

An FWR Guide

Natural Capital and its Relevance to Improving Freshwater and Wetland Habitats

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1 Introduction

1.1 Aim of the Guide

Natural Capital is a relatively recent, emerging concept that has become embedded in the environmental and biodiversity policies of governments and their agencies, both in the UK and internationally. Traditional economics assigned no value to sub-surface material wealth (fossil fuels, metallic ores, mineral aggregates) per se, placing monetary value only on the inputs required to extract such materials and the processing need to get them into commercial markets. The same has applied to the living world and the range of resources it provides to society. Should a resource become overexploited then mankind's ingenuity would come to the rescue and alternative materials would be put into service and, with the application of technological inventiveness, economic growth would continue. A classic historic example is the switch from timber-based charcoal production, for use as fuel in ore smelting, to coal-based coke production.

Nature in fact provides society with many goods and services that we all too often have taken for granted, qualitatively appreciating but not valuing them. The list of goods and services is long and includes recreation, health, water, aesthetic appreciation, food and timber. In economic terms the value of these services to society is large but most lie outside the commercial market. For example, as is explained later in the Guide, timber has a market value but the total economic value of woodlands – which deliver other societal services and from which timber is obtained – is far greater than that of the timber.

Economics has progressed as a discipline, however, and it is now mainstream to consider non-market impacts of activities or developments on society – what are technically known as 'externalities' – and to place monetary values on those impacts, whether positive (benefits) or negative (harmful). It is important to appreciate that **economics and finance are quite distinct** though they share certain methodologies, and both use monetary values. So, Natural Capital has emerged as a fundamental concept that is increasingly important as an influence on policy, development and practice. An influence that is likely to grow rather than fizzle out as a fad.

But how many of us having a keen interest in nature and the environment have more than an inkling as to what the term 'Natural Capital' means? And how many of us are aware of the concept but dismiss it as practically irrelevant? Or regard the idea of putting a price on nature, biodiversity and a clean environment – including good quality surface waters – as an affront to morality and the intrinsic value of nature?¹ While the present authors regard it as reasonable to question the validity of placing a value on nature purely from mankind's perspective (its utility to humans), we regard the third, fundamentalist viewpoint as a 'counsel of perfection' and not conducive to progress. We take the view that valuing the life-giving economic services (including mental and physical health) that nature provides to humanity, can co-exist with recognising the intrinsic properties and worth of nature. Regardless of one's viewpoint, it cannot be denied that Natural Capital is increasingly becoming embedded in the UKs, and certainly England's, environmental policy framework.

As motivated environmentalists and naturalists, therefore, we should have at least a basic grasp of Natural Capital and related concepts. This can only help us to engage more effectively in the critical shaping of environmental policies, strategies and plans – whether at national, regional or

¹ See, for instance, George Monbiot (2018) The UK Government wants to put a price on nature – but that will destroy it. *The Guardian*, 15 May 2018.

local level. The same reasoning applies also to monitoring the implementation of policies, strategies and plans and their impacts. This Guide has been prepared, therefore, to contribute to developing such an understanding. Consequently, it aims to be of assistance to readers who would like to gain a basic appreciation of Natural Capital and to consider its relevance when applied at local and other levels to the conservation and restoration of freshwater and wetland habitats. It may be read as complementing FWR's Guide to those habitats.²

1.2 Scope of the Guide

Chapter 2 provides a summary account of how Natural Capital has become embedded into government policy, legislation and planning – it seeks to provide context. Selected key messages from independent reviews, conducted since the mid-late 2000s, are also given – reviews that have been commissioned by government and have influenced the shaping of its policies.

Chapter 3 introduces how the study of economics has expanded over time to include Natural Capital amongst the various other types of capital that people are more familiar with. It then defines and explores Natural Capital and associated concepts in language that the authors hope is meaningful to people having a general but non-expert interest in the topic.

Chapter 4 provides several examples where a Natural Capital approach has been trialled in England, introducing their objectives, activities and outputs. The coverage in this chapter is somewhat wider than freshwater and wetland habitats but seeks to provide a 'water focus' where possible.

Chapter 5 introduces some of the tools that are currently available for applying the Natural Capital approach in practice, and the types of information needed.

The Guide concludes with an account in Chapter 6 of how an understanding of Natural Capital and its associated tools may be relevant to the conservation and restoration of freshwater and wetland habitats.

1.3 What this Guide is not

This Guide is not designed as a manual on how to measure Natural Capital or changes in Natural Capital, though sources of information, the tools currently available, and links to guidance on how they may be used, are introduced and referenced. Non-specialist readers who, after reading this Guide, are interested in undertaking Natural Capital assessments should consult an economist for further advice.

Hyperlink references are given throughout the Guide to allow readers ready, direct access to the primary sources of information of interest and relevance.

Annex 4 contains a list of acronyms used in the Guide, together with a glossary of terms unless defined in Chapter 3.

² Frost RC and Newman PJ (2021) FWR Publication FR/G0011, *Freshwater and Wetland Habits – Opportunities to Get Involved in their Conservation and Restoration*.

2 Natural Capital's Embedding in Government Policy

2.1 Scope

This chapter provides an overview of the process whereby Natural Capital has become integral to government policy and legislation in England (Figure 1). It notes key messages from several influential independent reviews and assessments that have been commissioned by Governments of many persuasions since 2005; outlines the vital role played by the 2011 Environment White Paper (EWP, 2011³) and its recommendations; and summarises the scope of the Natural Capital Committee's (NCC) outputs, principally aspects of the first 25 Year Environment Plan and the draft Environment Bill.

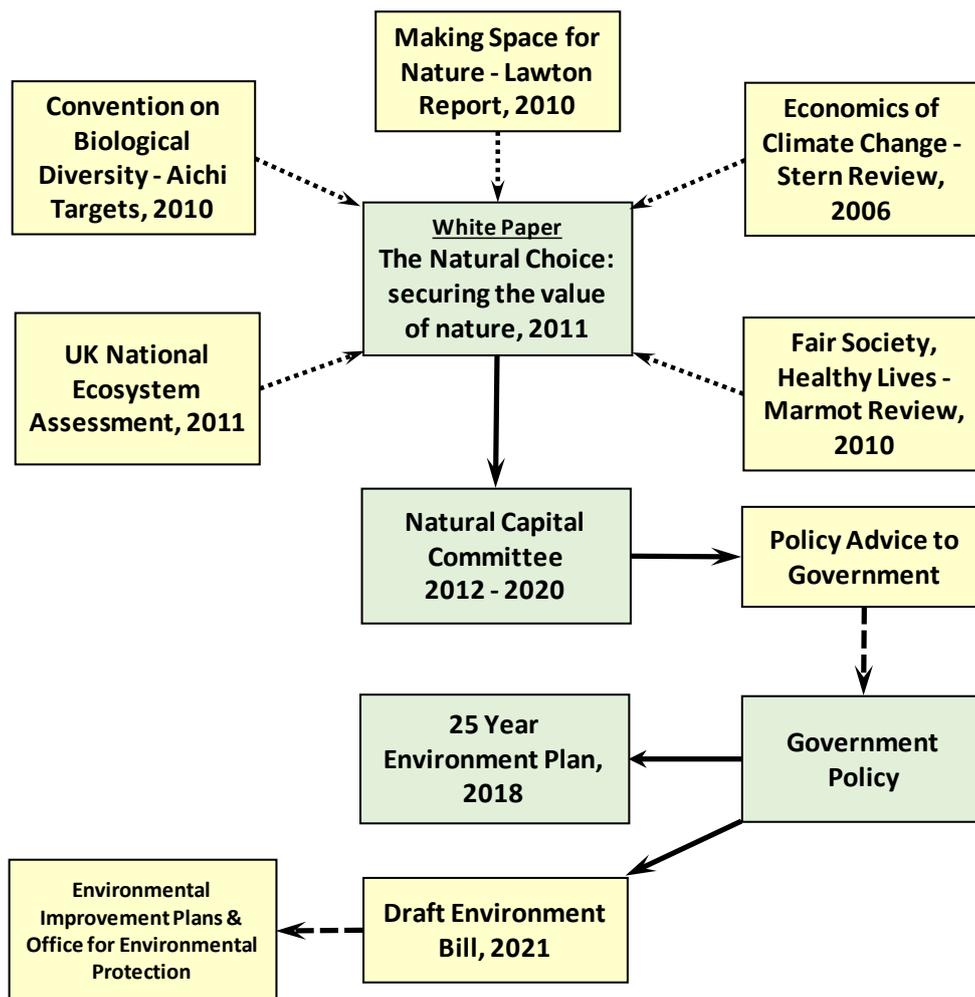


Figure 1 Key Stages in the Inclusion of Natural Capital in England's Policy Framework

Source: R C Frost

2.2 The Natural Choice: securing value from nature

2.2.1 Significance of the Environment White Paper (2011)

EWP 2011, *The Natural Choice: securing value from nature*³, may be regarded as a landmark in the development of England's environmental policy. For present purposes, its significance lies

³ Accessible at: <https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature>

mainly in its recommendation to form a Natural Capital Committee. The NCC's outputs and recommendations have paved the way for, amongst other things, the preparation of the first 25 Year Environment Plan and the draft Environment Bill, both primarily affecting England.

Sections 3.2.2 to 3.2.5 of the Guide introduce the scope and key messages of several influential reviews whose commissioning by government preceded the EWP. The ambitions embedded in the EWP and its Natural Capital recommendations are given in Section 3.2.6.

2.2.2 The Economics of Climate Change: The Stern Review, 2006

Published in October 2006, the Stern Review was commissioned by the Chancellor of the Exchequer in July 2005 to report on an evidence-based assessment of the economics of moving to a low-carbon global economy and the implications of that assessment for the UK.⁴ Though there has been much debate within the economics profession concerning the discount factors used and other features of the economic assessment, the review has certainly been influential in its consideration of:

- The current level, and future trajectory, of the 'social cost of carbon', i.e. the costs of impacts associated with an additional unit of greenhouse gas (GHG) emission. In economic terms this 'social cost' may be termed an externality, i.e. the impacts and the costs of those climate change impacts are not necessarily borne by the emitter.
- Marginal abatement costs, i.e. the costs associated with incremental unit reductions in GHG emission.

2.2.3 Making Space for Nature: The Lawton Report, 2010

Though its remit did not extend to the consideration of Natural Capital per se, the Lawton Report⁵ has been influential in encouraging a shift in wildlife conservation away from simply *hanging on to what we have, to one of large-scale habitat restoration and re-creation, underpinned by the re-establishment of ecological processes and ecosystem services, for the benefits of both people and wildlife*. It further observed that: *There are strong moral arguments for recognising the intrinsic values of other species and for passing on the natural riches we have inherited to future generations. We have also recently begun to better understand (or perhaps remember) that our natural world is not a luxury: it is fundamental to our well-being, health and economy. The natural environment provides us with a range of benefits – ecosystem services, including food, water, materials, flood defences and carbon sequestration – and biodiversity underpins most, if not all, of them.*

2.2.4 UK National Ecosystem Assessment, 2011 (UK NEA)⁶

Funded by all UK governments, the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC) undertook this collaborative assessment involving about 500 experts under the chairmanship of Professors Robert Watson and Steve Albon. It was a first attempt to assess the UK's stocks of natural ecosystem resources, their state and the trends in their development. It provided a coherent body of evidence about the state of the UK's natural

⁴ An Executive Summary is available at: https://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/media/4/3/executive_summary.pdf

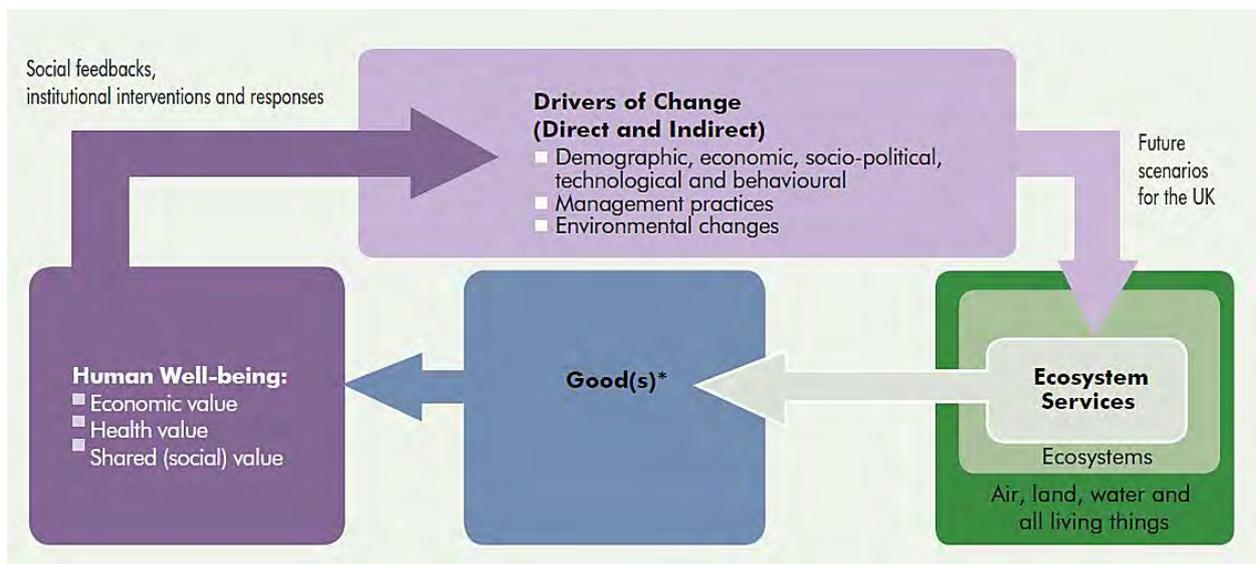
⁵ Lawton Report (2010) Making Space for Nature: A review of England's wildlife sites and ecological network. <https://webarchive.nationalarchives.gov.uk/20130402170324/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf>

⁶ UK National Ecosystem Assessment (2011) The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge. Available at: <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

environment and the services it provides. Snapshots were given of the situation in each of the UK's countries. Of ten key questions addressed in the UK NEA, three are of particular importance for the development and integration of Natural Capital concepts:

1. Why should we incorporate the economic values of ecosystem services into decision making?
2. What are the economic implications of different plausible futures?
3. How have we advanced our understanding of the influence of ecosystem services on human well-being and what are the knowledge constraints on more informed decision making?

The UK NEA introduced a conceptual framework for ecosystem assessment (Figure 2). This was structured around the processes that link human societies and their well-being with the environment. It explored the drivers of change having impacts on ecosystems, and the services that flow from them, delivering goods that we value individually and as a society.



* Note that the term good(s) includes all use and non-use, material and non-material benefits from ecosystems that have value for people. All these terms are explained in Chapter 3 of the Guide.

Figure 2 UK NEA Conceptual Framework

Source: UK NEA, Figure 9

Key messages (authors' emphasis) of the UK NEA include the following:

- The natural world, its biodiversity and its constituent ecosystems are **critically important** to our well-being and economic prosperity **but are consistently undervalued in conventional economic analyses and decision making.**
- Actions taken and decisions made now will have consequences far into the future for ecosystems, ecosystem services and human well-being. It is important that these [consequences] are understood, so that we can make the best possible choices, not just for society now but also for future generations. Contemporary **economic and participatory techniques allow us to estimate values for a wide range of ecosystem services.** Applying these to scenarios of plausible futures shows that **allowing decisions to be guided by market prices alone forgoes opportunities for major enhancements in ecosystem services, with negative consequences for social well-being.** Recognising the value of ecosystem services more fully would allow the UK to move towards a more

sustainable future, in which the benefits of ecosystem services are better realised and more equitably distributed.

Though prepared post-EWP, the subsequent UK National Ecosystem Assessment follow-on, 2014 (UK NEAFO)⁷, re-emphasised and elaborated the above key messages:

- The UK NEAFO provided **new information and tools to help decision-makers** across all sectors understand the wider value of our ecosystems and the services they offer us.
- The UK NEAFO confirmed that the **ecosystem services derived from Natural Capital contribute to the economic performance** of the nation by supporting economic sectors, regional and national wealth creation and employment. But the relationship between our ‘Natural Capital’ and the wider economy is complex. By mapping the relationships between ecosystem services and major sectors of the economy, such as agriculture and food manufacture, we can begin to understand the economic impacts arising from any changes in our ecosystem services. The UK NEAFO has developed a Natural Capital Asset Check (NCAC) to help this process.
- Building on the UK NEA, the UK NEAFO quantitatively valued a number of additional ecosystem services. The assessment concluded that **spatially targeted policies deliver more economically efficient outcomes**. It also showed that before decisions are made it is important to fully appraise the widest possible range of policy options that take into consideration our Natural Capital stocks and flows.
- The UK NEAFO made particular **advances in the valuation of cultural ecosystem services** that give rise to a range of material and non-material benefits to human well-being, but which are frequently overlooked in decision-making.
- The UK NEAFO concluded that **embedding knowledge of our ecosystems and their services into project, programme and policy appraisals** – rarely considered explicitly in government impact appraisals before 2013 – **is critical for decision-making**. This knowledge could provide many wider benefits for society if considered at an early stage of policy development.

2.2.5 Fair Society, Healthy Lives: The Marmot Review, 2010⁸

In November 2008, the then Secretary of State for Health invited Professor Sir Michael Marmot to chair an independent review to propose the most effective evidence-based strategies for reducing health inequalities in England from 2010. Though perhaps not obviously relevant to a guide on Natural Capital, this review is significant for proposing policy objective (E) to ‘Create and develop healthy and sustainable places and communities’. This directly links the Marmot Review to the Natural Capital considerations of the UK NEA and UK NEAFO, specifically to the messaging on the value of cultural ecosystem services. Published in February 2010, key messages from the Marmot Review included:

⁷ UK National Ecosystem Assessment (2014) The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, LWEC, UK. Available at: <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>

⁸ ‘Fair Society, Healthy Lives: The Marmot Review: Strategic Review of Health Inequalities in England post-2010’. Available: <https://www.gov.uk/research-for-development-outputs/fair-society-healthy-lives-the-marmot-review-strategic-review-of-health-inequalities-in-england-post-2010>. A subsequent review ‘Health Equity in England: The Marmot Review Ten Years On’, was published in February 2020 by the Institute of Health Equity. Available at: <https://www.health.org.uk/publications/reports/the-marmot-review-10-years-on>

- There is a social gradient in health: the lower a person’s social position, the worse his or her health.
- Reducing health inequalities requires action on several fronts, including the **creation and development of healthy and sustainable places** and communities.
- **Action that reduces health inequalities benefits society in many ways**, including the reduction of economic losses from mental and physical illness associated with health inequalities. Included in such losses are productivity losses, reduced tax revenue, higher welfare payments and increased treatment costs.

Under policy objective (E), recommendations to achieve the priority objective of ‘improving community capital and reduce social isolation across the social gradient’ include:

- **Improving the availability of good quality open and green spaces** across the social gradient
- Fully integrate the planning, transport, housing, environmental and health systems to address the social determinants of health in each locality
- Remove barriers to community participation and action.

2.2.6 Convention on Biological Diversity (CBD) and the Aichi Targets, 2010

The United Nations’ Rio ‘Earth Summit’ of 1992 led to the adoption of the Convention on Biological Diversity (CBD), to which the UK became a Party by ratification. Since coming into force the CBD has provided a basis for agreeing biodiversity conservation goals at international and national levels. Parties to the CBD meet periodically at Conferences of the Parties (COP). The Strategic Plan for Biodiversity, formed in 2010 with a planning horizon of 2020, was a major COP output.⁹ This set five strategic biodiversity goals accompanied by 20 ambitious supportive targets, collectively known as the Aichi Targets. Though many targets other than procedural ones have proved to be overly ambitious, three of specific relevance to this Guide are:

- Target 02: By 2020 at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.
- Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contributing to health, livelihoods and well-being, are restored and safeguarded.
- Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Aichi Target 02 is specifically addressed in the EWP through commitments 35, 40, 41 and 44 (see 2.2.7), which signal the intention that Natural Capital is included fully in the UK Environmental Accounts, a roadmap for further improvements is published, and that businesses are helped to understand their impacts on Natural Capital.

⁹ Published in 2012, the UK’s Post-2010 Biodiversity Framework (Framework) built on the UK’s Biodiversity Action Plan of 1994. It cascaded the Aichi targets down to priorities for action at a country level. Reflecting a revised direction for nature conservation, it acknowledged the value of nature and looked to the inclusion of nature’s value in future decision-making. An implementation plan was produced in November 2013, updated and revised in June 2018.

2.2.7 Natural Capital Proposals in the Environment White Paper, 2011

The EWP addressed four main themes:

- (i) the case for a better approach to assessing our nation's ecosystems, making space for nature, and well-being in a healthier economy
- (ii) protecting and improving our natural environment
- (iii) growing a green economy and
- (iv) reconnecting people and nature.

Table 1 states the ambitions elaborated in Chapters 2, 3 and 4 of the EWP. Influenced by the above reviews, international obligations and targets, and by other strategic documents,¹⁰ the EWP places Natural Capital at the heart of its overriding objective for '**... this generation to leave the natural environment of England in a better state than it inherited**'.¹¹ To this end, the EWP makes 92 commitments, of which several relate directly to Natural Capital:

- Commitment 35: We will put Natural Capital at the heart of government accounting. We will work with the Office of National Statistics (ONS) to fully include Natural Capital in the UK Environmental Accounts, with early changes by 2013. In 2012 we will publish a roadmap for further improvements up to 2020.
- Commitment 36: The government will establish an independent Natural Capital Committee (NCC) reporting to the Economic Affairs Cabinet Committee which is chaired by the Chancellor of the Exchequer. The Committee will advise the government on the state of English Natural Capital.
- Commitment 37: To support the initial work of the NCC, the government will take forward a scoping study in 2011 for a Natural Capital asset check.
- Commitment 38: Later this year (2011), the government will publish a 'Roadmap to a Green Economy', to provide business with as much clarity as possible about the future direction of policy.
- Commitment 39: We have established a Green Economy Council with leading businesses, which will consider Natural Capital in its terms of reference.
- Commitment 42: We will work with local authority partnerships through the Total Environment initiative to identify and address barriers to using green infrastructure to promote sustainable growth, and share the lessons learned.

¹⁰ For example, the EWP acknowledged that the White Paper, HM Government (2010), *Healthy Lives, Healthy People: Our strategy for public health in England*, recognised that the quality of environment, including the availability of green space and the influence of poor air quality and noise, affects people's health and well-being.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216096/dh_127424.pdf

¹¹ The wording of this objective has to be interpreted carefully. It concerns Natural Capital only. It should not be read as a denigration of the effectiveness and efforts of countless scientists and economists in the field of environmental management over many previous years.

Table 1 Ambitions of the EWP

Chapter		Our ambition is:
2	Protecting and improving our natural environment	To improve the quality of our natural environment across England, moving to a net gain in the value of nature. We aim to arrest the decline in habitats and species and the degradation of landscapes. We will protect priority habitats and safeguard vulnerable non-renewable resources for future generations.
3	Growing a green economy	For a green and growing economy which not only uses Natural Capital in a responsible and fair way but contributes to improving it. It will properly value the stocks and flows of Natural Capital. Growth will be green because it is intrinsically linked to the health of the country's natural resources. The economy will capture the value of nature. It will encourage businesses to use Natural Capital sustainably, protecting and improving it through their day-to-day operations and the management of their supply chains.
4	Reconnecting people and nature	To strengthen the connections between people and nature. We want to help more people enjoy the benefits of nature by giving them more freedom to connect with it. Everyone should have fair access to a good quality natural environment. We want to see every child in England given the opportunity to experience and learn about the natural environment. We want to help people take more responsibility for the environment, putting people and local communities in control and making it easier for people to take positive action.

2.3 Natural Capital Committee, 2012–2020

Responding to commitment 36 of the EWP, the government established the independent NCC in May 2012 under the chairmanship of Professor Dieter Helm. The Committee provided independent advice to government on Natural Capital matters in England up to the end of its (second) term in December 2020. The Committee's 'End of Term Report' provided its terms of reference, the scope of its comprehensive advice to government (Table 2), a listing of its publications (all available online), and a concise assessment of the NCC's impacts.¹²

¹² Natural Capital Committee (November 2020) 'End of Term Report' to the Domestic and Economy Implementation Committee of the Cabinet. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931695/ncc-end-of-term-report.pdf

Table 2 Abbreviated Scope of the NCC’s Advice to government

First Term: 2012–2015. Advising on:	Second Term: 2016–2020. Advising on:
Defining the meaning of Natural Capital and the development of national Natural Capital accounts – essential for understanding the state of our Natural Capital assets and whether they are being used sustainably.	Development and implementation of an integrated 25-year environment plan (YEP) to protect and improve our Natural Capital; making use of appropriate knowledge and tools to identify priority assets for protection and improvement: forming an environmental baseline census of Natural Capital stocks.
Proposing a framework for defining and measuring changes in Natural Capital.	Regarding the 25 YEP: identifying appropriate goals, scale of investment for Natural Capital assets, milestones, metrics and indicator framework for tracking progress, and governance for delivering the 25 YEP – including an independent body to scrutinise delivery and placing the 25 YEP on a meaningful statutory basis in the (forthcoming) Environment Bill. The NCC engaged with the ONS to ensure that the indicator framework and the ONS’s national Natural Capital accounts are in alignment.
The development of a long-term, 25-year plan for improving the environment, and providing a detailed framework for how to achieve it.	Delivering the net zero (climate change) target within the context of the 25 YEP goals (goal 7): mechanisms to include nature-based interventions, which have multiple benefits including health and well-being.
Priority areas for Natural Capital improvements and research.	Using the concept of ‘environmental net gain’ to obtain the biggest benefits from environmental improvements, replacing ‘biodiversity net gain’ as a metric.
Corporate Natural Capital accounting.	Pioneer projects to explore the challenges and opportunities raised in implementing a Natural Capital approach in practice, focusing on river catchments (Cumbria), urban areas (Manchester), landscapes (North Devon) and marine areas (Devon and Suffolk).
Guidance on project cost-benefit analysis – the Green Book.	Green Book guidance: embedding Natural Capital into public policy appraisal, recommending changes to public policy appraisal/evaluation to better embed Natural Capital into government decision making.
	The need for locally and nationally significant Natural Capital assets to be identified with a view to compiling a Natural Capital asset register, an associated risk register and a Natural Capital account for each (related) project.
	The National Infrastructure Commission’s incorporation of Natural Capital, including its maintenance, restoration and recovery, into long-term infrastructure plans – such as the ‘National Infrastructure Assessment’ – to ensure consistency with the objectives of the 25 YEP.
	Using the Natural Capital approach to link the CBD COP15 and UNFCCC COP26 meetings.

The NCC prepared several annual ‘State of Natural Capital’ reports, which included specific advice and recommendations additional to those contained in published advisory notes. The Committee

also provided robust critiques of the implementation of its accepted recommendations, summarised in the 'End of Term Report'. The NCC's End of Term Report assessed the Committee's impacts in three areas, summarised in Annex 1:

1. In the 25 Year Environment Plan (25 YEP) and its essential statutory framework
2. In an asset-based framework for assessing changes in Natural Capital/progress against the 25 YEP
3. In embedding Natural Capital in decision making.

The NCC's critiques indicate that progress in practice has been limited in some areas, and that firm resolve will be needed in future if Natural Capital aspirations are to be met. For instance:

- Requested by the government to advise on the first two 25 YEP progress reports, the NCC concluded (in September 2019) that Defra's first progress report did not provide an assessment of whether the natural environment in England had improved, and (in July and October 2020) that the second progress report demonstrated very little progress had been made. The NCC presented its own framework for comprehensively measuring the state of the Natural Capital assets.
- The *National Infrastructure Assessment* published by the NIC in July 2018 paid little regard to the 25 YEP and its 10 goals. Indeed, the environment appeared to be considered a constraint.

2.4 25 Year Environment Plan (England), 2018¹³

The 25 YEP adopts the Natural Capital approach as a tool to aid long-term decision-making, a world first. It sets the overarching goal that our generation will *become the first generation to leave the environment in a better state than we found it*, passing on to the next generation a natural environment that is protected and enhanced for the future. This goal might sound rather 'bumptious' to seasoned environmental professionals, but it makes sense once it is appreciated that it refers to the concept of Natural Capital, which lies at the heart of the 25 YEP. High standards are to be set to protect and expand Natural Capital, recognising the often hidden benefits to be found in every aspect of the environment for national well-being, health and economic prosperity. The plan's 25-year goals refer to ten aspects of the natural environment, making several specific references to Natural Capital:

- Natural Capital and Values: largely reiterating the messages of previous policy documents on the commonly unrecognised economic value of the natural environment, and that traditional accounting methods fail to capture these values leading too often to their being ignored in policy decision-making, development planning, and management.
- Goals for Environmental Improvement: these are framed around the primary goods and benefits derived from Natural Capital: clean air, clean and plentiful water, thriving plants and wildlife, reduced risks of harm from environmental hazards and using natural resources more efficiently. The 25 YEP states that:
 - The planning system is to be adjusted to enable local authorities to develop locally-led strategies which produce environmental 'net gains' and create greater certainty

¹³ 25 Year Environment Plan (25 YEP) <https://www.gov.uk/government/publications/25-year-environment-plan>

and consistency in development planning and decision-making, without placing greater burdens on developers, whether large or small.

- The 'net gain' approach currently used in relation to decisions concerning biodiversity is to be expanded to include wider Natural Capital benefits, such as flood protection, recreation and improved water and air quality.
 - The use of tariffs to steer development towards the least environmentally damaging outcomes and to secure investment in Natural Capital is to be explored – involving the introduction of a new environmental land management system, providing incentives to land managers to restore and improve local Natural Capital and rural heritage.
 - A greater uptake of Natural Capital reporting, standards and accounting across government and businesses is to be encouraged to ensure a proper and consistent use of Natural Capital approaches in environmental protection, development planning and decision-making. As an initial step, current environmental indicators and monitoring programmes are to be reviewed for their relevance and, where appropriate, reworked to take account of Natural Capital.
- Natural Capital Accounting: involves research to establish which measures of the relationship between Natural Capital and its benefits to society give the best insights into how Natural Capital changes over time – including its quantity, quality and where it is vested. Additionally, ONS will continue to develop a full set of Natural Capital accounts for the UK, forming the baseline against which changes to Natural Capital can be measured over time. National metrics are likely to be supplemented by local metrics, tailored to a narrower set of needs and circumstances.
- Government-led Activities: at local levels, environmental effort should have strong local leadership, guided by the 25 YEP goals and integrated with satisfying local needs. In developing this approach, Defra, working closely with local partners, created four Pioneer Projects (Chapter 4) to help inform 25 YEP implementation: Greater Manchester Urban, Cumbrian Catchment, North Devon Landscape, and the Marine Pioneer at two marine/coastal locations (North Devon and Suffolk). Each project has been designed to explore four objectives: (1) demonstrating integrated approaches to planning and delivery, (2) building an understanding of 'what works' in practice, (3) applying a Natural Capital approach to decision making, and (4) developing innovative funding opportunities.

In addition, Defra identified 14 geographical areas in each of which an Area Integrated Plan was to be formed by the Environment Agency, Natural England and the Forestry Commission working in concert with the aim that:

- Area Integrated Plans would be developed into Natural Capital Plans
 - Areas would collaborate in using a Natural Capital approach, and bring in other partners to maximise the delivery of environmental benefits
 - The 14 identified Areas are mapped and, ultimately, their Natural Capital is managed strategically as a system.
- Funding Improvements in Natural Capital: given that there is strong evidence on how Natural Capital underpins the economy, supports long-term growth, and benefits human health and well-being; and that carefully planned investments in Natural Capital assets

can deliver significant value for money and generate economic returns that rank favourably with those generated by more traditional infrastructure investments; the 25 YEP refers to the exploration and testing of several funding mechanisms:

- With Defra support, the West of England Nature Partnership has worked closely with local authorities and the West of England Combined Authority to explore the establishment of a Natural Capital Trust for the West of England; and how this might benefit people across the region by enabling development and investment in Natural Capital. Having the right mix of public and private funding will be crucial to the successful delivery of the Plan. Such projects have typically been resourced through subsidies and grants from government, the EU, the Heritage Lottery Fund and philanthropic foundations, as well as local authorities, environmental organisations and private sector investment, notably by water companies.
- Under its price review PR19, Ofwat proposed higher rewards for water companies that deliver innovative outcomes, in the expectation they could spur a shift towards greater innovation in delivering environmental benefits, supported by private capital. It also expected the business plans of water service undertakings to embed Natural Capital approaches at catchment scales.
- 2017 saw the first UK public utilities green bonds issued. Anglian Water issued a green bond that raised £250m to fund projects that contribute to its sustainability strategy. And Tideway (the company responsible for delivering the Thames Tideway Tunnel), supported by contingent government financing, issued a £250m green bond which was three times oversubscribed. On a second green bond being issued, Tideway became the largest issuer of corporate green bonds in sterling, with a total amount of £450m.
- The 25 YEP recognised that increased private sector investment in Natural Capital will be crucial, and that robust measurements of the benefits of Natural Capital improvements will help sharpen the business case for private sector investment. This will help to unlock new markets, funding streams and private finance for natural environment projects, such as those previously identified and explored by the industry-led Ecosystems Markets Task Force. Other initiatives cited in the 25 YEP include a more recent report for Defra, a paper published by The Aldersgate Group, and Business in the Community.
- Potential for establishing a National Environment Impact Fund that blends capital from a range of sources (e.g. public, private/philanthropic) to provide technical assistance funding and repayable finance to suitable projects. Such a blended facility could issue a mix of grants and loans on a long-term repayment basis at below-market rates to help address some of the market failures that have to date limited the take up of return-generating natural environment projects. It would encourage innovation, help to develop the evidence base, and develop a track record that could lead to such projects attracting mainstream investment and the creation of new Natural Capital markets.

2.5 Draft Environment Bill, 2021

Whilst the 25 YEP is rich in its referencing of Natural Capital, the Draft Environment Bill is silent on Natural Capital per se.¹⁴ Nevertheless, the draft Bill (Annex 1) requires that the Secretary of State must prepare an ‘environmental improvement plan’ (EIP, for England) whose scope must include: (i) setting out the government’s steps (actions) for significantly improving the natural environment over the plan’s period, and (ii) setting out the steps that the government intends to take to improve people’s enjoyment of the natural environment in that period. The draft Bill also requires the Secretary of State to prepare annual reports on the implementation of the current EIP, to review it and, if required, revise the EIP. The 25 YEP is to be regarded as the first EIP and the first review must be completed by 31 January 2023. **Given the centrality of Natural Capital in the 25 YEP**, therefore, it is clear that **the provisions of the draft Bill provide a mechanism for assessing annual changes in Natural Capital**.

Furthermore, Chapter 2 of the draft Bill makes provision for the establishment of an Office for Environmental Protection (OEP) whose duties will include (i) monitoring and reporting on EIPs and targets, (ii) preparing a progress report for each annual reporting period, the same annual reporting period as applies above to the Secretary of State, and (iii) arrange that such annual reports are laid before Parliament and published.

However, the Secretary of State may issue guidance to the OEP on matters concerning the OEP’s enforcement policy and the OEP’s exercising of its enforcement functions: guidance that the OEP must have regard to. As the NCC (Annex 1) and a number of other commentators have pointed out, this provision potentially constrains the OEP from exercising independent thought. Whilst other provisions would constrain courts that had found a public authority acted illegally in approving a development, for instance, from reversing harmful developments if doing so caused ‘substantial hardship’ to the developer or other body.¹⁵ The future application of Natural Capital in decision making might therefore be constrained somewhat, contingent on political considerations.

2.6 UN Biodiversity Conference – COP 15, October 2021

Due to the COVID-19 pandemic, the fifteenth UN Biodiversity Conference of the Parties (COP 15) under the International Convention on Biological Diversity has been rescheduled to 2022 (in Kunming, China) together with interim, online meetings between 10 and 24 October 2021. In preparation for COP 15, the UK Treasury commissioned the Dasgupta Review on the Economics of Biodiversity, which was published on 2 February 2021.¹⁶ The Dasgupta Review makes a strong economic case for biodiversity, whilst recognising that *‘nature is more than an economic good: many value its very existence and recognise its intrinsic worth*. Annex 2 provides a brief introduction to its key messages and recommendations. Chapter 6 refers further to the Review.

¹⁴ <https://bills.parliament.uk/publications/42243/documents/555>. Most recently accessed 19/09/2021.

¹⁵ *Financial Times*, 10 June 2021, Post-Brexit green watchdog will lack teeth, warn legal experts. Reporters: Camilla Hodgson and Peter Foster.

¹⁶ The Economics of Biodiversity: The Dasgupta Review, published February 2021.

<https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review>.

3 Natural Capital – Concepts and Terms

3.1 Scope

For the benefit of readers not acquainted with economics and economic terms, this chapter introduces the more salient elements of Natural Capital terminology. It attempts, with Annexes 3 and 4, to explain the terms used and the context within which they are used. This chapter therefore considers:

- Natural Capital definition: its structure, Natural Capital assets, biotic and abiotic stocks and services, and what is meant by a baseline Natural Capital
- Ecosystem services
- The value of Natural Capital and ecosystem services
- Accounting for Natural Capital
- The concept of net gain; considering environmental net gain and – a constituent of this – biodiversity net gain.

3.2 What is Natural Capital?

3.2.1 Introductory Comments

The concept of Natural Capital was first recognised in the early 20th century, but it was not until the pioneering work of Professor David Pearce and his colleagues in the 1980s and 1990s that the concept became grounded in a systematic and robust economic framework.¹⁷ Later, its significance for economic and environmental policy became more widely recognised, especially within the context of resource sustainability and human well-being.

The Natural Capital approach provides an overarching framework that can be used to recognise the full environmental and economic implications for society of a proposed strategy or project. It is analogous to other forms of capital in that it consists of a capital base of assets (stocks) – such as financial, produced or manufactured, human and social capital – that generates flows of goods and services that have economic values.

Underlying the service flows from Natural Capital, a myriad of physical and ecological functions occur autonomously. It is those functions that enable the service flows, and the benefits they deliver, to be realised. In economic terms, **discounting the value of these benefits over time (using the standard discounted cash flow technique, DCF, explained in Annex 3) provides a lower bound value of the Natural Capital assets** from which the benefits are derived.

The value of the Natural Capital asset base provides a baseline against which the effects – positive or negative – of proposed interventions can be gauged. Applying a Natural Capital approach when planning and appraising environmental, land-use and development projects or interventions is a holistic attempt to enable the full effects of an activity to be assessed. It considers the changes in extent, condition and value of the flows of services provided by nature, and net changes in the baseline value of Natural Capital assets.

¹⁷. See, for example, Pearce DW (1988) Economics, equity and sustainable development. *Futures* 20 (6), pp.598–605; Pearce DW and Turner RK (1990) Economics of Natural Resources and the Environment. *American Journal of Agricultural Economics* 73(1); Missemer A (2019) Natural Capital as an Economic Concept, History and Contemporary Issues. *Ecological Economics*, Elsevier, 143, pp.90–96

Having the capacity to gauge the impact of a potential intervention against baseline conditions creates the opportunity to define and implement measures in ways such that adverse impacts can be minimised. And to define and implement measures that are intended specifically to protect and enhance the baseline conditions. This can lead to better decision making, based on a broader information base and considering a wider set of values than in traditional financial and economic appraisal.

3.2.2 Definition of Natural Capital

The Natural Capital Committee (NCC) defined Natural Capital as: *That part of nature which directly or indirectly underpins value to people, including ecosystems, species, freshwater, soils, minerals, the air and oceans, as well as natural processes and functions. Natural Capital underpins the four types of capital set out below. In combination with other types of capital, Natural Capital forms part of our wealth: our ability to produce actual or potential goods and services into the future to support our well-being.*¹⁸ The four other types of capital (Figure 3) are: produced or manufactured capital (e.g. machines, roads and buildings); financial capital (e.g. shares, banknotes, and other media of exchange); human capital (e.g. labour, knowledge and skills); and social capital (e.g. levels of trust, institutions and connections between people).

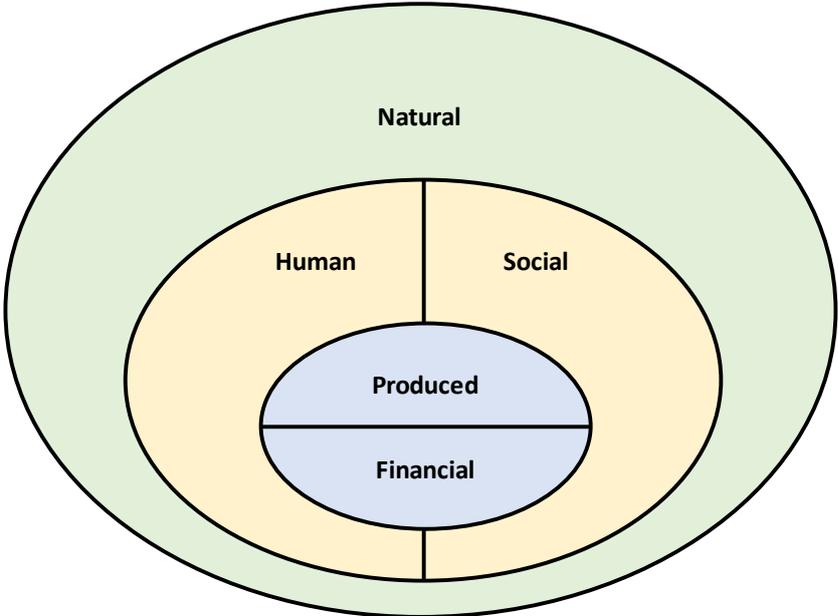


Figure 3 Forms of Economic Capital
 Source: R C Frost (adapted from multiple sources)

Important aspects of this definition are that Natural Capital:

- Relates directly to *human well-being*
- Refers directly to the *value* of Natural Capital *to people*
- Includes resources that are living (biotic) and non-living (abiotic)

¹⁸ Natural Capital Committee (August 2019) *Natural Capital Terminology*.
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf

- Recognises that when combined with other forms of capital, Natural Capital contributes to the total *wealth* of society, on which society draws for its current and future well-being.

3.2.3 The Structure of Natural Capital

The concept of Natural Capital is broader than the related concept of Ecosystem Capital. ***Ecosystem Capital consists of the biotic and abiotic assets which form an ecosystem, from which ecosystem services are derived (see Section 3.3).*** Natural Capital, on the other hand, consists of ecosystem capital ***plus abiotic minerals and subsoil assets.***

Natural Capital is thus the stocks of natural assets that include ecosystems, species, freshwater, land, soils, atmosphere, minerals and sub-soil assets, oceans and coasts.¹⁹ From this are derived:

- Flows of **ecosystem services** that provide food, clean air and water, wildlife, energy, wood, recreation and protection from hazards.
- Flows of **abiotic resources** (minerals and subsoil assets) on which society depends.

Box 1: Assets and Stocks²⁰

Natural Capital assets: *a Natural Capital asset is a distinctive component or grouping of Natural Capital components, including soils, freshwater, and species. However, Natural Capital assets are not mutually exclusive – overlaps between categories exist. For example, soils include species, minerals and water. Natural Capital assets typically come in systems, rather than discrete atomised components, limiting the scope for conventional economic analysis. Natural Capital assets provide ecosystem services (flows) such as pollination and water purification, which support the production of goods and services, and generate benefits.*

Natural Capital stocks: *refer to the extent and condition of a natural resource. For example, the total number of a fish species that can be harvested would be a measure of extent; a measure of condition could be the size of adult fish (which acts as a proxy for longevity and breeding potential).*

Extent (Quantity): *refers to the extent, volume or amount of an asset, benefit or a good.*

Condition (Quality): *the underlying condition of a Natural Capital asset and its ability to maintain flows of services.*

Abiotic assets can be divided into two categories, assets that can be regenerated within an ecosystem and those which are non-recyclable. For instance, soil is part of an ecosystem, but mineral deposits are not. Hence, **abiotic assets comprise:**

- those such as soils that are an integral part of an ecosystem
- minerals and subsoil assets that make no contribution to the supply of ecosystem services, but do provide society with key resources, including minerals, oil, gas, coal and aggregates.

¹⁹ Groundwater is included as an ecosystem asset as it is maintained by the functioning of surface ecosystems and because the service provided – freshwater – is not always distinguished from the freshwater service provided by surface water sources. Similarly, the atmosphere is also recognised as an ecosystem asset although it is not separately identified as an ecosystem.

²⁰ Natural Capital Committee (August 2019) *Natural Capital Terminology*.

3.2.4 Defining a Natural Capital Baseline

The conceptual steps involved in defining a Natural Capital baseline for a selected geographical region or zone are broadly as defined and shown schematically below (Figure 4):

- Define the discrete geographical area to be studied. For instance, if an intervention is proposed the area might be an ecosystem, habitat type, catchment area, a river stretch, a lake, or a length of hedgerow.
- Define and map the Natural Capital assets within the assessment area, establishing their extent and condition.
- Define the relevant physical and ecosystem service flows within the assessment area, determine both their individual unit (monetary) values and their total (monetary) value to the affected population.
- Calculate the present value of the baseline Natural Capital assets by discounting the projected future (monetary) values of the service flows.

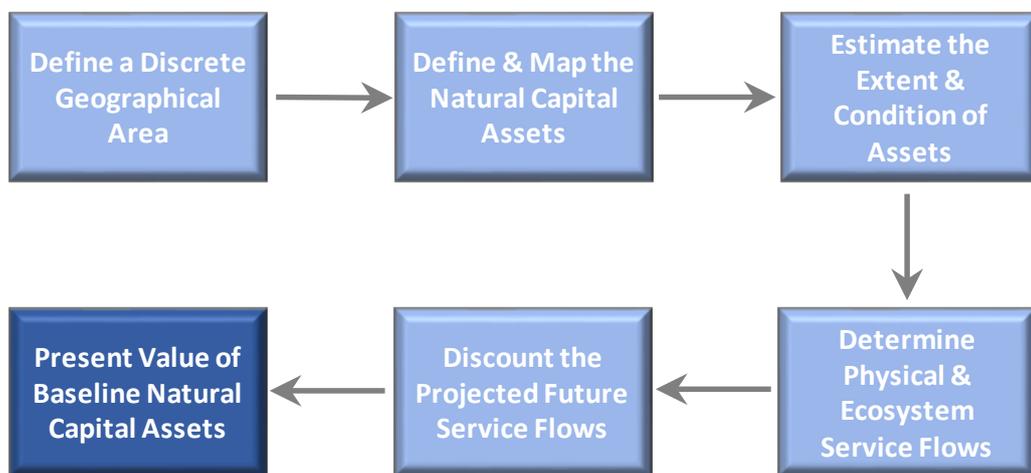


Figure 4 Conceptual steps in estimating the baseline Natural Capital of a defined area

Source: PL Faircloth and RC Frost

Once the baseline Natural Capital has been determined, an assessment may be made of the positive and negative effects on existing services of the proposed intervention or interventions, and hence the (net) effects on Natural Capital value.

3.3 Ecosystem Services

3.3.1 Natural Capital and Ecosystem Services

The Natural Capital Committee defined **ecosystem service (flows)** as being: *provided by Natural Capital stocks and the systems within which they are embedded. Examples include pollination, biomass, water purification, protection from flooding, and carbon sequestration. These yield the goods and services which provide benefits to humans. Flows can be split between ecosystem and abiotic services.*²¹ The above definition has been expanded to state: *The most obvious (environmental services) are **the food we eat, the water we drink and the air we breathe**. Other less visible services are **climate regulation, the natural flood defences provided by forests,***

²¹ Natural Capital Committee (August 2019) *Natural Capital Terminology*.

*carbon stored by peatlands, the pollination of crops, the provision of medicines, and the processes by which air and water are purified and wastes sequestered or broken down. Even less visible are services such as the inspiration we take from wildlife and the natural environment, and a source of recreation, health and solace in which our culture finds its roots and sense of place.*²²

The variety and complexity of environmental services can be illustrated by considering a single component of Natural Capital; forests. **Forests** are not simply wood production units. They also prevent soil erosion, absorb rainwater and provide flood control; they provide habitat for a diversity of plant and animal species which may serve as foods or medicines for other species; they absorb the natural wastes of these diverse life forms; they generate oxygen and sequester carbon from the atmosphere; they affect the microclimate of their area; **they are a key component of the hydrologic cycle**; and **they provide aesthetic enjoyment and spiritual inspiration**. Forest ecosystem functions have evolved to maintain the overall health of the forest environment and the creatures in it. They are another form of natural income derived from the same Natural Capital of forest ecosystem that generates timber for economic use. **Ecosystem functions that have particular value to humans, whether tangible or not, are called ecosystem services.**

The above paragraph distinguishes between ecosystem functions and processes that are intermediary flows (such as the absorption of natural wastes) and those that are final services which bring direct benefit to human society in the form of goods and services (such as clean water). Linkages between Natural Capital, intermediary services and Natural Capital goods and services are illustrated in the following diagram (Figure 5).



Figure 5 Relationships between natural assets, the services they support, and the benefits derived from them

Source: NCC (2017), *How to do it: a natural capital workbook*²³

Ecosystem services provide the flows of benefits which society gains from Natural Capital, while **Natural Capital is the stock of natural assets** from which those benefits flow. The distinction between the two is further illustrated by the following examples:

²² See, for example, The Wildlife Trusts: <https://www.wildlifetrusts.org/sites/default/files/2018-11/TWT%20Population%20Resources%20Consumption%20Statement%20FINAL%201%2008-13.pdf>

²³ NCC (2017) *How to do it: a natural capital workbook*
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957503/ncc-natural-capital-workbook.pdf

- A forest is a component of the Natural Capital stock, but **timber, climate regulation, recreation and spiritual well-being** are examples of **the ecosystem services** it may yield.
- Wetlands are a component of the Natural Capital stock, while **water treatment and purification, flood prevention and wildlife habitat** are examples of **the ecosystem services** it might provide.
- Soil is a component of Natural Capital stock, while **food and energy production** are **ecosystem services** it provides.

Natural Capital goods such as fish, farmed food and drinking water are examples of goods that deliver benefits or are ‘of value’ to humans. However, other types of **goods and services can produce well-being even without a direct use**. For example, the **knowledge that a valued species continues to exist can generate well-being**.²⁴ The following section introduces a system in which ecosystem services are classified into four categories: provisioning, regulating, cultural and supporting. These four categories reveal the Total Economic Value (TEV) that Natural Capital and its associated ecosystem services confer on society.

When combined with other forms of capital, Natural Capital can be thought of as the glue which connects environment, economy and community, underpinning our societies, economic activity and social well-being.

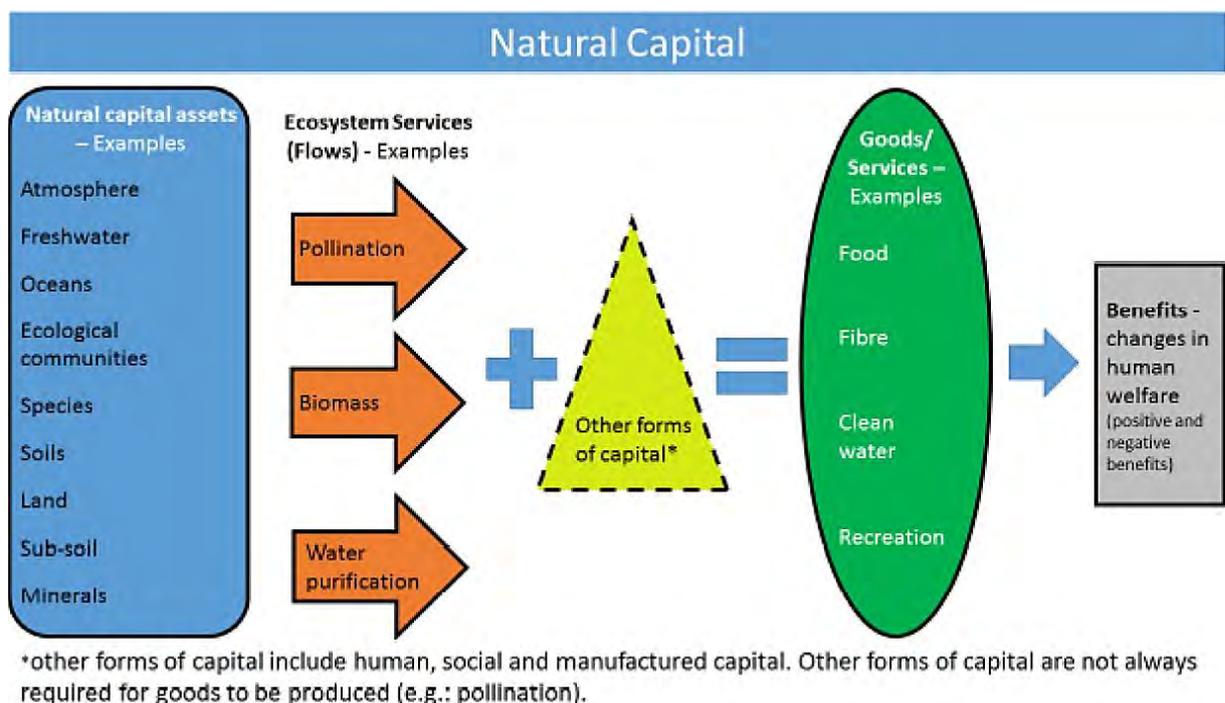


Figure 6 Natural Capital logic diagram

Source: NCC (2019), Natural Capital Terminology, Fig 2, p. 9.

3.3.2 Classification of Ecosystem Services

Ecosystem services are grouped into four categories, described more fully in Box 2.

- **Supporting services** regulate the processes needed for all the other ecosystem services. They include maintaining species habitats, biodiversity and genetic diversity;

²⁴ National Capital Committee (2019) *Natural Capital Terminology*

soil formation; photosynthesis; and nutrient recycling. They provide the ecosystem services on which the other three services ultimately depend.

- **Regulating services** regulate ecosystem processes. Examples include cleansing the air; water treatment; water flow regulation; biological control; pollination; erosion control; soil fertility maintenance; and the decomposition of organic wastes. Their role can be intermediary – such as pollination – in the provision of ecosystem goods, or it can be to provide final ecosystem services directly – such as climate regulation.
- **Provisioning services** provide resources used in the production of goods. Examples include timber; food; freshwater; raw materials; medicines; water, wind, solar energy.
- **Cultural services** provide benefits that support recreation and mental and physical health; tourism; aesthetic appreciation and inspiration; spiritual experience and sense of place. They relate to environmental settings that evoke strong emotions and feelings.



Supporting services provide the basic infrastructure of life. They include primary production, (the capture of energy from the sun to produce complex organic compounds), soil formation and the cycling of water and nutrients in terrestrial and aquatic ecosystems. All other ecosystem services – regulating, provisioning and cultural – ultimately depend on them. Their impacts on human well-being are indirect and mostly long-term in nature: the formation of soils, for example, takes place over decades or centuries. Supporting services are strongly interrelated to each other and generally underpinned by a vast array of physical, chemical and biological interactions. Our current understanding of exactly how such ecological interactions influence ecosystem processes and the delivery of supporting services is limited (TR 13).



Regulating services provided by ecosystems are extremely diverse and include the impacts of pollination and regulation of pests and diseases on provision of ecosystem goods such as food, fuel and fibre. Other regulating services, including climate and hazard regulation, may act as final ecosystem services, or contribute significantly to final ecosystem services, such as the amount and quality of available freshwater. As with supporting services, regulating services are strongly linked to each other and to other kinds of services. Water quality regulation, for example, is determined primarily by catchment processes and is thereby linked to other regulating services such as control of soil and air quality and climate regulation, as well as to supporting services such as nutrient cycling (TR 14).



Provisioning services are manifested in the goods people obtain from ecosystems, such as food and fibre, fuel in the form of peat, wood or non-woody biomass, and water from rivers, lakes and aquifers. Goods may be provided by heavily managed ecosystems, such as agricultural and aquacultural systems and plantation forests, or by natural or semi-natural ones, for example in the form of capture fisheries and harvest of other wild foods. Supplies of ecosystem goods are invariably dependent on many supporting and regulating services. Provisioning services have historically been a major focus of human activity and are thus closely linked to cultural services (TR 15).



Cultural services are derived from environmental settings (places where humans interact with each other and with nature) that give rise to cultural goods and benefits. In addition to their natural features, such settings are imbued with the outcomes of interactions between societies, cultures, technologies and ecosystems over millennia. They comprise an enormous range of so-called 'green' and 'blue' spaces, such as gardens, parks, rivers and lakes, the seashore and the wider countryside, including agricultural landscapes and wilderness areas. Such places provide opportunities for outdoor learning and many kinds of recreation; exposure to them can have benefits including aesthetic satisfaction and improvements in health and fitness and an enhanced sense of spiritual well-being. People's engagement with environmental settings is dynamic: meanings, values and behaviours change over time in response to economic, technological, social, political and cultural drivers; and change can be rapid and far-reaching in its implications (TR 16).

BOX 2 The UK's Ecosystem Services

Source: UK National Ecosystem Assessment (2011), Box 1. p. 17²⁵

Examples of the goods (*) and services (†) derived from the provisioning, regulating and cultural ecosystem services that the eight UK broad habitat types provide are shown below (Figure 7). Items in **yellow** are considered to derive from provisioning services, those in **purple** from regulating services, and those in **green** from cultural services.

²⁵ UK National Ecosystem Assessment (2011) *The UK National Ecosystem Assessment: Synthesis of the Key Findings*. UNEP-WCMC, Cambridge. Available at: <http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx>



Figure 7 Goods and services derived from the provisioning, regulating and cultural ecosystem services provided by eight broad habitat types
 Source: UK National Ecosystem Assessment (2011), Figure 11. p. 16

3.4 The Value of Natural Capital and Ecosystem Services

3.4.1 Overview

Recognition of the significance of Natural Capital for human well-being has led to an extension of the scope of traditional environmental economics. It now considers and estimates values for the stocks of natural assets and the associated flows of ecosystem services on which society depends. Consider woods and forests, for example:

- the **annual value of the services provided by England’s woods and forests is estimated to be £2.3bn**. Of this, **timber value represents just 10%**, the remainder coming from benefits such as recreation, drugs, clean water, habitat, aesthetics, shelter and carbon sequestration.²⁶

Assessment of ecosystem services is undertaken within a discrete ecological area or habitat. It is typically made to establish the baseline Natural Capital assets and the services derived from them by society. Or it may be made to assess the implications of implementing new infrastructure developments, environmental protection schemes, or habitat conservation / restoration projects.

Ecosystem service flows have value to society which, to a greater or lesser degree, can be represented by monetary values. The present value of these service flows and their monetary values projected into the future provides a lower-bound of the value of the Natural Capital assets from which they are derived.²⁷ This is analogous to determining the present value of a physical asset (such as a manufacturing plant) as the discounted value of its projected net income stream.

Ecosystem goods and services range from:

- Those which have value in use and can be valued either using market-based techniques (such as food and timber) or for which monetary values can be determined (such as flood regulation and coastal defence) to
- Those which clearly provide benefits but do not involve (physical) ‘use’. Placing a monetary value on those benefits – such as aesthetic appreciation, sense of space or existence value – is complicated and uncertain. **Many of the goods deriving from cultural services fall into this category.**

The combined value of the services provided by a Natural Capital asset is known as the **total economic value (TEV)**. It is typically divided between use and non-use values; the values individuals and society gain from the services. ‘Use values’ can be divided into direct use, indirect use and option values – explained below – whilst ‘non-use’ values relate to the benefits the environment provides but do not involve its use directly or indirectly (Figure 8).

In theory, each of the sub-types of value can be estimated and added together for an estimate of the Total Economic Value of ecosystem services (Figure 9). In practice, the methods are best established and available for the direct use values on the left-hand side of the diagram and become more difficult to define and measure towards the right. It is particularly difficult to estimate non-use values, as bequest and existence values are often restricted to a sub-set of species, typically charismatic ones such as large mammals, birds, butterflies and some flowering

²⁶ 25 YEP, p. 19

²⁷ See Annex 3

plants. *Direct use values are measured by the benefits to individuals, but all others may be shared (social) values.*

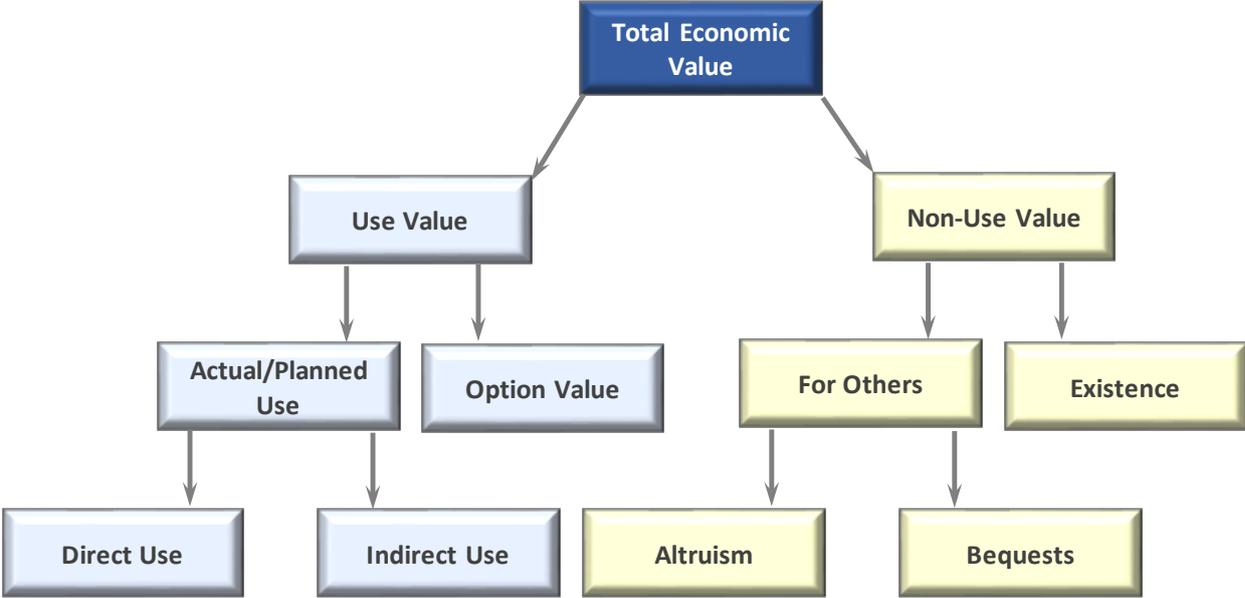


Figure 8 Total economic value and its structure
 Source: PL Faircloth and RC Frost (adapted from multiple sources)

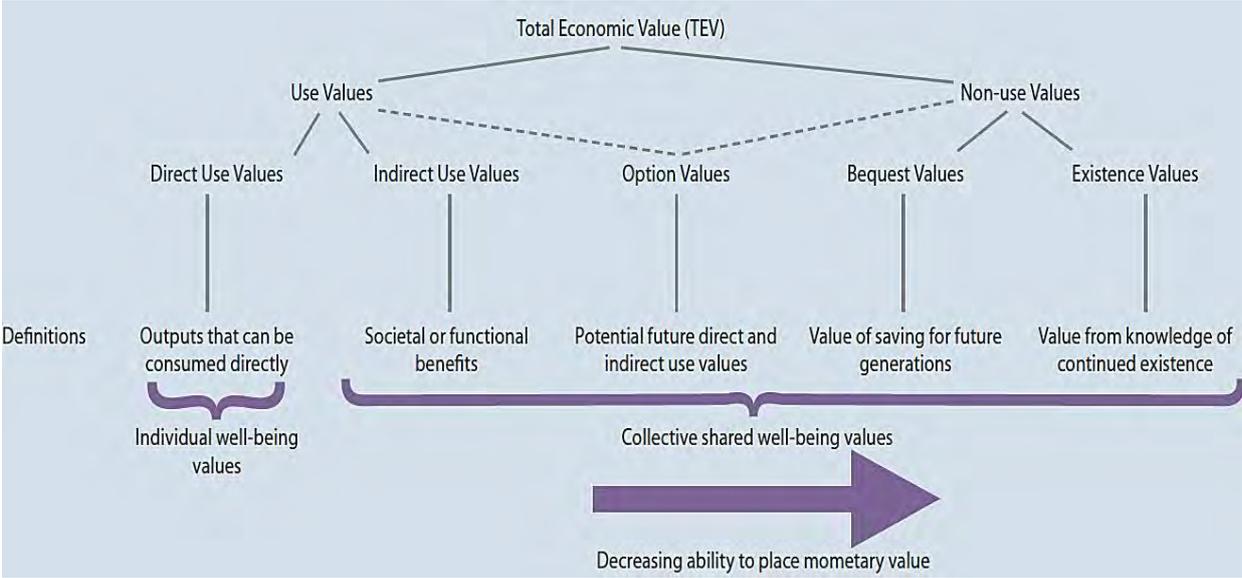


Figure 9 Further classification of total economic value
 Source: UK NEA Full technical Report (2011). Chapter 2: Conceptual Framework and Methodology, Box 2.1, p. 18.²⁸

3.4.2 Total Economic Value – Use Values

Direct use values are values that can be extracted, consumed or directly enjoyed: a river can provide water for drinking; industrial or agricultural processes; fishing, kayaking and other

²⁸ <http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=KSXkgw7AKSY%3d&tabid=82>

recreational activities. These benefits are real, can be measured and have value. Some can be traded in markets, some are non-marketable.

- Goods having a market value (e.g. minerals, timber sales, freshwater supply, food) can be exchanged on a market, thereby revealing their value. They broadly relate to the provisioning services described above. Consumptive use is generally the easiest to value, e.g. quantities and quality of water abstracted can be measured and monetised.
- Services that are non-consumptive and non-marketable, e.g. outdoor recreation and landscape amenity, are more difficult to value, since both the prices and quantities may not be observed in any market. They broadly apply to the cultural services described above.

Indirect use values refer to the services provided by an ecosystem to society indirectly. For example, wetlands filter water, thereby improving water quality for downstream users; rivers and lakes provide opportunities for flood control. Society benefits from services provided by a resource rather than by using it directly – erosion control and water flow regulation are examples. They broadly apply to the regulating (and supporting) services described earlier. These services have value but changes in the quality or quantity of the service being provided are often difficult to measure or are poorly understood.

Option values represent the value that people place on having the option to use a resource in the future even if they are not current users. These future uses may be direct or indirect. A national park is an example where people may be willing to pay something to preserve the option to use it in the future. More broadly, option value describes the value placed on maintaining natural systems for possible future uses, some of which may not yet be known: the maintenance of biodiversity and the conservation of habitats are examples. Option values reflect the value people place on a future ability to use the environment and thus on the potential future benefits of goods and services it provides.

3.4.3 Total Economic Value – Non-Use Values

Non-use values relate to the benefits provided by nature and the environment that do not involve their use, either directly or indirectly. **Value is thus derived simply from the knowledge that the environment is maintained.** This is the most difficult value to estimate since it is not, by definition, reflected in people's behaviour and is thus wholly unobservable. There are three components:

- **Bequest value:** the value derived from a desire to pass on values to future generations
- **Altruistic value:** the value attached to the availability of the ecosystem resource to others in the current generation
- **Existence value:** the value derived from the knowledge that something exists, even if a person may never plan to use it.

Where service flows are not marketed, or where market prices do not include their full value to society, non-market values may be estimated using a range of non-market valuation techniques or tools. Available tools are identified in Chapter 5. The techniques employed can include

replacement costs, effects on production, damage cost avoided, mitigative or avertive expenditures, hedonic pricing, travel costs, contingent valuation.²⁹

3.4.4 Integration with Other Capital Inputs

The full value of ecosystem service provision also depends on the addition of other capital inputs. The final value of the goods provided from ecosystems (where ‘goods’ includes all use and non-use, material and non-material outputs) having value for people is attributable to ecosystem and human inputs combined. For a fair valuation of ecosystem services, it is necessary to separate final ecosystem services from underpinning processes, and account for other capital inputs (Figure 10).

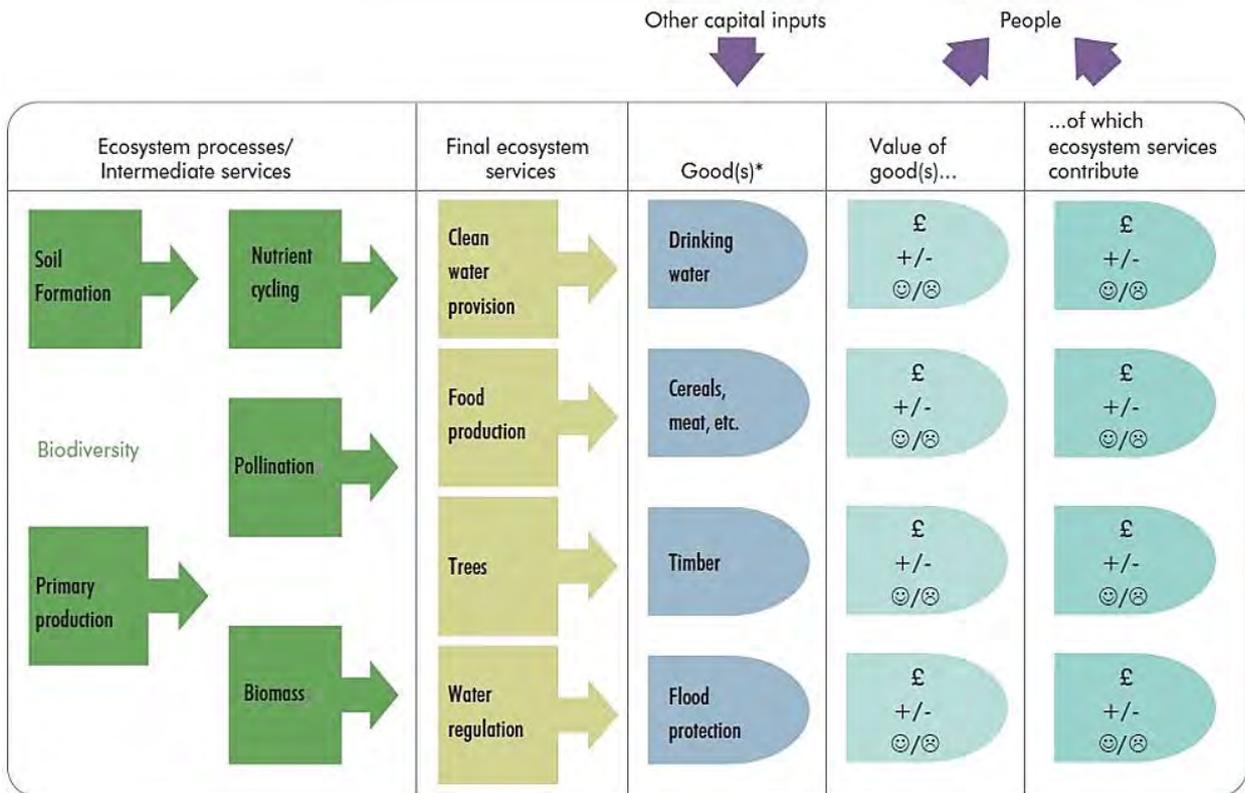


Figure 10 Final ecosystem services and the goods and values they generate

Source: NEA (2011). Full Technical Report, Chapter 2, p. 16, Figure 2.2

A mixture of valuation techniques and tools exists for placing monetary values on ecosystem services and the underlying Natural Capital stocks, and for enabling values defined in one location to be transferred and used elsewhere. Systematically valuing Natural Capital services and stocks in this way can help inform decisions on development and environmental improvement schemes by ensuring that maximum social benefit is achieved from Natural Capital and that it is managed in a sustainable manner. Sources of information and tools that can be used in establishing such values are referred to in Section 5.

²⁹ See H M Treasury (2020) *The Green Book, Central Government Guidance on Appraisal and Evaluation*. Chapter 6, Valuation of Costs and Benefits.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf

3.5 Accounting for Natural Capital

The following brief introduction to Natural Capital accounts draws heavily on Principles of Natural Capital Accounting, published in 2017 by the Office for National Statistics (ONS). **Readers wanting to understand further the concepts and methodology underlying the UK Natural Capital accounts being developed by ONS and Defra should refer to that document.**³⁰

Natural Capital accounts record changes in the extent and condition of ecosystems and the beneficial ecosystem services they provide to society. Comprising a set of linked accounts that provide information relating to the stocks of Natural Capital and the flows of services they generate, Natural Capital accounts provide a baseline against which the impacts of proposed development options and environmental improvement schemes can be assessed.

Figure 11 summarises in simple terms how Natural Capital accounting is based on a rigorous distinction between (i) assets or stocks, (ii) flows or services (net of human and other economic inputs) generated by the assets or stocks, and (iii) their further processing in some way before conferring benefits through their final use or consumption.

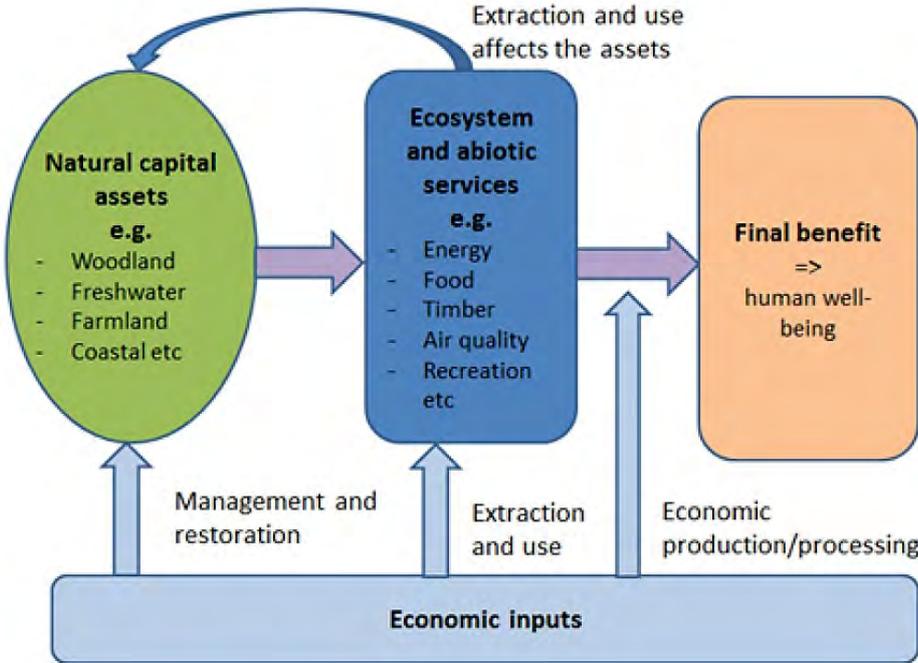


Figure 11 The links between assets, ecosystem services and final benefits
 Source: ONS (2017), *Principles of Natural Capital Accounting*, p. 4, Figure 1.1

A key distinction exists between asset (stock) accounts and service (flow) accounts. Ecosystems and mineral resources are assets that are recorded in the **‘stock’ account**. In practice, a stock account may be separated into two accounts, covering respectively the extent or volume of the asset and its condition or quality. In contrast, **services provided by natural assets are regarded as ‘flows’**, and are recorded in a **‘flow’ account**, in the same way that the services from the economy to final users are recorded as the sum of the flows over a certain time period (normally

³⁰ Office for National Statistics (ONS, Feb. 2017) *Principles of Natural Capital Accounting*.
<https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting>

a year). As with services provided by the economy, this may not involve any physical transfer of materials.

Stock (asset) accounts and flow (services) accounts may be recorded in either physical or monetary terms. Physical accounts classify and record measures of extent, condition and annual service flow. Monetary accounts assign a monetary valuation to selected services on an annual basis and record an overall valuation of the natural asset’s ability to generate future flows of services.

There is a clear sequence to the basic types of accounts, in that the volume or extent of the natural assets, combined with information on the physical state and condition of the assets, can be seen as representing the asset base from which the flows of ecosystem services are provided. Figure 12 summarises this sequence.

Once monetary values are put on these flows, it is possible to value the assets as well. As referred to elsewhere in this Guide, valuation of the stock of Natural Capital assets is calculated as the present value of the projected flow of (monetised) final ecosystem services provided by the assets.

Non-Monetary Accounts



Monetary Accounts

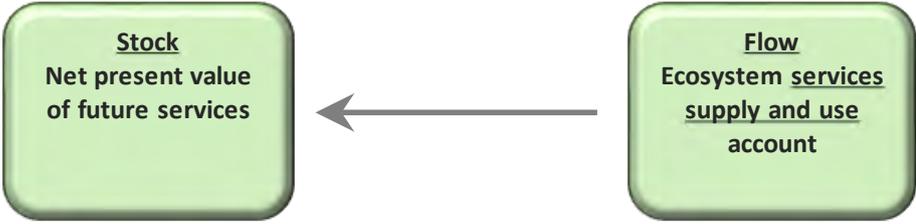


Figure 12 The sequence of physical and monetary accounts
 Source: Adapted from ONS (2017), Principles of Natural Capital Accounting, p. 7, Figure 2.1

Assessing the national status and trends of Natural Capital, in particular ecosystem services, is a significant challenge in view of the scale and diversity of environmental stocks and flows. The outline above relates to the national Natural Capital accounts, but accounts may be prepared similarly for clearly defined, environment-related projects being prepared at regional, catchment or local levels.

3.6 Biodiversity Net Gain vs Environmental Net Gain

3.6.1 Introduction

Net gain: an umbrella term for environmental net gain and the narrower biodiversity net gain. Gain in this respect refers to a Natural Capital value.

Environmental net gain: can refer to a single development, ranging through to generational developments, that leave the environment in a measurably better state overall compared to the pre-intervention baseline.³¹ The NCC advised the government to adopt this measure of net gain in its policies (Annex 1). Environmental net gain is inclusive of biodiversity net gain.

Biodiversity net gain: a narrower measurement of net gain that refers to habitats only. It is a component of environmental net gain. The government has adopted the biodiversity net gain measure in the draft Environment Bill (Annex 1).

3.6.2 Biodiversity Net Gain

Biodiversity has been defined as ‘the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part’. Biodiversity net gain refers to biodiversity being in a measurably better state than prior to a development or developments – as determined by the size, distinctiveness, condition, strategic location and connectivity of habitats, alongside other measures.³²

Achieving biodiversity net gain requires measurable improvements in biodiversity by creating or enhancing habitats in association with a development. Development proposals must lead to ‘genuine and demonstrable gains for biodiversity’, against **baseline conditions**, all of which are **quantified using the government’s biodiversity metric**. To achieve biodiversity net gain, proposals must follow the ‘**mitigation hierarchy**’ (Figure 13) which compels planning applicants to avoid harm in the first instance, then mitigate or finally compensate for losses on-site, off-site or through a combination of the two solutions. Measures will be required in planning conditions.³³

The government plans to mandate the use of the **Biodiversity Metric** to measure biodiversity losses and gains resulting from development or land management change. Biodiversity Metric 3.0 (JP039) is the most recent calculation tool, published 7 July 2021. The spreadsheet-based tool is populated with data acquired through ecological assessments before development and for the habitats proposed after development, whether on-site or off-site. The Biodiversity Metric Tool, User Guide, Technical Supplement, Habitat Condition Assessment Sheets and other information are available from the Natural England website, together with an accompanying GIS data import facility that can be used with it.³⁴

³¹ Department for Environment, Food & Rural Affairs (2019) Biodiversity net gain: updating planning requirements; CIRIA (2019) Biodiversity net gain. Good practice principles for development.

³² Department for Environment, Food & Rural Affairs (2019) Biodiversity net gain: updating planning requirements <https://www.gov.uk/government/consultations/biodiversity-net-gain-updating-planning-requirements>

³³ <https://www.lodders.co.uk/blog/building-with-nature-planning-seminar-faqs/>

³⁴ <http://publications.naturalengland.org.uk/publication/6049804846366720>

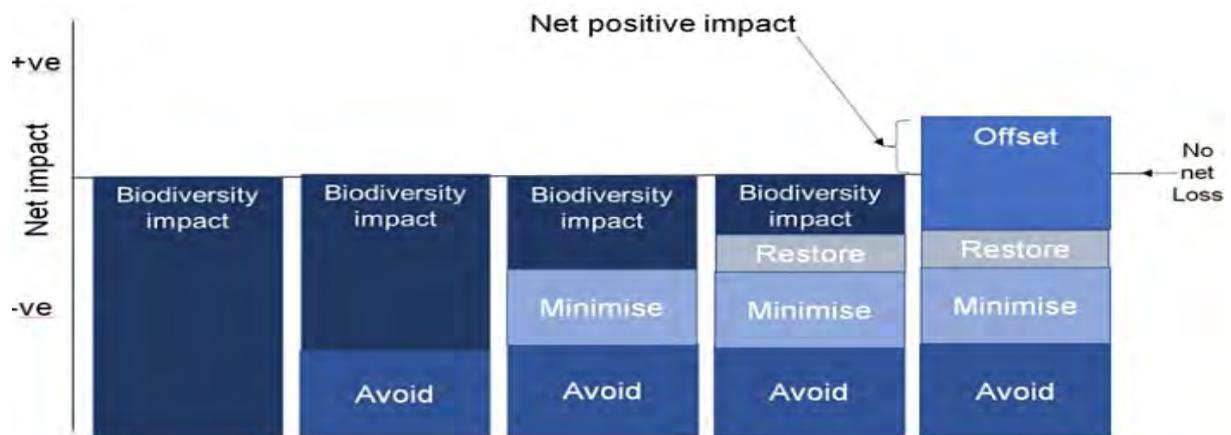


Figure 13 Mitigation hierarchy for biodiversity net gain

Source: Loddars Planning Seminar (Footnote 34)

Metric 3.0 can be used or specified by any development project, consenting body or landowner that needs to calculate biodiversity losses and gains for terrestrial and/or intertidal habitats. It will be this metric that underpins the Environment Bill’s provisions for mandatory biodiversity net gain in England, subject to any necessary adjustments for application to major infrastructure projects. However, as Natural England makes plain in its User Guide to Metric 3.0 (para 1.7):

*Biodiversity metric 3.0 only accounts for **direct impacts** on habitats within the footprint of a development or project. It has been developed to be a simple assessment tool and only considers direct impacts on biodiversity through impacts on habitats. Although Natural England acknowledges the importance of considering **indirect impacts**, these have not been included in the metric.*

3.6.3 Natural Capital and Environmental Net Gain

It is the **indirect impacts** referred to above in Natural England’s statement that are amongst those **included in environmental net gain**. Those indirect impacts may include the ecosystem services of recreation and all the health benefits that can flow from recreation in nature, flood prevention and mitigation, improved air and water quality – again with all the health benefits that flow from that. Current good practice, as with biodiversity net gain, is to follow the ‘mitigation hierarchy’:

- Do everything possible first to **avoid impacts**
- **Minimise predicted impacts** on biodiversity and ecosystem services
- **Assess the current quantity and condition of natural assets** with the development footprint and what (ecosystem) services they are providing to society
- Determine whether **the creation of additional assets or the restoration / improvement of natural assets** could enhance the benefits flowing to society
- As a last resort, **offset**, compensate for losses that cannot be avoided, preferably within the development footprint or if this does not generate the most benefits, then elsewhere.³⁵

³⁵ CIRIA (2019) *Biodiversity net gain. Good practice principles for development*, quoted in NIC Natural Capital and Environmental Net Gain, February 2021. <https://nic.org.uk/app/uploads/Updated-Natural-Capital-Paper-Web-Version-Feb-2021.pdf>

The context of environmental net gain was explained well by Robert Spencer, Chair of the Environmental Industries Commission:³⁶

The UK Government's 25-year environment plan's (25 YEP) central premise was that development must leave our natural systems in a better place than they were before the development started. That is a tough ask and invites us to assess the current condition of natural assets, work out what (ecosystem) services they are providing to society and determine whether their restoration or improvement could enhance the benefits flowing to society in the context of development.

The next crucial step is to determine what impact the development has on the natural assets and their continued ability to provide services to society (e.g. air quality improvement) and, where this is negative, to compensate for it by restoring and enhancing the condition of surrounding Natural Capital assets. The extent to which this can be accomplished within the development site perimeter is a function of the scale of the development and it may be that the enhancements have to occur adjacent to and well beyond the site, to fulfil the promise of the 25 YEP. This latter element is Environmental Net Gain (ENG) in a nutshell.

ENG goes well beyond Biodiversity Net Gain as it considers not only the diversity of species on a given plot, but the wider condition of and benefits flowing from the interrelated natural systems in a defined area, a function of the interaction between living things and the air, soil, rock and water matrix on which they thrive – you then layer on the benefits to society from that living matrix. When we disrupt this with development, we need to have a method for putting it right.

This is especially the case where a development is seeking to integrate green infrastructure or nature-based solutions for enhancing the resilience of infrastructure and the communities that depend on it. For example, a housing scheme might deliver Biodiversity Net Gain (BNG), while also responding to a need for flood risk alleviation and local air quality improvement – the wider Environmental Net Gain approach provides a framework for nesting all these public benefits, which could simultaneously restore and enhance the functioning of natural systems in the locale.

So, taking an ENG approach can actually help reveal opportunities for community and ecosystem enhancement that might have been missed had a purely BNG approach been adopted. A natural follow-on is that in taking a combined BNG and ENG approach, the most valuable habitats are retained. They provide a resilient core for the nature recovery networks proposed in the new Environment Bill.

3.6.4 Current Status of Natural Capital and Environmental Net Gain

In its 2017 advice to government on the 25 Year Environment Plan, the NCC proposed that the concept of net Natural Capital gain (environmental net gain) should be incorporated as a key policy intent within the government's 25 YEP. The Committee welcomed its inclusion in the plan published in January 2018.

The Committee was disappointed that the revised National Planning Policy Framework produced in 2018³⁷ maintained the much narrower concept of biodiversity net gain (BNG), and that this

³⁶ Spencer R, The Environmental Industries Commission (EIC) blog, *Environmental net gain: An enduring development concept for resilient legacies*, 04/03/2020

³⁷ Ministry of Housing, Communities & Local Government, National Planning Policy Framework (2018): <https://www.gov.uk/government/publications/national-planning-policy-framework-2>

continued into the Environment Bill (Schedule 14). The principle of reversing biodiversity decline was inherent in the NCC's original recommendations, but the natural environment is an interconnected system. Changing one element inevitably affects the whole system and the ecosystem services it can deliver. The Committee considered it vital that the wider system and outcomes are considered.

The Committee recognised that BNG is based on habitat creation and has potential to deliver improvements in Natural Capital assets. Nevertheless, it considered the gain to be smaller than if a Natural Capital focus was taken, considering the environment as an integrated system. It considered the commitment made in the forthcoming Environment Bill to mandate biodiversity net gain, but not environmental net gain, to be a lost opportunity.

The Committee notes that the 'net gain' approach presented in the government's consultation on biodiversity net gain is one where biodiversity is viewed within 'habitat units' and their connectivity, and is based on broad habitat types, with hedgerows, lines of trees and rivers and streams as additional extras. It notes that this approach fails to appreciate that many Natural Capital assets are spatially and context specific, operating at a number of scales including river-catchment, coastal-sea and landscape, and are often not linked to biodiversity 'habitat' types.

The Committee offered the example of a combination of soils and trees in upstream drainage basin catchments which prevent soil erosion, improve the quality and quantity of water in rivers, reduce downstream flooding risk and improve the quality of water at the coast. It notes that these often relatively small blocks of trees – growing on particular soil types, on a specific slope in a drainage basin – may not always be considered as a 'designated habitat type' and that within the BNG approach it could be seen as perfectly acceptable to remove these trees and replace them elsewhere with another block of more biodiverse forest. However, these assets (trees) provide a service because of where they are located.

Similarly, **cultural services such as recreation, and mental and physical health and well-being** are **provided by landscapes and green spaces**. Such spaces may be poor in terms of biodiversity but **are very important in terms of the services they provide** because of where they are located, i.e. near **to populations** that need them.

It concludes that **the proposed biodiversity net gain approach** falls short of many of the goals of the 25 YEP as it **fails to address most of the Natural Capital assets** that are included within the plan. It included the following among its recommendations on environmental net gain:

- An environmental net gain approach that considers first and foremost key Natural Capital assets should be developed as a priority. The approach should include an assessment of the losses of all the benefits provided by the natural environment and should present the individual benefits and losses.
- The environment net gain approach must recognise that many Natural Capital assets:
 - are spatially and context specific
 - provide a service because of where they are located
 - operate at various scales including river-catchment, coastal-sea and landscape
 - are often not linked to biodiversity 'habitat' types.
- Those whose activities give rise to the environmental damage should pay the associated costs of compensation and investment in net gain. The scheme should be compulsory rather than voluntary.

- Environmental net gain proposals associated with development should adopt an ‘avoid, minimise, remediate, compensate’ hierarchy. The approach needs to cover the costs of remediation as well as including a distinct investment component that delivers a gain over and above the starting baseline.
- An agreed methodology for establishing baseline habitat and Natural Capital conditions should be developed by government. This should be based on the NCC’s *How to do it* workbook³⁸ and the recommendations in the NCC’s 2019 Annual Report. Baseline assessments need to evaluate the potential Natural Capital that an area could support, e.g. were it in a non-degraded state.
- The location of the remediation and compensation aspects of the environmental net gain approach should include considerations such as: maximising ecological gains; promoting a coherent network of habitats across the country; providing benefit to those people who currently experience the lowest quality environments; proximity and providing benefits as close as possible to where the impact occurs.
- Remediation activities should be as local as possible to the development giving rise to the impacts whilst investment in the gain aspect (over and above dealing fully with the impacts) can be located elsewhere based on costs and a benefits-based approach.
- Everyone should have access to local greenspace and recreation for the health and well-being benefits it provides. Such considerations are important in the design of new housing developments.
- An environmental net gain principle should be applied to all projects, programmes and development covered by the Town and Country Planning regime and by the Planning Inspectorate.

³⁸ NCC (2017) How to do it: a natural capital workbook

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957503/ncc-natural-capital-workbook.pdf

4 Natural Capital Assessment – Examples

4.1 Scope

This chapter introduces the objectives, lessons learned and outcomes from the Natural Capital Pioneer Pilot Projects. These were established by Defra in 2016 under NCC advice to inform the development and implementation of the 25 YEP. It also notes the requirements laid on water service undertakings by Ofwat as part of the 2019 price review (PR 19), and gives a few examples of the many actions undertaken, or planned, by water undertakings.

4.2 Pioneer Pilot Projects

4.2.1 Introduction and Progress to 2018

Four Pioneer Natural Capital projects in England (Figure 14) were designed by Defra as flagship initiatives: an **Urban** pilot in Greater Manchester, a **Catchment** pilot in Cumbria, a **Landscape** pilot in North Devon, and **Marine pilots** in Suffolk and North Devon. Each addressed four Defra 'Asks':

- Apply a Natural Capital approach to decision-making
- Develop innovative funding opportunities
- Demonstrate integrated approaches to planning and delivery
- Build an understanding of 'what works' in practice.



Figure 14 Locations of the Pioneer Natural Capital pilots

Source ICF (Figure 1.1, p. 6)³⁹

³⁹ ICF (Nov 2018) Evaluation of the 25 Year Environment Plan Pioneers – Final Report.

<http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=20084>

Under the guidance of the agencies that implement Defra policies, each Pioneer had some freedom to develop its own set of specific objectives, responding to Defra's four requirements whilst addressing local priorities. Specific objectives were detailed in an interim progress review, based on information gathering between May and July 2018.⁴⁰ Observations made by the consultants (ICF) engaged by Defra to undertake this interim review included:

- Within the constraints imposed by limited resources and existing institutional and governance arrangements, it was unrealistic to expect them to have demonstrated proven approaches or delivered significant positive outcomes.
- The Pioneers faced some difficulties and uncertainties in having to set their objectives before the 25 YEP was published.
- The Pioneers have had to rely on a mix of resources of Defra and partner organisations, and the goodwill of partner organisations to volunteer time.
- Much time and effort had been invested in developing the required partnerships, networks and governance models – viewed as an early success of the Pioneers.
- Many early activities were based on existing, funded projects, the Pioneers influencing and adapting these to meet their objectives and national priorities. However, there was uncertainty amongst stakeholders as to whether the scale and ambition of the activities would be sufficient to deliver real change in Natural Capital.
- All the Pioneers were developing evidence, tools and methods to apply the Natural Capital approach, including engagement with local stakeholders to develop a shared understanding. Less progress had been made in its application to inform decision-making.
- Learning points included the significant time and resources needed to apply the Natural Capital approach; the importance of effective communication and stakeholder engagement; the challenges relating to data, language and stakeholder resistance; lack of standardised approaches; and the need for practical tools to influence decision-making.

4.2.2 Urban Pioneer

The Urban Pioneer, set in the 493 square miles of the Greater Manchester area, aimed to help develop a basis for the creation of a natural liveable city region – preventing further decline in the region's Natural Capital and harnessing the benefits that Natural Capital offers people. Home to a population of 2.7 million people, this highly urbanised region (Figure 15) is the largest functional economic area outside London, but presents severe quality of life challenges:⁴⁰

- Life expectancy at birth is the lowest in England, whilst there is a six-year gap in life expectancy between the poorest and most affluent areas within the region.
- Obesity, cancer and heart disease rates are significantly higher than the national average.
- Suffering disproportionately from deprivation: 36% of the Greater Manchester population live in a neighbourhood that ranks among the 20% most deprived nationally; 22% live in a neighbourhood amongst the 10% most deprived nationally.

⁴⁰ Urban Pioneer: Strategic Plan – Greater Manchester (2018). https://gmgreencity.com/resource_library/urban-pioneer-strategic-plan-jan-2018/

Nevertheless, the Greater Manchester landscape is diverse and hosts a wide range of natural habitats and wildlife. Those habitats include river valleys, lakes, wetlands, reed beds, moorland and woodland, in addition to urban parks and suburban gardens, whilst 21 Sites of Special Scientific Interest (SSSI) are found here. **Such Natural Capital assets are recognised by the Greater Manchester Combined Authority (GMCA) as *integral to the creation of quality places where people choose to live and work – and critical to health and well-being.***

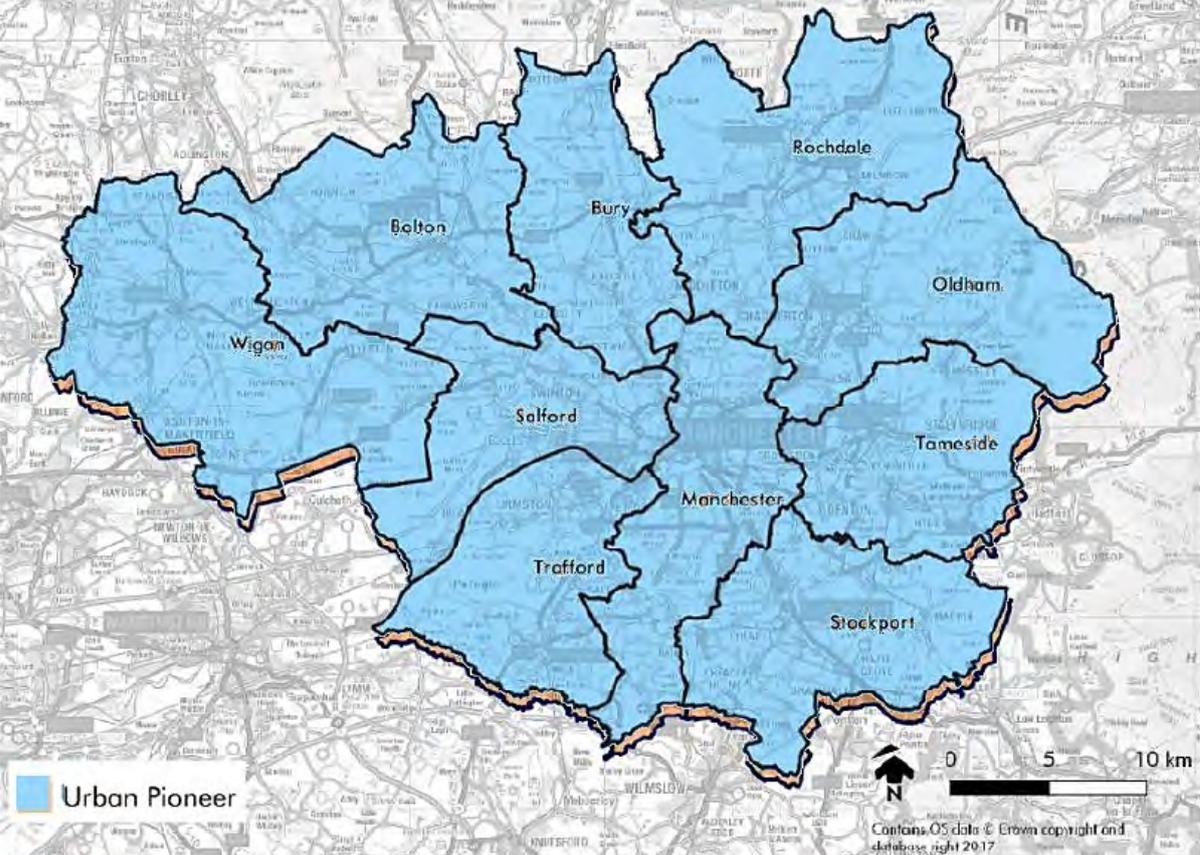


Figure 15 Greater Manchester Urban Pioneer area
 Source: Urban Pioneer: Strategic Plan – Greater Manchester (2018)

The GMCA and the ten districts within the region have worked collaboratively with many substantial partners through the Urban Pioneer in pursuit of Greater Manchester’s vision for:

A new model for sustainable economic growth based around a more connected, talented and greener city region, where all residents are able to contribute to and benefit from sustained prosperity and a good quality of life.

The Pioneer has supported GMCA in understanding how Natural Capital helps deliver defined objectives and the benefits of investing in it, including through the development of a Natural Capital account for the GMCA area. Respecting the four ‘Asks’, five objectives were set initially:

1. **Develop the evidence base:** led by the EA to provide knowledge and the means to ensure that the Pioneer’s work is evidence-based, collaborative and effective.
2. **Demonstrate an approach to delivery that is place-based and improves both policy and decision making:** led by Natural England to expedite decision making that (i) considers the benefits of nature to **local people’s health, well-being, prosperity and growth** (Figure

16) and (ii) **embeds biodiversity / Natural Capital net gain considerations** into the planning system and developments.

3. **Form a Natural Capital Investment Plan for Greater Manchester:** led by GMCA, **targeting future investments and resources at natural assets providing strategic benefit to local communities** across the region, and steering all stakeholders towards tackling in a collaborative fashion the challenges and threats to Natural Capital stocks and the benefits they provide.
4. **Develop a demonstrator project to show the benefits of a Natural Capital approach for project funding:** led by the Regional Water Authority, United Utilities (UU), to test a Natural Capital investment approach to assess whether or not it increases environmental delivery capacity.
5. **Develop and test a communications and engagement model for environmental delivery:** led by Lancashire Wildlife Trust.

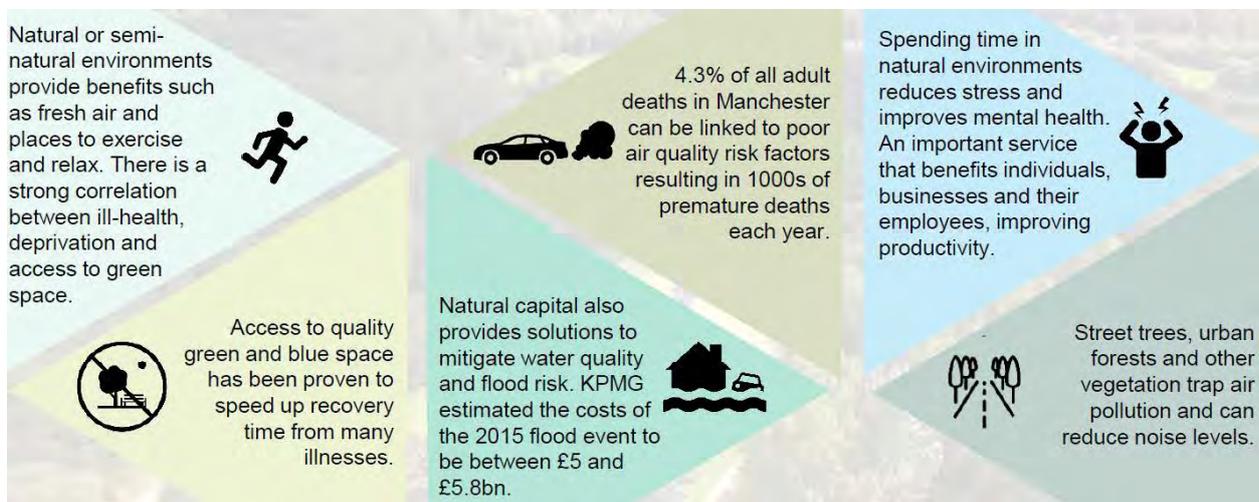


Figure 16 Qualitative benefits from nature to the residents of Greater Manchester

Source Urban Pioneer: Strategic Plan – Greater Manchester (2018)

Seminal activities of the Urban Pioneer included:

- **Natural Capital accounting:** (i) by identifying the ecosystem services expected to contribute benefits to society and, therefore, having Natural Capital value; (ii) by estimating the annual physical quantity of each ecosystem service provided; (iii) by assigning a monetary (economic) value to each unit of ecosystem service; and (iv) by multiplying the annual physical ecosystem service flow by its respective unit monetary value and summing up.
 - Figure 17 indicates the range of ecosystem services that were valued, their annual benefit contributions in monetary terms, and their summation by category; whilst Figure 18 indicates how those summed annual ecosystem service benefits are distributed between residents, the public sector, and the private sector.
- **Ecosystem service mapping:** an ecosystem services mapping tool was developed and applied across the region – the maps and user guide are available online.⁴¹ Baseline

⁴¹ https://mappinggm.org.uk/docs/metadata/ecosystem-services/GM_ESS_Mapping_Tool_User_Guide_Final.pdf

physical, social, economic, geographical and cultural data relevant to ecosystem service delivery was entered for land parcels across the region. The mapping tool then enables the identification, for each land parcel in the study area, of potential opportunities that changes in land use or management could bring in terms of improved ecosystem services.

Further information on the resources made available through the Urban Pioneer pilot project are provided in section 5.3.

Annual benefit from GM's Natural Capital

These are the natural capital assets that have been valued as part of our work. It should be noted that the financial values are derived from the total value of all benefits provided by any given asset.

The analysis is not exhaustive and does not include all benefits and services. Additionally it does not capture all assets such as soil, but represents those considered the most critical in an urban context.

For transparency, we have given an indication of the level of confidence we have in these valuations using the following

- HIGH
- MEDIUM
- LOW

* For physical health £92m/year of welfare value of QALYs gained is not included in the sum as this may double-count recreation value.

*The total CO_{2e} stored in GM's peat is estimated to be 100,460 tonnes valued at £7m, this has not been included in the above as this is not an annual flow.

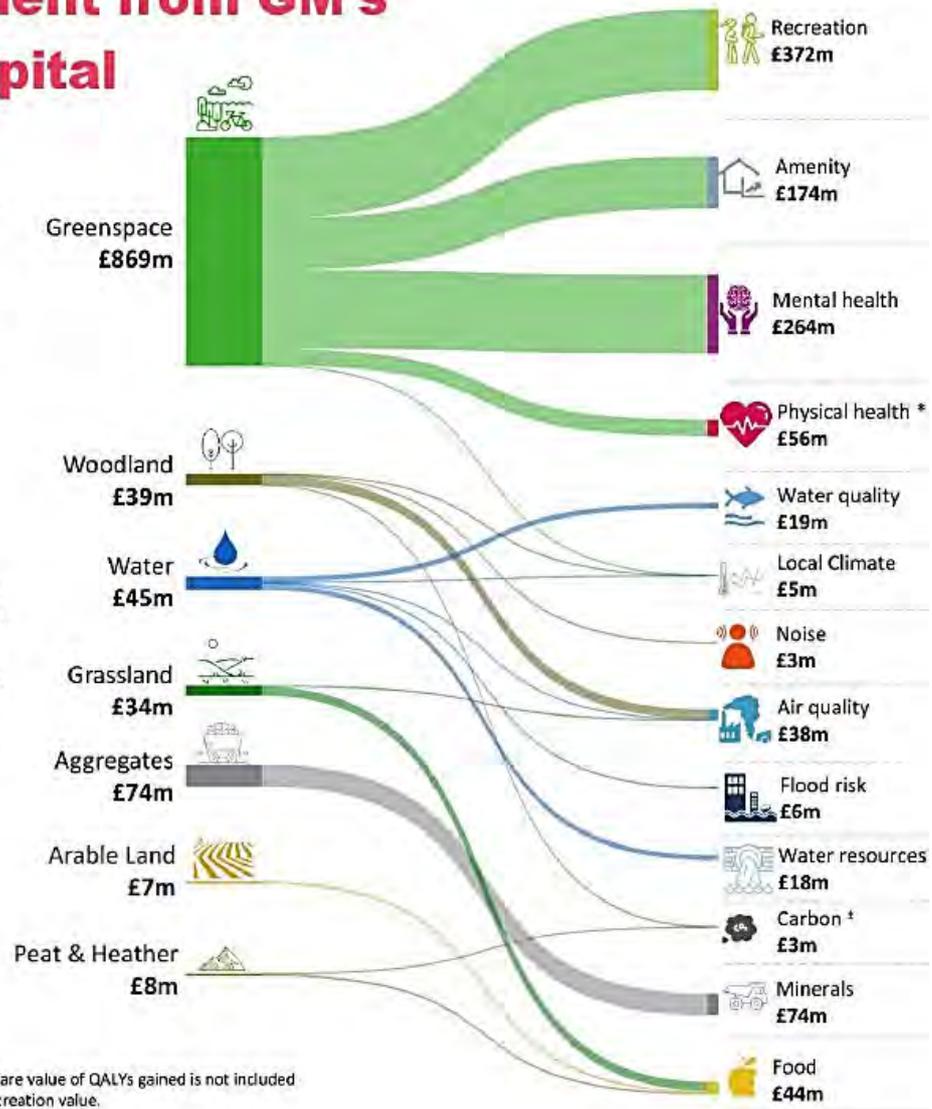


Figure 17 Annual ecosystem service benefits in monetary terms – Greater Manchester

Source: The Natural Capital Approach in Greater Manchester⁴²

⁴² Urban Pioneer, Environment Agency and Greater Manchester (2019). The Natural Capital Approach in Greater Manchester.

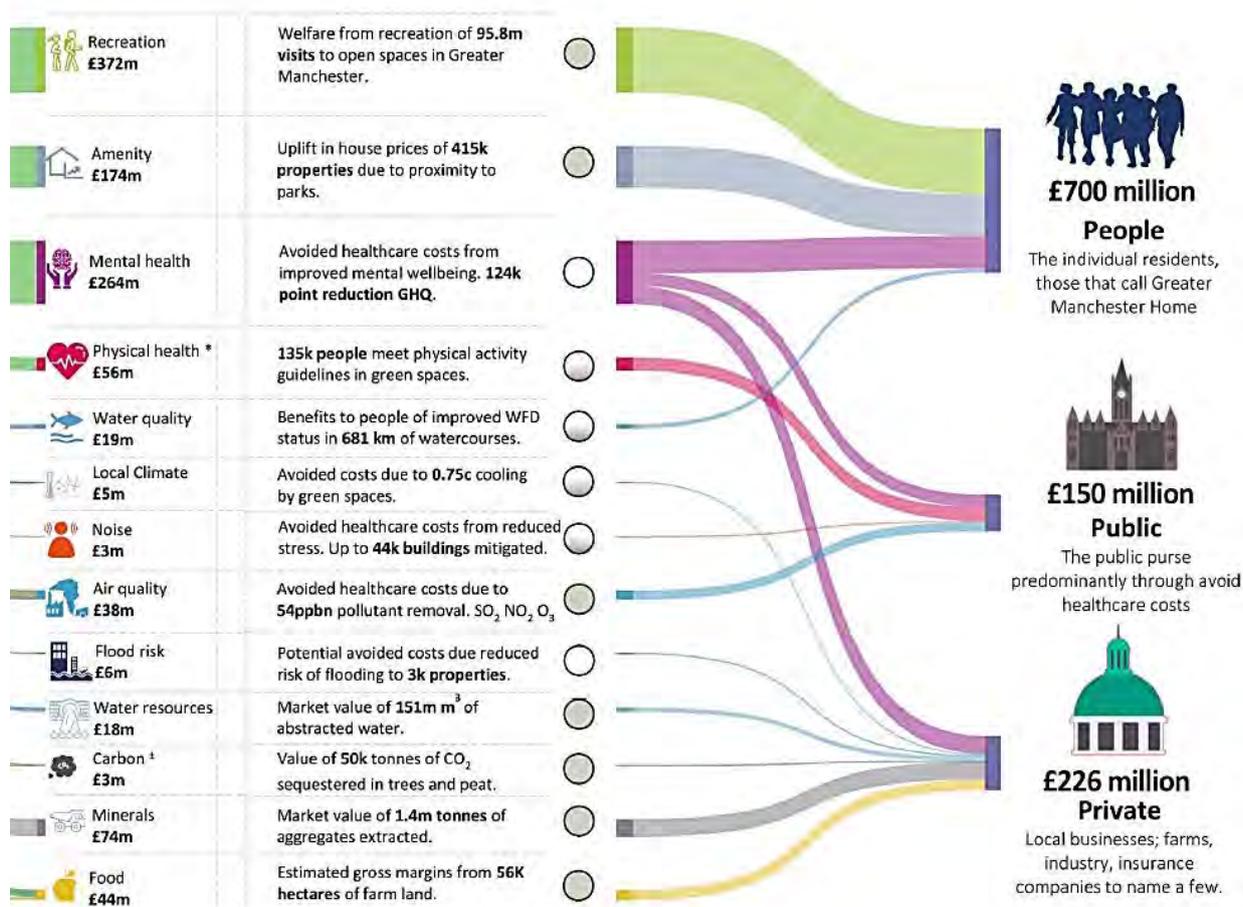


Figure 18 Sectoral distribution of annual ecosystem service benefits – Greater Manchester

Source: The Natural Capital Approach in Greater Manchester

The **Urban Pioneer** is recognised as being **highly successful**, having **supported** the development of expertise and experiential learning; **influenced** the development of a common language through building tools and skills, political communication, funding bids, and investment plans; **catalysed** engagement at multiple levels; and made **inputs** to data and evidence collection and its effective application (Figure 19). The Urban Pioneer project embraced four key drivers of success:

1. **Robust project governance** – embedding the project into the local political arena, using tried and tested, locally accepted mechanisms.
2. **Development of a common, thematic language** – analysis of environmental services and their thematic communication meant that the communication of Natural Capital reached a far broader audience than if communication was targeted at specific organisations.
3. **Multi-stakeholder ownership and collaboration** – involving amongst other things the provision of a unified platform for discussion and delivery, and the creation of tools that worked across political, organisational and budgetary boundaries.
4. **A strong project team** – entailing strong leadership, advocacy and motivation, with the core team having access to both technical expertise and wide-ranging ‘softer’ skill sets.

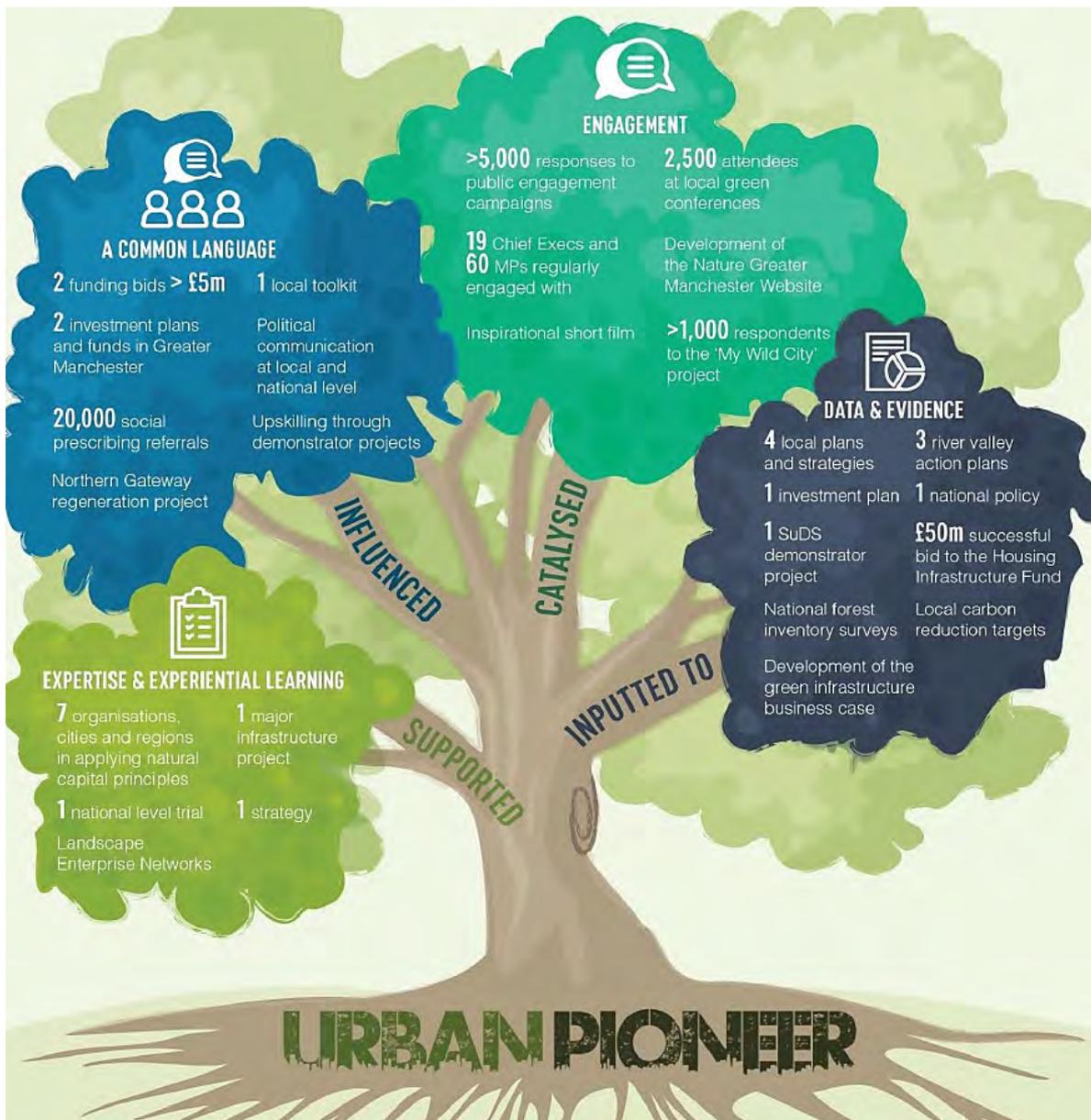


Figure 19 Impacts of the Urban Pioneer

Source: Green Arch Consulting (May 2020), Review of the impact of the Urban Pioneer, prepared for the Environment Agency, p.21⁴³

4.2.3 Cumbria Catchment Pioneer (2016–2018)

The Cumbria Catchment Pioneer Pilot Project was undertaken by the Cumbria Local Nature Partnership in conjunction with Natural Capital Solutions, with additional data provision and guidance from Cumbria Wildlife Trust, Natural England, Lake District National Park Authority and the Environment Agency (EA). The devastation caused by the floods of 2009 and 2015 provided a starting point and the Pioneer encouraged communities to take a broader interest in how the management of land and water affects them. By November 2017 good progress had been made

⁴³ <https://democracy.greatermanchester-ca.gov.uk/documents/s8626/14a%20Impact%20of%20the%20Urban%20Pioneer%20Final%20Report%20May%202020.pdf>

in data collection and the identification, mapping and quantification of ecosystem services in the three sub-catchments of Braithwaite, Glenridding and Staveley:⁴⁴

- Regulation of air quality
- Climate regulation
- Landscape value / aesthetics
- Livestock production
- Recreation
- Timber and wood fuel production.

Based on the interim review (November 2018) of the pilot project, though, the extent to which the application of a Natural Capital approach per se was being taken forward – especially regarding freshwater – is unclear. Similarly unclear is whether any lessons that might be learned from the pilot could be transferred elsewhere. The outcome of this pilot is uncertain. The authors of the current Guide could find no web-based publication regarding the pilot since 2018.

4.2.4 Landscape Pioneer

The Landscape Pioneer was led by Natural England and is based in the North Devon UNESCO Biosphere Reserve. A key role of the Natural Capital approach is to inform decision making and management by everyone involved and affected, so that people’s use of natural resources is sustainable. A major output of the Landscape Pioneer has been the formation of a Natural Capital Based Strategy for North Devon.⁴⁵ This has involved gathering relevant data and evidence to establish a Natural Capital baseline, employing the Natural Capital logic chain as shown by the NCC.

Exhaustive and non-overlapping, the National Ecosystem Assessment Typology of habitats was used in this process. A multi-criteria analysis, together with root-cause analysis, was used to identify four priority issues that the strategy should address. Three natural habitat-based criteria were employed in the multi-criteria analysis. In order of priority: (1) the estimated annual values of ecosystem service benefits provided by a habitat, (2) ‘Condition’ – how good the habitat is at delivering this service currently, (3) ‘Trend’ – how the condition has changed over the last 20 years. The four priority issues that the strategy should address were thus identified as:

- **Improving water quality:** many of the waterbodies – including rivers, wetlands, the estuary and coastal bathing waters – have poor water quality. This damages tourism, commercial shellfish production and wildlife. The problem is caused by industry, human waste treatment and agriculture. But a focus on changes to agricultural practice is seen as a central part of resolving the problem. The most significant agricultural cause of water pollution is livestock. An additional cause is the poor management of nutrients and soil.
- **Reducing flood risk:** flooding is a significant and growing issue in North Devon, which impacts negatively on the health and prosperity of the local population. The area is prone to flooding because of steep gradients and impermeable rocks, but the problem is

⁴⁴ Holt, A.R. (2017) *Natural capital assessments for Braithwaite, Glenridding and Staveley sub-catchments. Cumbria Catchment Pioneer Pilot Project Phase 1*. Natural Capital Solutions. <https://www.naturalcapitalsolutions.co.uk>

⁴⁵ Sunderland T, Rice P, Lord A and Traill Thomson JA (May 2020) *Natural Capital Strategy for North Devon*, Natural England Research Report number NERR083. <http://publications.naturalengland.org.uk/publication/6070000127574016>

intensified by the way land is used and managed. Natural approaches to reduce flood risk can form part of a cost-efficient response to this problem. For example, farm management practices that reduce the rate of run off, as well as restoring peatland, Culm grassland and woodland.

- **Increasing carbon capture and storage:** mitigation of climate change necessitates capturing and storing as much carbon as possible. Woodland and Culm grassland are effective in sequestering carbon. These habitats are present in North Devon but there is great potential for more. Increasing their extent and managing them for maximum carbon storage, wildlife recovery and sustainable timber therefore forms part of the strategy.
- **Dispersing tourism and recreation pressure:** North Devon attracts nearly 6 million visitors a year, the visitor economy supporting an annual business turnover of £0.56 billion and around 11,000 jobs. Tourism is highly seasonal and concentrates on the coastal strip. Accommodating this many visitors without damaging the local environment is difficult. Negative impacts include littering, damage to fragile habitats, and overloading wastewater treatment facilities. These pressures can be addressed by careful management of the coastal strip area and developing alternative tourist destinations away from the coast.

Strategic changes addressing these issues were then proposed, along with four management principles to take them forward: institutional responsibility, adaptive management, localization, and shared commitment. The Strategy will inform the 2050 Vision for the Local Plan and the North Devon Biosphere mid-term review.

4.2.5 Marine Pioneers

The Marine Pioneers are coordinated by the Marine Management Organisation. It operates in two separate locations, covering areas of coast and sea based on the North Devon Biosphere and the Suffolk Coasts and Heaths Area of Outstanding Natural Beauty. Applying a Natural Capital approach to the marine environment had not been attempted before on this scale. The Pioneer initiated a Natural Capital assessment of saltmarsh restoration and is developing a fisheries partnership with the industry and others to test regional management opportunities and create a market for sustainably-caught local fish.

4.3 Water Service Undertakings

As noted in Section 2.4, Ofwat expects that water service undertakings will embed Natural Capital approaches at catchment scales into their business plans. **All water service undertakings are addressing Natural Capital.** A selection of activities undertaken and planned are noted below.

Water Industry Forum: In October 2020 the Forum, working with Water UK Environment Policy Advisory Group members through Welsh Water and Ofwat, and supported by Atkins, developed and ran a workshop with a wide range of government, regulator and water company participants. The outcome of the workshop was an agreed set of principles to guide member organizations (industry, regulators, governments, customers, stakeholders and the supply chain) as to how Natural Capital type approaches to investment decision-making could work.⁴⁶

⁴⁶ http://www.waterindustryforum.com/documents/uploads/WIF_Natural_Capital_Principles_for_the_Water_Industry.pdf

United Utilities (UU): Through its integrated catchment approach UU have actively supported the Urban Pioneer (Greater Manchester) and the Catchment Pioneer (Cumbria).⁴⁷ UU's Asset Management Director was a member of the Catchment Pioneer steering group where the company's major contribution has been integrated catchment management work on the Petteril catchment in Cumbria. UU's Head of Sustainability was a member of the Greater Manchester Combined Authority Natural Capital Group, the steering group for the Urban Pioneer. Lessons learnt from the pilots will be shared nationally to inform best practice. Though in its initial stages of development, United Utilities has also been looking to develop a Natural Capital trading platform, an innovative financing mechanism that would support projects offering Natural Capital benefits.

Anglian Water: the company recognises its dependency on the natural world, especially in providing the water put into supply, to receive the treated wastewater returned to the environment, and building new pipelines. Anglian Water has worked with researchers at the University of East Anglia through the Centre for Water Studies to develop a register of the Natural Capital found in the Anglian region and to consider some of the pressures on it.⁴⁸

Yorkshire Water: the company has embedded Natural Capital into its new Decision Making Framework, a cross-business process, underpinned with a suite of systems and software which integrates with many of its management systems and uses live data and analytical tools to help improve the management of the company's assets and investments, efficiency, resilience and help increase customer service.⁴⁹ One component of the Decision Making Framework is an impact assessment tool, which quantifies risk and value to optimise investment and management decisions about its assets and operations, to help provide the greatest net benefit to customers and wider society. Case studies illustrate where the Framework has helped Yorkshire Water to optimise decision making, the lessons learned from developing and using the impact assessment tool so far, and identifies how the company plans to continue to develop and use the Decision-Making Framework in future.

⁴⁷ https://www.unitedutilities.com/globalassets/z_corporate-site/pr19/supplementary/s4004_ecosystem_resilience_approach.pdf

⁴⁸ <https://www.anglianwater.co.uk/environment/our-biodiversity-work/natural-capital>

⁴⁹ https://www.yorkshirewater.com/media/yvjfkhqd/yorkshire_water_dmf_website_case_study.pdf

5 Available Tools and Sources of Information

5.1 Introduction

In its *End-of-Term Report*, the Natural Capital Committee recommended a number of resources that could be useful when valuing ecosystem services (Table 3). The more accessible of these tools and resources are introduced in Section 5.2.

Other tools and resources have also become available, most notably those developed by the Urban Pioneer pilot project for Greater Manchester, outlined in Section 5.3.⁵⁰ Other resources are becoming available, increasingly so as case studies are implemented and as Natural Capital is mainstreamed. Some of these other resources are provided in Section 5.4.

Table 3 NCC recommended resources for the valuation of ecosystem services⁵¹

Valuation tool or relevant study	Web link
Environmental Value Look-up (EVL)	http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19514
Enabling a Natural Capital Approach (ENCA)	https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca
Natural Environment Valuation Online tool (NEVO)	https://sweep.ac.uk/portfolios/natural-environment-valuation-online-tool-nevo/
List of valuation tools from Ecosystems Knowledge Network	https://ecosystemsknowledge.net/tool-assessor-list-of-tools
Woodland Valuation Tool	https://forestry.gov.scot/publications/sustainable-forestry/economic-research/680-woodland-valuation-tool
Outdoor Recreation Valuation tool (ORVal)	https://www.leep.exeter.ac.uk/orval/
Natural Capital Planning Tool (NCPT)	http://ncptool.com/
Local Ecological Foot printing Tool	https://www.left.ox.ac.uk/
Valuing corporate environmental impact: PwC methodology document	https://www.pwc.co.uk/sustainability-climate-change/assets/pdf/pwc-environmental-valuation-methodologies.pdf
Green Infrastructure Valuation toolkit (GI-Val)	https://www.merseyforest.org.uk/services/gi-val/
Toolkit for Ecosystem Service Site-Based Assessment	http://tessa.tools/

5.2 NCC Recommended Resources and Tools

5.2.1 The Environmental Value Look-Up (EVL) Tool

EVL is a searchable database which contains indicative monetary values for a range of environmental impacts. The unit values in the tool are based on a review of over 350 UK valuation

⁵⁰ <https://www.greatermanchester-ca.gov.uk/what-we-do/environment/natural-environment/natural-capital/natural-capital-user-guide/> The Natural Capital User Guide for Greater Manchester.

⁵¹ Natural Capital Committee (2020) *End of Term Report*, p. 40.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931695/ncc-end-of-term-report.pdf

studies that have been conducted since 2000. The EVL tool was developed for Defra by 'economics for the environment' (eftec) to help analysts take better account of environmental impacts in policy and project appraisals. It is intended:

- As a first-cut, rapid analysis of the economic values of environmental impacts.
- To include secondary or incidental environmental impacts in appraisals that might otherwise be overlooked.

A quick introductory video (8 mins) explains the structure of the tool and goes through an informative worked example on how to use it by looking at the loss of recreational benefits on a woodland site. The video can be viewed at:

<https://www.eftec.co.uk/project/environmental-value-look-evl-tool>

The EVL tool, which comprises linked Excel worksheets plus user guide, can be purchased through the Defra website at:

<http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19514#Description>

5.2.2 Enabling a Natural Capital Approach (ENCA)⁵²

ENCA resources comprise data, guidance and tools to help you understand Natural Capital and know how to take it into account. You should use ENCA resources if you are a:

- government economist or analyst
- public sector organisation interested in understanding the scientific and economic evidence around the natural environment
- private practitioner, interested in Natural Capital evidence, tools and resources used in government.

ENCA aims to:

- build capacity among users to assess and value the natural environment by providing comprehensive information and resources
- reduce search costs for analysts and decision makers
- provide a platform to update tools and guidance as knowledge develops
- identify new evidence and areas for development.

HM Treasury's Green Book: appraisal and evaluation in central government (2020), recommends ENCA's use. ENCA represents supplementary guidance to the Green Book.

ENCA Guidance covers:

- the Natural Capital framework
- economic valuation of the environment
- how project or policy appraisal can incorporate Natural Capital

⁵² <https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca>

- Natural Capital accounting principles and methods, benefits and challenges
- applying Natural Capital at a local level.

The *ENCA assessment template* is an Excel tool for assessing the potential effects of a policy or project on Natural Capital. It follows the 4-step approach in The Green Book.

The ENCA assets databook collates over 100 UK data sources, tools and studies for the 8 Natural Capital asset categories, including freshwaters and coastal margins.⁵³

ENCA featured tools includes summaries of tools developed or supported by Defra and its agencies.⁵⁴ These tools provide:

- valuation evidence
- biodiversity metrics
- valuation of outdoor recreation
- ecosystem services management.

*ENCA case studies*⁵⁵ are real-world examples of how:

- Natural Capital approaches are used at a range of spatial scales
- economic valuation is used to inform decision making
- Natural Capital accounting works at various spatial scales
- projects attempt to create new streams of income from investment and maintenance of ecosystem services.

5.2.3 Natural Environment Valuation Online tool (NEVO)⁵⁶

The NEVO Tool is a web application to help users explore, quantify and make predictions about the benefits derived from existing and altered land use across England and Wales. It brings together spatially explicit data, natural science and economic models to provide insights into the integrated relationships between climate change, land use change, ecosystem service flows and economic values. Users can view information relating to a range of ecosystem services.

The tool allows users to choose the spatial scale that they are interested in. This ranges from 2km grid cell level, through administrative scales such as local authorities and government office regions and terrain-based scales, such as river network sub-basins, up to country scale (England and Wales).

The tool is freely available to all users and is designed to be easy to use, making it accessible to a wide range of users.

⁵³ <https://data.gov.uk/dataset/3930b9ca-26c3-489f-900f-6b9eec2602c6/enabling-a-natural-capital-approach>

⁵⁴ <https://www.gov.uk/government/publications/enca-featured-tools-for-assessing-natural-capital-and-environmental-valuation>

⁵⁵ <https://data.gov.uk/dataset/3930b9ca-26c3-489f-900f-6b9eec2602c6/enabling-a-natural-capital-approach>

⁵⁶ <https://www.leep.exeter.ac.uk/nevo>

5.2.4 Tool Assessor: valuation tools from Ecosystems Knowledge Network⁵⁷

Tool assessor is a free service that provides summary information on the means of showing the value of the natural environment in society. This value includes, for example, the role of natural features in reducing flood risk, improving health and storing carbon. Tool Assessor is provided by the Ecosystems Knowledge Network to help people understand what methods and tools are available; and enable people developing and using these tools to share information about them.

A range of methods and guidance documents are referred to as ‘tools’ or ‘toolkits’. The focus is on structured ways to collate and analyse information about the role of the natural environment in society. The latest revision of Tool Assessor (January – March 2021) was funded by Defra.

Tools assessed and described on the website are: Aries, susdrain BEST (benefits estimation tool), CMSi Site Management, Kings College London Co\$ting Nature, Greenkeeper, Green Infrastructure Valuation Toolkit, i-tree Eco, InVEST, NEVO, ORVal, Pollution Removal by Vegetation, SENCE, TESSA, and Viridian HydroloGIS.

5.2.5 Outdoor Recreation Valuation tool (ORVal)⁵⁸

The ORVal Tool is a web application developed by the Land, Environment, Economics and Policy Institute at the University of Exeter with support from Defra. Its primary purpose is to provide information that might be useful to government, businesses and communities in understanding the benefits that are derived from accessible greenspace in England and Wales.

ORVal is map-based and allows users to explore the distribution of greenspace across England and Wales, plotting out the locations of recreation areas like parks and nature reserves, paths through the countryside or along riverbanks, and recreation sites such as beaches. The greenspaces identified on the ORVal map take three different forms:

- Areas: accessible greenspace contained within well-defined boundaries over which visitors usually have freedom to wander
- Paths: walkable routes that pass-through greenspaces but confine visitors to defined routes of passage
- Beaches.

ORVal also allows users to learn something about the nature of those different sites: it provides a range of additional layers that users can display on the map. Those layers provide information on the land cover, land uses, water margins, special designations and points of interest to be found in or near each recreation site.

ORVal’s three key functions are that it allows users to:

1. Explore the visitation and welfare values that are generated by currently accessible greenspaces. Welfare values can be viewed at individual site level or aggregated by regions.
2. Estimate how visitation and welfare values might change if the characteristics of a recreational greenspace were changed.

⁵⁷ <https://ecosystemsknowledge.net/tool-assessor-list-of-tools>

⁵⁸ <https://www.leep.exeter.ac.uk/orval/>

3. Draw new recreation sites on the map, define their characteristics and estimate the visitation and welfare values that might be generated by creating that new greenspace in that particular location.

ORVal's estimates of visitation and welfare values are derived from a statistical model of recreational demand. The model is a person-level model: that is, it provides estimates of the recreational behaviour of a person with particular characteristics living in a particular location. It can be used to predict which greenspaces an individual might visit over the course of a year and how much welfare value they get from each of the greenspaces available for them to visit.

The default ORVal screen displays the locations of accessible greenspaces across England and Wales, presented on a background map provided by OpenStreetMap. Users interact with ORVal through this map-based interface and through a series of menus and wizards. The process of navigating around the ORVal map follows protocols familiar to users of map-based web applications.

5.2.6 Local Ecological Footprinting Tool (LEFT)⁵⁹

LEFT is a mapping tool, developed to provide a simple-to-use tool for industries and landowners who must make quick preliminary decisions about land-use change, assisting them to minimise the environmental impact of their operations. A user defines an area of interest – which may be anywhere in the world – using a web-based map. LEFT then automatically processes a series of high-quality datasets using standard published algorithms to produce maps at 30m resolution of:

- land cover class
- number of globally threatened terrestrial vertebrate and plant species
- biodiversity of terrestrial vertebrates and plants
- habitat intactness
- wetland habitat connectivity
- number of migratory species
- vegetation resilience.

These results are then aggregated in a single summary map showing the pattern of relative ecological value.

5.2.7 TESSA: A toolkit for rapid assessment of ecosystem services⁶⁰

The TESSA toolkit provides accessible guidance on the use of low-cost methods to evaluate the benefits people receive from nature at specific sites where biodiversity conservation is of importance, in order to generate information that can be used to influence decision making.

TESSA is primarily aimed at conservation practitioners, although the methods may be applicable to a wide range of users, including natural resource managers (e.g. forestry, fisheries, water managers), land-use planners, and the private sector. The methods in the toolkit are designed to be applicable to users from developing and developed countries, and across all terrestrial and wetland habitats (currently excluding marine areas).

⁵⁹ <https://www.left.ox.ac.uk/>

⁶⁰ <http://tessa.tools/> and <http://www.birdlife.org/worldwide/science/assessing-ecosystem-services-tessa>

The toolkit includes:

- an overview of ecosystem services, key concepts and caveats
- guidance on conducting a preliminary scoping appraisal at a site (or sites) to understand the important services they provide, and to whom
- decision trees (flow charts) to lead the user to the most appropriate methods according to the characteristics of the site
- methods for measuring the ecosystem services listed above
- the valuation of an ‘alternative state’ in order to compare a current and alternative state of the site and hence estimate the impact of potential or actual changes on the ecosystem services provided
- worked examples on how to derive a value – quantitative, including potentially economic, and/or qualitative – for each service, including presenting the difference in value between two states of the site
- guidance on how to synthesise the data for each service into a summary of ecosystem service change at site scale
- guidance on assessing the distribution of benefits across relevant beneficiary groups.

5.3 Resources Developed by the Urban Pioneer – Greater Manchester

Of the many outputs of the Urban Pioneer,⁶¹ two in particular are introduced here – the Natural Capital Accounts and the Ecosystem Services Map:

Natural Capital Accounts: this provides baseline valuations of each ecosystem service, presenting the monetary values of the benefits delivered to society on a local authority or river valley scale. Such valuation data are useful when presenting headline figures to decision makers.

Ecosystem Services Map: this shows the habitats on a site. It also contains a ‘heat map’ showing how different ecosystem services could be enhanced to improve a site’s Natural Capital. This can be beneficial for illustrating the value of a project.

Figure 20 identifies the classes of user who should consider using the tools and the value they may obtain from doing so.

The Catchment Based Approach (CaBA) is a methodology for partnership working to conserve and improve freshwater and wetland habitats at a catchment scale. Amongst other resources, the CaBA website directs its users to the resources developed by the Urban Pioneer.⁶²

⁶¹ <https://www.greatermanchester-ca.gov.uk/what-we-do/environment/natural-environment/natural-capital/natural-capital-user-guide/> The Natural Capital User Guide for Greater Manchester.

⁶² <https://catchmentbasedapproach.org/learn/>

Who can use the tools?



Strategic Planner

Identify baseline Natural Capital values. Identify opportunities for environmental improvements that could deliver multiple benefits and can draw in new funding streams.



Local Authority Planner

Produce evidence about which features of a site to protect and enhance in allocations, development frameworks, planning policy and decisions.



Land Manager

Use the habitat mapping and the list of practical actions when preparing management plans and biodiversity net gain schemes.



Friends Group

Use the Ecosystem Service Mapping Tool to identify multiple small scale opportunities and help to engage other third parties who would benefit from improving a specific Ecosystem Services.



Fundraiser

Use the Natural Capital Accounts to produce headline figures on how environmental investments can boost Natural Capital and thus influence decision-makers.



Developer

Use the Ecosystem Services Mapping Tool to identify opportunities for delivering biodiversity and environmental net gain on site. Use both tools to consider how the development site's Natural Capital can be uplifted to advocate for the benefits of the scheme to the neighbourhood and to incoming residents.



Figure 20 Who can use the Natural Capital tools developed through the Urban Pioneer – Greater Manchester
Source: Greater Manchester: The Natural Capital User Guide for Greater Manchester.

5.4 Selected Other Sources of Information

Additional to the tools and resources introduced above, other sources of information have been referred to in producing this Guide. For the convenience of readers, all are listed in Table 4.

Table 4 Sources of Further Information and Guidance

Sources of Further Information and Guidance
Nature Greater Manchester https://www.greatermanchester-ca.gov.uk/what-we-do/environment/natural-environment/natural-capital/natural-capital-user-guide/ The Natural Capital User Guide for Greater Manchester.
ONS (Feb. 2017) <i>Principles of Natural Capital Accounting</i> https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/principlesofnaturalcapitalaccounting
ONS (2020) <i>UK Natural Capital Accounts 2020</i> https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/uknaturalcapitalaccounts/2020
ONS (2020). <i>UK Natural Capital Accounts Methodology Guide</i> https://www.ons.gov.uk/economy/environmentalaccounts/methodologies/uknaturalcapitalaccounts/methodologyguide2020
Natural England (July 2020) <i>Natural Capital Atlases: Mapping Indicators for County and City Regions (NECR381)</i> http://publications.naturalengland.org.uk/publication/6672365834731520
Environment Agency (2021) <i>Natural Capital Register and Account Tool</i> Contact: naturalcapital@environment-agency.gov.uk .
UK NEA (2011) <i>UK National Ecosystem Assessment (Full) Report. Chapter 2: Conceptual Framework and Methodology; Chapter 3: Drivers of Change in UK Ecosystems and Services</i> . Available from a drop-down box at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
UK NEA (2011) <i>UK National Ecosystem Assessment Report, Synthesis of Key Findings</i> http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
Houses of Parliament: Parliamentary Office of Science & Technology (May 2011) <i>Natural Capital Accounting</i> , Post Note No. 376 https://www.parliament.uk/globalassets/documents/post/postpn_376-natural-capital-accounting.pdf
NCC (2017) <i>Economic valuation and its applications in Natural Capital management and the Government's 25 Year Environment Plan</i> https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957498/ncc-natural-capital-valuation.pdf
NCC (2020) <i>End of Term Report to the Domestic and Economy Implementation Committee of the Cabinet</i> https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/931695/ncc-end-of-term-report.pdf
NCC (2017) <i>How to do it: a natural capital workbook</i> https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957503/ncc-natural-capital-workbook.pdf

Sources of Further Information and Guidance

NCC (2019) *Natural Capital Terminology*

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/909202/ncc-terminology.pdf

Ignatyeva M et al (2020) A New Look at the Natural Capital Concept: Approaches, Structure, and Evaluation Procedure, *Sustainability*, 2 November 2020

<https://www.mdpi.com/2071-1050/12/21/9236>

H M Treasury (2020) *The Green Book: Central Government Guidance on Appraisal and Evaluation*

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf

Valuing Nature Paper (June 2016). *Demystifying Economic Valuation: Valuing Nature*. Paper VNP04.

<https://valuing-nature.net/demystifying-economic-valuation-paper>

Natural Capital Solutions

<https://www.naturalcapitalsolutions.co.uk/>

Eftec – economics for the environment

<https://www.eftec.co.uk/>

Lodders – Solicitors

<https://www.lodders.co.uk/>

Scottish Forum on Natural Capital

<https://naturalcapitalscotland.com/>

6 Relevance of Natural Capital for Freshwater and Wetland Habitats

6.1 UK Natural Capital Accounts 2020

The Office for National Statistics has published annual UK Natural Capital accounts estimates since 2019, though time series of certain asset values extend back to the late 1990s. The latest published accounts in 2020 refer to the year 2018.⁶³ The ONS makes clear that the 2020 accounts are experimental statistics and not comparable with those for previous years. Several Natural Capital services – including flood mitigation, carbon sequestration⁶⁴ by peatlands, and tourism – are not measured or are only partially captured. Furthermore, **the service values associated with the ‘existence’ of nature, and the mental and physical health benefits derived from accessing it, are also excluded from the accounts.** The ONS also acknowledges the need to strengthen the methodologies used for estimating the Natural Capital value of agriculture and water abstraction. Hence, **the Natural Capital (monetary) accounts should be interpreted as representing partial, minimum values.** The development of new service estimates in future should strengthen the accounts.

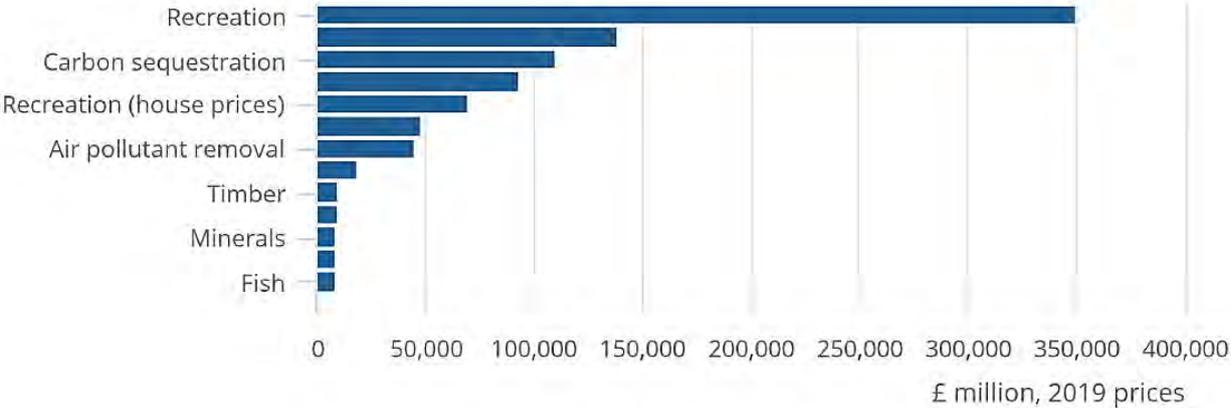


Figure 21 Estimated total Natural Capital asset values in the UK by service in 2018

Source ONS (2020) *UK Natural Capital accounts: 2020*, Figure 7, p. 13.

Bearing in mind the above caveats, the latest accounts indicate a total Natural Capital asset value across the UK of £921 billion in 2018, of which **recreational services makes the largest contribution to Natural Capital assets**, accounting for 38 per cent of the total (Figure 21). Lying in the cultural services category, recreation is considered in the accounts to comprise two components: (1) visits to green and blue spaces as measured by trip expenditure, e.g. car running costs, public transport costs, admission costs and/or parking fees, and (2) allowing for the effect on house prices of living within 500m of green and blue spaces, such residents having ‘free trip’ access to these spaces. The estimate excludes overnight and tourist visits and refers to visits made by those aged 16 years or more only. The aesthetic value placed on nature is an additional cultural service, which the ONS measures through examining the specific influence on house prices of being able to view green or blue spaces from a property. However, as relatively few

⁶³ ONS (2020), *UK natural capital accounts: 2020*.

⁶⁴ It may be noted also that the ONS’s estimate of the natural capital value of carbon sequestration excludes the global benefits of GHG mitigation.

houses have such views, the aesthetic service contribution to Natural Capital as estimated by ONS makes a relatively minor contribution.

The ONS reported that in 2018 over 10 billion visit hours were made to the natural environment in the UK, a significant increase since 2009. **Most of the time spent outdoors is in urban areas such as parks and gardens** (56 per cent in 2018) – a consistent observation since 2009 (Figure 22). Though the hours spent outdoors is smaller, trips to the coastal margins (the seaside), woodland (doubling from 2009 to 2018) and farmland collectively make a substantial contribution to the total.⁶⁵ The hours spent on trips to mountainous, moorland and hill areas and to freshwater is smaller still. It should be noted though that **many urban parks include freshwater features such as lakes, ponds and streams, whilst both rivers and wetland habitats feature in most upland and moors areas.**

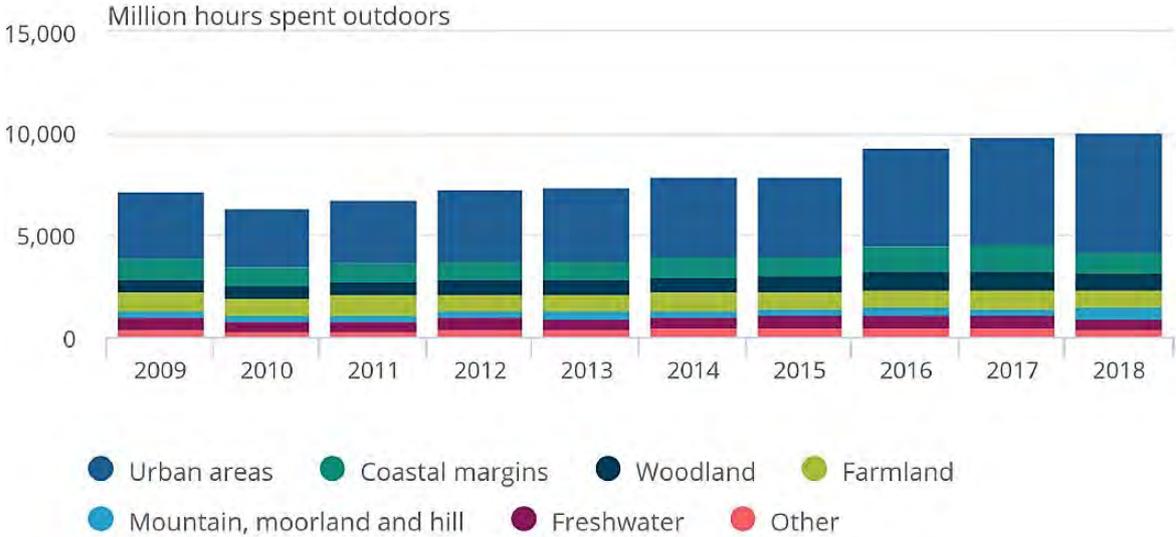


Figure 22 Recreation flow: million hours per year spent outdoors, UK, 2009 to 2018
 Source ONS (2020) *UK Natural Capital accounts: 2020*, Figure 5, p. 10.

The ONS reported that the average total time spent per visit – a few minutes over two hours – has changed little since 2009. In 2018 the average net time spent per recreational visit to the environment was 70 minutes, plus an additional (return) travel time of 48 minutes on average. In the absence of more detailed local, distributional data, an average one-way travel time of 22 minutes might therefore be taken as an initial estimate of the ‘radius of influence’ when valuing the recreational benefits of projects aimed at conserving or improving freshwater or wetland areas.

The accounts show also that **urban areas of blue space – freshwater features (lakes, ponds rivers, canals) – and green space – parkland, gardens –** contribute to Natural Capital through helping to **deliver urban cooling** (a regulating service). Blue and green spaces cool urban environments on hot days, benefiting the economy by mitigating labour productivity loss and reducing the use of air conditioning. The ONS state there were 68 hot days in UK city regions in 2018, the urban cooling service being valued at about £0.8 billion for that year. As it is expected generally that hot summers will become more common – ONS cite by up to several degrees

⁶⁵ Perhaps reflecting differences in population distribution, visits to the coast made up a much smaller portion of total outdoor visits in England, compared with Scotland and Wales.

warmer by the 2070s – **the urban cooling value of green and blue space in cities may grow significantly in future.** The ONS states that if it can move from a relatively simple model to a more precise, site-specific predictive model, it may also switch to a less conservative valuation price.

6.2 Significance of Ecosystem Service Co-Benefits

Both the national natural capital accounts presented above, and the more detailed compositional analysis presented in the Greater Manchester Urban Pioneer study (Figures 17 and 18 in Chapter 4 and their recasting in Figure 23) demonstrate the significance of cultural ecosystem services in the overall value of the benefits that people derive from Natural Capital.

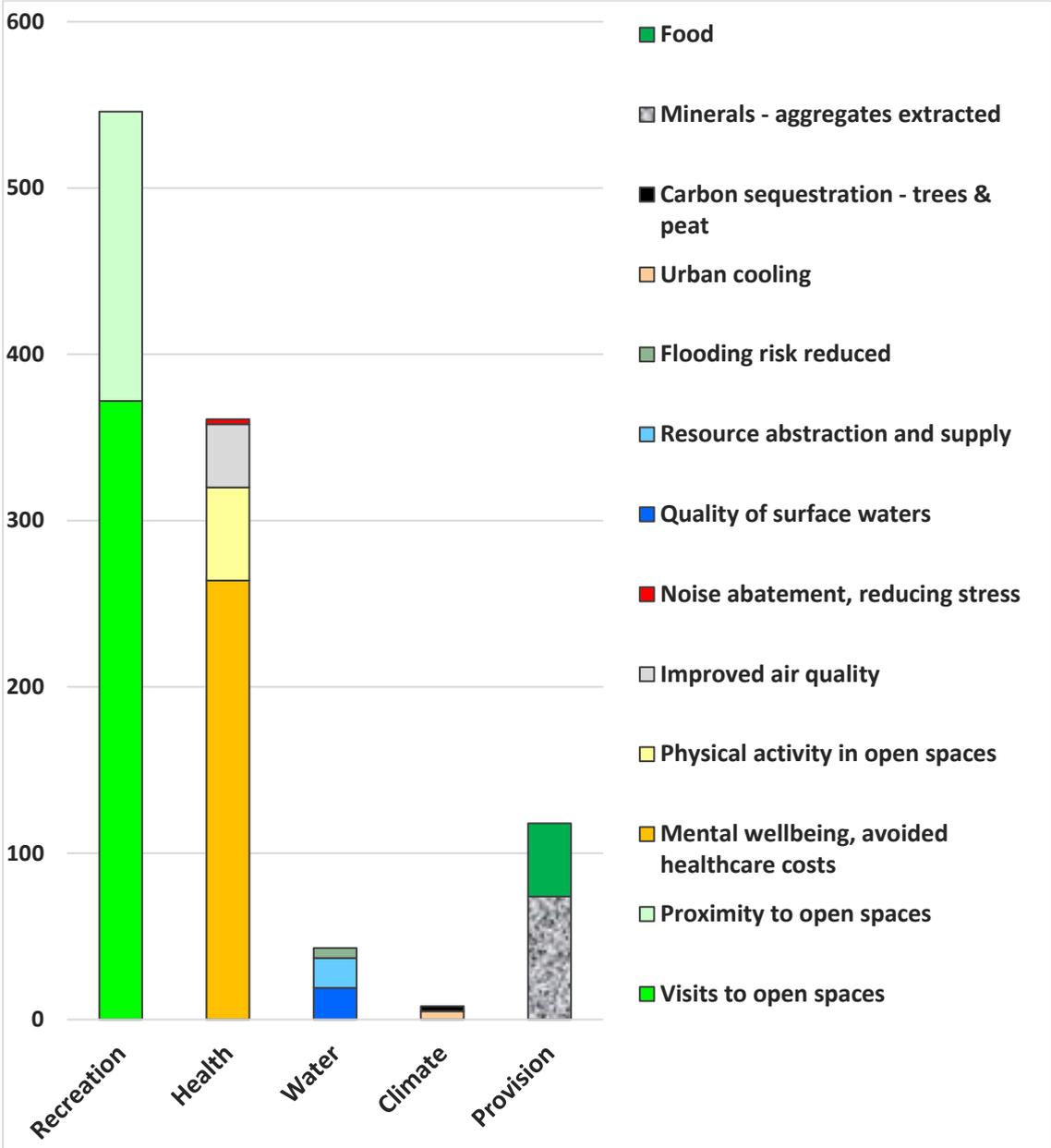


Figure 23 Distribution of annual ecosystem service benefits (£m) in Greater Manchester
 Source: Natural Capital Approach in Greater Manchester: authors’ adaptation of data

The Urban Pioneer’s assessment notably includes a range of health benefits that are not included in the ONS’s national accounts. And Figure 23 shows clearly the predominance of the recreational and health benefit flows (£m/year) in Greater Manchester. The extent to which the estimates of these two cultural ecosystem service flows exceed those of the provisioning and regulating services concerning water and climate in Greater Manchester is striking. Though it should be noted that the valuation of several goods and services is partial whilst others have escaped evaluation – either because of methodological uncertainties or because they are beyond quantification (or appear so at present).

More generally, it should be remembered that issues of ‘place’ are likely to affect the overall outcomes of Natural Capital assessment and the estimated benefit distributions. For instance, the GMCA’s Natural Capital User Guide for Greater Manchester observed, in response to a Frequently Asked Question, *Are Natural Capital Accounts unfairly weighted towards human populations?*, that *Natural Capital valuations include a dependence on population density for many of the methodologies, because of the high value of natural greenspaces in respect of health, well-being and recreation. This will produce higher values in more populated locations.* The implications of this observation for the value of Natural Capital in rural and wilder areas are unclear as yet but could be significant.

6.3 Goods and Services Derived from Freshwater and Wetland Habitats

6.3.1 Scope

This section serves as a checklist of the issues to consider, either when planning local or larger-scale developments affecting freshwater and wetland habitats, or when preparing a bid for funding habitat conservation and improvement. Table 5 presents an array of the goods and services that may be derived from freshwater and / or wetland areas. It is based on Figure 7 in Chapter 3, observing that freshwater and wetland areas may be present in several habitat types.

Table 5 Goods and services derived from habitats where freshwater and / or areas of wetland may be found

Ecosystem Service Type	Goods & Services Provided
Cultural	Aesthetic values
	Spiritual values
	Sense of place
	Cultural heritage
	Education
	Recreation and tourism
	Health
Regulating	Flood regulation
	Climate regulation
	Water and water quality regulation
Provisioning	Freshwater
	Peat (horticulture & fuel)
	Navigation

Section 6.3.2 touches on nature's intrinsic worth, what Dasgupta (see reference in footnote 16) has referred to as nature's 'sacredness'.⁶⁶ Subsequent sub-sections of this Guide discuss issues, threats and opportunities regarding selected goods and services provided by cultural, regulating, and provisioning services, respectively.

6.3.2 Nature's Intrinsic Worth: Sacredness

Alluded to in Chapter 1, nature's intrinsic worth can be considered as separate to Natural Capital, lying beyond it. This echoes the views of the GMCA, whose response to the FAQ cited at the close of Section 6.2 went on to say that *Nature has its own intrinsic value which goes beyond the benefits that flow to society*. Addressing this issue in Part II of the abridged version of his Economics of Biodiversity Review Dasgupta noted that:

The Review has developed the economics of biodiversity by viewing nature in anthropocentric terms. That is an altogether narrow viewpoint, but it has a justification. If, as we have shown in Part I, nature should be protected and promoted even when valued solely for its uses to us, we would have even stronger reasons to protect and promote it if we were to acknowledge that it has intrinsic value. Review.⁶⁷

It is worthwhile, therefore, to consider Natural Capital and nature's intrinsic worth in parallel. Ignoring either may weaken, for instance, a bid for project funding to improve a freshwater or wetland habitat. More to the point, in making a case for funding development to conserve and improve a habitat, referring solely to nature's unquestioned intrinsic worth, whilst ignoring the estimated benefits to society derived from the expected environmental net gain, may be ineffective. No matter how imprecise or incomplete are the estimated benefit flows, Natural Capital should be considered. This is especially pertinent when there is competition for funding.

6.3.3 Cultural Services

Aesthetic and Spiritual Values: Dasgupta introduced these terms, which may be regarded as synonymous to bequest, altruistic and existence values – terminology that was defined in Section 3.4.3. In principle, the distinction between society's aesthetic and spiritual values and nature's intrinsic worth, its 'sacredness', is that while a monetary value may – though with some difficulty, using 'willingness to pay' and other economic techniques – be placed on our aesthetic and spiritual values, nature's intrinsic worth is non-negotiable. The latter is autonomous, independent of society's views and beyond price.

In practice, however, drawing these distinctions is difficult and liable to be contentious. For instance, existence value was described as 'the value derived from the knowledge that something exists, even if a person may never plan to use it'. That is clearly an anthropocentric viewpoint, to which a purist might argue, reasonably so, that a species, let's say a water vole, has a right to exist totally independent of society's view on the matter. The issue can become even more tangled and contentious if the species in question is not 'cute' or if it may cause some actual or perceived harm to sectors of society. For instance, though otters are certainly 'cute', efforts to conserve them might not be greeted enthusiastically by all anglers.⁶⁸

⁶⁶ The Dasgupta Review – abridged version, p. 80.

⁶⁷ *Ibid* pp. 80-81.

⁶⁸ Though not relevant to UK freshwater and wetland habitats, the conservation of tigers and great white sharks in areas frequented by mankind represent an even clearer illustration of the conflicts that can arise.

A further illustration of the potential difficulties in this area concerns the valuation of spiritual appreciation. For instance, most if not all of us will have experienced brief moments of transcendence in the presence of nature, moments when the glory of the natural world is revealed to us, forming indelible memories. A few examples illustrate:

- walking alongside a river, coming to a stretch of rapids, pausing for a rest and unexpectedly catching a glimpse of a jumping trout or salmon
- catching sight of a brightly plumed kingfisher fishing in a local stream
- seeing the wonder in a young child’s face when they first see an iridescent dragonfly hovering over a pond
- after a wet, arduous, uphill walk amongst low-lying cloud alongside a mountain stream, the feeling of exhilaration on emerging onto a ridge in bright sunshine, the sun’s rays sharply defining rocky outcrops rising above a sea of cloud.

Endless examples exist, each ‘spiritual’ experience being unique to an individual. In principle, we might place an economic value on our individual and collective ability to experience such moments in future. But should we? Are such moments not precious instances when we catch a glimpse of nature’s intrinsic worth, of residing in and not separate to nature? Placing a monetary value on such moments, therefore, should be recognised as contentious, an exercise that many may find objectionable and regard as *knowing the price of everything and the value of nothing*.⁶⁹ This emphasises once again that it can be worthwhile to present nature’s intrinsic worth and Natural Capital considerations in parallel.

Education: Part 2 of the Dasgupta review of the economics of biodiversity (abridged version) recommended a three-pronged approach to ensure humanity’s engagement with nature is sustainable whilst enhancing our collective well-being and that of our descendants. One prong was for humanity to transform its institutions and systems – finance and education systems in particular – to enable sustainable change. Arguing that a detachment of nature from economic reasoning has accompanied an increasingly anthropocentric view of nature, and the acceptance of an ‘emptying world’, from a biodiversity perspective, Dasgupta made a number of suggestions in the educational field to help counteract the acceptance of decline:

- Every child is owed the teaching and experience of natural history, to be introduced to the awe and wonder of the natural world, and to appreciate how it contributes to our lives.
- Environmental and ecological education should be provided throughout school years and into tertiary education, reversing its marginalisation relative to the wider curriculum.
- Field studies should be integrated into courses, enabling students to connect with nature, this being especially valuable to students who may have grown up in an urban environment.

There are messages here for the UK educational establishment, developers of infrastructure and land, and for organisations whose remits encompass habitat conservation and improvement. They include:

⁶⁹ Oscar Wilde (1892) *Lady Windermere’s Fan*. Lord Darlington, a character in the play, defines a cynic as such.

1. For the goals of the 25 YEP and subsequent EIPs to be realised, space needs to be made for the integration of practical natural history in primary, secondary and tertiary education.
2. Developers should be creative in incorporating appropriate educational resources and activities in their proposals and developments. This could be most effective if done in partnership with one or several organisations concerned with natural history and the improvement and / or conservation of freshwater and wetland areas.
3. Conservation and habitat improvement programmes and organisations should incorporate natural history education in their activities and projects. A good example is the 'Trout in the Classroom' initiative undertaken by several organisations.⁷⁰
4. The design of habitat conservation and improvement projects should include educational activities – alongside ensuring public access, see below – wherever possible. This would be beneficial in general but particularly helpful perhaps when mounting a bid for project funding.

Responding positively to these messages would help create an environment in which an appreciation of Natural Capital could flourish and the goals of sustainable development relevant to freshwater and wetland areas may be realised.

Recreation and Health: Both the UK and GMCA Accounts show the significance of recreation and health for Natural Capital. Noting that these Accounts provide minimal values – for example, they don't include the cultural services provided by tourism – they provide solid reinforcement for the views expressed, and recommendations made, in the Marmot Review of health inequalities published in 2010 and the NCC's observations on environmental net gain.

Marmot Review

- Reducing health inequalities (the lower a person's social position, the worse his or her health) requires action on several fronts, including the **creation and development of healthy and sustainable places** and communities.
- **Action that reduces health inequalities benefits society in many ways**, including the reduction of economic losses from mental and physical illness associated with health inequalities. Included in such losses are productivity losses, reduced tax revenue, higher welfare payments and increased treatment costs.
- **Improving the availability of good quality open and green spaces across the social gradient** is one of the recommendations under policy objective E (*Improve community capital and reduce social isolation across the social gradient*).

NCC

- **Cultural services such as recreation, and mental and physical health and well-being are provided by landscapes and green spaces.** Such spaces may be poor in terms of biodiversity but **are very important in terms of the services they provide** because of **where they are located**, i.e. near to **populations** that need them.

⁷⁰ Summarised in Frost RC and Newman PJ (2021) FWR Publication FR/G0011, *Freshwater and Wetland Habits – Opportunities to Get Involved in their Conservation and Restoration*. Chapter 8.

An example of how the valuation of recreational services is likely to capture all the benefits of recreation in outdoor spaces is provided by considering trips to relatively wild spaces accessible to an urban population – perhaps a walk across moorland or other uphill areas, or fishing. Such trips will involve travel expenditure and the likely consumption of a packed lunch and flask of hot coffee. Travel expenditure may be captured in assessing the value of a trip but neither the packed lunch, nor the drink, contribute to market-based expenditure and so escape capture. Yet the value of a daytrip to the person or persons concerned may be far higher than accounted for by travel expenditure alone.

The above observation by the NCC is highly pertinent when considering urban development or regeneration projects. It emphasises that, from a Natural Capital perspective, **blue and green spaces are important for being where they are, i.e. located near to the populations that use them, rather than for their biological diversity.** This has **important implications** for valuing water parks and **water features** – including canals – **in or proximate to urban settings.** It is not so much the biodiversity of the water feature or features that is of prime importance but their location (Figure 24). This may be borne in mind when designing land developments and when preparing bids for project (grant) funding.



Figure 24 Recreation on and by freshwater
Source: RC Frost

6.3.4 Regulating Services

Flood Regulation: river flood plains, wetlands and woodlands are all natural landscape features – interfaces between terrestrial and freshwater ecosystems – that provide natural flood regulation services. All such features have been degraded over the years by development activity, for example, the construction of housing and retail parks on floodplains, and exploitation such as the cutting of peat and draining of wetlands for agricultural purposes. Their degradation has resulted in a reduction in Natural Capital and increased risks of flooding, the latter exacerbated by the impacts of climate change.

Development planning and activities should factor in a consideration of the Natural Capital of flood regulation. And planning authorities need to pay serious heed to the Natural Capital costs of the project proposals they receive.

At local and regional levels, concerned organisations should consider the opportunities to adopt nature-based solutions for flood regulation and the Natural Capital benefits they may offer. For instance, techniques to be considered could include tree planting, agricultural land management, installing permeable barriers such as tree debris in (headwater) streams and inflows to hold up flash-flows, and reconnecting rivers with their floodplains to allow them to flood and drain naturally.⁷¹

Climate Regulation: the Natural Capital value of freshwater and wetlands is relevant here in two respects. The first is the role of peat beds (wetland bogs and moors) in sequestering carbon, Natural England in November 2020 reporting that the UK’s peatlands sequester an estimated 3,000 million tonnes of carbon, England contributing a little over 19% to this total⁷²; whilst the Scottish Forum on Natural Capital reported in 2016 that peatland covers some 20% of Scotland’s land area.⁷³ And, conversely, the emission of CO₂ once peat beds become degraded through over-exploitation, overuse through mass tourism, or land management practices. The Scottish Forum on Natural Capital, for instance, has briefed that 80% of the UK’s peatlands are in a degraded or damaged condition. The second role in climate regulation is that surface water and green spaces provide a measure of cooling in urban areas.



Figure 25 Peat erosion and flowing water in northern Britain
Source: Alan Morris / Shutterstock

Regarding peatlands, the priority is to conserve the remaining peat bogs so as to prevent or at least minimise further CO₂ emissions to air, restoring degraded areas wherever possible. The positive, cooling role of freshwater bodies and green spaces in urban areas appears to be of secondary importance at present but could become more significant in future, dependent on the trajectory of climate change.

⁷¹ Lawson C et al (2018) *The Natural Capital of Floodplains: management, protection and restoration to deliver greater benefits* <https://valuing-nature.net/FloodplainNC>

⁷² <https://naturalengland.blog.gov.uk/2020/11/04/blanket-bogs-a-natural-asset/>

⁷³ Scottish Forum on Natural Capital. <https://naturalcapitalscotland.com>

Water and Water Quality Regulation: open freshwaters, rivers in particular, are used extensively for the reception, dilution and further treatment of residual waterborne pollutants discharged by municipal wastewater collection and treatment plants, and present in farm discharges. The financial (not to mention energy, chemical and land-take) costs of providing the same service through other methods would be very high. Equally, the costs incurred in treating this material before disposal are a measure of how much value is placed on good quality freshwater ecosystems. Overloading the regulatory capacity of freshwater in this regard may lead to chronic, and/or occasional acute pollution episodes that may be harmful to aquatic life and biological diversity – to the detriment of fishing and other interests.

Wetlands, whether naturally occurring or constructed, also provide a regulating service through their use to treat diffuse pollutants such as nutrients and particulate matter in farm run-off, to treat acidic, metal-rich mine discharges and to treat road run-off.

6.3.5 Provisioning Services

Freshwater: provision, whether from surface sources or groundwater resources, is vital to life. However, estimates of its value to society are uncertain. The ONS stated in the National Natural Capital Accounts published in 2020 that:

top-down industry-level estimates present difficulties in establishing clear Natural Capital service logic chains and disaggregation. And that, we [the ONS] are exploring alternative methods used to value water provisioning services, with the aim to look at the short-term cost and certainty, and long-term sustainability of the UK's water supply. Our aim is to capture the impact of the changing demand for water, and of climate change on the UK water supply by reporting on current and projected demand and water abstraction levels, weather forecasts and costs of ecologically excessive abstraction, water movements by truck, and restrictions on supply.

The construction of upland reservoirs to supply freshwater and to regulate river flows has been contentious in the past but the over-abstraction of groundwater has been and perhaps is now the most problematic issue.

Peat – horticulture and fuel: In addition to their climate change regulation roles, peatlands have traditionally been used as a source of fuel in remote areas and, in more recent years, as a source of compost for horticultural use. Extraction of peat for horticultural use is increasingly seen as unsustainable and is being phased out in England.

Navigation: Most of England's rivers have been heavily modified for flood protection and navigational purposes. Canals were created to extend navigation. Weirs and locks have allowed human navigation upstream but, in the process, have constrained the mobility of aquatic species. In the absence of fish and eel passes, migratory species are prevented from travelling upstream to spawn, whilst all aquatic species may be prevented from 'escaping' to unpolluted tributary flows in the event of pollutant episodes on the trunk flow.

6.4 **Freshwater and Wetland Conservation or Improvement Projects**

Where funds have been needed to design and implement local-scale river and wetland conservation and improvement projects, the benefits of those projects have usually been qualitative or, where quantitative, have not been presented in monetary terms. This has almost certainly resulted in good quality interventions being denied the necessary funds. The practical application of Natural Capital concepts now offers the opportunity to improve the quality of

decision making – both at the project design stage and in deciding which competing bids should be chosen for funding. With current levels of awareness, information and the tools now available, decision making that ignores Natural Capital considerations is increasingly likely to appear short-sighted, and the outcomes flawed (Box 3).

Box 3: Ignoring Natural Capital can lead to a flawed outcome

In the 1960s a stream flowing through a market town was culverted and covered over as part of a development scheme which involved building a shopping centre and associated road works. The development was beneficial in many ways for the town, but residents and visitors were deprived of green and blue space in the centre of town, and the scheme isolated the upper and lower reaches of the stream. Several decades later, the local Authority initiated planning to amend the road network in and around the town.

Local NGOs pressed the Authority to take this opportunity to uncover the stream as part of the development work. A financial assessment was made, which showed that uncovering the stream would incur an additional capital cost of about £2 million. Whilst Councillors appreciated qualitatively the social and environmental benefits that would flow from uncovering the stream – creating an appealing green space, enhancing the experience of shoppers, workers and visitors to the town, thereby increasing footfall and stimulating business activity – they questioned whether these could justify the additional expenditure. Consequently, the Authority commissioned consultants to examine the potential financial returns to the Authority of uncovering the stream, it being presumed that the stimulation of business activity would generate higher business rental and rate incomes to the Authority. The financial appraisal conducted by the Authority’s consultants indeed suggested that higher rate and rental incomes would be generated. However, Councillors considered the pay-back period too long.

In parallel, interested but independent third parties undertook an economic assessment of the non-market benefits of deculverting the stream. This adopted the ORVal tool to evaluate the benefits to visitors of using the recreated green space (Chapter 5). Noting that this model doesn’t take specific account of the co-benefits of improved health (mental, physical and air quality effects), aggregate non-market benefits would be higher than predicted: ORVal’s predictions gave conservative, lower-bound benefit values. Even so, the economic value (PV) of the quantified benefits were estimated as £2.9 million, giving a benefit-to-cost ratio (BCR) in excess of 1. Were the net value of increased business activity (additional business income after deduction of higher rates and rents) also taken into consideration, the BCR could have been even more favourable. Thus, there was sound justification for approving the scheme to deculvert the stream. The third parties provided this assessment to the Authority for their consideration prior to a final decision being made, but to no avail. From what was made public, it seems clear that the broader economic justification for the scheme was given fairly short shrift.

Deploying Natural Capital might be helpful in several situations (Figure 20 in Chapter 5), such as when:

- submitting bids for project funding
- seeking to gain support and approval for a planned development or developments
- presenting information on strategic plans to the public.

Organisations motivated to include Natural Capital considerations in their future activities should seek specialist advice from consultants or contractors with capability in the Natural Capital field. Aspects of Natural Capital for which specialist advice might be most beneficial are:

- Identification of relevant ecosystem services – to ensure that potentially significant services are included in the analysis and assessments.
- Describing and defining the ecosystem service flows as parameters that may be quantified, both physically and in monetary terms. Proxies for the parameters of real interest may have to be used, or it may be necessary to use parameters that will yield conservative estimates for the value of the benefits received.
- Quantifying the physical ecosystem service flows.
- Translating the physical ecosystem service quantities into monetary values.
- Undertaking discounted cash flow analysis, where relevant, and presenting the results.

6.5 Summing Up

Natural Capital is an extension to the practice of economics that has become embedded in England's environmental and biodiversity policies, culminating in its centrality to the first of England's Environment Improvement Plans, the 25 YEP and, implicitly, in the current draft Environment Bill. Many tools and techniques are now available to apply Natural Capital in practice, but continual development is likely in future as practice evolves from its current embryonic state to one of greater maturity. More refined and inclusive determination of ecosystem service flows and monetary valuations may be expected as experience grows.

Based on the current state of knowledge it seems clear that cultural services provide the greatest contribution of Natural Capital benefits to society, at least in urban areas. Of these, the recreational benefits and avoided health costs (mental and physical) offered by open green and blue spaces predominate. As related in the Guide, many open spaces also contain water features, and analysis has not (so far) determined the benefits contribution of freshwater and wetland assets relative to purely green space.

To capitalise on these observations, it would seem reasonable to suggest that freshwater and wetland conservation and improvement projects include prioritising the provision of public recreational opportunities – including the facilitation of greater access. Also, in order to maximise the probability of putting together strong bids for project funding, that urban green and blue spaces are a focus for improvement efforts, regardless of baseline habitat biodiversity.

Proposals for improvement should clearly delineate between project benefits that can be valued and project features that may be best presented as allowing nature's intrinsic worth to shine. Depending on the project's features and the interests of the funding organisation, it may be beneficial to present both aspects – one being a quantitative monetary benefit-to-cost ratio, the other a qualitative argument.

Whatever the nature of the intended project it is clear that a consideration of its implications for Natural Capital benefits will serve to strengthen a bid for funding and assist the prioritisation of competing projects for available funds.

ANNEXES

- Annex 1: The NCC's End of Term Report: Assessing its Impacts**
- Annex 2: Dasgupta Review: The Economics of Biodiversity, 2021**
- Annex 3: A Brief Introduction to DCF Analysis**
- Annex 4: Acronyms and Glossary of Terms**

Annex 1: The NCC's End of Term Report: Assessing its Impacts

1. 25 Year Environment Plan (25 YEP) and Essential Statutory Framework

25 Year Environment Plan

The National Capital Committee regarded its single most important achievement was advising on the creation and content of a long-term plan to protect and improve the environment. This recommendation built on the landscape-scale approach advocated in the Lawton Report 2010. The NCC considered that a long-term plan was necessary in order to deliver the government's commitment in its 2011 White Paper, *The Natural Choice, to be the first generation to leave the environment in a better state than it inherited*. The 25 YEP was a result of this recommendation and the NCC further advised that the 25 YEP should be placed on a statutory footing with legally binding targets in order that the plan (and subsequent plans) did not end up as *yet another interesting document on the shelf*. By and large, much, but not all, of the NCC's advice to government on this issue has been followed. Further, specific recommendations, therefore, were made by the NCC in its End of Term Report:

- The 25 YEP and all future Environmental Improvement Plans (EIPs) require legally binding interim targets which are clearly linked to the legally binding long-term targets. Without statutory interim targets, it is likely that the ten goals of the 25 YEP and future EIPs will become aspirational, and risk long-term targets being missed because, for example, the government may prioritise other short-term public expenditure items.
- The government should include a general overall statutory duty to protect and improve the environment in the Environment Bill as a priority. The significant improvement test for targets, as described in the (draft) Environment Bill, is highly subjective and is decided by the Defra Secretary of State. For example, improving part of the environment could be classed a significant improvement even while other natural assets may be declining.

Essential Statutory Framework

The NCC recommended that a lead body should be designated and given responsibility for overseeing the delivery of the 25 YEP and its goals. Accordingly, the (draft) Environment Bill establishes a new statutory body, the Office for Environmental Protection, designed to hold government to account on its environmental commitments. However, the NCC expressed significant reservations:

- The NCC does not consider the OEP being accountable to government to be a credible position; the OEP should be accountable to Parliament. Other similar regulatory bodies, such as the Office for National Statistics (ONS) and the Audit Commission are accountable to Parliament. The OEP should be fully independent from the organisations it is responsible for; its budgets and appointments should be decided by Parliament.
- The NCC recommends that the OEP's remit is expanded so that government must consider and respond to its advice on target setting and any revisions to interim and long-term targets/EIPs. Without a clear remit for the OEP in environmental target setting, the NCC advises that the ambition to significantly improve the environment could be compromised in favour of other government priorities and lead to further stalling of progress in meeting 25 YEP objectives, undermining confidence in the government's green commitments.

- Defra should review the roles and remit of the existing environmental delivery bodies. There is a case to be made for incorporating aspects of environmental protection at a national level within one body. This would entail substantial changes to existing bodies.

Environmental Net Gain

The NCC proposed in 2017 that environmental net gain should be incorporated as a key policy intent within the government’s 25 YEP, and welcomed its inclusion in the 25 YEP, in which the government committed to *embed an ‘environmental net gain’ principle for development, including housing and infrastructure*. The NCC reported its disappointment, therefore, that the government has pursued the much narrower concept of biodiversity net gain. In its 2020 Annual Report the NCC reiterated its earlier advice that *the proposed biodiversity net gain approach* [in the draft Environment Bill] *falls short of many of the goals of the 25 YEP as it fails to address most of the Natural Capital assets that are included within the plan*. The NCC regarded this as a missed opportunity to embed an environmental net gain principle at the heart of decision making. Its End of Term Report makes three specific recommendations:

- that the government should replace biodiversity net gain in the Environment Bill with environmental net gain, to ensure that aggregate Natural Capital is maintained and enhanced⁷⁴
- that environmental net gain (which also delivers biodiversity net gain) should be mandatory and funded by developers whose activities give rise to the environmental damage
- that Defra’s chosen methodology/metrics for measuring biodiversity net gain and environmental net gain be reworked so that they produce accurate accounts for establishing when a ‘net gain’ has been achieved.

2. Asset-based Framework for Measuring Changes in Natural Capital/Progress Against the 25 YEP

Natural Capital Baseline and Asset-based Metrics

In 2018 the NCC recommended that building a baseline understanding of natural assets should be a key milestone for the first five years of the 25 YEP. It warned that gaps and duplications in the data collected would impede the effective decision-making necessary to deliver the 25 YEP. As a direct result of the Committee’s advice, in 2020 the Defra Secretary of State announced a £5m Natural Capital and Ecosystem Assessment pilot to improve the baseline understanding of habitats and species abundance across the country.

The NCC’s advice has consistently highlighted the need for asset-based metrics to (i) assess more accurately the changes in condition and extent of Natural Capital assets, and (ii) to effectively manage these assets to ensure they continue to provide sustainable flows and benefits into the future. However, less than 20% of the 66 proposed indicators included in the government’s Outcome Indicator Framework provide a measure of Natural Capital assets. Even then, the data included for air, water, species, ecological communities and other assets are partial. A comprehensive approach is needed so decisions about different Natural Capital assets can be made in an evidence-based manner. Natural Capital assets operate as a system, hence co-dependencies and trade-off between assets should be identified. The NCC noted that the

⁷⁴ At the time of writing (September 2021), the draft Environment Bill retained the principle of biodiversity net gain.

government had acted on some of the committee's advice, by including a number of measurable commitments in the 2020, 25 YEP Progress Report.

The NCC made three recommendations in its End of Term Report concerning a Natural Capital baseline and metrics:

- Defra should ensure that the Natural Capital and ecosystem pilot, and any subsequent fully developed baseline exercise, focuses on identifying and measuring the extent and condition of Natural Capital assets across England and that the baseline assessment should be repeated (not 'reset') every five years to enable a periodic understanding of the trends in England's Natural Capital assets. Also, that the Treasury should ensure that baseline assessments are properly funded. **The OEP will be unable to carry out its 25 YEP scrutiny function effectively without a Natural Capital asset baseline.**
- Many existing datasets and monitoring programmes are suitable for measuring changes in Natural Capital assets and should be included in the baseline, with new data collection targeted on filling gaps.
- Information from the baseline census should be used in a natural asset system model – which Defra should develop jointly with the OEP – to identify the trade-offs, co-dependencies, and ecosystem services which flow from Natural Capital assets, and inform decisions related to optimising 25 YEP policy interventions.

Corporate Natural Capital Accounts

The private sector in England owns and manages the majority of natural assets – for example, over two thirds of land. In general, privately owned Natural Capital assets are not reflected in market prices and, therefore, the private sector has no overt financial incentive to deliver or conserve them. Public and private organisations and landowners, therefore, need to recognise their role in maintaining and enhancing the Natural Capital they own. A first step is to produce a corporate Natural Capital account (CNCA).

The development of CNCA is fundamental for securing the government's environmental objectives. Such accounts enable assets to be measured in the context of company profits, providing a powerful 'self-interest' incentive for organisations such as landowners and corporate investors to maintain and enhance natural assets. The NCC concluded that, without such an incentive, it is unlikely that any substantial environmental improvement will be achieved.

The NCC developed and piloted, in collaboration with the Royal Society for the Protection of Birds and PwC, an innovative and ground-breaking CNCA framework. This would enable organisations to account for the natural assets they own and the value they derive from them, and to document their assets and liabilities in a balance sheet format – extending traditional financial reporting. The methodology, therefore, should complement traditional financial and management accounts, aiding decision making to the benefit of both the organisation and society.

Uptake of the CNCA template has been positive, including by organisations participating in the pilot: the National Trust, Lafarge Tarmac, the Crown Estate and United Utilities. The NCC used the CNCA Framework as a basis when advising the government's Council for Sustainable Business on developing Natural Capital accounts. The government has incorporated elements of the CNCA into Natural Capital accounting practice, including informing the work of the British Standards Institute on its new standard, which will enable replicable and consistent ways to report Natural Capital accounts. The committee noted that there is increasing recognition of the need to adopt Natural Capital by institutional investors as a risk class equivalent to CO₂ emissions and global

warming, as reflected by setting up a Taskforce for Nature-related Financial Disclosures (TNFD). It was expected that the TNFD would be launched in 2021 with the aim of delivering a framework to guide nature-related disclosure by the end of 2022. Accordingly, the NCC recommended that:

- Defra should work with the Department for Business, Energy and Industrial Strategy to encourage private sector production of corporate Natural Capital accounting. Provisions need to be made for the maintenance of Natural Capital, notably by engaging with the TNFD initiative and accounting bodies to consider future revisions to accounting standards to include Natural Capital.
- The government should require businesses to make use of the practical CNCA that the NCC has developed, including a set of corporate accounting standards as a formal audit requirement. The NCC is concerned that the plethora of initiatives and different Natural Capital accounting approaches that are emerging will lead to greenwashing. There should be a standardisation of structures and principles to support external reporting – similar to those used in financial accounting.

National Natural Capital Accounts

The 25 YEP reiterated the government’s commitment to work with the ONS to incorporate Natural Capital into the UK Environmental Accounts by 2020. In 2018, the ONS published an updated road map to 2020. The NCC’s End of Term Report noted that Natural Capital accounts had been published for several broad habitats, also aggregate UK-wide accounts, with regular updating, and that development would continue so that accounts will be compiled for all eight broad habitats – including freshwater. The NCC’s closing recommendations included that:

- The ONS should further develop national Natural Capital accounts and, in particular, include estimates of the capital maintenance and restoration costs as well as the valuation of renewable natural assets, and incorporate cost-based approaches that complement existing valuation methods.
- A full set of national accounts for the extent and condition of individual components of Natural Capital – such as freshwater – is needed. This will enable the state of these assets, in addition to the values derived from them, to be recorded and reported at a more detailed level, relevant for decision making and policy development. Such ‘bottom-up’ accounts can be aided by a Natural Capital baseline assessment, which should enable further refinement of ‘wealth accounts’.
- The next iteration of the national accounts should work towards/include a national balance sheet of the value of our natural assets, estimates of their depreciation (where this occurs) and a redefinition of the way in which income and savings are measured in national accounts.

Natural Capital Framework for the OEP to Scrutinise the 25 YEP

Invited to scrutinise the first and second 25 YEP Progress Reports, the NCC responded with several recommendations for improving the reporting framework: the need for baseline, clearly defined 25 YEP goals with statutory, quantitative targets and an increased number of metrics that measure the extent and condition of natural assets. It also raised concerns that the evidence presented at best provided a partial picture only, given the narrow range of datasets considered. The Committee set out a Natural Capital approach that aligned seven of the main Natural Capital assets (six abiotic and the biotic) to the ten 25 YEP goals and the four priority areas outlined in the Environment Bill.

In its final response to the 25 YEP Progress Report, the NCC demonstrated how the Natural Capital framework can be applied to independently scrutinise progress. The associated information provided with that demonstration and assessment provides a robust template for the OEP to undertake its statutory 25 YEP scrutiny function from 2021. The NCC's advice to the OEP set-up team has shaped the OEP business case and first-year work programme. In particular, the NCC emphasised:

- The need for a decision support tool and sufficient staffing – well beyond the size of the then NCC secretariat – to enable the OEP to undertake a comprehensive assessment of the overall environmental system, future trajectories, and potential impact of changes in natural assets on ecosystem services.
- That such a comprehensive analysis is critical for informing whether or not the government will meet the environmental *significant improvement test* that it has set itself in the Environment Bill; and for developing optimal policy interventions to achieve not only the ten 25 YEP goals but attaining net zero greenhouse gas emissions by 2050.

3. Embedding Natural Capital Principles into Decision Making

The Green Book

The H M Treasury Green Book sets out government guidance on how new or revised policies, programmes and projects undertaken by government, or its agencies, should be appraised and evaluated. Its intention is to guide assessments to provide objective analysis of the impacts of public spending proposals, analysis which is consistent across government, and considers the effects of a proposal in terms of its impacts on social welfare.

The NCC worked with H M Treasury between 2016 and 2018 to advise and co-author a revised Green Book published in March 2018. In relation to the environment, the 2018 edition of the Green Book embraced the NCC's recommendations on the use of a Natural Capital-based approach to decision making. This included the incorporation within decision making of:

- Natural Capital asset stocks
- the flows of services derived from Natural Capital.

The requirement to consider capital stocks rather than just the services they provide represents a fundamental change to project appraisal. It is no longer sufficient that a project or programme deliver benefits which exceed costs by some set margin. Projects also need to demonstrate their impact on sustainability in terms of their effects on Natural Capital stocks. The approach accords with the ambitions set out in the EWP 2011, the 25 YEP and the Environment Bill.

To gauge the impacts of the revised Green Book, the NCC examined how it had influenced appraisals since its publication in 2018. Reporting in March 2020, the NCC identified 20 of the 280 appraisals produced since 2018 where a consideration of Natural Capital impacts would have been justified. The societal value of the policies/appraisals within these 20 assessments was over £8.2 billion. However, the **NCC found no evidence of Natural Capital assessment within any of the appraisal summaries**. The NCC made a number of recommendations subsequently as part of the ongoing Green Book review.

Valuing Ecosystem Services

Stocks of Natural Capital assets (such as stocks of fertile soils or populations of fish and bees) deliver flows of ecosystem services (such as natural levels of crop growth, potential harvests of fish and pollination services). These services, often combined with inputs from different types of

capital (such as manufactured and human capital) and the flows of services they provide (e.g. machinery and human labour inputs), yield goods which maintain human well-being. However, the latter inputs (machinery and human labour, etc.) are supplied through markets and are therefore priced, whilst many ecosystem services are non-marketed and unpriced. This risks over-exploitation, i.e. unsustainability, which occurs when ecosystem services are used at rates that deplete the stocks they come from.

An important step towards sustaining Natural Capital stock levels is to ensure that the value of ecosystem service flows is recognised in policy and decision making. In April 2018 the NCC published its guide to economic valuation, which included their recommended approach for how to value ecosystem services. The optimal approach is to value non-market ecosystem service flows in the same way that flows of services from other types of capital are assessed: using economic values. This allows fair, commensurate comparison of ecosystem services alongside other values.

Decisions based on market prices only, ignore some of the most important ways that Natural Capital benefits society. Special valuation techniques must be used where market prices are not available. The NCC has recommended a range of techniques and resources for the evaluation of non-market costs and benefits (Table 3 in Chapter 5).

The Green Book noted the significant strides which the NCC and Treasury colleagues had made in improving access to the valuation of non-market, environmental costs and benefits. And to Natural Capital decision support tools more generally. Endorsement of the NCC's advice in this field was further boosted by Defra's launch, in January 2020, of the 'Enabling a Natural Capital Approach (ENCA)' online resource.⁷⁵ ENCA brings together case studies, templates, and good practice guidance in the valuation of Natural Capital, including material developed by the NCC.

How to do it workbook

The NCC also published a *How to do it workbook* in 2017.⁷⁶ The workbook is a guide aimed at those wanting to use a Natural Capital approach in making decisions related to the natural environment. It has been used extensively by practitioners to help support place-based decision making. The application of a Natural Capital approach by decision makers such as planners, communities and landowners will be key to achieving the objectives of the 25 YEP.

The workbook provides a five-step model. It describes the planning cycle that practitioners can use to develop a Natural Capital plan. The process may be iterative. As the plan develops and more information is gathered it may be necessary to revisit earlier steps.

⁷⁵ Defra, *Enabling a Natural Capital Approach (ENCA)* (2020) <https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca>

⁷⁶ NCC, *How to do it: a natural capital workbook* (2017) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957503/ncc-natural-capital-workbook.pdf

Annex 2: Dasgupta Review: The Economics of Biodiversity, 2021

Terms of Reference

This independent review of the Economics of Biodiversity (the Dasgupta Review) was commissioned by the UK Treasury to help shape the international response to biodiversity loss and inform global action, to be addressed at two Conferences of the Parties (COP) in 2020: the 15th COP to the Convention on Biological Diversity,⁷⁷ and the 26th COP to the UN Framework Convention on Climate Change.⁷⁸ The target audience for the review therefore is not confined to the UK governments and stakeholders but extends internationally. The Dasgupta Review was published on 2 February 2021. Based on its examination of available evidence, the core objective of the Review was to provide an assessment of:

- a range of scenarios for enhancing global biodiversity compared with business as usual, focusing on the medium to long-term perspective and the relationship with economic growth
- the range of best practices, initiatives and interventions for industry, communities, individuals and governments that best achieve the simultaneous goals of enhancing biodiversity and delivering sustainable economic growth
- assess the implications and timescales for action under the scenarios considered, recognising interactions with climate change mitigation and adaptation opportunities.

Headline Messages

The full review is comprehensive, long and technical. However, it is accompanied by a shortened, non-mathematical monograph based upon it. A separate 10-page document, available at the website referred to in Section 2.6 (Footnote 16), provides and elaborates its headline messages. The Review's headline messages are itemised below (Table 6), those in bold being introduced below as abridgements of the full text in the review.

Headline Message No. 2

Between 1992 and 2014 it is estimated that global 'produced capital' per person doubled, 'human capital' increased by about 13%, but the stock of 'Natural Capital' per person declined by nearly 40%. The Review terms this imbalance between our demands and Nature's supply, the 'Impact Inequality'. Nature's supply is affected by the 'stock' of natural assets and its ability to regenerate. Our collective demands are affected by:

- the size and composition of our individual demands
- the size of the human population
- the efficiency with which we both convert Nature's services to meet our demands and return our waste back into Nature.

Headline Message No. 4

Nature's worth to society – the true value of the various goods and services it provides – is not reflected in market prices because much of it is open to all at no monetary charge. The consequent pricing distortions result in underinvestment in our natural assets. The mobility,

⁷⁷ At the time of writing COP15 is rescheduled to 11–15 October 2021 (online) and 25 April – 8 May 2022, Kunming, China.

⁷⁸ Rescheduled to 31 October – 12 November 2021, Glasgow, UK.

invisibility and silence of many aspects of Nature mean that the effects of our actions may be unrecognised, giving rise to widespread ‘externalities’, creating further market distortion.

The Review notes that this represents not only a market failure but a broader institutional failure. Many of our institutions have proved unfit to manage the externalities, government almost everywhere exacerbating the problem – by paying more to exploit than protect Nature and by subsidising unsustainable economic activities.

Table 6 Headline messages from the Dasgupta Review

Headline Messages	
1	Our economies, livelihoods and well-being all depend on our most precious asset: Nature
2	We have collectively failed to engage with Nature sustainably, to the extent that our demands far exceed its capacity to supply us with the goods and services we all rely on
3	Our unsustainable engagement with Nature is endangering the prosperity of current and future generations
4	At the heart of the problem lies deep-rooted, widespread institutional failure
5	The solution starts with understanding and accepting a simple truth: our economies are embedded within Nature, not external to it
6	We need to change how we think, act and measure success
	(i) Ensure that our demands on Nature do not exceed its supply, and that we increase Nature’s supply relative to its current level
	(ii) Change our measures of economic success to guide us on a more sustainable path
	(iii) Transform our institutions and systems – in particular our finance and education systems – to enable these changes and sustain them for future generations
7	Transformative change is possible – we and our descendants deserve nothing less

Headline Message No. 5

Most models of economic growth rest ultimately on humanity being ‘external’ to Nature: that technological progress can, in principle, overcome the exhaustibility of Nature’s finite flow of goods and services. The Review develops the economics of biodiversity on the understanding that we, and our economies, are embedded within Nature, not external to it. This approach helps us to understand that the human economy is bounded and reshapes our view of what constitutes truly sustainable economic growth and development.

Headline Message No. 6 (i)

Food production is the most significant driver of terrestrial biodiversity loss. Technological innovations and sustainable food production systems can reduce the sector’s environmentally damaging inputs, waste and effects, and improve production system reliance. Methods such as precision agriculture, integrated pest management, and molecular breeding techniques may contribute and are likely to have a positive economic impact. But sustainability cannot rely on technology alone. Consumption and production patterns will need to be fundamentally restructured. Breaking the links between damaging forms of consumption and production and Nature can be accelerated through a range of policies that change prices and behavioural norms.

Conserving and restoring our natural assets will sustain and enhance their supply. In many cases there is a strong economic rationale for quantity restrictions over pricing mechanisms. Large-scale and widespread investment in Nature-based solutions would help reduce biodiversity loss and significantly contribute to climate change mitigation and adaptation, not to mention wider economic benefits, including job creation.

Headline Message No. 6 (ii)

Nature needs to enter economic and financial decision-making in the same way buildings, machines, roads and skills do. Ultimately, this requires changing our measures of economic success since Gross Domestic Product (GPD) does not account for the depreciation of assets – including the natural environment.

The Review demonstrates that in order to judge whether economic development is sustainable, an inclusive measure of wealth is needed: one that includes natural assets. ‘Inclusive wealth’ provides a clear and coherent measure that corresponds directly with the well-being of current and future generations. This approach accounts for the benefits from investing in natural assets and illuminates the trade-offs and interactions between investments in different assets.

Introducing Natural Capital into national accounting systems would be a critical step towards making inclusive wealth our measure of progress. Frameworks for Natural Capital accounting and assessments exist at various stages of development. Whilst significant problems of design and measurement remain, this should not deter governments and businesses from supporting and embracing them. Increased investment in physical accounts and valuation would improve the quality of Natural Capital accounts.

Headline Message No. 6 (iii)

Financial flows devoted to enhancing our natural assets are small and are dwarfed by subsidies and other financial flows that harm these assets. A financial system is needed that channels public and private financial investments towards economic activities that enhance our stock of natural assets and encourage sustainable consumption and production activities.

Financial actors can help manage and mitigate the risks and uncertainty that results from an unsustainable engagement with Nature. Financial institutions and businesses can do this by accounting for dependencies and impacts on Nature in their activities; and through their measurement and disclosure not only of climate-related financial risks but also Nature-related financial risks. In addition, central banks and financial regulators can support increased understanding by assessing the systemic extent of Nature-related financial risks.

However, interventions to enable people to understand and connect with Nature are also necessary. They would result not only in improved health and well-being, but also help to empower citizens to make informed choices and demand the changes needed; for example, by insisting that financiers invest our money sustainably and that firms disclose environmental conditions along their supply chains. Establishing the natural world in education policy is therefore essential.

Recommendations: The Road Ahead and Options for Change

The Review identifies options for change that are geared toward three broad, interconnected transitions. Figure 26 illustrates the scope of these transitions, each resolved into its component options.



Figure 26 Summary of Options for Change

Source: The Economics of Biodiversity: The Dasgupta Review (abridged version, p. 70)

Annex 3: A Brief Introduction to DCF Analysis

The Guide refers at various points to the valuation of baseline Natural Capital and its calculation as the present value of future service flows presented in monetary values (e.g. in Sections 3.2.4 and 3.4). This Annex briefly explains how discounted cash flow (DCF) analysis is used in making the valuation. First it is necessary to understand some terms.⁷⁹

Discounting is a technique that converts future values occurring over different periods of time to a present value by taking account of the human preference for value now rather than later. This concept is known as ‘social time preference’ and is applied to real⁸⁰ prices expressed in the values of the base year.⁸¹ It has nothing to do with inflation, as it is true even at constant prices. All economic values are expressed in real prices.

Discount rate is the annual percentage rate at which the present value of future monetary values is estimated to decrease over time. The Green Book discount rate – known as the Social Time Preference Rate (STPR) – for use in UK government appraisal is set at 3.5% in real terms. Exceptions to the use of the standard STPR are outlined in the Green Book.

The use of the STPR in public sector appraisal contrasts with private sector discounting where, unlike that for the public sector, the discount rate incorporates allowances for the cost of raising capital and compensation for risk.

Present Value is the value of a projected future cash (monetary) flow discounted to the base year at a given discount rate and over a given assessment period. It allows comparisons to be made between flows of future values in terms of their value in the present (which is always assumed to be the base year of the proposal). Discounting converts a future value (benefit or cost) into its present value.

The Discount Factor is the factor applied to a value in a specific year to convert it to its equivalent present value. It can be calculated from the formula: $\text{discount factor} = 1/(1+i)^j$ where i is the discount rate and j is the number of years into the assessment period in which the value occurs. The discounted value is the original number multiplied by the relevant discount factor.

Net Present Value (NPV) is a generic term for the sum of a stream of any future values (over the appraisal period) that have been discounted to bring them to a present value. As values when discounted in each year are expressed in present value terms, they can be added together. The sum of the discounted values represents their Net Present Value.

Table 7 shows how the present value of £1,000 declines in future years with a discount rate of 3.5%. The discounted values are calculated as the undiscounted value multiplied by the discount factor and when summed equal £9,317. NPV may be calculated using the Excel spreadsheet NPV function.

Net Present Social Value (NPSV) is the present value of a stream of future costs and benefits to UK society that have been discounted by the appropriate social discount rate. This allows proposals with different time profiles of costs and benefits to be compared on a common basis.

⁷⁹ Adapted from the Green Book, 2020

⁸⁰ The projected monetary valuations to be discounted over the assessment period are expressed in real prices relating to the first year of the appraisal. That is, the prices are not adjusted for average inflation in future years.

⁸¹ The base year to which future values are discounted is usually the first year of the assessment period. This means that a value occurring in the base (first) year of a monetary flow is not discounted.

Table 7 Illustration of discounting monetary flows over a ten-year period (3.5% discount rate)

Year	Monetary Value (£)	Discount Factor	Discounted Value (£)
0	1,000	1.000	1,000
1	1,000	0.966	966
2	1,000	0.934	934
3	1,000	0.902	902
4	1,000	0.871	871
5	1,000	0.842	842
6	1,000	0.814	814
7	1,000	0.786	786
8	1,000	0.759	759
9	1,000	0.734	734
10	1,000	0.709	709
Net Present Value (NPV £)			9,317

Measures used to summarise the findings of Social Cost Benefit Analysis include estimates of Net Present Social Value (NPSV) and Benefit Cost Ratio (BCR):

- **NPSV** is defined as the present value of benefits less the present value of costs. It provides a measure of the overall impact of an option. For example, it can indicate the net value added to society by an intervention (a positive NPSV) or the value lost to society by the intervention (a negative NPSV).
- **BCR** is defined as the ratio of the present value of benefits to the present value of costs. It provides a measure of the benefits relative to costs. A ratio greater than 1 indicates that an intervention would create value whereas a ratio of less than 1 indicates that an intervention would destroy value.

Situations in which DCF analysis might be used:

- To estimate a lower bound for the present value of the Natural Capital base (it is typical that not all economic values can be determined).
- To estimate the contributions made by individual ecosystem flows to the estimated total present value of the Natural Capital base.
- To justify an intervention to improve the condition and extent of an area of Natural Capital, such as the path and adjacent habitat of a degraded stream. Here, the objective is to determine if the benefits generated by the measures exceed its costs – both expressed in present value terms. Whereas a single measure, such as flood control system, may not directly generate sufficient monetised benefits to warrant its construction, the inclusion of other values, such as recreational opportunities, can bring additional benefits that enable the project to be justifiable in economic terms and thereby justify its financial costs.
- To estimate the NPV of the impact of a proposed intervention on Natural Capital, taking account of all necessary ancillary mitigation and enhancement measures proposed to achieve net gain objectives.

Annex 4: Acronyms and Glossary of Terms

25 YEP	25 Year Environment Plan, published in 2018
Biodiversity	Variety and variability of life on Earth – typically a measure of variation at the genetic, species, and ecosystem levels
BNG	Biodiversity Net Gain
CaBA	Catchment Based Approach
CBA	Cost-Benefit Analysis
CBD	Convention on Biological Diversity: dedicated to promoting sustainable development, signed by governments at the 1992 Rio Earth Summit
CNCA	Corporate Natural Capital Account
COP	Conference of Parties
Defra	Department for Environment, Food and Rural Affairs of the UK government
DCF	Discounted Cash Flow – see Annex 3
Discounting	A technique used in the economic evaluation of development and other projects to place capital investment outlays and recurring operational costs on an equal footing. It may also be used as a term allowing the ‘time-value’ of money preference to be considered. See Annex 3.
EIP	Environmental Improvement Plans, proposed in the Draft Environment Bill of 2021
ENCA	Enabling a Natural Capital Approach
ENG	Environmental Net Gain An approach to development that aims to leave the natural environment in a measurably better state.
EU	European Union
EWP 2011	Environment White Paper published in 2011
Externalities	Externalities are the impacts of an activity on a third party or parties that is / are not directly involved in the transaction. For example, polluting discharges into a river may have downstream effects on people who abstract water or take fish from the river. Externalities can either be positive or negative.
GDP	Gross Domestic Product
GHG	Greenhouse Gases
Goods	Goods and Services deliver benefits to, or are of ‘value’ to, humans. For example, goods such as farmed food and drinking water. Other types of goods and services can produce well-being without there being a direct use – for example, the knowledge that a valued species, such as water voles, continues to exist can generate wellbeing.

GMCA	Greater Manchester Combined Authority
Hedonic Pricing	An approach used in environmental economics to establish the value of environmental amenity from a related market. Property prices are an example. Here, analysis of house price differences between locations of higher and lower environmental amenity can be used to help reveal the value added by environmental quality.
Human Capital	Physical labour capacity, skills, training and experience
JNCC	Joint Nature Conservation Committee – the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation
LEFT	Local Ecological Footprinting Tool
Natural Capital	The stock of natural resources – including soils, air, water and all living organisms – some of which provide people with goods and services, often called ‘ecosystem services’. Clean water, air and fertile soil underpins our economy and society and make human life possible. The stock may be considered at local, regional and national levels.
NCC	Natural Capital Committee. An independent advisory committee that provided advice to the government on the sustainable use of Natural Capital and the benefits so derived.
NCAC	Natural Capital Asset Check
NCD	Natural Capital Declaration: launched at the Rio + 20 Summit in 2012, this is a commitment by Chief Executive Officers (CEOs) from the world’s major finance sector to work towards integrating Natural Capital criteria into their products and services
NCP	Natural Capital Protocol: a decision-making framework that enables organisations to identify, measure and value their direct and indirect impacts and dependencies on Natural Capital
NEA	UK National Ecosystem Assessment, 2011
NEAFO	UK National Ecosystem Assessment Follow-on, 2014
NEVO	Natural Environment Valuation online tool
NEWP	Natural Environment White Paper, 2011
NIC	National Infrastructure Commission
NPV	Net Present Value – see Annex 3
NPSV	Net Present Social Value – see Annex 3
OEP	The Office for Environmental Protection, proposed in the draft Environment Bill of 2021
ONS	Office for National Statistics
ORVal	Outdoor Recreation Valuation tool

PR 19	A price review undertaken by Ofwat (Office for Water Services) in 2019, setting (the basis for) water and sewerage prices over the period 2020–2025. Pricing formulae are set, based in part, on agreed major investment programmes undertaken by the service providers under Ofwat’s jurisdiction.
PV	Present Value – see Annex 3
Services	See Goods. Note that ‘Services’ are not the same as ‘Ecosystem Services’ (Flows), which yield the welfare-bearing goods and services that provide the actual benefits to humans.
Social Capital	Relationship-related capital, for example the levels of trust and connections amongst people
STPR	Social Time Preference Rate
TESSA	Toolkit for Ecosystem Service Site-Based Assessment
TEV	Total Economic Value
TNFD	Taskforce on Nature-Related Financial Disclosures
UK NEA 2011	UK National Ecosystem Assessment, published 2011
UKI NEAFO 2014	UK National Ecosystem Assessment Follow-On, published 2014
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UU	United Utilities

