Scoping a State of Natural Capital Report

June 2022

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Acknowledgements

Special thanks go to the Steering Group and those who provided helpful comments on drafts: Tim Sunderland, Ruth Waters, Dave Stone, Patricia Rice and Jenny Craven, and members of the project advisory group: Andrew Canning-Trigg (Forestry Commission), Chris Cheffings (JNCC), Ben Ditchburn (Forestry Commission), Chrissy Ingle (Defra), Will Le Quesne (Cefas), Aisling Lannin (MMO), Dan Lear (MBA), Natasha Lombino (EA), Lauren Molloy (JNCC), Vicky Morgan (MMO), Niki Newton (JNCC), Eleanor Tew (FE), Lawrence Way (JNCC), Jacob Waller (FE).

As well as others for their input in producing the report, including: Stephen Arnott (NE), Mike Best (EA), Josh Bowler (NE), Zoe Buddle (DLUHC), Emma Burden (MoD), Richard Caldow (NE), Ian Crosher (NE), Lisa Curtis (NE), Tim Deverell (DfT), Ray Dickinson (MoD), Jessica Elias (NE), Jane Frank (NE), Laura Gannon (NE), Ben Green (EA), Carla Henry (DfT), Alex Kilcoyne (NE), Robert Knight-Strong (DfE), Rachel Locke (NE), Claire Ludgate (NE), Mandy Marler (NE), Maija Marsh (NE), Martin Moss (NE), Andrew Nisbet (NE), Ruth Oatway (NE), Jakub Olewski (NE), Stuart Otway (MoD), Emily Parker (EA), Ruth Parker (Cefas), Ingrid Pechinger (BEIS), Laura Petitt (JNCC), Julia Powell (MoD), Ian Saunders (NE), Helen Sheridan (MoD), Ginny Swaile (NE), Alison Wainwright (NE), Peter Walker (NE), Andrew Webb (NE), Sarah West (EA), Sarah Wren (NE), Sarah Young (Defra).

Organisational abbreviations/acronyms used above: BEIS – Department for Business, Energy and Industrial Strategy, Cefas – Centre for Environment, Fisheries and Aquaculture Science, Defra – Department for Environment, Food and Rural Affairs, DfE – Department for Education, DfT – Department for Transport, DLUHC – Department for Levelling Up, Housing and Communities, EA – Environment Agency, FC – Forestry Commission, FE – Forestry England, JNCC – Joint Nature Conservation Committee, MBA – Marine Biological Association, MMO – Marine Management Organisation, MoD – Ministry of Defence, NE – Natural England.

Contents

Annexes

This report has the following 4 annexes:

Annex 1: Data for a *State of Natural Capital Report*

Annex 2: Ecosystem services and CICES framework

Annex 3: Indicator spreadsheet

Annex 4: Drivers of change and opportunities

Annexes 1 and 2 are presented at the end of this document. Annexes 3 and 4 are presented as separate spreadsheets.

Executive summary

Aim

This report scopes a future *State of Natural Capital Report* for England, relevant to policy makers. We set out a method, content, indicators, metrics and data sets to be used. We also show how a future *State of Natural Capital Report* could be structured, aiming for an accessible, attractive product. As this is a scoping report, all graphics are for illustrative purposes only.

What does this report do?

Relevance to policy areas

The natural environment has a vital role to play in the delivery of key policy areas. If we enhance our natural assets, they can help to deliver policy; if they deteriorate, this can pose a substantial policy risk. Looking through a natural capital lens, we focus on the ability of nature to provide multiple benefits to people. We outline how natural capital, our stock of natural assets, relates to policy and national assessments of risk. We demonstrate what a *State of Natural Capital Report* could look like for 5 key policy areas:

- Resilient economic development
- Net Zero carbon emissions
- Climate change adaptation
- Food security
- Health and well-being

Nature provides benefits to people through living and non-living components, interacting as a system, or ecosystem. We show how ecosystem assets contribute to delivering the policy areas, through the provision of services and goods (ecosystem services) which benefit people. We also sign-post a selection of indicators, for measuring change in ecosystem assets, relevant to each policy area.

Natural capital risk register

We propose a method for developing a natural capital risk register. This will set out how ‘at risk’ our ecosystem assets are, and how this affects the services they can provide and subsequent delivery of policy. Whilst a *State of Natural Capital Report* can provide a snapshot in time, we also need to understand the drivers of change and how at risk our natural assets are. We present a method for developing a natural capital risk register for the ecosystem assets and link this to the 5 policy areas. The risk register method is based on the asset state (in relation to targets and thresholds) and trends in this state. We

propose a method using the best available evidence, in combination with expert opinion, taking account of drivers of change.

State of the ecosystem assets

We propose how to assess the state of our ecosystem assets for 7 broad ecosystem types, collectively covering the whole of England:

- Woodland and scrub
- Mountains, moor and heath
- Freshwaters
- Semi-natural grassland
- Enclosed farmland
- Urban
- Coastal margins and marine

Coastal margins and marine are considered together to acknowledge their connectedness and functioning as a system, avoiding the need to define any artificial boundary between them.

Photo: Derwent Water © Natural England/Paul Glendell (cropped) (CC BY-NC-ND 2.0)

Indicators for measuring change

We propose a set of indicators for measuring change in each broad ecosystem. How effective ecosystems are at providing benefits to people, depends on how extensive they are (quantity), how good their condition is (quality) and where they are situated in relation to the people who benefit (location). These three aspects, together, determine the state of

natural capital. We therefore propose indicators for the quantity, quality and location (where possible) of ecosystem assets. These indicators are based on previous work Natural Capital Indicators: for defining and measuring change in natural capital - NERR076. This work systematically identified the attributes of the natural environment vital for underpinning the benefits which nature provides to society. A good indicator should tell you more than just about itself. We propose a concise suite of key indicators, related to the provision of ecosystem services, for each broad ecosystem, and the metrics for measuring them.

Data and the Natural Capital and Ecosystem Assessment (NCEA)

We set out data sets to use in a future *State of Natural Capital Report*, and data gaps. The current Defra-led Natural Capital and Ecosystem Assessment programme is providing a step change in the availability and accessibility of data for measuring the state of natural capital. The data sets we propose therefore include both existing ones and those which will be collected over the next few years. The details of all data sets proposed, and how we selected them, are included in a data annex (Annex 1). In this annex, we also set out where there are critical gaps in data, for understanding the state of our ecosystem assets.

Recommendations for next steps

We set out proposals for next steps towards the production of a future *State of Natural Capital Report*. This includes reviewing this scoping report with policy stakeholders to ensure it meets their needs.

Photo by buckerstc, accessed from Pixabay

1 Introduction

1.1 Aim

This report scopes a future *State of Natural Capital Report* for England, relevant to policy makers. We set out a method, content, indicators, metrics and data sets to be used. We also show how a future *State of Natural Capital Report* could be structured, aiming for an accessible, attractive product. As this is a scoping report, all graphics are for illustrative purposes only.

We propose to review this report, with partners and policy makers, to ensure that it meets their needs and informs the development of a future *State of Natural Capital Report*.

1.2 What is natural capital?

Natural capital is defined as “the elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions” (Natural Capital Committee 2013). A natural capital logic chain shows how ecosystem assets underpin the provision of ecosystem services, which provide benefits and value to people (Figure 1).

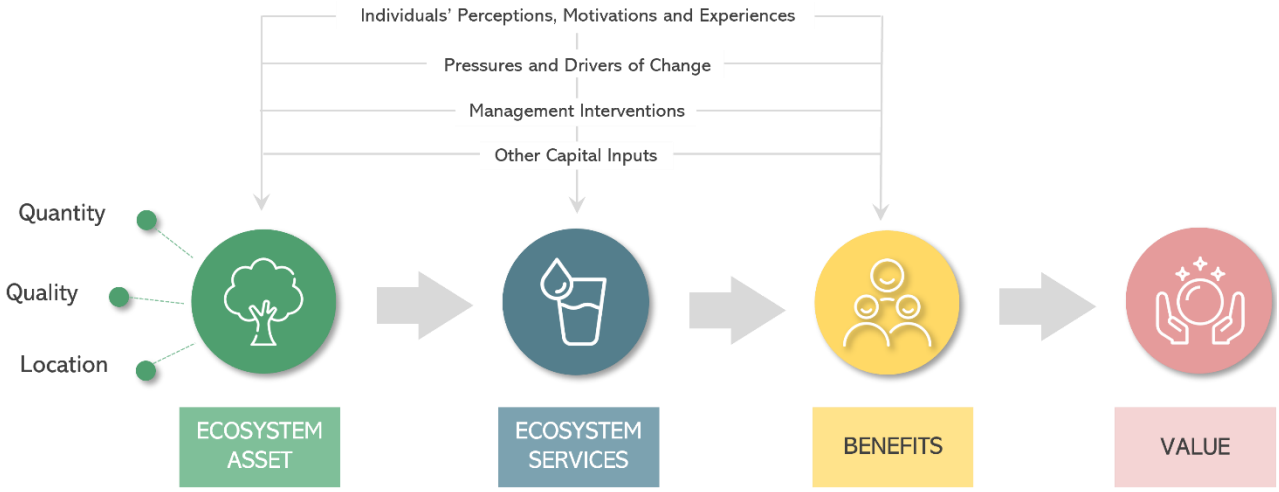


Figure 1 Natural capital logic chain (based on Haines-Young & Potschin 2010). © Natural England.

The provision of ecosystem services depends on the state of the ecosystem assets, their extent (quantity), how good they are (quality) and where they are (location), with respect to providing benefits to people. Definitions of other terms used in this report are given in **Box 1**.

Box 1 Definitions of terms, as used in this report:

Natural capital: the elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions.

Attribute: an environmental characteristic or property.

Indicator: a non-quantitative measure of an environmental property.

Metric: a quantitative measure of an indicator, including the units used.

Ecosystem: a community of living and non-living components, interacting as a system.

Ecosystem assets: the stock of nature with a living component (species, habitats and soils) which provides ecosystem services and benefits to people.

Ecosystem services: the goods and services provided by the natural environment that contribute to human well-being.

Benefits: the improvements in people's wellbeing that are obtained from ecosystem services.

Value: the worth that people place on the well-being benefits obtained from ecosystem services. Values can be expressed in both monetary and non-monetary terms.

Logic chain: also known as a causal model, a model demonstrating the links in a process to deliver a particular outcome. In this report, the logic chains depict the links between ecosystem assets, services, benefits and values and the factors affecting them.

Semi-natural habitats: our most natural habitats in England, which are high in value in terms of biodiversity and the services they provide. They have evolved through traditional low intensity farming or other human activities which support their characteristic composition, structure and function.

1.3 Why does the state of our natural capital and ecosystem assets matter?

Our natural capital provides us with the air we breathe, the water we drink, the food we eat. It boosts our mental health and well-being. It captures and stores carbon and has a vital role to play in helping us adapt to the impacts of climate change. How well ecosystem assets do this depends on how good a state they're in. More biodiverse ecosystems, with a full complement of species, are better at supporting natural processes and better at providing a wealth of benefits to people. As with a financial portfolio, breadth and diversity ensures resilience and reduces risk (Figure 2).

Figure 2 Increasing biodiversity reduces risks and increases resilience in the provision of benefits to people from ecosystems (Dasgupta 2021).

We need to take account of both how our decisions affect our ecosystem assets, and how our ecosystem assets should affect our decisions. To do this we have to understand the state of these assets. Are they at risk of degradation? Can we enhance them to help deliver policy?

While the economic value of natural capital benefits helps inform decisions, the state of the underpinning ecosystems is vital if we want to provide these benefits sustainably into the future. Value only tells us part of the story, as we are not able to put a monetary value on everything we get from nature. It also focusses our attention on the value of the assets, rather than whether they are in a fit state to provide benefits into the future. Values can go up or down, irrespective of the state of the underlying assets. In this scoping of a *State of Natural Capital Report*, we focus on the state of the ecosystem assets and show how they link to ecosystem services relevant to policy delivery. With this in-depth focus on the assets, we also aim to provide additional data for natural capital accounting, such as the Office for National Statistics natural capital accounts.

Natural capital includes air, minerals, geology and other non-biological components. In this report however, we focus on assets which include a living, biological component. We call these ecosystem assets. This focus on ecosystems is critical at this point in time. Decades of loss and degradation of our species and ecosystems have resulted in a biodiversity crisis. This crisis puts at risk not just nature, but also the benefits we will be able to get from it in the future. Declines include partial or total loss of ecosystems' extent (quantity) as well as degradation in their quality. We use a framing of whole ecosystem assets, with a focus on understanding and reporting how well they are functioning. It is the functioning of these whole systems which provide the benefits that we rely on.

1.4 Structure of a State of Natural Capital Report

We propose a structure for a future *State of Natural Capital Report*, based on three elements:

- Relevance to policy areas
- State of the ecosystem assets
- Natural capital risk register

The structure of this scoping report mimics this structure. Under each of the three sections we set out a proposed method and content, and demonstrate what reporting could look like. In the policy area section, we outline the contribution of ecosystem assets, providing ecosystems services, to policy areas.

2 Relevance to policy areas

2.1 Aim

In this section we show how ecosystem assets contribute to the delivery of policy. We present a method for linking the state of ecosystem assets, through ecosystem services, to policy. We also demonstrate what state of natural capital reporting could look like for five key policy areas.

2.2 Natural capital's contribution to policy delivery

Policies affect the state of our ecosystem assets, and our ecosystem assets affect policy delivery. Policy delivery depends on a range of ecosystem services provided by natural capital. This includes market goods such as timber, produce from the sea, crops and reared livestock. Ecosystems also play an important role in helping us to reduce greenhouse gases and cope with the impacts of climate change, through flood protection, urban cooling, pest and disease control and the sustainable supply of water. They also contribute to mediating pollution, in water, in air and from noise. Importantly ecosystem assets provide us with benefits to our health (mental and physical) and well-being. The contribution of ecosystems is often hidden, until it is not functioning effectively. If we enhance our ecosystems, they can contribute to policy delivery. If we let them deteriorate, or make policy decisions which enhance their decline, we risk being unable to achieve policy aims.

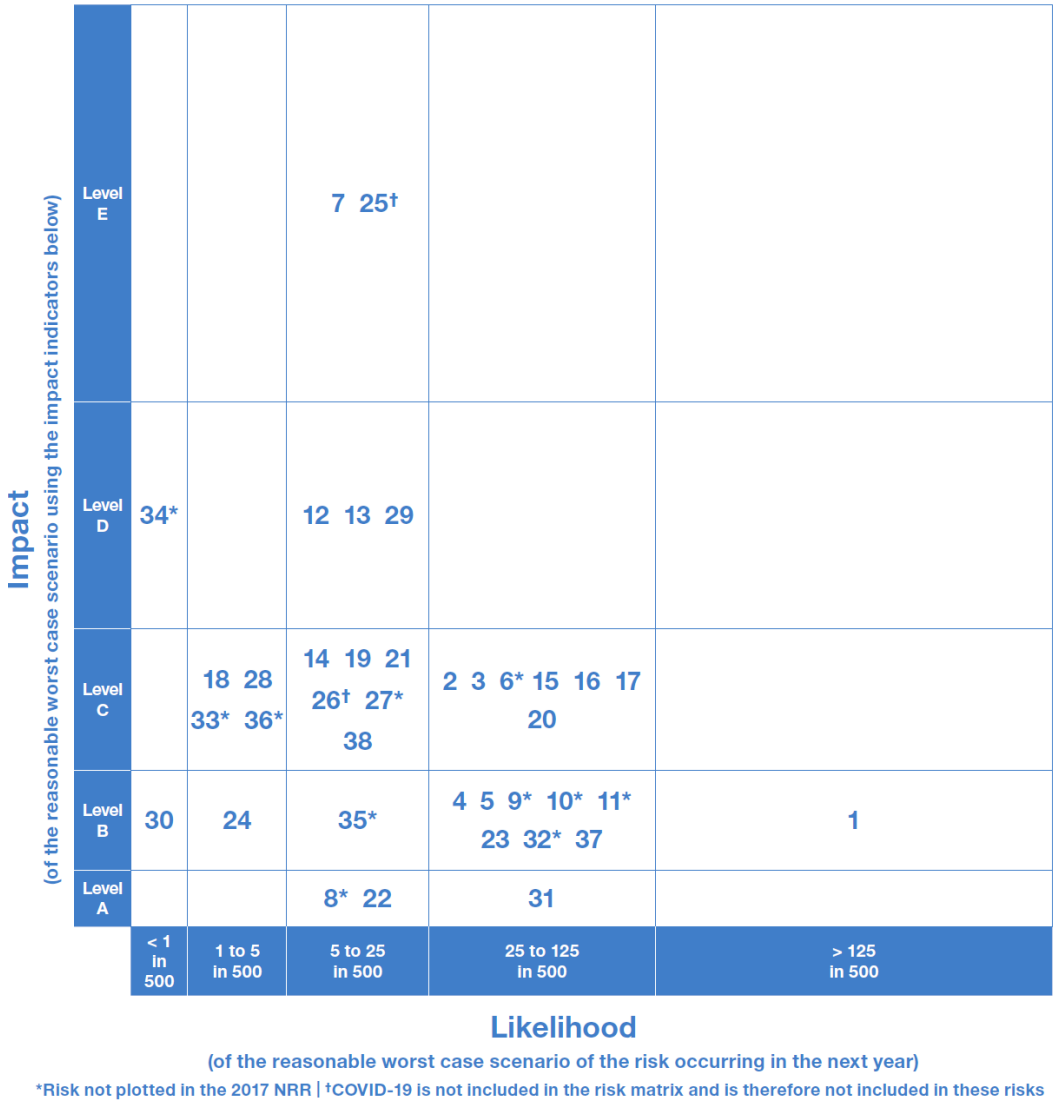
2.3 Natural capital related risk to policy

The UK Government National Risk Register 2020 identifies 13 of 38 major acute risks as being environmental hazards (see Figure 3). Restoration of our ecosystem assets has an important role to play in mitigating the risk of some of these hazards, eg through natural flood protection, urban cooling and the provision of clean air and plentiful water.

The UK Climate Change Risk Assessment 2022 (HM Government 2022) also identifies eight priority risk areas that require the most urgent UK-wide action over the next two years. It lists the key policy areas affected (Table 1). Six of these eight priority risks relate to the state of ecosystem assets (including soils) and/or the ecosystem services they provide.

The risk register section of this scoping report sets out a systematic method for assessing risk across the breadth of our ecosystem assets and drivers of change (Section 4), linking this to key policy areas and major societal risks. We propose that a summary of this risk assessment is included in each policy section.

Figure 3 UK Government National Risk Register 2020 outlines the key malicious and non-malicious risks that could affect the UK in the short term (2 years).



*Risk not plotted in the 2017 NRR | †COVID-19 is not included in the risk matrix and is therefore not included in these risks

Malicious Attacks
1. Attacks on publicly accessible locations
2. Attacks on infrastructure
3. Attacks on transport
4. Cyber attacks
5. Smaller scale CBRN attacks
6. Medium scale CBRN attacks
7. Larger scale CBRN attacks
8. Undermining the democratic process*

Serious and Organised Crime
9. Serious and organised crime – vulnerabilities*
10. Serious and organised crime – prosperity*
11. Serious and organised crime – commodities*

Environmental Hazards
12. Coastal flooding
13. River flooding
14. Surface water flooding
15. Storms
16. Low temperatures
17. Heatwaves
18. Droughts
19. Severe space weather
20. Volcanic eruptions
21. Poor air quality
22. Earthquakes
23. Environmental disasters overseas
24. Wildfires

Human and Animal Health
25. Pandemics†
26. High consequence infectious disease outbreaks†
27. Antimicrobial resistance*
28. Animal diseases

Major Accidents
29. Widespread electricity failures
30. Major transport accidents
31. System failures
32. Commercial failures*
33. Systematic financial crisis*
34. Industrial accidents – nuclear*
35. Industrial accidents - non nuclear*
36. Major fires*

Societal Risks
37. Industrial action
38. Widespread public disorder

Table 1: Eight priority risk areas that require the most urgent UK-wide action over the next two years (from UK Climate Change Risk Assessment (CCRA) 2022 (HM Government 2022)).

Priority risk area	Magnitude of risk	Key policy areas identified by UK CCRA 2022
Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards.	High	Biodiversity Soil and water protection and restoration Environmental land management Sustainable farming and forestry Net Zero Green finance
Risks to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards.	Medium but will increase to high by 2050.	Biodiversity Soil and water protection and restoration Environmental land management Sustainable farming and forestry Net Zero Green finance
Risks to natural carbon stores and sequestration from multiple hazards leading to increased emissions.	Medium but will increase to high by 2050.	Biodiversity Soil and water protection and restoration Environmental land management Sustainable farming and forestry Net Zero Green finance
Risks to crops, livestock and commercial trees from multiple hazards.	Medium but will increase to high by 2050.	Biodiversity Soil and water protection and restoration Environmental land management Sustainable farming and forestry Net Zero Green finance
Risks to supply of food, goods and vital services due to climate-related collapse of supply chains and distribution networks.	Medium but will increase to high by 2050.	Public procurement Business resilience Environmental land management Trade
Risks to people and the economy from climate-related failure of the power system.	High	Infrastructure Energy Net Zero
Risks to human health, wellbeing and productivity from increased exposure to heat in homes and other buildings.	High	Building regulations and strategies Planning reform
Multiple risks to the UK from climate change impacts overseas.	High	National resilience Overseas aid Research and capacity building

2.4 Method for the selection of key policy areas for a State of Natural Capital Report

The 25 Year Environment Plan (HM Government 2018) sets out the Government's ambitions to improve the environment, within a generation. We reviewed wider Government policy to pick out those areas where natural capital makes a major contribution. We also held initial discussions with policy stakeholders in Department for Business, Energy and Industrial Strategy, Department for Transport, Department for Education, Ministry of Defence and Ministry of Housing, Communities and Local Government. To ensure coverage of marine policy we also took account of the work by the Marine Management Organisation, to identify the objectives of policies that affect marine planning and management. We chose to focus on high level policy areas, rather than a large number of individual policies which may change over time. From this we selected five key policy areas as the focus of a *State of Natural Capital Report*:

- Net zero carbon emissions
- Climate adaptation
- Health and well-being
- Food security
- Resilient economic development

We also identified nature recovery (or biodiversity) itself, as a relevant policy area. This was considered separately from the other policies areas because it links to natural capital assets in a different way. Nature recovery policies aim to improve the health of assets, and so to secure positive outcomes for the assets themselves. The five other policy areas, however, link to assets through use of the ecosystem services the assets provide.

2.5 Nature recovery policy and natural capital

This section outlines the relationship between nature recovery policy and natural capital. Both nature recovery and natural capital aim to restore healthy functioning ecosystem assets, for nature and the benefits provided to people. Commitments and targets for nature recovery are captured in the Government's 25 Year Environment Plan and the 2021 Environment Act. The UK has also signed up to the United Nations Leaders' Pledge for Nature, launched at the UN General Assembly in 2020, and the 30 by 30 commitment to protect 30% of our land and sea for nature by 2030. This is part of a journey to become "nature positive" by 2030. This means reversing the current decline of biodiversity, with ecosystem restoration underway, species increasing in abundance and fewer threatened by extinction. This is a critical milestone to re-establishing thriving nature by 2050.

The Dasgupta Review (2021) recognises nature as a precious and declining asset with the pressing need to factor the value of nature into decision making. Despite supporting globally important chalk rivers and blanket bogs, England is one of the most nature-depleted countries on earth with the State of Nature Partnership reporting 40% of UK species in decline (Hayhow and others 2019). Natural capital and nature recovery

(including for nature's sake) are both dependent on restoring biodiverse ecosystems, resilient to future changes. This means thriving, diverse and species-rich ecosystems, which support natural processes.

Ecosystem size, quality and location matter, for both nature and people. Natural functioning is fundamental to the quality of ecosystems, for both nature and the benefits it provides to people. The quality indicators in this report are therefore based on elements of natural function: hydrology; soil processes; species composition and vegetation characteristics; and nutrient and chemical status. Aspects of ecosystems important for cultural benefits are also reported on. The location of ecosystems is fundamental to establishing nature recovery networks. Where ecosystems are located is also key if they are going to help reduce flooding and pollution, pollinate crops and reduce urban temperatures and noise. To provide benefits to people, access to ecosystems near to where people live is essential.

The Leaders' Pledge for Nature includes a commitment to provide regularly updated evidence on the extent and condition of natural capital. A future *State of Natural Capital Report for England* will contribute to this, using data from both the Natural Capital and Ecosystem Assessment and existing monitoring programmes.

Nature loss harms human health and well-being. Nature recovery aims to restore our ecosystem assets to benefit both nature in its own right, and people. Because nature recovery includes this focus on benefits to people, the whole of this report and all the indicators in it are relevant to this policy area. Nature recovery is also captured in the "thriving plants and wildlife" ecosystem service.

2.6 Method for linking policy areas to ecosystem assets and services

We link the ecosystem assets to the policies by first identifying the ecosystem services[1] which contribute to the policies (

[1] For this report we have identified plain English names for the ecosystem services identified in the Common International Classification of Ecosystem Services (CICES version 5.1). Annex 2 details the full CICES category titles and shows links to the Government's 25 Year Environment Plan themes.

Table 2). We consider that thriving plants and wildlife and natural capital's role in climate regulation contribute to all of the policy areas.

Table 2 Key policy areas and contributing ecosystem services

Policy area	Timber	Produce from the sea	Plant-based energy	Cultivated crops	Plentiful water	Reared animals	Clean water	Clean air	Noise regulation	Urban cooling	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services
Net Zero			X											X		X	
Climate adaptation					X					X	X	X		X	X	X	
Resilient economic development	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Food security		X		X	X	X	X				X	X	X	X	X	X	
Health & well being		X		X	X	X	X	X	X	X		X		X		X	X

We use the publication Natural Capital Indicators: for defining and measuring change in natural capital - NERR076 (Lusardi and others 2018) to identify the indicators which are relevant to the ecosystem services. This report took a systematic logic-chain based approach to identify attributes and indicators for 17 ecosystem services across the 8 broad ecosystems in the UK National Ecosystem Assessment (2011). The attributes and indicators were identified using the evidence in the UKNEA and the expert opinion of 89 specialists in Natural England and the Environment Agency.

Using this method, there are a large number of indicators relevant to policy areas. We have therefore identified a selection of key ecosystem asset indicators for each policy area. This selection aims to give a spread of the key indicators, across the ecosystem services which contribute to a policy area. The full lists of indicators and the ecosystem services to which they relate can be viewed in the spreadsheet (Annex 3). Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (identified as an indicator in Lusardi and others 2018); (S) a secondary indicator, for an attribute providing a substantial contribution to the ecosystem service which is not a primary indicator; or (T) a tertiary indicator with only a limited contribution to the service. These judgements were made by the project team and will be reviewed by the Deputy Chief Scientists at Natural England before a full *State of Natural Capital Report* is produced.

We propose that a full *State of Natural Capital Report* should include an interactive graphic to enable the user to view all the relevant indicators for a policy area, and potentially a facility to generate PDFs of this. We also propose that it includes key opportunities for enhancing natural capital to contribute to each policy area. We propose that these opportunities are grouped into the following categories: ecosystem creation and restoration; sustainable management of ecosystems; reducing pressures; natural capital as infrastructure; evidence; finance and investment; other. See Annex 4 for examples of these opportunities.

2.7 Key policy areas

The following sections demonstrate what reporting against key policy areas in a *State of Natural Capital Report* could look like. For each of the five policy areas there is a summary of the contribution ecosystem assets make, through the provision of ecosystem services, plus a table with a selection of relevant ecosystem asset indicators. Important ecosystem services for each policy area are highlighted in bold.

2.7.1 Net zero

The state of our ecosystem assets is vital for achieving UK net zero targets. These include reducing greenhouse gas (GHG) emissions by 78% of 1990 levels by 2035 and achieving net zero emissions by 2050. Ecosystems play an essential role in **climate regulation**.

Carbon is absorbed through natural sinks, creating stores in plants, animals, soils and oceans. The oceans provide important carbon sinks in water, plankton, reefs and other marine life. These are ultimately laid down in rock-forming sediment carbon stores. Seagrass beds and fine mud-rich sediments are particularly high in carbon. On land, trees and other plants also capture carbon through photosynthesis. As they die and decompose, the carbon builds up in the soil.

Saltmarsh, seagrass and intertidal mud have particularly high levels of carbon uptake and storage, but marine sediments hold the largest stocks overall due to the vast area they cover (Swaile and others 2022). Peatlands are the UK's largest terrestrial carbon store. In 2010 it was estimated that five years' worth of England's CO_2 emissions were stored in English peatlands (Natural England 2010). In addition to bogs and woodland, soil carbon densities are highest terrestrially under semi-natural habitats, especially heath, fen, marsh and swamp, semi-natural grasslands and saltmarsh (Gregg and others 2021). They are lowest under enclosed farmland and urban.

The quality of ecosystems determines whether they are carbon sinks or sources. Woodland is a net sink of carbon and is estimated to have captured 4% of our UK annual emissions in 2019 (Brown and others 2021). Semi-natural grassland has been a net sink since 2013 (Brown and others 2021).

Degraded ecosystems release previously stored carbon. This includes marine ecosystems damaged by trawling and dredging (Epstein and others 2022). Peatlands are currently a net source of carbon, responsible for an estimated 4% of emissions in 2019 (Brown and others 2021). With a healthy surface layer, dominated by bog mosses (Sphagnum), bogs continuously capture carbon as they lay down peat. However, peat extraction, drainage, over-grazing and burning lower the water table, damage the growing peat surface and release previously stored carbon back to the atmosphere. Peatlands drained for agriculture have the highest greenhouse gas emissions per unit area of any land use (Brown and others 2021).

Plant based energy also has a role to play in achieving net zero. Bioenergy generated 12% of the UK's electricity in 2020, contributing to generation from renewable sources (42%) exceeding that from fossil fuels (41%) for the first time (EMBER 2022).

Table 3 Net zero indicators

This table shows a selection of ecosystem asset indicators and the ecosystem services they support, relevant to net zero. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets.

Indicator category	Indicator	Timber	Produce from the sea	Plant-based energy	Cultivated crops	Plentiful water	Reared animals	Clean water	Clean air	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Bog					P		P		P	P		P	P	P	
Extent	Broadleaved, mixed and yew woodland	P		P				P	P	P	P		P	P	P	
Extent	Dwarf shrub heath						P	P		P	P		P	P	P	
Extent	Acid, calcareous, neutral grassland					P	P	P			P	P	P	P	P	
Extent	Salt marsh									P	P		P	P	P	
Extent	Seagrass beds		P					P					P	P	P	
Extent	Subtidal mud		P										P	P		

Indicator category	Indicator	Timber	Produce from the sea	Plant-based energy	Cultivated crops	Plentiful water	Reared animals	Clean water	Clean air	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Soil/ sediment processes	Soil carbon/organic matter content				**P**	**S**		**P**		**P**	**T**		**P**	**P**		
Species Composition	Naturalness of biological assemblage: plankton		**P**					**S**					**P**	**S**		
Species Composition	Naturalness of biological assemblage: Extent of physical damage to predominant and special habitats (marine)		**P**										**P**	**P**	**S**	
Vegetation	Proportion of peat mass actively forming peat					**S**		**S**		**P**	**T**		**P**	**P**		
Vegetation	Above ground carbon							**S**		**S**	**S**			**P**		
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed													**P**		

2.7.2 Climate adaptation

Extremes of weather are already being recorded in the UK. Future climate predictions suggest further increases in temperature, winter rainfall, storms, flooding and sea level rise. Less summer rainfall, and more drought, are also predicted. Our ecosystems are both affected by and play an important role in our adaptation to these changes. The impact of climate change on our ecosystem assets will be covered in the drivers of change part of the risk register. Here we cover the role of ecosystems in contributing to climate change adaptation.

5.2 million homes and businesses are at risk from flooding (Environment Agency 2020). Ecosystems have a role in **flood protection**, alongside built infrastructure. This includes providing space for flood waters, increasing infiltration and slowing flows. Woodland and scrub particularly increase water infiltration to the soil and uptake by plants, while their surface bulk slows run-off (Environment Agency 2021). Sand dunes can provide a barrier to protect coastal settlements from flooding. Salt marshes can help to protect sea walls from erosion, as they reduce wave energy. Green space helps to reduce surface run-off in urban areas. Soil life (biota) aids infiltration (eg through burrowing earth worms), while soil carbon increases water retention. Bare soil, prone to compaction during heavy rain, and modifications of hydrology such as drainage, speed up surface run-off.

Photo: Saltfleetby-Theddlethorpe Dunes NNR © Natural England/Peter Roworth (CC BY-NC-ND 2.0)

Decreasing summer rainfall and increasing drought are a risk to **plentiful water**, for public supplies, food production, industry, and water quality in our streams, rivers and lakes. Slowing surface flows gives more time for infiltration and reduces **soil erosion**. Ecosystems affect replenishment of water resources through interception, infiltration and evapo-transpiration. The balance of these factors, coupled with soils and geology, influences whether water reaches aquifers and is slowly released to surface water supplies. Low density and young broadleaf woodland, heath and semi-natural grassland can tip the balance in favour of infiltration (Environment Agency 2021).

As summer temperatures increase, so does the need for green/blue space and trees for **urban cooling** (local climate regulation). Risks from extreme heat are greatest in the south-east of England (Climate Change Committee 2021). Ecosystems help to counter the urban heat island effect. They provide shade and reduce temperatures through evaporation. Vegetation also absorbs and retains less heat than built surfaces. A 10% increase tree cover in London could reduce surface temperature by 3-4°C (Forestry Commission 2010).

20-40% of potential food production is already lost each year to pests and diseases, at an estimated cost of £4 billion (LEAF 2015). As the risk increases with climate change, so will the importance of **pest and disease control** by ecosystems, through predation, parasitism and pathogens. Dense single species crops and improved grassland, are at greatest risk. Increasing biodiversity strengthens the response to pests and diseases (Agriculture and Horticulture Development Board 2021). This is particularly true for soil biodiversity (European Commission 2010). Hedges and patches of semi-natural habitat increase the species diversity of enclosed farmland.

Table 4 Climate adaptation indicators

This table shows a selection of ecosystem asset indicators and the ecosystem services they support, relevant to climate change adaptation. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; (T) a tertiary indicator providing only a limited contribution to the service; or (N) an indicator which has a negative association with the provision of the ecosystem service. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets.

Indicator category	Indicator	Timber	Plant-based energy	Cultivated crops	Plentiful water	Reared animals	Clean water	Clean air	Noise regulation	Urban cooing	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Broadleaved, mixed and yew woodland	P	P				P	P			P	P		P		P	P	
Extent	Scrub		P				P	P			P	P		P		P	P	
Extent	Urban woodland							P	P	P		P		P		P	P	
Extent	Sand dunes										P	P		P		P	P	
Extent	Salt marsh										P	P		P		P	P	
Extent	Dwarf shrub heath					P	P				P	P		P		P	P	

Indicator category	Indicator	Timber	Plant-based energy	Cultivated crops	Plentiful water	Reared animals	Clean water	Clean air	Noise regulation	Urban cooing	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Acid, calcareous, neutral grassland				P	P	P					P	P	P		P	P	
Extent	Bare soil			S	N		N				N	N	N	N	N	N		
Soil/sediment processes	Soil compaction (absence of)			P	S	P	S				P	P	P	P				
Soil/sediment processes	Soil biota			P	S	P	S				T	S		P	P	P		
Vegetation	Extent and condition of hedgerows and lines of trees						T				P	S	P	P	P	T	P	

2.7.3 Health and well-being

The state of England's ecosystem assets is fundamental to our health and well-being. This includes both our physical and mental health. What we eat contributes to our physical health, with ecosystem assets contributing to **produce from the sea**, **crops** and **reared animals**. 40% of today's medicines globally are also extracted from plants, micro-organisms or animals (National Food Strategy 2021). The biodiversity of our ecosystems is therefore vital for the provision of potential future medicines.

Public Health England (2018) identifies air quality as the greatest environmental risk to public health. Air pollution is best tackled at source. However, plants, and especially trees, can contribute to **clean air**. UK vegetation (particularly woodland) has been estimated as reducing annual surface concentrations by around 10% for fine particles (PM2.5) and 24% for ammonia (Jones and others 2017). However, new urban tree planting needs to consider design and species, to avoid pollution being caught in canyon-like streets and increasing pollen allergens (Eisenman and others 2019). Urban trees have also been estimated to **reduce noise** to 167,000 UK buildings (ONS 2020). The total annual value of this was estimated to be £15.3 million, in avoided loss of quality adjusted life years.

Clean water is important for human health, whether for drinking water, swimming outdoors or eating foods such as shellfish. While tackling pollution at source is key, ecosystems also have a role to play in the dilution, filtering, breakdown and take up of pollutants. It's a fine balance between ecosystems helping to mediate water quality and being impacted themselves by pollution and nutrient enrichment. The roughness of vegetation, particularly next to water courses is important for slowing the flow of water and enabling infiltration. Soil organic matter (carbon) both increases infiltration and accumulates pollutants. Marine shellfish such as oysters also maintain clean water by filtering out particles and toxins. A single native oyster can filter up to 25 litres of water per hour, and in doing so removes nutrients, microplastics and bacteria (Green 2016; Watson and others 2020). Providing this service, however, may mean the shellfish is no longer fit for human consumption (Florini and others 2020).

With climate change and population growth, demand for water in England will exceed supply by between 1.1 billion and 3.1 billion litres per day by the 2050s (National Audit Office 2020). Ecosystems can affect the potential replenishment of **plentiful water** supplies both negatively and positively. Conifers have higher water requirements compared to broadleaf trees (Nisbet and others 2011). Wood pasture, less dense woodland and young trees, generally increase water seepage into the ground over interception by the tree canopy (Environment Agency 2021).

Flooding affects both mental and physical health. Mental health impacts can persist for at least 3 years (Public Health England 2017). Ecosystems and their soils play a crucial role in **flood protection**, with woodland, scrub, sand dunes and salt marsh being particularly important. Soil organic matter and vegetation structure also slow flows and aid infiltration.

In the summer of 2020, three heat waves periods caused 2556 excess deaths (Public Health England 2020). The occurrence of heat waves is likely to increase with climate change. Tree planting and the creation and restoration of urban green and blue space can increase shade and provide local **climate regulation**.

Data from 2018 show 17.7% of the UK population suffering from mental health issues, with the cost estimated to be equivalent to 4.1% of UK Gross Domestic Product (OECD/EU 2018). Urban green and blue spaces have a vital role to play in reducing the prevalence of depression and anxiety (Callaghan and others 2021). Outdoor exercise contributes to mental health and reduces the risk of cardio-vascular disease, high blood pressure, diabetes, osteoporosis and arthritis (Hollick 2005, Kampmann and others 2007). However, the benefits of engaging with nature (**cultural ecosystem services**) for general well-being are wider reaching, as was shown in the pandemic lockdowns (Natural England 2020, Surfers Against Sewage 2021).

Experiences of nature are very personal and can contribute to well-being in terms of sense of identity, experiences and building personal capability (Dickie and others, 2014). How people experience nature also varies widely, encompassing playing, swimming, picnicking, fishing, exercising, drawing, volunteering and much more. The People and Nature Survey shows that most visits to nature are close to home, with 85% of adult respondents saying that being in nature makes them happy (Natural England 2020). This emphasises the importance of nature-rich places, and access near to where people live. In the Surfers Against Sewage survey (2021) most respondents strongly agreed that visiting the sea makes them feel calm and relaxed, followed closely by feeling refreshed and revitalized.

Photo by jplenio, accessed from Pixabay

Table 5 Health and wellbeing indicators

This table shows a selection of ecosystem asset indicators relevant to health and well-being and the ecosystem services they support. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets.

Indicator category	Indicator	Timber	Plant-based energy	Cultivated crops	Plentiful water	Clean water	Clean air	Noise regulation	Urban cooling	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Urban woodland						P	P	P		P		P		P	P	
Extent	Urban semi-natural habitats (not woodland)						P	P	P		P		P		P	P	
Extent	Broadleaved, mixed & yew woodland	P	P			P	P			P	P		P		P	P	
Soil/sediment processes	Soil carbon/organic matter content			P	S	P				P	T		P		P		
Species Composition & Cultural: Nature	Naturalness of biological assemblage					P						S	P	S	S	P	

Indicator category	Indicator	Timber	Plant-based energy	Cultivated crops	Plentiful water	Clean water	Clean air	Noise regulation	Urban cooling	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Vegetation	Vegetation structure					**P**	**P**		**S**	**P**	**P**	**P**	**P**		**S**		
Cultural: Nature	Bathing Water quality					**S**										**P**	
Ecosystem service flow: Cultural	Number of visits															**P**	
Ecosystem service flow: Cultural	Range of activities undertaken															**P**	
Spatial configuration	Woodlands near roads						**P**	**P**								**P**	
Spatial configuration	Meeting Access to Natural Green Space Standards															**P**	

2.7.4 Food security

Food security is defined in the National Food Strategy 2021 as being able to feed the population at a reasonable cost, even in the face of future shocks. Self-sufficiency is an important component of food security, with the UK currently producing 65% (by total value) of the food we eat (National Food Strategy 2021).

Technological development has been responsible for increasing agricultural yields, through mechanisation, new varieties/breeds, fertilisers and pesticides, as well advances in fishing methods and fish detection. However, our food security is still fundamentally dependent on our ecosystem assets. The impact of the intensification of food production on ecosystems will be covered in the drivers of change section of the risk register.

Produce from the sea is dependent on wild species and healthy marine and coastal ecosystems. The UN Food and Agriculture Organisation assesses that 35% of stocks globally are fished at unsustainable levels, up from 10% in 1974 (National Food Strategy 2021). Damage to sea-bed ecosystems has contributed to an 80% decline in the UK landings of bottom living fish species, such as cod, plaice and haddock (MMO 2020). Seagrass and saltmarsh provide important nursery areas for fish, and a thriving marine environment more widely is essential in supporting the food chains on which the fish we eat rely.

Photo: Tompot blenny © Natural England/Angela Gall (CC BY-NC-ND 2.0)

UK **crops** and **reared animals** (including arable feed stuff) have been estimated to be worth £1,330 million (ONS, 2017). Soil health is vital for agriculture. The role of ecosystems in **erosion control** is critical. Soil erosion is estimated to affect 17% of land in England and Wales (Cranfield University SSLRC 2000) with productivity losses estimated at around £40 million/year (Graves and others 2015). Loss of organic matter reduces water storage, nutrients, chemical buffering and soil life (biota).

The role of ecosystems in **flood protection** and the provision of **plentiful water**, also affect food security. Vegetation, particularly trees and scrub, slows flows by intercepting rainfall, increasing infiltration to soil and taking up water. Low density and young broadleaf woodland, heath and semi-natural grassland can tip the balance in favour of infiltration (Environment Agency 2021). Bare soil can result in increased run-off and decreased infiltration due to compaction. Soil carbon increases water retention.

Pollination by insects and other animals has been estimated to be worth £430 million each year in the UK (University of Reading 2018). Pollinator dependent crops, such as oil seed rape, strawberries, apples and pears, covered 20% of the cropped area of the UK in 2007 (Breeze and others 2011). Ecosystems with a diversity of flowering plants, plus hedges and other boundary features, are important for supporting a diversity of pollinators.

Natural **pest and disease control** is likely to become increasingly important as crop pests and diseases increase with warmer temperatures. It is estimated that 20-40% of potential food production, worth £4 billion is lost each year due to pests and diseases (LEAF 2015). Species diversity is important for controlling pests and diseases. Soils rich in biodiversity have a greater capacity to impede pest and disease development (EU 2010).

The genetic reservoir of **thriving plants and wildlife** is vital for our future food security. Twenty species currently make up 90% of the world’s food (National Food Strategy 2021). Being dependent on so few species for our food is risky in terms of our food security. As well as providing potential new food stuffs, desirable genes from wild relatives of crops can enhance resilience.

Table 6 Food security indicators

This table shows a selection of ecosystem asset indicators relevant to food security and the ecosystem services they support. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets.

Indicator category	Indicator	Produce from the sea	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Arable & horticultural		**P**										**P**	
Extent	Improved grassland				**P**		**P**					**P**	**P**	
Extent	Acid, calcareous, neutral grassland			**P**	**P**	**P**		**P**	**P**	**P**		**P**	**P**	
Extent	Salt marsh						**P**	**P**		**P**		**P**	**P**	
Extent	Seagrass beds	**P**				**P**				**P**		**P**	**P**	
Nutrient (& chemical) status	Bacteriological & viral water quality	**P**				**P**				**P**				

Indicator category	Indicator	Produce from the sea	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Soil/sediment processes	Soil carbon/organic matter content		**P**	**S**		**P**	**P**	**T**		**P**		**P**		
Soil/sediment processes	Soil biota		**P**	**S**	**P**	**S**	**T**	**S**		**P**	**P**	**P**		
Soil/sediment processes	Soil compaction (absence of)		**P**	**S**	**P**	**S**	**P**	**P**	**P**	**P**				
Species composition	Naturalness of biological assemblage: Extent of physical damage to predominant and specific (marine) habitats	**P**								**P**		**P**	**S**	
Species Composition	Naturalness of biological assemblage: (marine) fish	**P**								**P**				
Vegetation	Extent and condition of hedgerows and lines of trees					**T**	**P**	**S**	**P**	**P**	**P**	**T**	**P**	

2.7.5 Resilient economic development

Natural capital is vital to resilient economic development, with a potential role to play in addressing inequality across England. The Dasgupta Review (2021) clearly sets out that economies are bounded globally by the ecosystems on which they depend. The Office for National Statistics natural capital accounts demonstrate the magnitude of the UK asset value, estimated to be £1.2 trillion in 2019 (ONS 2021b), based on multiple ecosystem services. This is a very partial estimate, as it was not possible to value all ecosystem services.

Ecosystem assets underpin the provision of a suite of market goods including food from **crops**, **livestock** and the sea, as well as **timber and other wood products** and **plant-based energy**. The previous food security section (2.7.4) shows how the agricultural sector is dependent on soil health, water supply and **pollination** as well as the natural control of **pests and diseases**, floods and other natural hazards. Our fishing industry is dependent on **produce from the sea** straight from our wild marine ecosystems.

Tourism and recreation (providing **cultural ecosystem services**) are also highly dependent on our ecosystem assets. The ONS (2021) estimate that in Great Britain in 2019, the natural environment contributed £12 billion to the tourism and outdoor leisure industries. They further estimate that between 2011 and 2019, 8% of all tourism and leisure spending was driven primarily by nature (ONS 2021).

Photo by dimitrisvetsikas1969, accessed from Pixabay

Resilient economic development is also dependent on natural capital for a plethora of services not traded in markets. One of these more hidden contributions is in reducing risks to economic development, including from climate change (Section 2.7.2). The Stern Report (Stern 2006) set out the economic need to both reach net zero and adapt to climate change. The UK Climate Risk Assessment (2022) strengthens this message with its eight priority areas for action in the next two years (Table 1). Furthermore, the UK National Risk Register (Figure 3) identifies a suite of major societal risks, where ecosystem assets can contribute to mitigation. This includes through natural **flood protection**, **urban cooling**, the provision of **clean air** and **plentiful water**, as well as the fundamental role of ecosystems in **climate regulation** through carbon capture and storage.

As detailed in Section 2.7.3, ecosystem assets, particularly in cities, play a vital role in societal health and well-being. Well-designed green infrastructure can help to mediate air and water quality and reduce surface water run-off and noise. It can also decrease the urban heat island effect, with vegetation providing shade and absorbing less heat than concrete and tarmac. Mental health and well-being are boosted by contact with nature (**cultural ecosystem services**). Blue and green space is also crucial in creating attractive and healthy places to live and work. Employee retention and low rates of sick days are both associated with increases in green and blue space (Moran and others 2021).

Addressing inequalities in access to green space and wider benefits from nature, can also play a part in addressing inequalities in economic resilience. As an example, 8% of people have no access to personal green space such as a garden or allotment, particularly those living in areas of social deprivation, low-income households, ethnic minority groups, the unemployed and those suffering from poor health (Natural England 2021).

Table 7 Resilient economic development indicators

This table shows a selection of ecosystem asset indicators relevant to resilient economic development and the ecosystem services they support. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets. In a full *State of Natural Capital Report*, we also propose to include information on risk alongside the indicators, which would communicate the impact of current and future drivers of change on our ecosystem assets.

Indicator category	Indicator	Timber	Produce from the sea	Plant-based energy	Cultivated crops	Plentiful water	Clean water	Clean air	Noise regulation	Urban cooling	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Extent	Urban semi-natural habitats (not woodland)							P	P	P		P		P	P	P	
Extent	Broadleaved, mixed and yew woodland	P		P			P	P			P	P		P	P	P	
Extent	Salt marsh										P	P		P	P	P	
Extent	Bog					P	P				P	P		P	P	P	
Nutrient (& chemical) status	Chemical status of water bodies, not nutrients						P							P		S	

Indicator category	Indicator	Timber	Produce from the sea	Plant-based energy	Cultivated crops	Plentiful water	Clean water	Clean air	Noise regulation	Urban cooling	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services	Risk status – proposed inclusion informed by risk register
Soil/sediment processes	Soil carbon/organic matter content				**P**	**S**	**P**				**P**	**T**		**P**	**P**		
Species composition	Naturalness of biological assemblage: Extent of physical damage to predominant and specific habitats		**P**											**P**	**P**	**S**	
Vegetation	Vegetation structure						**P**	**P**		**S**	**P**	**P**	**P**	**P**	**S**		
Cultural: Nature	Bathing Water quality						**S**									**P**	
Spatial configuration	Woodlands near roads							**P**	**P**							**P**	
Ecosystem service flow: Cultural	Number of visits															**P**	
Ecosystem service flow: Cultural	Range of activities undertaken															**P**	

3 Scoping the state of the ecosystem assets

The *State of Natural Capital Report* will focus on the State of Ecosystem Assets. Here we set out:

- How we have developed our approach to reporting
- The indicators and data that we propose using
- Outlines of each broad ecosystem asset chapter
- An example indicator dashboard

Photo: Blelham Tarn © Natural England/Paul Glendell (cropped) (CC BY-NC-ND 2.0)

3.1 Developing our approach to reporting

3.1.1 Natural Capital Indicators

We have used Natural England's Natural Capital Indicators report (Lusardi and others 2018) to identify what to report on in a State of the Ecosystem Assets section.

The Natural Capital Indicators report asked: what are the properties of the natural environment which enable it to provide benefits to people? The report developed detailed logic chains to identify these properties, and indicators for measuring them. The indicators describe the state of the ecosystem in terms of their quantity (how much), quality (how good) and location or spatial configuration (where assets need to be to provide benefits to people). We propose to include a concise set of key indicators, with each telling you about the property they are measuring, as well as indicating how naturally an ecosystem is functioning and able to provide benefits to people. The first in a series of *State of Natural Capital Reports* will set the baseline, summarising current evidence. In following reports we may also describe the trends in the indicators so that we can report change.

3.1.2 Data sources

We have selected data sources which are, or will be: openly available, transparent, consistently collected across England, usable at a national scale, collected regularly and sensitive to changes. These criteria mean that regular reporting would be consistent and able to measure change. To find potential data sources we explored both existing data and new data which is being generated through the Natural Capital and Ecosystem Assessment (NCEA). This report scopes how we would report on the State of Natural Capital when new NCEA data is available, rather than providing interim data. Through our partner advisory group, we identified and discussed these potential data sources with data managers. We also explored the data sources identified in the Natural Capital Indicators report (Lusardi and others 2018) and tested in Natural England's Natural Capital Atlases (Wigley and others 2021, Lear and others 2021). A summary of the main data sources that we propose to use is in Box 2. For a list of the indicators and data that we propose to include see the ecosystem asset indicator tables (Tables 9-15).

Box 2 The data sources we propose to use in a *State of Natural Capital Report*. (Numbering corresponds to data code used in Tables 9-15. * shows data sources being developed or enhanced through the NCEA.)

1. **Living England* (LE):** A habitat map created using satellite imagery, machine learning and ground-truthed habitat data.
2. **Natural England's Marine Evidence Base*:** A database of marine evidence for marine and coastal ecosystem quantity.
3. **England Ecosystem Survey* (EES):** A programme of sample data collection to understand ecosystem quality. It will include data about vegetation, soils and peat, ponds, hedges, and landscape quality, with the first round of data collection finished in 2027.
4. **England Green Infrastructure Mapping Database*:** Multiple datasets to describe a baseline of Green Infrastructure (GI) across England.
5. **Historic England data:** Data on nationally important archaeological sites (Scheduled Monuments) including those at risk of being lost due to neglect, decay or inappropriate development (Heritage at Risk).
6. **Common Standards Monitoring Information (CSMI):** Data held by Natural England on the condition of Sites of Special Scientific Interest (SSSIs).
7. **People and Nature Survey (PANS):** Data collected about people's interaction with, and use of, the natural environment.
8. **New* and existing National Forest Inventory data (NFI):** A suite of indicators which describe woodland quantity and quality.
9. **Breeding Bird Survey** (and other UK-wide bird monitoring schemes): Data used to report on the combined Biodiversity Indices for farmland, woodland and wetland birds.
10. **UK Butterfly monitoring scheme:** Data used to report on the combined Biodiversity Indices for farmland and woodland butterfly species.
11. **New Sentinel Monitoring* and Existing Water Environment Regulations/Water Framework Directive Data:** New and existing monitoring from the Environment Agency on the quality of waterbodies.
12. **UK Marine Strategy/OSPAR Good Environmental Status Indicators:** Existing marine evidence used to report on good environmental status.
13. **Natural England Designated Sites View: Marine Reports:** Marine Protected Area feature condition data.
14. **Bathing Water Quality:** Water quality at designated bathing water sites in England.
15. **Carbon Values:** Publications providing carbon values for marine and coastal habitats and derived from data collected in English waters.
16. **Saltmarsh Zonation*:** Saltmarsh extent and zonation mapped from aerial photography.
17. **JNCC Marine Biodiversity Indicators and data:** National-scale marine data, including data collected for Good Environmental Status Indicators.

3.1.3 Ecosystem asset quantity - deciding what to report on

We split our ecosystems down into broad ecosystems using a framework based on the UK National Ecosystem Assessment (UKNEA, 2011). These are:

- Semi-natural grassland
- Urban (including other ecosystems present within urban built-up areas)
- Mountains, moor and heath
- Enclosed farmland
- Woodland and scrub
- Freshwaters
- Coastal margins and marine – which we propose to consider together due to the dynamic relationships between them.

To report on ecosystem asset quantity, we will use Living England and the Natural England Marine Evidence Base. We do not propose to report on terrestrial habitats at a more detailed level than the classes used in Living England, as this report is an overview of the state of England's ecosystems and not designed for detailed reporting. For Living England/Marine Evidence Base habitat classes which occur within more than one broad ecosystem as set out above, we propose only reporting on them under one. For example, bog would be reported under mountain, moorland and heath. Ensuring that the overall quantity of ecosystem assets reported will add up to 100% of England is important and this will be set out in our overall quantity table (see Table 8). These quantities can then be used without issues of double counting, for example in a natural capital account. To achieve this, further work is needed to integrate the Living England and Natural England's Marine Evidence Base habitat class boundaries, to avoid overlap.

For marine ecosystems we will combine EUNIS level 3 categories into the habitat classes identified in Table 8 below. We propose to use a short list of marine benthic habitats reporting at a high level because EUNIS level 3 habitat maps rely heavily on modelling, using physical parameters of the seabed with a small amount of monitored additional data. Ideally, we would be able to measure change in the quantity of different marine habitats, but this is not possible due to the way the data is modelled and due to a lack a ground-truthing through monitoring surveys. We therefore propose reporting at a high (or low EUNIS-level[2]), rather than more detailed level. We will not report on marine habitats, such as kelp or biogenic reef, because data is not recorded consistently for the whole country and the distribution of kelp, for example, is dynamic and constantly changing.

[2] EUNIS is a standard European habitat classification which covers both built and natural environments. The classification is hierarchical with level 1 is the most broad and level 5 the most detailed. https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1

Urban greenspaces include parks and gardens, as well as other semi-natural ecosystems, such as woodland or semi-natural grassland. We propose using the Office for National Statistics built-up areas dataset boundary (areas with a population of at least 10,000 (ONS 2016)) to report on all the different habitats that occur within urban areas.

In Table 8 we set out which habitat classes from Living England and the Marine Evidence Base will be included in each broad ecosystem asset section.

Table 8 Ecosystem asset quantity indicators which we propose to include, split by Living England and marine habitat class. In a State of the Ecosystem Assets section, we will include overall hectares (ha) of habitats as well as their percentage cover of England. We will report on urban ecosystem assets in the urban section. Other modifications to the UKNEA broad ecosystem boundary are shown in italics.

Broad ecosystem asset	State of Natural Capital Report Quantity Indicators, using Living England or marine habitat class	Area in ha	Percentage cover of England (of terrestrial OR marine areas to 200nm)
Enclosed farmland	Improved grassland		
	Arable and horticulture		
	Bare soil		
Woodland and scrub	Broadleaved, mixed and yew woodland		
	Coniferous woodland		
	Scrub		
Semi-natural grassland	Acid, calcareous and neutral grassland		
Mountain, moor and heath	Dwarf shrub heath		
	Inland rock		
	Bracken		
	Bog		
Urban	Built-up areas and gardens		
	Urban improved grassland		
	Urban arable and horticultural		
	Urban bare soil		
	Urban bare sand		
	Urban broadleaved, mixed and yew woodland		
	Urban coniferous woodland		
	Urban scrub		

Broad ecosystem asset	State of Natural Capital Report Quantity Indicators, using Living England or marine habitat class	Area in ha	Percentage cover of England (of terrestrial OR marine areas to 200nm)
	Urban acid, calcareous and neutral grassland		
	Urban dwarf shrub heath		
	Urban inland rock		
	Urban bracken		
	Urban bog		
	Urban water		
	Urban fen, marsh and swamp		
	Urban saltmarsh		
	Urban sand dune		
Freshwater	Water		
	Fen, marsh and swamp		
Coastal margins and marine	Saltmarsh		
	Sand dune		
	Bare sand		
	Intertidal rock		
	Intertidal sediment (mud, sand and muddy sand, coarse sediment)		
	Subtidal rock		
	Subtidal sediment (mud, sand, coarse sediment)		
Not included in a specific ecosystem asset section	Unclassified		

3.1.4 Ecosystem asset quality - deciding what to report on

For ecosystem asset quality, we propose reporting on properties that underpin natural processes and that are critical for the provision of benefits. These properties, identified by the Natural Capital Indicators Report, are:

- nutrient and chemical status
- soil / sediment processes
- species composition
- vegetation characteristics
- hydrology and geomorphology

We also propose reporting on:

- cultural quality, important for the provision of cultural benefits

Here we describe the *State of Natural Capital Report* indicators (SONC indicators) that we propose to include in more than one ecosystem asset section and the data which will be used to measure them. **Indicators specific to only one broad ecosystem asset are described in the corresponding ecosystem section, along with the metrics for each indicator** (see Sections 3.2.1 – 3.2.7).

The nutrient status of soils is an important factor in determining how well ecosystems can support thriving plants and wildlife. Many rarer plant species need low levels of soil nutrients. The England Ecosystem Survey (EES) data will enable us to report on soil nutrient concentrations of nitrogen and phosphorous. We will also report on soil biota and compaction (EES). In future we may be able to report on overall soil health; this indicator is in development.

Ecosystems provide critical carbon storage benefits to society, with large amounts of carbon stored in soils and sediments. We propose to report on average soil carbon (EES) for terrestrial habitats and sand dunes. We will estimate the total amount of carbon stored in soil and sediment using the latest agreed average carbon density for these habitats (including in Gregg and others 2021; Parker and others 2021 and EES / additional new data), and the extent of these ecosystems using Living England and the Natural England Marine Evidence Base. Using these data, we also propose to report on carbon stored in vegetation, and the ecosystem flow indicator of carbon sequestration across different ecosystems.

The nutrient and chemical status of rivers, streams, lakes, estuaries and coastal waters are important indicators for understanding the impact of pressures on waterbodies and how well they can support thriving plants and wildlife, as well as provide other benefits. We propose to use Environment Agency Water Environment Regulations (WER) (previously Water Framework Directive (WFD)) and Sentinel data, being collected under the NCEA, to report on the nutrient status of waterbodies. This will include reporting phosphorus status for rivers, lakes and streams, nitrogen status for lakes, and dissolved inorganic nitrogen status for estuaries and marine waterbodies. We will use Environment Agency WER/WFD

and Sentinel data to report on waterbody chemical status overall, which includes uPBTs (ubiquitous, persistent, bioaccumulative and toxic substances: mercury, brominated diphenyl ethers, tributyltin and certain polyaromatic hydrocarbons), and with uPBTs excluded.

To describe species composition, we propose to report on a number of indicators, including plant species diversity and invasive non-native species (EES and NFI for terrestrial species, and marine species tbc). We propose to report on some charismatic species which tell us about cultural quality as well as species composition. These include breeding birds (using the Breeding Bird Survey and reporting the combined indices for farmland, woodland and wetland birds), butterflies (using the UK Butterfly Monitoring Scheme, reporting the combined indices for farmland and woodland species, with grassland species needing additional analysis) (Defra 2022), seals, seabirds, fish and plankton (with data collected and indices reported on for UK Marine Strategy/OSPAR Good Environmental Status and JNCC Marine Biodiversity Indicators). All ecosystems contain important sites for conserving nature and its scientific interest. We will report on the area and condition of protected sites, focusing on Sites of Special Scientific Interest (using SSSI extent and monitoring data held by Natural England) and Marine Protected Areas (MPAs, using Natural England's Marine Evidence Base and Marine Reports).

Additionally, we propose to report on vegetation structure using EES, an important indicator of natural processes for thriving plants and wildlife as well as other benefits, such as slowing flood flows.

Natural and green spaces can provide calm and relaxing places to visit where we can enjoy nature and connect with the heritage of a place. We will report on factors important to understanding cultural benefits. To understand access to nature we will use layers mapped in Natural England's England Green Infrastructure Mapping Database, to report on public rights of way. We will also report on scheduled monuments and protected wrecks (Heritage at Risk Register) and the ecosystem flow indicators of proportion of most recent visits to natural and greenspaces to the different broad ecosystems, and the activities people undertook (PANS).

There are additional indicators that we propose to investigate further, to be able to include them in a *State of Natural Capital Report*. Further investigation will include, deciding what additional data may be needed, discussing new and emerging data with data managers, doing test analysis and/or developing a method for analysing data to report on the indicator.

These include:

- Exploring what data to combine and how to report on the Biodiversity Intactness Index (Natural History Museum, 2021)
- Testing analysis to find out if we can use EES field drainage data to report on the naturalness of hydrology at a broad ecosystem level
- Developing metrics for the number/density and condition of ponds

- Testing analysis to explore whether we can use EES data to report on pollinator food plants
- Exploring data for the quantity and quality of trees outside of woodlands (including veteran and urban trees)
- Investigating new NCEA data and developing metrics to report on bats in woodlands, and cetaceans (whales, dolphins and porpoises)
- Further testing to explore which EES landscape attributes can be used to measure change in different broad ecosystems, for example nature noises and perceived tranquillity (EES)

3.1.5 Ecosystem asset location

The location or spatial configuration of ecosystem assets is important for the provision of some ecosystem benefits. For example, woodlands nearer roads will absorb more pollution than those in rural areas. Indicators to describe location are more difficult to report. They require further, sometimes challenging, data analysis and it is not always possible to develop a meaningful indicator. We have been able to identify a small number of location indicators which we propose to report on which all need further exploration. However, most location indicators are identified as data gaps (see Annex 1).

3.2 Ecosystem asset sections

Below we include outlines of each broad ecosystem asset section.

Each section includes:

- a description of the ecosystem
- the indicators we propose to report on, covering ecosystem quantity, quality and, where possible, location
- descriptions of quality or location indicators which are specific to one broad ecosystem
- the metrics and data that we will use
- the ecosystem services that the indicators tell us about

We propose to use an indicator dashboard for most indicators to display evidence succinctly. An example dashboard is included for semi-natural grasslands (see Section 3.3).

Pressures and drivers impacting on ecosystems, and their ability to provide benefits to people, will be described in the risk register section.

3.2.1 Semi-natural grassland

Semi-natural grasslands are species rich ecosystems, filled with rare and treasured flora and fauna. They were once an important part of our farming system, however, approximately 90% of our semi-natural grasslands are estimated to have been lost since 1945 (Bullock and others 2011). This loss is due to agricultural improvement of grassland or conversion to arable for higher levels of productivity, through re-seeding, draining, and fertiliser application. Semi-natural grasslands are a product of traditional extensive farming practices, such as cutting for hay, low levels of nutrient applications and grazing with hardy native breeds of cattle and sheep. Small patches remain across lowland areas, with larger patches more common in the uplands.

Semi-natural grasslands provide ground nesting sites for skylark and meadow pipit, and forage areas for butterflies, like marsh fritillary and green hairstreak. Stunning plants live in grasslands ecosystems, such as yellow rattle, black knapweed and devil's-bit scabious.

Semi-natural grasslands provide many benefits to people, including clean and plentiful water, reared animals, flood protection, pollination, pest and disease control, thriving plants and wildlife, climate regulation and cultural benefits both through experiencing them as well as appreciating their existence.

Photo: Chalk grassland © Natural England/Des Sussex (CC BY-NC-ND 2.0)

Table 9 Proposed indicators for semi-natural grassland

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; (T) a tertiary indicator providing only a limited contribution to the service; or (N) an indicator which has a negative association with the provision of the ecosystem service.

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Acid, calcareous, neutral grassland	ha and % cover	1	**P**	**P**	**P**	**P**	**P**	**P**	**P**	**P**
Nutrient (& chemical) status	Soil nutrient status	Average soil nitrogen concentrations in semi-natural grassland samples - % (tbc)	3			**N**			**N**	**N**	
Nutrient (& chemical) status	Soil nutrient status	Average soil phosphorous concentrations in semi-natural grassland samples - mg/kg (tbc)	3			**N**			**N**	**N**	
Soil/sediment processes	Soil compaction (absence of)	Bulk density - metric to be developed	3	**S**		**S**	**P**	**P**	**P**		
Soil/sediment processes	Soil biota	Earthworm count and/or microbial activity - metric to be developed	3	**S**	**P**	**S**	**S**		**P**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in semi-natural grassland samples - mean tonnes/ha	3	**S**		**S**	**T**		**P**	**P**	

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services
Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil carbon stored in semi-natural grasslands	1, 15/3 tbc	**S**		**S**	**T**		**P**	**P**	
Vegetation	Above ground carbon	Total estimated tonnes of carbon stored in semi-natural grassland vegetation	1, 15 tbc							**P**	
Vegetation	Vegetation structure	Average number of vegetation surfaces present across semi-natural grassland stands	3			**S**	**P**	**P**	**P**	**S**	
Species Composition	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc			**P**		**S**	**P**	**S**	**P**
Species Composition	Absence of invasive non-native species	Invasive plant species - average % cover on semi-natural grassland stands	3						**S**		
Species Composition & Cultural: Nature	Grassland butterflies	Metric to be developed	10					**S**	**S**		**P**
Species Composition & Cultural: Nature	SSSI area	% area of semi-natural grassland which is a notified feature of an SSSI	6			**T**	**T**	**T**	**S**	**T**	**P**
Species Composition & Cultural: Nature	SSSI condition	% of SSSI semi-natural grasslands in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6			**T**	**T**	**T**	**S**	**T**	**P**

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Flood protection	Pollination	Thriving plants & wildlife	Climate regulation	Cultural services
Cultural: Accessibility	Public Rights of Way density	Density of PRoW on semi-natural grasslands - m/km^2	4								**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number on semi-natural grasslands which are on the Heritage at Risk register	5								**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to semi-natural grassland	7								**P**
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to semi-natural grassland habitats who did each activity	7								**P**
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered per year by semi-natural grassland	1, 15 tbc							**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at Risk), 6 - CSMI, 7 - People and Nature Survey, 10 - UK Butterfly Monitoring Scheme, 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021).

3.2.2 Urban

Urban ecosystems consist of a mix of built-up areas and gardens, parks and greenways, canals, allotments, and other green infrastructure like sustainable urban drainage (SuDs), sports pitches and natural play areas. Urban areas also contain semi-natural ecosystems, such as woodlands, heathlands, and freshwater. These vary from pocket woodlands or small ponds to large open spaces containing a mosaic of different habitats. Urban green and semi-natural spaces are particularly important for providing people with places to relax and unwind and interact with wildlife. They are often the closest and most used spaces near to where people live.

Urban green and semi-natural ecosystems can help to provide clean and plentiful water, reduced noise levels, flood protection, thriving plants and wildlife, climate regulation, urban cooling and cultural benefits. Urban semi-natural habitats are particularly important for providing multiple benefits compared to amenity greenspace used mostly for recreation.

Within urban areas, we propose to report on the overall quantity of urban built-up areas and gardens compared with the quantity of urban green, blue and semi-natural ecosystems. We will also include indicators on the quantity of specific habitats. The table below explains which quantity indicators are included in the overall 100% area quantity calculation (see Table 8) and which are additional.

Additional indicators included to report on urban ecosystem asset quality

The perception of how welcoming and safe urban spaces are, is critical to how well used they are and the benefits that people can receive from them. We will use People and Nature Survey (PANS) data on recent visits to urban green spaces to report on how welcoming and safe the places felt. Access to nature in urban areas can also be through gardens and allotments. PANS data will allow us to report on the proportion of people who have access to allotments and gardens (private or shared).

Additional indicators included to report on urban ecosystem asset location

The location of urban green and semi-natural ecosystems is critical for people to be able to access benefits. The Accessible Natural Greenspace Standards (ANGSt) set out the provision for greenspace that everyone should be able to access. Using the GI mapping portal data, we will report an estimate of the proportion of the population who live in an area which meets a local ANGSt standard and a wider ANGSt standard.

Table 10 Proposed indicators for urban

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. * Additional indicator, not part of 100% cover.

SONC indicator category	SONC indicator	Metric	Data	Clean water	Clean air	Noise regulation	Urban cooling	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Urban green and blue space	ha and % cover of all Living England habitat classes except 'Built up areas and gardens' in ONS urban areas	1		**P**	**P**	**P**	**P**	**P**	**P**	**P**
Extent*	Urban woodland	ha and % cover of ONS urban areas (includes broadleaved, mixed and yew, coniferous and scrub)	1		**P**	**P**	**P**	**P**	**P**	**P**	**P**
Extent*	Urban semi-natural habitats (not woodland)	ha and % cover of ONS urban areas (includes semi-natural grassland, MMH, freshwater and coastal habitats)	1		**P**	**P**	**P**	**P**	**P**	**P**	**P**
Extent*	Urban grassland (not semi-natural)	ha and % cover of ONS urban areas (improved grassland only)	1		**P**	**P**	**P**	**S**		**P**	**P**
Soil/sediment processes	Soil compaction (absence of)	Bulk density - metric to be developed	3					**S**	**P**		

SONC indicator category	SONC indicator	Metric	Data	Clean water	Clean air	Noise regulation	Urban cooling	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Soil/sediment processes	Soil biota	Earthworm count and/or microbial activity - metric to be developed	3					**S**	**S**	**S**	
Vegetation	Vegetation structure	Average number of vegetation surfaces present across urban habitat stands	3	T	**P**		**S**	**P**	**P**	**S**	
Species Composition & Cultural: Nature	SSSI area	% area of ONS urban areas which is designated SSSI	6	T	**T**			**T**	**S**		**P**
Species Composition & Cultural: Nature	SSSI condition	% of SSSIs in urban areas in: favourable condition; unfavourable recovering; unfavourable declining or destroyed condition	6	T	**T**			**T**	**S**		**P**
Cultural: Safety	Perceived safety	% of urban spaces which felt welcoming/safe during visit	7								**P**
Cultural: Landscape, seascape & urban green space	Access to gardens	% of people with access to an allotment, private or shared garden	7								**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to an urban green space	7								**P**

SONC indicator category	SONC indicator	Metric	Data	Clean water	Clean air	Noise regulation	Urban cooling	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to urban green space who did each activity	7								**P**
Spatial Configuration	Meeting Access to Natural Green Space Standards	% of population which meet doorstep standard (an accessible greenspace of at least 0.5ha within 200m)	4								**P**
Spatial Configuration	Meeting Access to Natural Green Space Standards	% of population which meet wider neighbourhood standard (an accessible greenspace of at least 20ha within 2km)	4								**P**

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 6 - CSMI, 7 - People and Nature Survey.

3.2.3 Mountain, moor and heath

Mountain, moor and heath ecosystems are perceived as some of our most wild places, however, they have been influenced by centuries of management by people. In this section we include dwarf shrub heath, bog (including blanket bog and lowland raised mire), bracken and inland rock. Semi-natural grassland, freshwaters and fen, marsh and swamp are considered in other sections.

Since the Second World War there has been a reduction in the quantity and quality of mountain, moor and heath habitats (Van der Wal and others 2011). In upland areas this is mainly due to the conversion of these ecosystems to forestry and more intensive agricultural use or management for other uses. Lowland areas are more often affected by urbanisation and abandonment (der Wal and others 2011). In good condition mountain, moor and heath provide a home to a huge variety of plants and animals, including plants such as bog asphodel, bogbean, cotton grass and heathers, as well as invertebrates, reptiles, birds, and mammals, such as small copper butterfly, adder, golden plover, hen harrier and brown hare.

As well as supporting thriving plants and wildlife, mountain, moor and heath ecosystems can provide people with clean and plentiful water, reared animals, flood risk reduction, erosion control, climate regulation and cultural benefits both through experiencing them as well as appreciating their existence.

Additional indicators included to report on mountain, moor and heath ecosystem asset quality

Peat bogs need to be covered with peat forming vegetation and prevented from drying out to enable them to build up and continue to store carbon. We propose to use EES data to report the coverage of Sphagnum mosses on bog vegetation plots.

Photo: Cotton-grass © Natural England/Allan Drewitt (cropped) (CC BY-NC-ND 2.0)

Table 11 Proposed indicators for mountain, moor and heath

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; (T) a tertiary indicator providing only a limited contribution to the service; or (N) an indicator which has a negative association with the provision of the ecosystem service.

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Bog	ha and % cover	1	**P**		**P**	**P**	**P**	**P**	**P**	**P**
Extent	Bracken	ha and % cover	1			**P**	**P**	**P**	**P**	**P**	
Extent	Dwarf shrub heath	ha and % cover	1		**P**	**P**	**P**	**P**	**P**	**P**	**P**
Extent	Inland rock	ha and % cover	1						**P**		**P**
Nutrient (& chemical) status	Soil nutrient status	Average soil nitrogen concentrations in MMH samples - % (tbc)	3			**N**			**N**	**N**	
Nutrient (& chemical) status	Soil nutrient status	Average soil phosphorous concentrations in MMH samples - mg/kg (tbc)	3			**N**			**N**	**N**	
Soil/sediment processes	Soil compaction (absence of)	Bulk density - metric to be developed	3	**S**		**S**		**S**	**S**		

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Soil/sediment processes	Soil biota	Earthworm count and/or microbial activity - metric to be developed	3	**S**		**S**		**S**	**S**	**S**	
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in MMH samples - mean tonnes/ha (tbc)	3	**T**		**P**	**P**	**T**	**P**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil carbon stored in MMH ecosystems	1, 3, 15	**T**		**P**	**P**	**T**	**P**	**P**	
Vegetation	Above ground carbon	Total estimated tonnes of carbon stored in MMH vegetation	1, 15 tbc			**S**	**S**	**S**		**P**	
Vegetation	Proportion of peat mass actively forming peat	Average cover of 2m x 2m bog samples with Sphagna moss (% or Domin scale tbc)	3	**S**		**S**	**P**	**T**	**P**	**P**	
Vegetation	Vegetation structure	Average number of vegetation surfaces present across MMH habitat stands	3			**P**	**P**	**P**	**P**		
Species Composition	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc			**S**			**P**	**S**	**P**
Species Composition	Absence of invasive non-native species	Invasive plant species - average % cover on MMH habitat stands	3						**P**		
Species Composition & Cultural: Nature	SSSI area	% area of MMH habitat which is a notified feature of an SSSI	6			**T**	**T**	**T**	**S**	**S**	**P**

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Species Composition & Cultural: Nature	SSSI condition	% of SSSI MMH habitats in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6			**T**	**T**	**T**	**S**	**S**	**P**
Cultural: Accessibility	Public Rights of Way density	Density of PRoW on MMH habitats - m/km^2	4								**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number on MMH habitats which are on the Heritage at Risk register	5								**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to an MMH habitat	7								**P**
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to MMH habitats who did each activity	7								**P**
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by MMH ecosystems	1, 15							**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at risk), 6 - CSMI, 7 - People and Nature 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021).

3.2.4 Enclosed farmland

Enclosed farmland areas are primarily used for food production. In this section we include arable and horticulture, improved grassland and bare soil. Arable and horticultural areas tend to be more concentrated in the east of England, with improved grassland more common in the west of England. This is because the wetter, milder west is better for growing grass, and the drier east is better for arable crops (Firbank and others 2011).

As well as land used primarily for production, enclosed farmland can contain small patches of semi-natural habitats like wildflower margins, patches of scrub, ponds, and hedgerows and other boundary features. Farmland that occurs within a mosaic of semi-natural habitats, along with sensitive management of productive areas, can help to support our native species. These include farmland birds, such as the turtle dove and lapwing, mammals, such as harvest mice, as well as rare arable weeds.

The benefits provided by farmland depends on their management and draws on surrounding semi-natural habitats. Sustainably managed enclosed farmland, with surrounding semi-natural habitats and on-farm habitat patches can provide a number of benefits. This includes food (crops and reared animals) as well as other products like wool and bioenergy crops, clean and plentiful water, erosion control, flood protection, pollination, regulation of pests and diseases, climate regulation, thriving plants and wildlife and cultural benefits. However poor management of farmland can reduce these benefits and impact on the state of surrounding ecosystems.

Additional indicators included to report on enclosed farmland ecosystem asset quality

Hedgerows and small woodlands are an important component of farmland ecosystems supporting thriving wildlife, slowing the flow of water during high rainfall events, and providing cultural benefits. We propose to explore data collected in the England Ecosystem Survey to report on the extent and quality of hedgerows, lines of trees and small woodlands.

Photo: Harvest Mouse © Natural England/Allan Drewitt (cropped) (CC BY-NC-ND 2.0)

Table 12 Proposed indicators for enclosed farmland

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; (T) a tertiary indicator providing only a limited contribution to the service; or (N) an indicator which has a negative association with the provision of the ecosystem service.

SONC indicator category	SONC indicator	Metric	Data	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services
Extent	Arable & horticultural	ha and % cover	1	**P**										**P**
Extent	Improved grassland	ha and % cover	1			**P**		**P**					**P**	**P**
Extent	Bare soil	ha and % cover	1	**S**	**N**		**N**	**N**	**N**	**N**	**N**	**N**	**N**	
Nutrient (& chemical) status	Soil nutrient status	Average soil nitrogen concentrations in farmland samples - % (tbc)	3	**P**		**P**	**N**				**N**		**N**	
Nutrient (& chemical) status	Soil nutrient status	Average soil phosphorous concentrations in farmland samples - mg/kg (tbc)	3	**P**		**P**	**N**				**N**		**N**	
Soil/sediment processes	Soil compaction (absence of)	Bulk density - metric to be developed	3	**P**	**S**	**P**	**S**	**P**	**P**	**P**	**S**			

SONC indicator category	SONC indicator	Metric	Data	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services
Soil/sediment processes	Soil biota	Earthworm count and/or microbial activity - metric to be developed	3	**P**	**S**	**P**	**S**	**T**	**S**		**P**	**P**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in farmland samples - mean tonnes/ha (tbc)	3	**P**	**S**		**P**	**P**	**T**		**P**		**P**	
Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil carbon stored in farmland ecosystems	1, 3, 15	**P**	**S**		**P**	**P**	**T**		**P**		**P**	
Vegetation	Absence of invasive non-native species	Invasive plant species - average % cover on farmland stands	3								**S**	**S**		
Vegetation	Extent of small woodlands	Metric to be developed	3				**T**	**P**	**S**	**P**	**P**	**P**	**S**	**P**
Vegetation	Extent and condition of hedgerows and lines of trees	Metric to be developed	3				**T**	**P**	**S**	**P**	**P**	**P**	**T**	**P**
Species Composition	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc				**P**			**S**	**P**	**S**	**S**	**P**
Species Composition & Cultural: Nature	Farmland breeding birds	Farmland bird index - % change in short term and long term	9								**S**			**P**

SONC indicator category	SONC indicator	Metric	Data	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services
Species Composition & Cultural: Nature	Farmland butterflies	Farmland butterfly index - % change in short term and long term	10							**S**	**S**			**P**
Species Composition & Cultural: Nature	Plant species diversity: arable and horticulture	Average number of plant species in 2m x 2m plots	3							**S**	**S**			**P**
Species Composition & Cultural: Nature	Plant species diversity: improved grassland	Average number of plant species in 2m x 2m plots	3							**S**	**S**			**P**
Cultural: Accessibility	Public Rights of Way density	Density of PRoW on farmland - m/km^2	4											**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number on farmland which are on the Heritage at Risk register	5											**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to farmland	7											**P**
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to farmland who did each activity	7											**P**

SONC indicator category	SONC indicator	Metric	Data	Cultivated crops	Plentiful water	Reared animals	Clean water	Erosion control	Flood protection	Pollination	Thriving plants & wildlife	Pest & disease control	Climate regulation	Cultural services
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by farmland ecosystems	1, 15										**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at risk), 7 - People and Nature Survey, 9 - Breeding Bird Survey (and other UK-wide bird monitoring schemes), 10 - UK Butterfly Monitoring Scheme, 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021).

3.2.5 Woodland and scrub

In this section we include the Living England categories of broadleaved, mixed and yew woodland, coniferous woodland, and scrub. The quantity of scrub is included in this section as it can be a successional habitat becoming broadleaved woodland if left to mature, as well as being an important habitat in its own right. However, most quality indicators that we propose to include below will report on the condition of broadleaved, mixed and yew and coniferous woodland due to the data available. Where scrub is included, it is specified.

Historically native woodlands would have covered a large proportion of England but were cleared for agricultural use and urban areas. However, since 1945 England's woodland cover has doubled. This is due to a variety of reasons, including a drive to plant more woodland for timber after the second world war and nature conversation efforts in recent years (Quine and others 2011).

England's woodlands are very diverse, from wet Atlantic oak woodlands full of mosses and ferns, bluebell carpeted beech and ash woodlands, to new woodlands dominated by fast growing trees and scrub. Woodland ecosystems support cherished plants and wildlife, including pine martens, red squirrels, as well as rare plants and fungi.

Woodlands provide us with a variety of benefits including timber and other wood products as well as biomass for plant-based energy, clean and plentiful water, clean air, reduced noise, erosion control, flood protection, climate regulation and adaptation, thriving plants and wildlife and cultural benefits both through experiencing them as well as appreciating their existence.

Additional indicators included to report on woodland and scrub ecosystem asset quality

We will use the National Forest Inventory (NFI) Woodland Ecological Condition Indicators (Ditchburn and others 2020), as well as other data sources, to report on attributes to measure broadleaved, mixed and yew and coniferous woodland quality. Pests and diseases impact woodland health and how sustainably they can provide benefits. The NFI scores are based on the presence of pests and disease and crown die back in woodlands, with the absence of these being favourable.

Age structure is important for supporting thriving plants and wildlife, and sustainable supplies of timber and other benefits. Regeneration is assessed by the NFI by the presence of seedling, saplings and new small trees in stands, the presence of these is seen as vitally important to the long-term survival of woodland, through self-propagation. Veteran trees are critical for supporting thriving plants and wildlife as well as being important culturally to people. The NFI measures the number of veteran trees per hectare of woodland and determines stand condition for veteran trees.

Additional indicators included to report on woodland and scrub ecosystem asset location

The location of woodlands can be an important factor for the delivery of some benefits. Woodlands next to roads are particularly good at absorbing particulate matter from traffic and cleaning the air for local people and habitats. Using Living England data on the location of woodlands, and Ordnance Survey data on the location of roads, we will be able to calculate the proportion of roads which are within a specified distance of a woodland (precise metric to be developed). We may also explore further indicators and metrics to report on the spatial location of woodlands and the provision of benefits (for example, water quality).

Photo: Clumber Park © Natural England/Bruce Cutts (cropped) (CC BY-NC-ND 2.0)

Table 13 Proposed indicators for woodland and scrub

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service.

SONC indicator category	SONC indicator	Metric	Data	Timber and other wood products	Plant-based energy	Plentiful water	Clean water	Clean air	Noise regulation	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Broadleaved, mixed and yew woodland	ha and % cover	1	**P**	**P**		**P**	**P**		**P**	**P**	**P**	**P**	**P**
Extent	Coniferous woodland	ha and % cover	1	**P**	**P**		**P**	**P**		**P**	**P**		**P**	**P**
Extent	Scrub	ha and % cover	1		**P**		**P**	**P**		**P**	**P**	**P**	**P**	**P**
Soil/sediment processes	Soil biota	Metric tbc	8			**S**	**S**				**S**	**P**	**S**	
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in broadleaved, mixed and yew and coniferous woodland samples - mean tonnes/ha (tbc)	8			**T**	**P**			**P**	**T**	**S**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in scrub samples - mean tonnes/ha (tbc)	3			**T**	**P**			**P**	**T**	**S**	**P**	

Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil carbon stored in broadleaved, mixed and yew and coniferous woodland	1, 8, 15 tbc			**T**	**P**			**P**	**T**	**S**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil carbon stored in scrub	1, 3, 15 tbc			**T**	**P**			**P**	**T**	**S**	**P**	
Vegetation	Above ground carbon	Total estimated tonnes of carbon stored in vegetation of broadleaved, mixed, yew and coniferous woodland	8, 15 tbc										**P**	
Vegetation	Above ground carbon	Total estimated tonnes of carbon stored in vegetation of scrub	1, 15 tbc										**P**	
Vegetation	Veteran trees	Stand condition for veteran trees - % at condition: favourable; intermediate; unfavourable	8									**P**		**P**
Vegetation	Age structure	Stand condition for age class structure - % at condition: favourable (3 age classes present in the stand); intermediate (two age classes present); unfavourable (one age class present in the stand)	8	**P**			**S**			**T**		**P**	**S**	
Vegetation	Regeneration	Stand condition for regeneration - % at condition: favourable; intermediate; unfavourable	8	**P**			**S**	**S**		**S**	**S**	**P**	**S**	

Vegetation	Tree health	Stand condition for pests and diseases - % at condition: favourable; intermediate; unfavourable	8	**P**	**P**							**P**	**P**	
Species Composition	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc				**P**					**P**	**S**	**P**
Species Composition	Absence of invasive non-native species	Stand condition for invasive species - % at condition: favourable (no invasive species); intermediate (rhododendron and laurel not present, other invasive species <10% cover); unfavourable (rhododendron and laurel present, or other invasive species >10% cover)	8									**P**		
Species Composition & Cultural: Nature	SSSI area	% area of woodland and scrub which is a notified feature of an SSSI	6				**T**	**T**		**T**	**T**	**S**	**T**	**P**
Species Composition & Cultural: Nature	SSSI condition	% of SSSI woodland and scrub features which are in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6				**T**	**T**		**T**	**T**	**S**	**T**	**P**
Species Composition & Cultural: Nature	Woodland breeding birds	Woodland bird index - % change in short term and long term	9									**S**		**P**
Species Composition & Cultural: Nature	Woodland butterflies	Woodland butterfly index - % change in short term and long term	10									**S**		**P**

Species Composition & Cultural: Nature	Woodland bats	Metric tbc	8									**S**		**P**
Cultural: Accessibility	Public Rights of Way density	Density of PRoW in woodlands and scrub - m/km^2	4											**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number in woodlands and scrub which are on the Heritage at Risk register	5											**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to woodland	7											**P**
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to woodlands who did each activity	7											**P**
Spatial Configuration	Woodlands near roads	% of roads within Xm of a woodland (to be developed)	1					**P**	**P**					**P**
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by woodland and scrub ecosystems	1, 8, 15 tbc										**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 – England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at risk), 6 - CSMI, 7 - People and Nature Survey, 8 - National Forest Inventory, 9 - Breeding Bird Survey (and other UK-wide bird monitoring schemes), 10 - UK Butterfly Monitoring Scheme, 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021).

3.2.6 Freshwater

In this section we include open water habitats, such as rivers, ponds, lakes, streams, canals and reservoirs, as well as wetland habitats of fen, marsh and swamp, and groundwater. All bogs are covered in the mountain, moor and heath section (Section 3.2.3), as they are identified as one habitat class by the Living England model, based on satellite imagery. This differs from the UKNEA (2011) which includes lowland raised bog with freshwater.

Freshwaters are some of the UK's most productive and naturally diverse ecosystems (Maltby and others 2011), supporting a huge range of species throughout their lifecycles. Rivers, lakes and streams are home to some our most charismatic and treasured species, such as otter, kingfisher, water vole, dipper and salmon. Wetlands in the UK support over 3,500 species of invertebrates, 150 aquatic plants as well as ducks and waders (Merritt, 1994). However, freshwater ecosystems suffer from habitat fragmentation, modification, and habitat loss, with the extent of wetlands reduced by approximately 90% across the UK since Roman times (Maltby and others 2011).

In good condition freshwater ecosystems provide several benefits, including clean and plentiful water, food, flood risk reduction, erosion control, climate regulation, cultural benefits and thriving plants and wildlife.

Additional indicators included to report on freshwater quality

The naturalness of hydrological processes in water and wetlands are important indicators for thriving plants and wildlife, reducing flood risk, and clean and plentiful water. We propose to use Environment Agency Water Environment Regulations (previously Water Framework Directive) and Sentinel data to report on the morphology (the physical characteristics of the channel or lake) of rivers, streams and lakes to understand how constrained they are by physical modifications. We will also use surface water availability data to report on the naturalness of flow and the overall ecological status of rivers and streams using Environment Agency WER/WFD and Sentinel data. The EES will enable us to report on the number or density of ponds, as well as their quality, with the metrics for ponds to be developed.

Aquifers, or groundwater bodies, are critical sources of water running underground. Groundwater bodies feed rivers and streams through springs, and we abstract from groundwater directly for our supply of clean water. We will use Environment Agency WER/WFD and Sentinel data to report on groundwater status for quantity and quality.

Vegetation within and next to waterbodies can intercept pollution and improve water quality, and slow the flow of water along the watercourse, reducing flood risk. The EES will enable us to report on the average width of semi-natural vegetation buffering rivers, canals, streams, and ditches from a cultivated or disturbed edge.

Table 14 Proposed indicators for freshwater

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; (T) a tertiary indicator providing only a limited contribution to the service; or (N) an indicator which has a negative association with the provision of the ecosystem service.

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Fen, marsh & swamp	ha and % cover	1	**P**	**P**		**P**	**P**	**P**	**P**
Extent	Water	ha and % cover	1	**P**	**S**			**P**		**P**
Hydrology and geomorphology	Lack of physical modifications of water bodies	Morphology status of rivers and streams - % at good status	11		**T**		**P**	**P**	**P**	
Hydrology and geomorphology	Lack of physical modifications of water bodies	Morphology status of lakes - % at good status	11				**P**	**P**	**P**	
Hydrology and geomorphology	Naturalness of flow regime	Water resource availability and abstraction reliability - % waterbodies with: Water available for licensing; Restricted water available for licensing; Water not available for licensing; Heavily Modified Waterbodies (and /or discharge rich water bodies)	11	**P**			**P**	**P**		

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Hydrology and geomorphology	Natural aquifer function: recharge & discharge	Groundwater quantity - % at good status	11	**P**						
Hydrology and geomorphology	Pond number/density	Metric to be developed	tbc					**P**		**P**
Hydrology and geomorphology	Pond condition	Metric to be developed	tbc					**P**		**P**
Nutrient (& chemical) status	Chemical status of water bodies, not nutrients	Chemical status of rivers and streams - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Chemical status of water bodies, not nutrients	Chemical status of rivers and streams (excluding uPBTs) - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Chemical status of water bodies, not nutrients	Chemical status of lakes - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Chemical status of water bodies, not nutrients	Chemical status of lakes (excluding uPBTs) - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Nutrient status of water bodies	Phosphate status of rivers and streams - % at good status	11		**P**			**P**		**S**

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Nutrient (& chemical) status	Nutrient status of water bodies	Phosphorous status of lakes - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Nutrient status of water bodies	Nitrogen status of lakes - % at good status	11		**P**			**P**		**S**
Nutrient (& chemical) status	Groundwater quality (chemical)	Groundwater quality - % at good status (chemical)	11		**S**					
Nutrient (& chemical) status	Soil nutrient status	Average soil nitrogen concentrations in wetland samples - % (tbc)	3		**N**			**N**	**N**	
Nutrient (& chemical) status	Soil nutrient status	Average soil phosphorous concentrations in wetland samples - mg/kg (tbc)	3		**N**			**N**	**N**	
Vegetation	Above ground carbon	Total estimated tonnes of carbon stored in fen, marsh and swamp vegetation	1, 15 tbc		**S**		**S**		**P**	
Vegetation	Vegetation next to water bodies	Average width (m) of vegetation between waterbody (rivers and streams) and cultivated or disturbed edge for: waterbodies under 1 m wide, waterbodies 1-2.5 m wide and waterbodies more than 2.5 m wide	3		**P**	**S**	**P**	**P**		
Soil/sediment processes	Soil compaction (absence of)	Bulk density - metric to be developed	3	**S**	**S**		**P**	**S**		
Soil/sediment processes	Soil biota	Earthworm count and/or microbial activity - metric to be developed	3	**S**	**S**		**S**	**S**	**S**	

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in wetland samples - mean tonnes/ha (tbc)	3	**S**	**P**		**T**	**P**	**P**	
Soil/sediment processes	Soil carbon/organic matter content	Total estimated tonnes of soil/sediment carbon stored in fen, marsh and swamp	1, 3, 15 tbc	**S**	**P**		**T**	**P**	**P**	
Species Composition	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc		**P**			**P**	**S**	
Species Composition	Naturalness of biological assemblage	Ecological status of rivers and streams - % at good status	11		**P**			**P**		
Species Composition	Absence of invasive non-native species	Invasive plant species - average % cover on wetland habitat stands	3		**T**			**P**		
Species Composition & Cultural: Nature	SSSI area	% area of freshwater which is a notified feature of a SSSI	6		**T**	**T**	**T**	**S**	**T**	**P**
Species Composition & Cultural: Nature	SSSI condition	% of freshwater SSSIs in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6		**T**	**T**	**T**	**S**	**T**	**P**
Species Composition & Cultural: Nature	Wetland breeding birds	Water and wetland bird index - % change in short term and long term	9					**S**		**P**

SONC indicator category	SONC indicator	Metric	Data	Plentiful water	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Cultural: Accessibility	Public Rights of Way density	Density of PRoW on wetlands - m/km^2	4							**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number on wetlands which are on the Heritage at Risk register	5							**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to a freshwater/wetland habitat	7							**P**
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to freshwater/wetland habitats who did each activity	7							**P**
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by fen, marsh and swamp	1, 15 tbc						**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at risk), 6 - CSMI, 7 - People and Nature Survey, 9 - Breeding Bird Survey (and other UK-wide bird monitoring schemes), 11 - WFD/WER/Sentinel, 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021).

3.2.7 Marine and coastal margins

Marine and coastal ecosystems function as a system driven by natural processes. It is this system which determines the benefits we get from the coast and sea. With tides going in and out each day, we don't want to draw a hard boundary between what is part of a coastal ecosystem and what is part of a marine ecosystem. Therefore, we propose to include them together in one chapter.

Photo: Caerthillian Cove - The Lizard © Natural England/Neil Pike (cropped) (CC BY-NC-ND 2.0)

The English coast stretches 8,982km in length (Jones and others, 2011) with dunes, saltmarshes, estuaries, beaches and sea cliffs along the boundary between land and sea. Sand dunes form where sand, blown inland from the beach, is trapped by vegetation. Sand dunes are dynamic with several successional dune stages in a single system. These support a huge diversity of plants, invertebrates and birds, as well as the rare Natterjack toad. Saltmarshes are a common habitat along sheltered coastlines where they are regularly flooded and drained by the sea. Saltmarshes are composed of mud and fine sand that form coastal wetlands dominated by salt-tolerant plants. Saltmarshes are important breeding and feeding sites for wintering waders and wildfowl as well as many fish species.

Historically there have been huge losses in coastal habitats. Over 30% of sand dunes in England have been lost since 1900 (Rees 2020). In the Wash alone 3000 ha of saltmarsh have been reclaimed over a similar time period (Doddy 2008). Habitat loss is due to land reclamation for farming, harbour construction and the development of coastal towns. Sea level rise and increased storminess, due to climate change, particularly affect this thin strip of habitats and will continue to do so in future. Living England can detect bare sand

(beaches), sand dunes and coastal saltmarsh, and will be used to report on these quantity indicators. Living England data will also be integrated with other data to ensure habitats within the intertidal area (including estuaries) are accounted for (for example, with Natural England's Marine Evidence Base).

The quantity and quality of intertidal (between the high and low tide levels) and subtidal (permanently submerged) ecosystems will also be reported. We propose to include ecosystems occurring within the UK Continental Shelf (UKCS) in waters which stretch to 200 nm from the shore. Sediments, including sandy beaches and mudflats are important habitats in the intertidal zone, as well as rocky shores. In the subtidal zone, soft bottom habitats, such as sand, gravel, muds and mixed sediments, cover almost all of England's continental shelf (Austen and others, 2011). Seagrass beds and kelp forests grow in shallow subtidal sediments, with some seagrass beds extending into the intertidal zone. Other habitats that occur on subtidal rock and sediments including mussel beds and biogenic reefs (created by species such as oysters or worms), can be extensive in particular areas, but have a relatively small extent when considered nationally and so we will not report on their extent. Also, we will not report on the quantity of some marine habitats, such as kelp and biogenic reef, because data is poor and often the distribution is dynamic. We propose to use the Natural England Marine Evidence Base to report on the quantity of intertidal and subtidal ecosystems at a broad scale[3].

Intertidal and subtidal ecosystems support a wealth of plants, invertebrates, fish and mammals. This includes rare and fascinating species, such as sea pens anchoring themselves in muddy sediments, as well as sea horses and stalked jellyfish living in seagrass beds. Seagrass and kelp provide physical structure on sand and mud seabeds, which can otherwise be a somewhat structureless environment, and serve as refuge and nursery areas for commercially valuable fish such as mackerel, plaice and cod. These in turn provide food for larger fish and marine mammals, including seals which use kelp forests as their hunting ground. Seagrass beds and kelp forests are of particular importance as they provide multiple benefits and are some of the few marine habitats that can be actively restored. As a whole, marine and coastal margin ecosystems provide many benefits to people, including wild seafood, improving seawater quality, climate regulation, erosion control, protection from coastal flooding, thriving plants and wildlife, and cultural benefits.

Additional indicators included to report on marine and coastal margins quality

We will use Environment Agency data (covering 85% of saltmarshes) to show the zonation of vegetation across saltmarshes from the intertidal area moving inland.

[3] A broad scale of reporting refers to lower EUNIS levels, generally we propose to report at low EUNIS level, with the exception for some habitats, such as sea grass.

Elevated bacterial and viral content in shellfish beds can cause a health risk and affect their use as a food source. We will use Environment Agency WER/WFD data to report whether designated Shellfish Waters pass or fail their water quality targets.

The presence or absence of marine species across food chains is indicative of healthy functioning ecosystems and their ability to provide wider benefits. We will use data collected and reported on for the Good Environmental Status (GES) indicators and the JNCC Marine Biodiversity Indicators for our reporting. These include indicators on seabed habitats that are subject to high levels of disturbance from human activities, plankton communities and biomass, the proportion of marine commercial wild seafood stocks subject to quota management reaching reproductive capacity, and the mean maximum and typical length of demersal (bottom feeding) and pelagic (water column feeding) fish.

We also propose reporting on a number of iconic and charismatic species which are culturally valued as well as playing a vital role in food chains. We will report GES indicators using JNCC Marine Biodiversity Indicators and associated data for breeding[4] and wintering seabirds[5], harbour seal abundance[6] and Atlantic grey seal pup production in the greater North Sea and Celtic Seas sub-regions. We will also report on coastal Designated Bathing Water quality using EA bathing water data. The quality of these bathing waters is extremely important for health and wellbeing benefits for people.

[4] Derived from JNCC Marine bird abundance indicator

[5] Derived from JNCC Marine bird abundance indicator

[6] Derived from JNCC Changes in abundance and distribution of seals

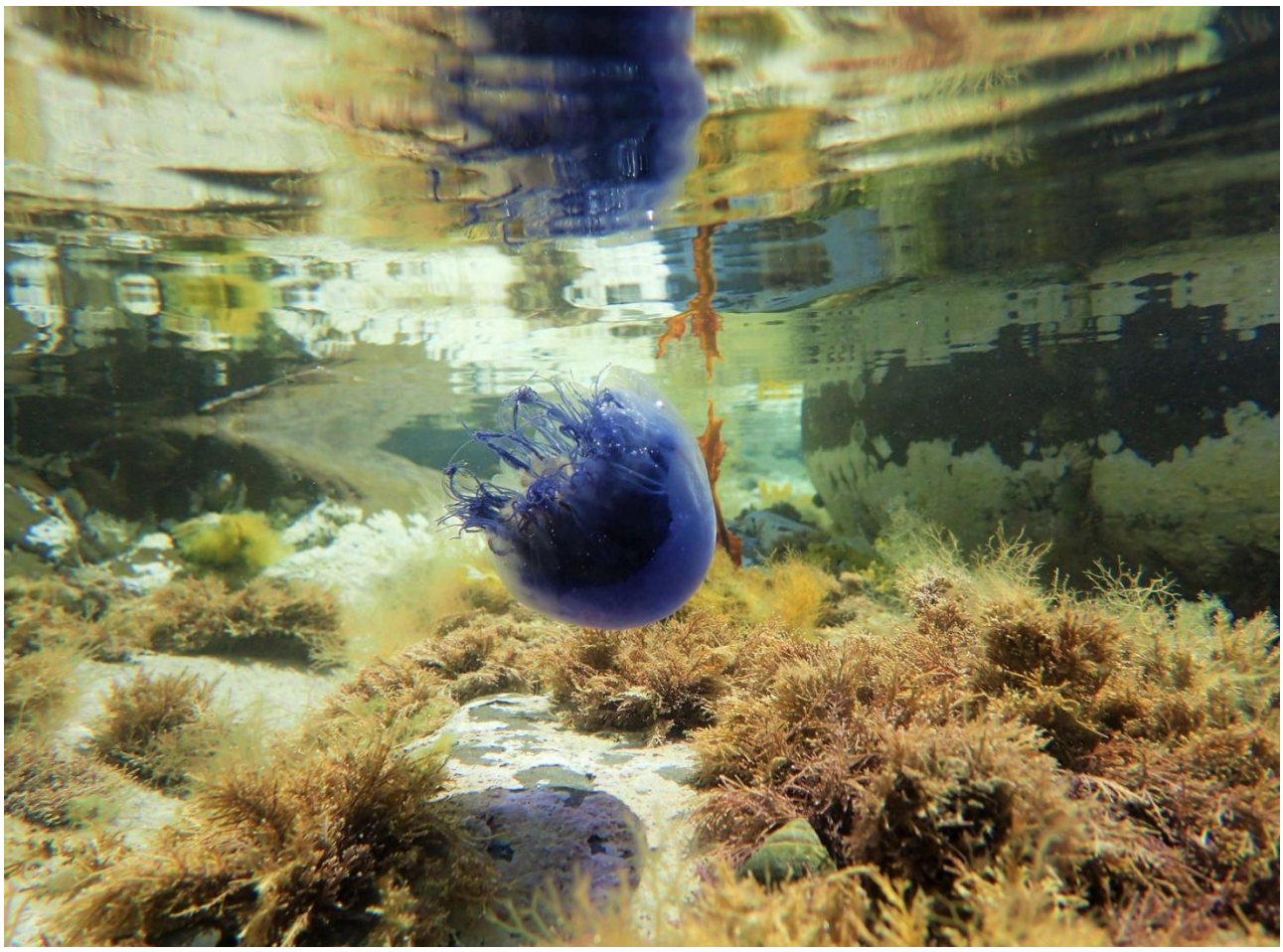


Photo: Blue jellyfish (Cyanea lamarckii) in the Hartland Point to Tintagel MCZ © Natural England/Adele Morgan (CC BY-NC-ND 2.0)

Table 15 Proposed indicators for marine and coastal margins

The following table shows which *State of Natural Capital Report* (SONC) indicators we propose to include in this section, the metric and data that will be used and the benefits that the indicator tells us about. We propose to include indicators which are reported from the UK Marine Strategy / OSPAR Good Environmental Status Indicators, where this occurs we describe how we will report on these indicators in the metric column. Each indicator is coded according to whether it is: (P) a primary indicator of the ecosystem service (Natural Capital Indicators short or long list indicator); (S) a secondary indicator providing a substantial contribution to the ecosystem service but is not a primary indicator; or (T) a tertiary indicator providing only a limited contribution to the service. * Additional indicator, not part of 100% cover.

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Salt marsh	ha and % cover	1				**P**	**P**	**P**	**P**	**P**
Extent	Sand dunes	ha and % cover	1				**P**	**P**	**P**	**P**	**P**
Extent	Bare sand	ha and % cover	1				**T**	**T**	**S**	**T**	**S**
Extent	Intertidal rock	ha and % cover	2	**P**					**P**		
Extent	Intertidal mud	ha and % cover	2	**S**					**P**	**P**	**P**
Extent	Intertidal sand and muddy sand	ha and % cover	2	**S**					**P**	**P**	**P**
Extent	Intertidal coarse sediment	ha and % cover	2						**P**	**S**	**P**

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Extent	Subtidal rock	ha and % cover	2	**P**					**P**		
Extent	Subtidal mud	ha and % cover	2	**P**					**P**	**P**	
Extent	Subtidal sand	ha and % cover	2	**P**					**P**	**P**	
Extent	Subtidal coarse sediment	ha and % cover	2	**P**					**P**	**S**	
Extent*	Seagrass beds	ha and % cover in: intertidal, subtidal or brackish waters	2	**P**	**P**	**P**			**P**	**P**	**P**
Nutrient (& chemical) status	Bacteriological & viral water quality	% of Shellfish Water Protected areas that pass/fail	11	**P**	**P**	**P**			**P**		
Nutrient (& chemical) status	Chemical status of sediment & sea water: toxic contaminants	Chemical status of coastal and estuarine waters - % at good status	11	**P**	**P**	**P**			**P**		**S**
Nutrient (& chemical) status	Chemical status of sediment & sea water: toxic contaminants	Chemical status (excluding UPBTs) of coastal and estuarine waters - % at good status	11	**P**	**P**	**P**			**P**		**S**
Nutrient (& chemical) status	Nutrient status of sediment & sea water (N, P, Si & water turbidity)	Dissolved Inorganic Nitrogen status of coastal and estuarine water in the winter - % high or good	11	**P**	**P**	**P**			**P**		**S**

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Soil/sediment processes	Soil carbon/organic matter content	Average soil organic carbon density in sand dune samples - mean tonnes/ha (tbc)	3							**P**	
Soil/sediment processes	Soil carbon/organic matter content	Estimate total tonnes of carbon stored in sand dunes sediment	1, 3, 15 tbc							**P**	
Soil/sediment processes	Soil carbon/organic matter content	Estimate total tonnes of carbon stored in saltmarsh sediment	2, 15						**S**	**P**	
Soil/sediment processes	Carbon content of sediment	Estimate total tonnes of carbon stored in sediment of: intertidal sand and muddy sand, intertidal mud, subtidal mud and subtidal sand	2, 15						**S**	**P**	
Vegetation	Carbon content of vegetation	Estimate total tonnes of carbon stored in vegetation (saltmarsh and seagrass)	1, 2, 15 tbc			**S**		**S**		**S**	
Vegetation	Vegetation structure	Average number of vegetation surfaces present across sand dune stands	3				**P**	**P**	**S**	**T**	
Vegetation	Saltmarsh formation and zonation	Saltmarsh zonation - % area of: driftlines; pioneer; low-mid; mid-upper; upper saltmarsh; saline and brackish reed; rush and sedge beds	16				**S**	**T**	**S**	**S**	**S**
Species Composition	Absence of invasive non-native species	Invasive plant species - average % cover on sand dune and saltmarsh stands	3						**P**		
Species composition	Absence of invasive non-native species	Marine INNS - metric tbc	tbc	**P**					**P**		

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Species composition	Population size structure	Meeting the GES target, including % change in the mean maximum length and the typical length of demersal and pelagic fish communities	12	**S**					**S**		
Species Composition	Population reproductive capacity	Meeting the GES target, including % of commercially exploited marine fish stocks achieving reproductive capacity capable of producing maximum sustainable yield	12	**S**					**S**		
Species composition	Naturalness of biological assemblage: Extent of physical damage to predominant and special habitats	Meeting the GES target, including % of total area of each seabed habitat that is predicted to be subjected to higher levels of disturbance (category 5-9) in each of the UK Sub-Regional Seas	12, 17	**P**					**P**	**P**	**S**
Species composition	Naturalness of biological assemblage: plankton	Meeting the GES target, including a) changes in the plankton community life forms and b) changes in plankton biomass and abundance	12	**P**		**S**			**P**	**S**	
Species Composition & Cultural: Nature	Naturalness of biological assemblage	Biodiversity Intactness Index tbc	tbc						**P**	**S**	**S**
Species Composition & Cultural: Nature	Naturalness of biological assemblage: seals	Meeting the GES target, including % change in harbour seal abundance	12, 17						**P**		**P**

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Species Composition & Cultural: Nature	Naturalness of biological assemblage: seals	Meeting GES target including % change in Atlantic grey seal pup production	12, 17						**P**		**P**
Species Composition & Cultural: Nature	Naturalness of biological assemblage: sea birds	% of breeding seabirds and wintering waterbirds meeting breeding success targets for GES	12, 17						**P**		**P**
Species Composition & Cultural: Nature	Naturalness of biological assemblage: sea birds	% of non-breeding waterbirds meeting population size targets for GES	12, 17						**P**		**P**
Species Composition & Cultural: Nature	SSSI area	% area of sand dunes which is a notified feature of a SSSI	6				**T**	**T**	**S**	**S**	**P**
Species Composition & Cultural: Nature	SSSI area	% area of saltmarsh which is a notified feature of a SSSI	6				**T**	**T**	**S**	**S**	**P**
Species Composition & Cultural: Nature	SSSI condition	% of sand dune SSSIs in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6				**T**	**T**	**S**	**S**	**P**
Species Composition & Cultural: Nature	SSSI condition	% of saltmarsh SSSIs in: favourable; unfavourable recovering; unfavourable declining or destroyed condition	6				**T**	**T**	**S**	**S**	**P**

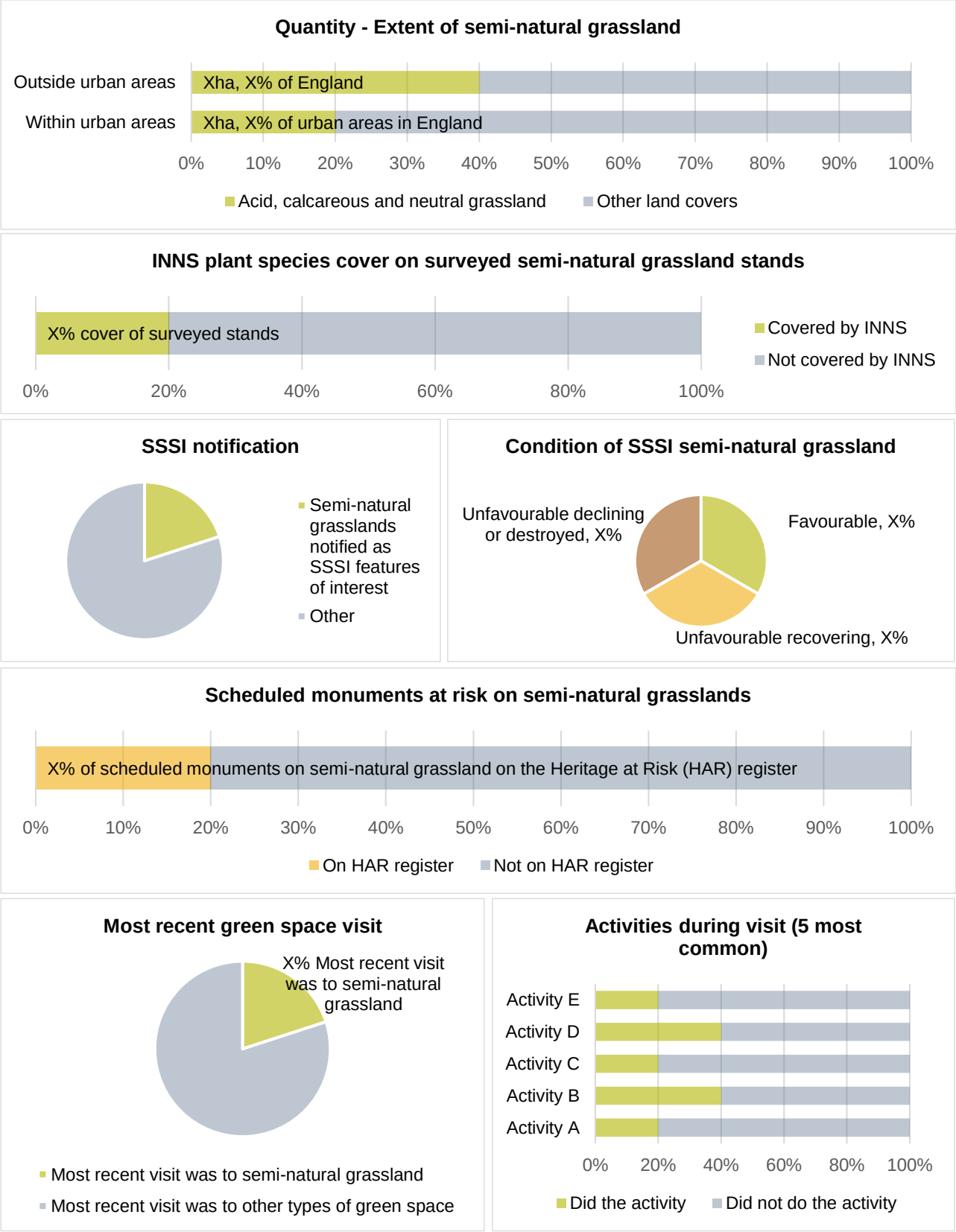
SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Species Composition & Cultural: Nature	Marine Protected Area coverage	% of coastal and marine area to 200 nm designated as MPA	2	**S**					**S**	**S**	**P**
Species Composition & Cultural: Nature	Marine Protected Areas condition	% of MPA features in condition: favourable; unfavourable-recovering; unfavourable-no change; unfavourable-declining; not recorded. (Features to cover: H1110 Sandbanks slightly covered by seawater all the time, H1130 Estuaries, H1140 Mudflats and sandflats not covered by seawater at low tide, H1150 Coastal lagoons, H1160 Large shallow inlets and bays, H1170 Reefs, H8330 Submerged or partially submerged sea caves)	13	**S**					**S**	**S**	**P**
Cultural: Accessibility	Public Rights of Way density	Density of PRoW tbc	4								**P**
Cultural: Culture & history	Scheduled Monuments at risk	Scheduled monuments - % of total number in coastal and marine ecosystems which are on the Heritage at Risk register (including Protected Wrecks)	5								**P**
Cultural: Nature	Bathing Water quality	% of Bathing Waters in excellent, good, sufficient or poor condition	14			**S**					**P**
Ecosystem service flow: Cultural	Number of visits	% of people whose most recent visit was to coastal margins and marine ecosystems	7								**P**

SONC indicator category	SONC indicator	Metric	Data	Produce from the sea	Aquaculture	Clean water	Erosion control	Flood protection	Thriving plants & wildlife	Climate regulation	Cultural services
Ecosystem service flow: Cultural	Range of activities undertaken	% of visitors to coastal margins and marine ecosystems who did each activity	7								**P**
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by coastal ecosystems	1, 15 tbc							**P**	
Ecosystem service flow: Carbon	Carbon sequestered and greenhouse gases fixed	Tonnes per ha of CO_2 equivalent sequestered by marine ecosystems	tbc							**P**	

The Data column shows the main dataset or, where there may be multiple datasets from the same source, the main data source required to report the metric. Other additional datasets may be required to cut or support the analysis of the data. The datasets/sources are coded as: 1 - Living England, 2 - Natural England Marine Evidence Base, 3 - England Ecosystem Survey, 4 - England Green Infrastructure Mapping Database, 5 - Historic England data (Scheduled monuments & Heritage at risk), 6 - CSMI, 7 - People and Nature Survey, 11 - WFD/WER/Sentinel, 12 - UK Marine Strategy/OSPAR Good Environmental Status Indicators, 13 - Natural England Designated Sites View: Marine Reports, 14 - Bathing water quality statistics, 15 - Carbon values papers (Gregg and others 2021; Parker and others 2021), 16 – EA Saltmarsh Zonation, 17 – Derived from indicators and data collected for JNCC Marine Biodiversity Indicators.

3.3 Example indicator dashboard

Semi-natural grassland



Note: Size of sections on graphs not representative of actual data.

4 Natural capital risk register

In this section we set out our proposals for creating a natural capital risk register. This risk register will communicate how “at risk” our ecosystems are, and therefore the risk on ecosystem service delivery and achieving the policy areas within this report. We also propose to report on the drivers of change impacting on our ecosystems and discuss how we will do this.

Photo: Bumblebee on Viper's Bugloss © Natural England/Allan Drewitt (CC BY-NC-ND 2.0)

4.1 The different elements of risk

A typical risk register describes risk in terms of the **likelihood** of an event occurring and the **magnitude** of the consequences should it do so. This is entirely appropriate when a specific event can be clearly defined (an earthquake or an oil spill, for example). However, environmental decline can also be gradual, rather than occurring in a series of dramatic events. Also, the connections between our natural capital assets, the services they provide and the benefits to society are complex and often poorly understood. Attempting to predict the likelihood and societal consequences of specific events associated with environmental degradation is likely to result in an assessment that is of low confidence, and from which important risks may be missing.

Therefore, we do not propose to use that approach as the model for our risk register. Instead, we will consider in more general terms whether ecosystem assets are “at risk”. By this, we mean where the assets are degraded and/or declining, in either their extent or quality (or both). This allows us to highlight those assets that may fail to deliver the ecosystem services on which we rely.

We propose using two approaches to consider what the loss of these ecosystem services might mean for society. We intend to look at some of the major societal risks identified in the UK’s national risk register[7] (such as storms and flooding) and how ecosystem services reduce the impacts of these acute events. We also propose exploring how the risk to ecosystem assets could affect other national priorities. Ecosystem assets play an essential role in supporting the delivery of a suite of national policies. Where assets are at risk, this creates a corresponding risk that they may no longer deliver the ecosystem services needed to support wider policy goals.

Finally, we propose considering the drivers of change that are affecting the quality and quantity of our ecosystem assets and hence create the risks to them and to the continued delivery of ecosystem services.

4.2 Assets at risk

The method we propose broadly follows the approach taken by Natural Capital Committee members in developing a detailed method for a natural capital risk register (Mace and others, 2015), although with some key changes. Mace and others (2015) propose that risk levels are determined using a matrix that considers: (i) the trend in the state of the **asset**; and (ii) the current level of **benefits** derived from that asset. We intend to apply this risk matrix approach, but our method will concern only the asset status and trends. How this risk to assets connects to risks to the supply of ecosystem services (and hence benefits to

[7] https://www.gov.uk/government/publications/national-risk-register-2020

society) will be considered in separate stages. These additional steps will consider the ecosystem services that (i) mitigate the consequences of environmental hazards that have been identified as presenting major risks for society; and (ii) contribute to achieving the objectives of national policies (which reflect society's wider needs).

Conceptually, the proposed approach is straightforward. It combines two elements of asset status – the current state and the trend over time – into a matrix. From this matrix, the risk level can be determined on a three-point scale of low, moderate and high (Table 16). The method can be applied, separately, to different aspects of asset status, and we propose doing so for both extent/quantity and quality indicators. This helps to highlight which of these are the key factors driving overall risk to particular assets (and hence what response is needed). We propose recording risk information for individual indicators in the spreadsheet (Annex 3), although we will apply judgment as to which indicators are appropriate for this analysis. For example, extent is unlikely to be a reliable indicator for subtidal environments in most cases, as data is poor at the national scale. Broad scale habitat information for subtidal areas (particularly offshore) tends to be modelled based on factors such as depth and current speed, and so substantial changes in extent are not expected. Even where survey data exists, collection is sporadic. Understanding of whether subtidal marine assets are at risk may therefore rely on quality indicators only. Mace and others (2015) also applied their method to the spatial configuration/location aspect of natural capital assets. We do not intend to do so, as there are few location indicators in the report, due to the lack of readily available data to report on these without further complex analysis.

Table 16 The generic risk matrix, detailing how information on the current status of the assets and its trend over time is brought together to determine the level of risk to a particular asset (adapted from Mace and others, 2015)

		Status		
		Substantially below target	**Below target**	**At or above target**
Trend	**Strongly negative**	High	High	High
	Negative	High	Moderate	Moderate
	Positive or stable	High	Moderate	Low

The generic matrix defines asset status in the context of a known target, which is the preferred option. However, such targets are not currently available for all indicators. Information on trends may also be lacking for particular indicators. We will therefore adapt the approach depending on data availability, following the process illustrated in Figure 4. Where it is necessary to use expert judgment to determine the risk level, this will be informed by consideration of the known pressures and drivers of change (see section below). Expert judgment will be required for certain elements of the process, even if data are available, in, for example, determining where the line should be drawn between the 'below target' and 'substantially below target' status categories. For example, 75% of shellfish waters fail to meet the appropriate standard (HM Government 2021), suggesting that it is appropriate to consider shellfish water quality to be substantially below target at the national level. For bathing water, however, only 1.7% of sites failed to meet the appropriate minimum standard in 2019 (HM Government 2021) and so this is only just below the target level.

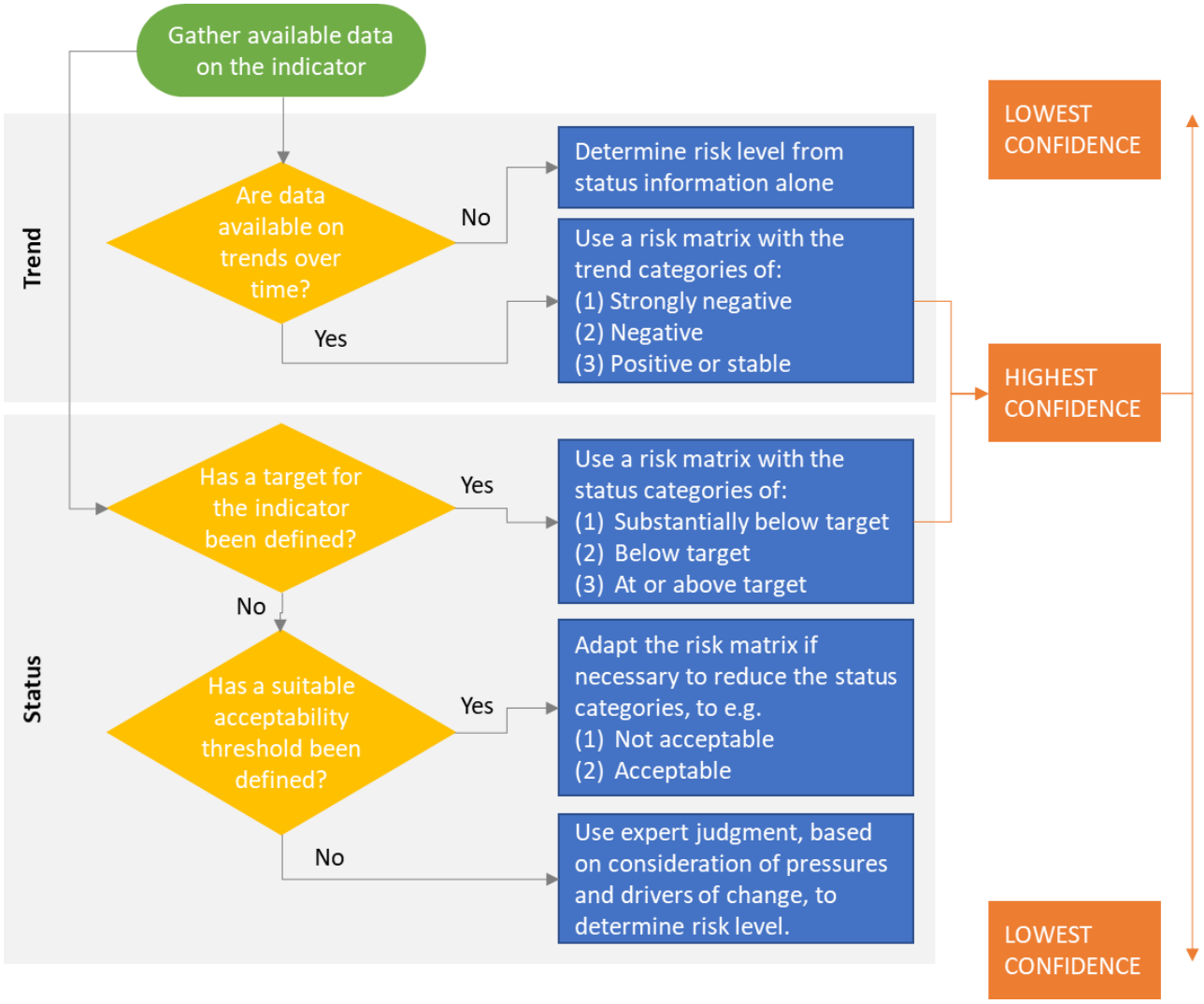


Figure 4 A schematic of the different options available to complete the risk analysis, depending on the available information.

We propose to include a confidence rating as part of the risk assessment. Any assessment that lacks trend information will not present a complete picture, and so will be of lower confidence. Risk ratings assigned using only expert judgment will normally be of lower confidence than those determined using expert judgement combined with data related to an established, accepted target or threshold. We propose that the risk information for each relevant indicator, as shown in Table 17, will be captured in a risk register spreadsheet.

Table 17 The risk information to be captured within the database for relevant indicators.

Risk characteristic	Categories
Trend	Stable/positive; Negative; Strongly negative; No trend available
Target	Substantially below target; Below target; At/above target; No target available
Threshold	Acceptable; Unacceptable; No threshold available
Rating determined using expert judgment	Yes; No
Overall risk rating	High; Medium; Low
Confidence rating	High, Medium, Low

4.3 Reducing risks to society

We propose considering risks to society in two ways: those arising from environmental hazards that cause acute events such as flooding and droughts as identified in the UK's National Risk Register (HM Government 2020), and those from the potential failure to deliver on wider national priorities, identified in the focus policy areas of this report (net zero, climate change adaptation, food security, health and wellbeing and resilient economic development). Ecosystem assets provide ecosystem services that can reduce these risks, by mitigating the effects of acute events and by supporting the delivery of policy objectives. Where assets are at risk, their ability to provide these services is also at risk. The purpose of this assessment will be to determine where the continued delivery of these services is most at risk, and so highlight where management and investment may be needed to reduce risks to society.

The same basic method will be applied in the context of both acute events and broader policy aims, and central to it are (i) the asset risk category (as determined using the method above), and (ii) the connection between assets and the ecosystem services they deliver. Regarding the latter relationship, each indicator will be coded according to whether it is:

(P) A primary indicator of the ecosystem service (Natural Capital Indicators: for defining and measuring change in natural capital - NERR076 short or long list indicator)

(S) A secondary indicator which provides a substantial contribution to the ecosystem service but is not a primary indicator; or

(T) A tertiary indicator which provides only a limited contribution to the service.

The relationship between ecosystem services and policy objectives is also captured in Table 2 (see Section 2.6).

The final societal/policy risk score will highlight where those assets providing the highest levels of the ecosystem services, that could best mitigate environmental hazards or supply policy objectives, are most at risk. This final score will again use a high, moderate, low scale. A high risk score will be allocated where ecosystem service delivery is high, and asset risk level high or moderate. A moderate risk score will be given where ecosystem service delivery is moderate, and asset risk level high or moderate. All other combinations result in a low risk score, or are noted as not applicable, where assets do not provide the relevant ecosystem services (Table 18).

Table 18 A matrix to show how the final societal/policy risk score can be calculated from the asset risk level and its capacity to deliver the relevant ecosystem service.

		Ecosystem service delivery		
		High	**Moderate**	**Low**
Asset risk level	**High**	High	Moderate	Low
	Moderate	High	Moderate	Low
	Low	Low	Low	Low

4.4 Drivers of change

The degradation of ecosystem assets, and hence the risk to national policy priorities and to society more generally, is caused by multiple factors. The UK National Ecosystem Assessment (2011) examined in detail these causes of environment change, including both the direct drivers that cause the immediate impacts on environmental assets, and the higher-level, indirect drivers that result from broader changes in the economy and society (Figure 5).

We propose to consider in more detail the connection between indirect and direct drivers, and how the indirect drivers accelerate/decelerate the risk of environmental change. Rather than adopt the UK National Ecosystem Assessment approach to indirect drivers, we will link closely to the Global Megatrends and related futures work, which provide a more up to date assessment of the specific indirect drivers of most importance in the current UK context. The connections between indirect and direct drivers are difficult to capture in a meaningful way in simple diagrams or tables, and are best explained through narrative. We therefore propose the full *State of Natural Capital Report* presents a narrative on the factors that cause specific changes in policy and behaviour, and which in turn create the direct drivers of environmental change.

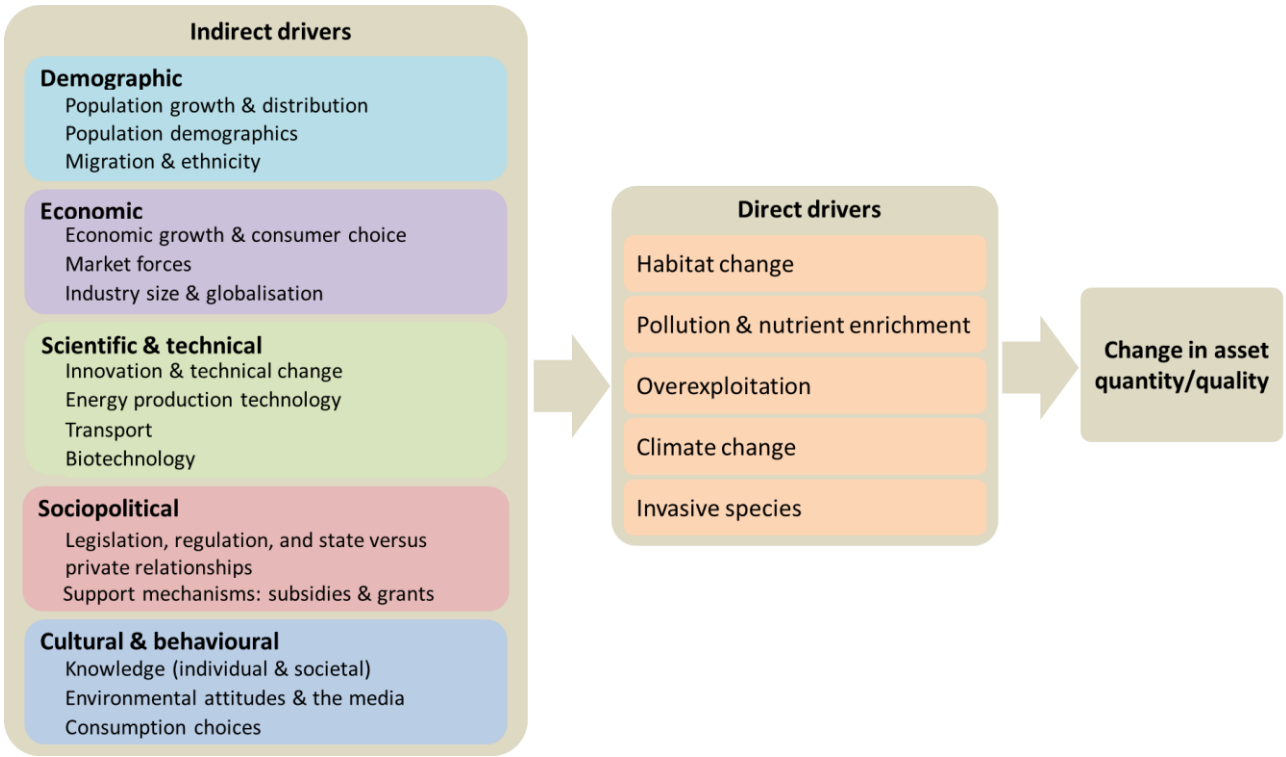


Figure 5 Graphic summarising the indirect and direct drivers that cause environmental change (adapted from information within the UK National Ecosystem Assessment)

Despite the many and various factors that cause them, the direct drivers of environmental change remain broadly consistent. Therefore, in documenting the role of specific direct drivers we propose following the approach used by, and updating the information contained within, the UK National Ecosystem Assessment. This includes using the

evidence in the Intergovernmental Panel on Climate Change's 6th assessment on impacts, adaptation and vulnerability (IPCC 2022). We will provide a summary of whether each driver is causing positive or negative change and its relative strength (minor, moderate, major). Examples of this are given in Annex 4. We will also provide a discussion on how these drivers link to policy priorities, to highlight negative/positive reinforcement of environmental change.

Photo by willea26, accessed from Pixabay

5 Recommendations for next steps

We propose the following recommendations for further work to enable the production of a *State of Natural Capital Report*.

- Review the scoping report with policy makers to ensure that it meets their needs in terms of content, structure and language.
- Review the proposed list of SONC indicators to assess whether it meets an appropriate balance of being both comprehensive and succinct. This includes consideration of both whether the list could be reduced or any vital gaps in indicators filled.
- Determine whether any additional data has become available, since the drafting of this scoping report, or provide better data and metrics for specific indicators.
- Assess whether data analysis would enable robust reporting of any further indicators related to the location of the provision of ecosystem services.
- If a *State of Natural Capital Report* is to be produced before all of the NCEA data becomes available, analysis will be required of existing data sets which could be used to measure the indicators. For example, UK CEH Countryside Survey data could be used, instead of England Ecosystem Survey, for a number of the indicators.
- Develop a succinct (half page) example to illustrate each policy area. Ensure that this series of examples provide coverage of marine, coastal, freshwater and terrestrial contexts.
- Work collaboratively with the Natural History Museum to investigate the requirements for development of Biodiversity Intactness Index indicators for a *State of Natural Capital Report*.

Photo: Child pond dipping © Natural England/Chris Gomersall (CC BY-NC-ND 2.0)

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Annex 1 Data for a State of Natural Capital Report

This annex provides an overview of:

Section 1: The process undertaken to identify indicators to report on, review existing and upcoming data sources, develop metrics and identify gaps

Section 2: The sources of data we propose to use in a future *State of Natural Capital (SONC) Report*

Section 3: Further development work on data and metrics needed for a future SONC

Section 4: Critical indicator gaps, due to a lack of suitable data or complexities in data analysis

Section 1 Process

Step 1: Identifying indicators: The proposed SONC indicators are based on previous work, Natural Capital Indicators: for defining and measuring change in natural capital - NERR076 (Lusardi and others 2018). This work systematically identified the attributes of the natural environment vital for underpinning the benefits which nature provides to society. To identify a concise set of indicators for a SONC, the full list of Natural Capital Indicators was reviewed. The aim was to select indicators which tell you not only about the state of the attribute, for example, soil organic matter (carbon), but also indicate information about other properties of ecosystem health and function (in this case, soil health, soil or sediment processes and carbon storage in soil). Together the indicators build a picture of the state of England's natural capital, covering our ecosystem assets' quantity, quality and where possible location, to understand the benefits that nature can provide to people.

Step 2: Identifying data: We explored existing and new or upcoming data sources. The review started from the data sources identified in the Natural Capital Indicators report (Lusardi and others 2018) and tested in Natural England's Natural Capital Atlases (Wigley and others 2020, Lear and others 2021). Then, we explored datasets being generated through the Natural Capital and Ecosystem Assessment (NCEA), including the Marine Natural Capital Ecosystem Assessment (mNCEA). We selected data sources which are or will be: openly available (or we are able to use in national-level metrics), transparent, consistently collected across England, usable at a national scale, updated regularly and sensitive to changes. The proposed SONC indicators and data sources were matched together.

Step 3: Exploring data: We explored the feasibility of using the data sources for the indicators by:

- Reviewing the properties of existing data and accessing published reports
- Exploring pilot data (such as the pilot England Ecosystem Survey data collected in 2021)
- Discussions with data managers and project teams producing the data

The metrics included for each indicator were developed by predicting what will be possible to report and how.

Step 4: Identifying further work and gaps: We identified further testing and development work which would be required ahead of a full SONC (see Annex 1 Section 3). Then, working from the data gaps identified in the Natural Capital Indicators report, we identified the remaining most important gaps (see Annex 1 Section 4).

Section 2 Natural capital datasets and data sources referenced in Scoping report

The following datasets and data sources are proposed to be used in a future SONC report. They are listed next to the indicators and metrics in each of the broad habitat sections of the SSONC report (Section 3.2) Each table below gives the code used in the indicator tables in the main scoping report, the name of the dataset or data source, the ecosystem asset properties we propose to use the data source to obtain information on (quantity, quality or location), how often the data is updated and the reference or attribution statement. Table 19 describes existing datasets or sources, Table 20 includes those being expanded or updated through the NCEA programmes and Table 21 lists new data which will be produced by the NCEA programmes.

Table 19 Existing data sources

These existing datasets and data sources are published or available and are not directly part of the NCEA or mNCEA.

Code	Name	Quantity	Quality	Location	Frequency of update	Reference/ Attribution
2	Natural England Marine Evidence Base	✓			Every 6 months	Natural England. 2021. Marine Habitats and Species Open Data (England) BNG. Available at: https://naturalengland-defra.opendata.arcgis.com/maps/marine-habitats-and-species-open-data-england-bng/about
5	Historic England data - Scheduled Monuments, Protected Wreck Sites, Heritage at Risk		✓		Listed sites data updated every two weeks, Heritage at Risk dataset updated annually	© Historic England [2021]. Contains Ordnance Survey data © Crown copyright and database right [2021]. The Historic England GIS Data contained in this material was obtained on [date]. The most publicly available up to date Historic England GIS Data can be obtained from HistoricEngland.org.uk.
6a	CMSi - SSSI condition assessment data		✓		As required	Not publicly accessible, but able to use in SONC as data shown in the report will be at a broad level of detail.

6b	SSSI Units		✓		As required	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right [2021].
7	People and Nature Survey		✓		Indicators published monthly and data released quarterly.	Natural England. 2021. The People and Nature Survey. https://www.gov.uk/government/collections/people-and-nature-survey-for-england#history
9	Breeding Bird Survey (and other UK-wide bird monitoring schemes), used in reporting the England Biodiversity Indicators		✓		Annual. The Breeding Bird Survey collects data on an annual basis for over 100 breeding bird species. The wild bird indicator analytical programmes to produce the species trends are run annually with the most up-to-date datasets available at the time. England Biodiversity Indicators are typically updated annually. The report gives details on latest data available for each indicator. To allow for review of the indicators it is anticipated that there will be a pause in publication in 2022. The next update will be in 2023. This will include 2022 data.	England Biodiversity Indicators: Defra. 2022. A strategy for England's wildlife and ecosystem services, Biodiversity indicators: 2021 assessment. Available from https://www.gov.uk/government/statistics/england-biodiversity-indicators Further information on bird data sources: Data on bird populations in the UK and England comes from a variety of UK-wide monitoring schemes run by Non-Governmental Organisations (NGOs), principally the BTO and RSPB but with other partners, in collaboration with the UK Government (the JNCC and the 4 statutory nature conservation agencies). The most important sources of data for the wild bird indicator are the BTO/JNCC Common Bird Census (CBC) (1966 to 2000) and its replacement survey, the Breeding Bird Survey (1994 to date). See: Eaton, M.A. & Noble, D.G. (2021) Technical paper: the wild bird indicator for the UK and England. Available from https://www.gov.uk/government/statistics/england-biodiversity-indicators
10	UK Butterfly Monitoring Scheme, used in reporting the England Biodiversity Indicators		✓		Annual. UK Butterfly Monitoring Scheme data are processed on an annual basis. England Biodiversity Indicators are typically updated annually. The report gives details on latest data available for	England Biodiversity Indicators: Defra. 2021. A strategy for England's wildlife and ecosystem services, Biodiversity indicators: 2021 assessment. Available from https://www.gov.uk/government/statistics/england-biodiversity-indicators

					each indicator. To allow for review of the indicators it is anticipated that there will be a pause in publication in 2022. The next update will be in 2023. This will include 2022 data.	The data source for butterfly indicators is the UK Butterfly Monitoring Scheme. For further information see: MIDDLEBROOK, I. & ROY, D. 2021. Technical background document – Assessing change in the England Butterfly Indicators. Available from https://www.gov.uk/government/statistics/england-biodiversity-indicators
11a	Water Environment Regulations/Water Framework Directive Classifications Note: WER/WFD monitoring is focused on providing waterbody level quality and quantity assessments. There are no developments to this dataset through the NCEA, but see below for information on the Sentinel networks which are being developed through the NCEA to provide England level assessments.		✓		WER data updated as a whole every 3 years	Environment Agency. 2021. Catchment data explorer. https://environment.data.gov.uk/catchment-planning/ Contains Environment Agency information © Environment Agency and/or database right
12	UK Marine Strategy/ OSPAR Good Environmental Status Indicators		✓		Every 5 years	UK Marine Online Assessment Tool. 2019. Available at https://moat.cefas.co.uk/

13	Natural England Designated Sites View: Marine Reports		✓		6 yearly reporting but updated when Natural England staff undertake site condition assessments	Natural England. 2021. Designated Sites View: Marine Reports. Available from https://designatedsites.naturalengland.org.uk/MarineReports/MarineReportLanding.aspx
14	Bathing water quality statistics		✓		Annual	Defra. 2022. Bathing water quality statistics. Available at https://www.gov.uk/government/statistics/bathing-water-quality-statistics
15	Carbon values papers: Gregg and others (2021), Parker and others (2021), Swaile and others (2022)		✓		To be used together with marine and coastal habitat extent values obtained from Natural England Marine Evidence Base (updated every 6 months)	GREGG, R., ELIAS, J. L., ALONSO, I., CROSHER, I.E., MUTO, P. AND MORECROFT, M.D. 2021. Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York. PARKER, R., BENSON, L., GRAVES, C., KRÖGER, S., VIEIRA, R. 2021. Carbon stocks and accumulation analysis for Secretary of State (SoS) region, Cefas Report for Defra project ME5439, 42 pp. SWAILE, G., MARSH, M.K., ELIAS, J.L., BURTON, S.M., TODD, D., WALKER, P., GANNON, L., ELLIOTT, J.M., SMIBERT, L., PERRY, G. AND HARTLEY, M. 2022. Blue carbon – mapping risks and opportunities. Natural England Research Report ME5440 to Defra.
17	JNCC Marine Biodiversity Indicators		✓		Every three years for seal and seabird data	© Joint Nature Conservation Committee. Available from: https://jncc.gov.uk/our-work/marine-biodiversity-indicators/

Table 20 Existing data sources, expanded through NCEA or MNCEA

These datasets and data sources are currently published but are being expanded, altered or built upon through the NCEA or mNCEA.

Code	Name	Quantity	Quality	Location	Frequency of update	Developments through NCEA or mNCEA	Reference/ Attribution
8	National Forest Inventory		✓	✓	NFI field survey assesses a large, stratified-random sample of woodlands across GB on a 5-year rolling cycle.	NFI sampling augmented by NCEA and NCEA providing additional outputs including soil data.	DITCHBURN, B., WILSON, T., HENDERSON, L., KIRBY, K. AND STEEL P. 2020. NFI woodland ecological condition in England: classification results. Available at https://www.forestresearch.gov.uk/documents/7548/FR_NFI_Condition_Scoring-Results_England.pdf
11b	NCEA Sentinel Networks		✓		5 years for full networks – interim assessment may be possible at reduced confidence	Sentinel monitoring in development through NCEA will provide England level assessments of quality and quantity but not water body level assessment. It will extend data availability from rivers only to cover small streams, lakes, estuaries and coastal waters, groundwater, water quantity and atmospheric deposition.	Networks are still under design so no data will be available until 2024/25
16	Saltmarsh zonation		✓		Annual	mNCEA Report (number NC19) Increasing the cover of England's saltmarsh zonation data 2022. Increased the coverage of zonation information in England from 86% to 96.5%.	© Environment Agency copyright and/or database right 2015. All rights reserved.

Table 21 NCEA or MNCEA data

These datasets and data sources are being developed through the NCEA or mNCEA.

Code	Name	Quantity	Quality	Location	Frequency of update	Future developments	Reference/ Attribution
1	Living England	✓			Every 2 years	To improve the accuracy of the satellite-derived map, regular provision of field survey data is required to train the model and carry out model validation. 'Ground Data Collection' is being undertaken via England Ecosystem Survey and by the Natural England field unit.	Contains data supplied by ©Natural England ©Centre for Ecology and Hydrology, Natural England Licence No. 2011/052 British Geological Survey © NERC. All rights reserved., © Environment Agency copyright and/or database right 2015. All rights reserved. ©Natural England © Crown copyright and database right [2014], © Rural Payments Agency, © Natural England © 1995–2020 Esri, Contains Environment Agency information © Environment Agency and/or database rights. Some information used in this product is © Bluesky International Ltd/Getmapping PLC. Contains freely available data supplied by Natural Environment Research Council (Centre for Ecology & Hydrology; British Antarctic Survey; British Geological Survey). Contains OS data © Crown copyright [and database right] (2014), © Environment Agency copyright and/or database right 2015. All rights reserved. Esri, Maxar, Earthstar Geographics, USDA FSA, USGS, Aerogrid, IGN, IGP, and the GIS User Community, Contains Ordnance Survey data © Crown copyright and database right 2021., EODS / CEDA ARD: ESA Copernicus: 'Contains modified Copernicus Sentinel data [2021]', © Carlos Bedson Manchester Metropolitan University, © Copyright 2020, worldclim.org Fick, S.E. and R.J. Hijmans, 2017. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. International Journal of Climatology 37 (12): 4302-4315. Pescott, O.L.; Walker, K.J.; Day, J.; Harris, F.; Roy, D.B.

							(2020). National Plant Monitoring Scheme survey data (2015-2019). NERC Environmental Information Data Centre. https://doi.org/10.5285/cdb8707c-eed7-4da7-8fa3-299c65124ef2 © UK Centre for Ecology & Hydrology © Joint Nature Conservation Committee © Plantlife © Botanical Society of Britain and Ireland. The National Plant Monitoring Scheme (NPMS) is organised and funded by the UK Centre for Ecology & Hydrology, Botanical Society of Britain and Ireland, Plantlife and the Joint Nature Conservation Committee. The NPMS is indebted to all volunteers who contribute data to the scheme.
3	England Ecosystem Survey (EES)		✓		Working towards 5 year survey cycle	Protocol under development following pilot survey season.	Upcoming publication - planned to be released under Open Government Licence
4	England Green Infrastructure Mapping Database		✓	✓	Baseline 1 of the database is due to complete in December 2022 upon publication of V 1.2	Version 2 will be built from Apr 22 to Mar 25 when it will become Baseline 2. Quintennial Change Detection is planned for every 5 years with annual mapping updates likely.	Contains data supplied by or derived from Natural England, Ordnance Survey, Forestry Commission, Historic England, Environment Agency, Office National Statistics, MHCLG, © Natural England. For full details of the datasets contained within the portal see the user guide.

Table 22 Additional datasets required for analysis

The following datasets have been identified as key requirements to allow the data in the previous section to be used as required for a future SONC.

Name	Attribution statement
ONS Built-up Areas (December 2011) Boundaries V2	Office for National Statistics licensed under the Open Government Licence v.3.0. Contains OS data © Crown copyright and database right [2021]
OS Boundary Line	Contains OS data © Crown copyright and database right [2021]
OS Open Roads	Contains OS data © Crown copyright and database right [2021]
Biodiversity Intactness Index	PHILLIPS, H., DE PALMA, A., GONZALEZ, R. E., CONTU et al. 2021. Dataset: The Biodiversity Intactness Index - country, region and global-level summaries for the year 1970 to 2050 under various scenarios. Natural History Museum Data Portal (data.nhm.ac.uk). https://doi.org/10.5519/he1eqmg1

Section 3 Further development work

Due to the developing nature of several of the data sources, and the scope and timescale of the project, there are some areas of further development work which would support the production of a full SONC report.

The key opportunities for further work are described briefly below, split by whether the work will help us to improve our reporting of asset quantity, quality or location.

General

Further testing of datasets which are currently under development (NCEA and mNCEA data) as the data is published or the protocols are fully established, particularly for data which measures properties of urban ecosystems

Quantity

A data integration exercise of key quantity data sets as required to achieve a single source for asset quantity with 100% coverage (may include Living England, National Forest Inventory and marine and coastal datasets, particularly for saltmarsh)

Quality

- An exploration of the potential to develop summary, or identify the most appropriate, metrics from detailed survey data, such as from a variety of pond and hedgerow condition attributes
- Further exploration of the Biodiversity Intactness Index, and the different data which can or should be used to calculate the index for different broad ecosystem types. This may include exploring citizen science data, particularly that being produced by the NCEA.
- Exploration of the opportunities to report on trees outside woodland, including small woodlands, street trees in urban areas and veteran trees outside of NFI woodland stands
- Further testing of EES data to explore the inclusion of data on field drainage to report on naturalness of hydrology, the presence and frequency of adult and larval pollinator food plants, and the inclusion of landscape attributes, such as nature noises and perceived tranquillity
- Investigation of new and emerging data sources which may enable us to update or improve the data and metrics currently included in the scoping report. Emerging opportunities currently identified for future investigation are:
    - Data on bats in woodland, part of the NCEA
    - New MNCEA cetacean monitoring data and evidence gathered to improve plankton indicators
    - Potential improved data for understanding the carbon content of sediment
    - Potential for Natural England Sensitivity Tool (NEST) to provide data on the extent of physical damage to seabed habitats at a higher resolution than the

UK Marine Strategy/OSPAR data currently outlined and the improvement of data for reporting in inshore areas
    - Potential for the English Seabird Conservation Strategy to provide improved data on sea bird assemblages
    - mNCEA work to investigate essential fish habitats, a suite of fish species to monitor, and how to combine these attributes into an indicator
    - NCEA soil health project which will support the interpretation of soil data across different soil types to report on overall soil health
    - Upland breeding bird index in development by JNCC

Location

Location indicators, these need more complex analysis which we have not tested through this scoping work. Further work would need to develop and test a method for reporting on the proposed indicators. Further indicators could be explored, particularly to understand the benefits provided by the spatial location of woodlands

Section 4 Gaps

We have identified the following indicators (or groups of indicators) as critical gaps. These are important and would ideally be reported on in a SONC report, but there is not consistent data available and/or substantial work would be required to analyse data in order to report on them. The latter particularly applies to the location indicators.

Quantity

- Active flood plain
- Consistently mapping and differentiating between freshwater bodies such as rivers, lakes, canals, reservoirs and ponds
- Some specific marine features, including:
    - Maerl beds
    - Reefs
    - Blue mussel beds

Quality

- Invasive non-native species – England Ecosystem Survey is only recording plant species, so the presence of other invasive species identified as a gap for terrestrial and coastal margin ecosystems
- Peat depth and peat gullying/erosion, because surveys done through the England Peat Map are not proposed to be repeated currently
- Some urban Green Infrastructure, including green roofs and sustainable urban drainage systems (SUDS)
- Linear vegetation features (other than hedgerows and riparian vegetation) and pockets of semi-natural vegetation, where these features are less than 20mx20m – these smaller features will not be recorded in England Ecosystem Survey

- Atmospheric deposition: exceedance of critical loads – data is available for protected sites but not more generally
- Presence of paths which are accessible to all eg people using wheelchairs or pushchairs

Location

Location of:

- Habitats, in relation to water quality: source-pathway-receptor
- Habitats & trees in relation to buildings & transport routes, to mitigate air quality, regulate noise and provide cooling
- Habitats and boundary features mitigating soil erosion and landslip risk
- Width/area/location of habitats providing flood protection in relation to settlements and infrastructure
- Proximity to other habitat patches, patch size and shape and naturalness of spatial configuration of habitats, for maintenance of habitats and species populations
- Proximity of boundary features and semi-natural habitats to insect pollinator crops
- Transition and connectivity of aquatic, terrestrial and marine habitats
- Area for dynamic movement and development of coastal habitats

Annex 2 Ecosystem services and CICES framework

Ecosystem service names in SSONC report (plain English)	**CICES version 4.3 as adapted for Indicators report** (Lusardi and others 2018)	**CICES version 5.1** (Haines-Young and Potschin 2018)	**Relevant 25 YEP ambition** (HM Government 2018)
Timber and other wood products	Materials from plants, animals and algae for agricultural/direct use or processing	Fibres and other materials from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic material)	Using resources from nature more sustainably and efficiently Mitigating and adapting to climate change
Produce from the sea	Wild animals, plants and algae and their outputs	Wild animals (terrestrial and aquatic) used for nutritional purposes	Using resources from nature more sustainably and efficiently
Plant-based energy	Plant -based energy	Cultivated plants (including fungi, algae) grown as a source of energy	Mitigating and adapting to climate change
Cultivated crops	Cultivated crops	Cultivated terrestrial plants (including fungi, algae) grown for nutritional purposes.	
Plentiful water	Water for drinking & non-drinking purposes	Surface water for drinking Surface water used as a material (non-drinking purposes) Ground (and subsurface) water for drinking Ground (and subsurface) water used as a material (non-drinking purposes)	Clean and plentiful water
Reared animals	Reared animals & their outputs	Animals reared for nutritional purposes	

Ecosystem service names in SSONC report (plain English)	**CICES version 4.3 as adapted for Indicators report** (Lusardi and others 2018)	**CICES version 5.1** (Haines-Young and Potschin 2018)	**Relevant 25 YEP ambition** (HM Government 2018)
Clean water	Maintenance of water quality - Mediation of wastes, toxins & other nuisances (by biota & ecosystems)	Regulation of the chemical condition of freshwaters by living processes Regulation of the chemical condition of salt waters by living processes Dilution by freshwater and marine ecosystem	Clean and plentiful water
Clean air	Maintenance of air quality - Mediation of wastes, toxins & other nuisances (by biota & ecosystems)	Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	Clean air
Noise regulation	Noise regulation - Mediation of wastes, toxins & other nuisances (by biota & ecosystems)	Noise attenuation	A reduced risk of harm from environmental hazards such as flooding and drought
Urban cooling		Regulation of temperature and humidity, including ventilation and transpiration	A reduced risk of harm from environmental hazards such as flooding and drought Mitigating and adapting to climate change
Erosion control	Mass stabilisation and control of erosion rates	Buffering and attenuation of mass movement Control of erosion rates	A reduced risk of harm from environmental hazards such as flooding and drought
Flood protection	Flood protection	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)	A reduced risk of harm from environmental hazards such as flooding and drought
Pollination	Pollination and seed dispersal	Pollination (or 'gamete' dispersal in a marine context)	Thriving plants and wildlife

Ecosystem service names in SSONC report (plain English)	**CICES version 4.3 as adapted for Indicators report** (Lusardi and others 2018)	**CICES version 5.1** (Haines-Young and Potschin 2018)	**Relevant 25 YEP ambition** (HM Government 2018)
Thriving plants and wildlife	Maintenance of nursery populations and habitats (and other stages of life cycles)	Maintaining nursery populations and habitats (Including gene pool protection)	Thriving plants and wildlife
Pest and disease control	Pest and disease control	Pest control (including invasive species) Disease Control	Enhancing Biosecurity
Climate regulation	Global, regional & local climate regulation	Regulation of chemical composition of atmosphere and oceans	Mitigating and adapting to climate change
Cultural services	Cultural Ecosystem Services	All services within the Cultural (Biotic) section of CICES v5.1	Enhanced beauty, heritage and engagement with the natural environment

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