildlife rich habitat. This habitat will provide a refuge for an abundance of priority species, improve biodiversity, and contribute to net zero, while mitigating ecological and hydrological threats currently facing the area. By creating a healthier landscape, the project will support local economies, safeguard communities, and deepen the connection between local people and nature [79].

- **Policy and governance:** Strengthening policies and governance frameworks to support natural capital conservation and sustainable development can create an enabling environment for positive change. This includes integrating natural capital into planning and decision-making processes and promoting stakeholder engagement and collaboration. One way of implementing this is through Local Nature Recovery Strategies (LNRS) or assessment and enhancement of natural capital through the local plan making process.

LNRS were introduced through the Environment Act 2021, as new systems of spatial strategies for nature in England. Each LNRS includes a local habitat map and a written statement of biodiversity priorities, outlining practical actions such as creating wetlands, restoring peatlands, planting trees, and managing existing woodlands more sustainably. Farmers and land managers will be able to use the LNRS to understand the potential of their land for strategic nature recovery actions, which in turn could be applicable for funding through Environmental Land Management Schemes and other funding mechanisms. LNRS should be used by plan-makers to inform the way they address the National Planning Policy Framework requirement for plans to protect and enhance biodiversity, which in turn will have positive outcomes for natural capital.

The LNRS for Peterborough and Cambridgeshire (which covers the majority of the catchment) is currently at public consultation stage (as of Spring 2025) and is due to be published in 2026. It includes the Doubling Nature Vision which aims to enhance biodiversity and create resilient ecosystems across six priority landscapes. Plans include restoring species-rich floodplain meadows in the Great Ouse Valley, and increasing wetland restoration and sustainable farming across the Connected Fens.

6. Bibliography

- [1] Capitals Coalition, “Natural Capital Protocol,” Natural Capital Coalition, 2016. [Online]. Available: https://capitalscoalition.org/capitals-approach/natural-capital-protocol/?fwp_filter_tabs=guide_supplement. [Accessed 11 December 2024].
- [2] Natural England, “England Peat Map,” Department for Environment, Food & Rural Affairs, 06 May 2025. [Online]. Available: <https://environment.data.gov.uk/dataset/3c72669a-1331-4930-a12d-b4f8032aa5cd>. [Accessed 06 June 2025].
- [3] HM Treasury, “The Green Book,” 2022. [Online]. Available: https://assets.publishing.service.gov.uk/media/6645c709bd01f5ed32793cbc/Green_Book_2022__updated_links_.pdf. [Accessed 21 November 2024].
- [4] Department for Environment, Food and Rural Affairs, “Enabling a Natural Capital Approach guidance,” 19 July 2023. [Online]. Available: <https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance#introduction-to-natural-capital>. [Accessed 29 October 2024].
- [5] R. a. d. G. R. Leemans, “Millennium Ecosystem Assessment: Ecosystems and human well-being: a framework for assessment,” Island Press, Washington/Covelo/London, 2003.
- [6] J. Lusardi, P. Rice, J. Craven, C. Hinson, F. Bell, A. Morgan, K. Martin, M. Dobson, T. Sunderland and R. Waters, “State of Natural Capital Report for England 2024: Risks to nature and why it matters,” Natural England, 2024.
- [7] Environment Agency, “The Environment Agency’s Natural Capital Catchment Register and Account Tool and Scorecard,” Environment Agency, 2019.
- [8] R. Lenane, “The Natural Capital Register and Account Tool, Version 1.2 – Technical Report,” Environment Agency, Bristol, 2023.
- [9] Natural Capital Coalition, “Natural Capital Protocol,” 2016.
- [10] Copernicus Land Monitoring Services, “Corine Land Cover,” 2018. [Online]. Available: <https://land.copernicus.eu/en/products/corine-land-cover/clc2018>. [Accessed 29 October 2024].
- [11] Environment Agency, “Statutory Main River Map,” 07 June 2024. [Online]. Available: <https://www.data.gov.uk/dataset/4ae8ba46-f9a4-47d0-8d93-0f93eb494540/statutory-main-river-map>. [Accessed 29 October 2024].
- [12] Ordnance Survey, “OS Open Rivers,” 2024. [Online]. Available: <https://www.ordnancesurvey.co.uk/products/os-open-rivers#get>. [Accessed 29 October 2024].

- [13] OpenStreetMap contributors, "OpenStreetMap database," OpenStreetMap Foundation, 2024. [Online]. Available: <https://www.geofabrik.de/data/download.html>. [Accessed 16 December 2024].
- [14] Forestry Commission, "National Forest Inventory England 2020," 30 June 2022. [Online]. Available: https://data-forestry.opendata.arcgis.com/datasets/30cf3ba3df444b6695cdafe250ed2172_0/about. [Accessed 29 October 2024].
- [15] Natural England, "England Peat Status GHG and C storage," 03 June 2024. [Online]. Available: <https://www.data.gov.uk/dataset/8ea9074e-bafc-4cc4-85dd-19cda1dfbfd5/england-peat-status-ghg-and-c-storage>. [Accessed 29 October 2024].
- [16] Natural England, "Ancient Woodland (England)," 03 June 2024. [Online]. Available: <https://www.data.gov.uk/dataset/9461f463-c363-4309-ae77-fdcd7e9df7d3/ancient-woodland-england>. [Accessed 29 October 2024].
- [17] Natural England, "Priority Habitats Inventory (England)," 25 September 2024. [Online]. Available: <https://www.data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitats-inventory-england>. [Accessed 29 October 2024].
- [18] Department for Transport, "Value for Money Framework," 2024. [Online]. Available: <https://assets.publishing.service.gov.uk/media/67459942b58081a2d9be968e/value-for-money-framework.pdf>. [Accessed 01 October 2024].
- [19] Department for Environment, Food and Rural Affairs, "Data Services Platform - WFD Groundwater Bodies Cycle 2 Classification 2019," 2020. [Online]. Available: <https://environment.data.gov.uk/dataset/6b5c81d9-1dc9-4635-b7bd-54d3d2488ccd>. [Accessed 29 October 2024].
- [20] Department for Environment, Food and Rural Affairs, "Data Services Platform - WFD Transitional and Coastal Waterbodies Cycle 2," 2013. [Online]. Available: <https://environment.data.gov.uk/dataset/78c2df61-d465-11e4-b839-f0def148f590>. [Accessed 29 October 2024].
- [21] Department for Environment, Food and Rural Affairs, "Data Services Platform - WFD Lake Waterbodies Cycle 2," 2014. [Online]. Available: <https://environment.data.gov.uk/dataset/76b02c00-d465-11e4-a772-f0def148f590>. [Accessed 29 October 2024].
- [22] Forestry Commission, "Felling Licence Applications England," 20 July 2021. [Online]. Available: https://data-forestry.opendata.arcgis.com/datasets/f0fe491790df46f8bb01d54e6875ef63_0/explore. [Accessed 29 October 2024].
- [23] Environment Agency, "Surface Water Availability for Water Resource Charging," 28 February 2021. [Online]. Available: <https://environment.data.gov.uk/dataset/3fb59850-ef87-4b0e-b429-1f42e9e101d9>. [Accessed 29 October 2024].
- [24] Environment Agency, "Groundwater Management Units coloured according to water resource availability colours," 12 April 2016. [Online]. Available: <https://environment.data.gov.uk/dataset/119e6ba7-b7fe-463a-961f-34232ef3e7cd>. [Accessed 29 October 2024].

- [25] Department for Environment, Food and Rural Affairs; and Environment Agency, "Swimfo: Find a bathing water," 2024. [Online]. Available: <https://environment.data.gov.uk/bwq/profiles/>. [Accessed 29 October 2024].
- [26] Natural England, "Sites of Special Scientific Interest (England)," 30 September 2024. [Online]. Available: <https://www.data.gov.uk/dataset/5b632bd7-9838-4ef2-9101-ea9384421b0d/sites-of-special-scientific-interest-england>. [Accessed 29 October 2024].
- [27] Natural England, "Special Protection Areas (England)," 03 July 2024. [Online]. Available: <https://www.data.gov.uk/dataset/174f4e23-acb6-4305-9365-1e33c8d0e455/special-protection-areas-england>. [Accessed 29 October 2024].
- [28] Natural England, "Special Areas of Conservation (England)," 03 July 2024. [Online]. Available: <https://www.data.gov.uk/dataset/a85e64d9-d0f1-4500-9080-b0e29b81fbc8/special-areas-of-conservation-england>. [Accessed 29 October 2024].
- [29] Natural England, "Ramsar (England)," 03 July 2024. [Online]. Available: <https://www.data.gov.uk/dataset/67b4ef48-d0b2-4b6f-b659-4efa33469889/ramsar-england>. [Accessed 29 October 2024].
- [30] Natural England, "National Nature Reserves (England)," 25 June 2024. [Online]. Available: <https://www.data.gov.uk/dataset/726484b0-d14e-44a3-9621-29e79fc47bfc/national-nature-reserves-england>. [Accessed 29 October 2024].
- [31] Natural England, "Local Nature Reserves (England)," 30 September 2024. [Online]. Available: <https://www.data.gov.uk/dataset/acdf4a9e-a115-41fb-bbe9-603c819aa7f7/local-nature-reserves-england>. [Accessed 29 October 2024].
- [32] Natural England, "Green Infrastructure Map," 2024. [Online]. Available: <https://designatedsites.naturalengland.org.uk/GreenInfrastructure/Map.aspx>. [Accessed 29 October 2024].
- [33] Land, Environment, Economics and Policy Institute at The University of Exeter, "Outdoor Recreation Valuation Tool (ORVal: Version 2.0)," No date. [Online]. Available: <https://www.leep.exeter.ac.uk/orval/>. [Accessed 07 October 2024].
- [34] Natural England, "Accounting for National Nature Reserves: A Natural Capital Account of the National Nature Reserves managed by Natural England (NERR078)," Natural England, 2019.
- [35] R. Lenane, "The Natural Capital Register and Account Tool version 1.2 – User Guide," Environment Agency, 2023.
- [36] International Union for Conservation of Nature and Natural Resources and Peatland Programme, "Peatland Code Field Protocol," 2022.
- [37] M. Christie, A. Hyde, R. Cooper, I. Fazey, P. Dennis, J. Warren, S. Colombo and N. Hanley, "Economic Valuation of the Benefits of Ecosystem Services delivered by the UK Biodiversity Action Plan (Defra Project SFFSD 0702)," 2011.
- [38] R. Gregg, J. Elias, I. Alonso, I. Crsoher, P. Muto and M. Morecraft, "Carbon Storage and Sequestration by Habitat 2021 (NERR094)," Natural England, 2021.

- [39] J. Nix, "Pocketbook for Farm Management 52nd edition," [Online]. Available: <https://theandersonscentre.co.uk/shop/john-nix-pocketbook/>. [Accessed December 2024].
- [40] Joint Nature Conservation Committee, "The Wash and North Norfolk Coast," [Online]. Available: <https://sac.jncc.gov.uk/site/UK0017075>. [Accessed 29 October 2024].
- [41] Joint Nature Conservation Committee, "Greater Wash SPA," December 2020. [Online]. Available: <https://jncc.gov.uk/our-work/greater-wash-spa/>. [Accessed 29 October 2024].
- [42] Ramsar Sites Information Service, "The Wash," 01 January 2007. [Online]. Available: <https://rsis.ramsar.org/ris/395>. [Accessed 29 October 2024].
- [43] Department for Environment Food & Rural Affairs, "MAGIC Map," [Online]. Available: <https://magic.defra.gov.uk/MagicMap.aspx>. [Accessed 29 October 2024].
- [44] Natural England, "Provisional Agricultural Land Classification (ALC) (England)," 2019. [Online]. Available: <https://naturalengland-defra.opendata.arcgis.com/datasets/Defra::provisional-agricultural-land-classification-alc-england/about>. [Accessed 16 12 2024].
- [45] Fens 2100+Partnership, "Witham South Forty Foot Drain Environmental and Agricultural baseline," March 2025. [Online]. [Accessed 2025].
- [46] Collinsons & Associates, "East and West Fens Agricultural Baseline Technical Note," 2024.
- [47] Water Resources East, "Draft Regional Water Resources Management Plan for eastern," Water Resources East, 2022.
- [48] International Union for the Conservation of Nature , "Peatland Programme - about peatlands," [Online]. Available: <https://www.iucn-uk-peatlandprogramme.org/about-peatlands>. [Accessed 03 01 2025].
- [49] F. Worrall, P. Chapman, J. Holden, C. Evans, R. Artz, P. Smith and R. Grayson, "Peatlands and Climate Change," 2010.
- [50] I. a. K. Holman, "A revised estimate of peat reserves and loss in the East Anglian Fens," Fens for the Future, 2011. [Online]. Available: <https://www.fensforthefuture.org.uk/admin/resources/banners/cranfieldfenland-phase-2-peat-assessment-19-01-11-final.pdf> . [Accessed 22 November 2024].
- [51] Fens for the Future Partnership, "A Strategic Plan for Fenland : A Proposal for an Enhanced Ecological Network (Final Report)," Mere Oak Ecology, Shrewsbury, 2012.
- [52] Office for National Statistics, "UK natural capital: peatlands," Office for National Statistics, 2019.
- [53] Environment Agency, "Policy paper, Cam and Ely Ouse abstraction licensing strategy (ALS), Environment Agency," 2020. [Online]. Available: <https://www.gov.uk/government/publications/cam-and-ely-ouse-abstraction-licensing-strategy/cam-and-ely-ouse-abstraction-licensing-strategy>. [Accessed 21 November 2024].

- [54] Environment Agency, "Old Bedford including Middle Level abstraction licensing strategy, Environment Agency," 2017. [Online]. Available: https://assets.publishing.service.gov.uk/media/5a82f227ed915d74e62386d3/ALS_2017_Old_Bedford.pdf. [Accessed 21 November 2024].
- [55] Environment Agency, "North West Norfolk abstraction licensing strategy, Environment Agency," 2017. [Online]. Available: https://assets.publishing.service.gov.uk/media/5a82f33340f0b6230269d8b3/ALS_2017_north_west_Norfolk.pdf. [Accessed 21 November 2024].
- [56] Environment Agency, Nene Catchment Abstraction Licensing Strategy, Environment Agency, 2021.
- [57] Anglian Water Services, "Fens Reservoir," [Online]. Available: <https://fensreservoir.co.uk/>. [Accessed 2025 September 2025].
- [58] M. Zari, "Utilizing relationships between ecosystem services, built environments, and building materials," *Materials for a Healthy, Ecological and Sustainable Built Environment*, pp. 3-27, 2017.
- [59] C. Earlie, G. Messelink and P. Russell, "The role of beach morphology on coastal cliff erosion under extreme waves," *EARTH SURFACE PROCESSES AND LANDFORMS*, vol. 43, pp. 1213-1228, 2018.
- [60] White, M., Elliott, L., Taylor, T., Wheeler, B., Spencer, A., Bone, A., Depledge, M. and Fleming, L., "Recreational physical activity in natural environments and implications for health: A population based cross-sectional study in England," *Preventive Medicine*, vol. 91, pp. p.383-388, 2016.
- [61] K. Vastila, P. Rowinski, J. Aberle, J. Jarvela and M. Kalinowska, "How vegetation can aid in coping with river management challenges: A brief review," *Ecohydrology & Hydrobiology*, vol. 18, no. 4, pp. 345-354, 2018.
- [62] Convention on Biological Diversity, "Sustaining Life on Earth," [Online]. Available: <https://www.cbd.int/convention/guide>. [Accessed 29 October 2024].
- [63] Department for Environment, Food & Rural Affairs, "Water abstraction statistics: England, 2000 to 2018," 4 January 2023. [Online]. Available: <https://www.gov.uk/government/statistics/water-abstraction-estimates/water-abstraction-statistics-england-2000-to-2018>. [Accessed 25 February 2025].
- [64] Department for Energy Security & Net Zero (DESNZ), "Renewable electricity by local authority 2014-2022," 2022. [Online]. Available: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fassets.publishing.service.gov.uk%2Fmedia%2F6512b64ff6746b000da4b9f7%2FRenewable_electricity_by_local_authority_2014_2022.xlsx&wdOrigin=BROWSELINK. [Accessed 29 10 2024].
- [65] Borough Council of King's Lynn & West Norfolk, "CO₂ Emissions Report 2018 to 2019," 2022.
- [66] East Cambridgeshire District Council, "Climate and Nature Action Plan and Monitoring," 2024.
- [67] A. Clasen, M. Peters, S. Ferger, M. Helbig-Bonitz, J. Shmack, G. Maassen, M. Schleunig, E. Kalko, K. Bohning-Gaese and I. Steffan-Dewenter, "Complementary

ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields,” *Proceedings of the Royal Society B*, vol. 281, no. 20133148, 2014.

- [68] Collisons and Associates, “Key land use, crop types and livestock populations on commercial holdings by 2021,” Arup, 2024.
- [69] Parliamentary office of Science and Technology , “Insect pollination POSTNOTE,” 2010.
- [70] V. e. a. 2014, “Status and value of pollinators and pollination services,” Defra, 2014.
- [71] Environment Agency, “The state of the environment: soil,” Environment Agency, 2019.
- [72] T. Sunderland, “Accounting for National Nature Reserves: A natural capital account of the National Nature Reserves managed by Natural England. Natural England Research Report, Number 078,” 2019.
- [73] K. R. e. al., “Earth beyond six of nine planetary boundaries,” *Science Advances*, vol. 9, no. 37, 2023.
- [74] Office for National Statistics, “UK natural capital accounts: 2023,” 2023. [Online]. Available: <https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2023>. [Accessed 29 10 2024].
- [75] P. Dasgupta, “The Economics of Biodiversity: The Dasgupta,” HM Treasury, London, 2021.
- [76] Environment Agency Engage, “Flood and Coastal Resilience Innovation Programme - Project Groundwater (Greater Lincolnshire),” 03 February 2025. [Online]. Available: <https://engageenvironmentagency.uk.engagementhq.com/lin011-groundwater>. [Accessed 08 August 2025].
- [77] Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire, “About the Great Fen,” No date. [Online]. Available: <https://www.greatfen.org.uk/about-great-fen>. [Accessed 28 April 2025].
- [78] Joint Nature Conservation Committee, “Great Fen,” 1 November 2021. [Online]. Available: <https://jncc.gov.uk/our-work/great-fen/>. [Accessed 28 April 2025].
- [79] Fens for the Future, “Conservation and Restoration,” No date. [Online]. Available: <https://www.fensforthefuture.org.uk/creating-the-future/conservation-and-restoration>. [Accessed 28 April 2025].
- [80] W. Trust, “Trees and Peat Position Statement,” September 2023. [Online]. Available: <https://www.woodlandtrust.org.uk/media/52958/trees-and-peat-position-statement.pdf>. [Accessed 2023 February 2025].
- [81] Ove Arup & Partners Limited, “Draft Steeping catchment biodiversity baseline Technical Note,” 2024.

Appendix A

Output - Benefits Statement

Natural Capital Benefits Statement

Data sensitivity: OFFICIAL
Place name: Great Ouse

Summary of physical and monetary flows

The Natural Capital Benefits Statement reports the provision ('flow') of a range of benefits. It draws on the currently available evidence to quantify the flow of benefits in physical and monetary terms. The quantitative results are accompanied by the Significance Assessment that provides a broader qualitative account of benefits, including those not currently assessed in quantitative terms. Each row represents a discreet combination of physical measurement and monetary valuation methods, and therefore this sheet shows the minimum number of unique rows required to cover all the benefits analysed.

Benefits are categorised according to a modified ecosystem service classification that incorporates some abiotic elements: (i) provisioning services (the production of physical goods we consume such as food and water); (ii) regulating services (ecosystems processes related to climate, air quality, hazard regulation, etc.); (iii) cultural services (aspects of the natural environment that enrich our lives, such as recreational benefits); and (iv) 'bundled' services (that combine multiple benefits). The contribution of supporting services - the ecological processes and functions such as nutrient cycling that maintain the conditions for life on earth and underpin ecosystem service provision - to current benefits flows is embedded within the monetary benefits for provisioning, regulating, cultural and bundled services.

Instruction: The Benefits Statement is automatically populated from the input and process tabs.

	Ecosystem service	Significance	Benefit valued	Benefit type	Beneficiaries			Physical flows		Monetary values						
					Local population	Wider Society	Private Sector	Measure (unit)	Avg unit / year	Valuation basis	Annual value (central) £m	Asset value (PV; 100 yr) (low) £m	Asset value (PV; 100 yr) (high) £m	Asset value (PV; 100 yr) (central) £m	Representation	
Provisioning	Agriculture - Arable	+++	Food	Market	●●●	●●●	●●●	Yield of arable production (tonnes/yr)	1,554,044	Gross margin	173.31	-	-	5,166.75	■	
	Agriculture - Livestock (dairy)	++	Food	Market	●●●	●●●	●●●	Yield of livestock (dairy) production (kL/yr)	95,685	Gross margin	13.55	-	-	404.06	■	
	Agriculture - Livestock (meat)	+	Food	Market	●●●	●●●	●●●	Yield of livestock (meat) production (tonnes/yr)	3,075	Gross margin	0.88	-	-	26.35	■	
	Fish and shellfish landings	--	Food	Market	○	○	○	Volume of fish and shellfish landings (tonnes/yr)	0	Net profit	0.00	-	-	0.00	■	
	Water supply (public)	+++	Water supply	Market	●●●	●●●	●●●	Abstracted raw water quantity (m3/yr)	38,048,947	Resource rent	45.89	-	-	1,368.05	■	
	Water supply (energy generation)	++	Water supply	Market	○	○	○	Abstracted raw water quantity (m3/yr)	6,028,341	Not valued	-	-	-	-	■	
	Water supply (all other)	+++	Water supply	Market	●●●	●●●	●●●	Abstracted raw water quantity (m3/yr)	31,410,737	Marginal value	275.22	-	-	8,204.97	■	
	Timber	+	Timber	Market	●	●	●	Volume of timber removals (m3/yr)	28,356	Stumpage price	0.96	-	-	28.51	■	
	Renewable energy	++	Renewable energy	Market	●●●	●●●	●●●	Renewable energy generation (MWh/yr)	602,848	Resource rent	8.41	-	-	250.85	■	
	Climate regulation	+++	Climate	Non-market	●●●	●●●	●●●	Net CO2eq sequestered (tonnes/yr)*	-1,014,889	Abatement cost	-292.52	896.20	897.37	896.78	■	
Regulating	Air quality - PM2.5	+	Health	Non-market	●●●	●●●	●●●	PM2.5 removed (tonnes/yr)	49	Avoided cost (treatment and productivity) plus welfare value	1.69	-	-	51.60	■	
	Air quality - SO2	+	Health	Non-market	●●●	●●●	●●●	SO2 removed (tonnes/yr)	339	Avoided cost (treatment and productivity) plus welfare value	0.01	-	-	0.96	■	
	Air quality - NO2	+	Health	Non-market	●●●	●●●	●●●	NO2 removed (tonnes/yr)	260	Avoided cost (treatment and productivity) plus welfare value	0.96	-	-	7.93	■	
	Air quality - O3	+	Health	Non-market	●●●	●●●	●●●	O3 removed (tonnes/yr)	10,793	Avoided cost (treatment and productivity) plus welfare value	0.80	-	-	41.22	■	
	Hazard regulation	++	Flood risk reduction	Non-market	●●●	●●●	●●●	Annual volume of potential flood storage by woodlands (m3/yr)	1,084,864	Not valued	-	-	-	-	■	
	Disease and pests	++			●●●	●●●	●●●								■	
	Pollination	++			●●●	●●●	●●●								■	
	Soil quality / erosion	++			●●●	●●●	●●●								■	
	Noise mitigation	+			●●●	●●●	●●●								■	
	Waste remediation	+			●●●	●●●	●●●								■	
Cultural	Recreation (adults)	++	Recreation	Non-market	●●●	●●●	●●●	No. visits to open spaces (visits/yr)	14,808,312	Welfare value	22.86	-	-	551.86	■	
	Recreation (children)	++	Recreation	Non-market	●●●	●●●	●●●	No. visits to open spaces (visits/yr)	3,756,072	Not valued	-	-	-	-	■	
	Physical Health	++	Health	Non-market	●●●	●●●	●●●	No. active visits to open spaces (visits/yr)	7,626,281	Avoided treatment cost	14.30	-	-	426.32	■	
	Education	++	Educational benefits	Non-market	●●●	●●●	●●●	No. educational visits (visits/yr)	0	Exchange value	0.00	0.00	0.00	0.00	■	
	Volunteering	+	Volunteering	Non-market	●●●	●●●	●●●	No. volunteering days (days/yr)	0	Opportunity cost	0.00	-	-	0.00	■	
	Amenity	++			●●●	●●●	●●●								■	
Bundled	Aesthetic / sense of place	++			●●●	●●●	●●●							■		
	Spiritual	++			●●●	●●●	●●●							■		
	Water quality - rivers	++	Various	Non-market	●●●	●●●	●●●			Welfare value of good water quality	1.91	46.71	67.14	56.93	■	
	Water quality - transitional, coastal waters and lakes	+	Various	Non-market	●●●	●●●	●●●			Welfare value of good water quality	0.00	0.00	0.00	0.00	■	
Biodiversity	+++			●●●	●●●	●●●								■		
Total market benefit value (£m)											518.22				15,449.54	
Total non-market benefit value (£m)												-250.17				2,033.20
Total quantifiable value (£m)												268.05				17,482.73

Notes:

- * Net carbon dioxide equivalent sequestration is estimated taking into account both carbon sequestration by habitats and green house gas sequestration and emissions from peatland
- Annual value is estimated flow at base year (Year 0)
- Asset value calculated as discounted flow of benefits (present value terms; 100 years). Future flows are discounted in accordance with HM Treasury Green Book guidance. This is an estimate of the gross asset value since it does include (net) costs of maintaining asset condition.
- Where available low - high ranges are reported for (gross) asset value; otherwise the cell has been left blank (-)

Significance key

Highly significant (+++)	The benefit flow is (very) important to the place in <u>relative terms</u> , because it impacts the wellbeing of a significant proportion (and possibly a wide variety) of people and businesses and/or due to wider social and cultural aspects.
Significant (++)	The benefit flow is of material importance in <u>relative terms</u> , because it impacts the wellbeing of a sizeable proportion of people and businesses.
Minor (+)	The benefit flow is of minor importance in <u>relative terms</u> , because it does not impact most people and business. Note: it may, though, still be highly important to a small number of specific individuals or groups.
Not significant (-)	There is very little or no provision of this benefit and it impacts only a very small number of people and businesses.
Not assessed (-)	Significance rating not completed.

See "Input - Significance Assessment" tab for more details

Beneficiaries key

<input checked="" type="radio"/>	Direct (primary and secondary) beneficiary from the ecosystem service provision.
<input type="radio"/>	Indirect beneficiary from the ecosystem service provision.
<input type="radio"/>	Beneficiary does not benefit from the ecosystem service provision.
Not assessed (-)	Beneficiaries rating not completed.

See "Input - Beneficiaries" tab for more details

Monetary valuation confidence key

Green	High confidence in results. Input data and assumptions are based on statistical reports, peer reviewed values or industry standard methodologies
Amber	Moderate confidence in results. Input data and/or assumptions from single source/not peer reviewed, or based on sources that are not specifically tailored to this context. We have used some assumptions or estimation and some of these may be open to question. Accuracy is better than +/- 50%
Red	Low confidence in results. Input data and/or parameters from single source and low level of transferability from original context. We are confident that the number is in the right order of magnitude. Order of magnitude implies that for an estimate of 5 that we are confident that the real figure is within the range 0.5 to 50
No value (-)	Not valued or it is not possible to provide a result that can be judged to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. Currently limited to qualitative assessment only.

Representation key

	The benefit flow is substantially represented in the monetary valuation process, with only minor elements not included.
	The benefit flow is partially represented in the monetary valuation process.
	The benefit flow is not represented in the monetary valuation process.
Not assessed (-)	Representation rating not completed.

See "Input - Significance Assessment" tab for more details