

Natural capital accounting 2020 roadmap

Interim review and forward look

March 2015



This report has benefited from the valuable contributions from colleagues from the Department for Environment, Food and Rural Affairs. ONS would like to thank them for their collaboration.

For information about the content of this publication, contact

Jawed Khan

Tel: 01633 456278

Email: ecosystem.accounting@ons.gsi.gov.uk

Contents

Abstract and key findings.....	4
1. Purpose and method of this Review	7
2. The Case for Natural Capital Accounting	8
3. Achievements and Progress	11
4. Key issues for the development of the accounts	13
5. Priorities for the next phase of the Roadmap.....	21
Annex 1 Proposals in the December 2012 Roadmap.....	27
Annex 2 Natural Capital Accounting Outputs, 2013-15	28
Annex 3 Overview of assets and services for initial habitat accounts	32
Annex 4 Selected methodological issues	33
Annex 5 Description of NEA Broad Habitats	35

Abstract and key findings

The strategic case for natural capital accounting remains strong ...

- GDP only tells us part of our economic story. Yet degradation of our natural resources and loss of the services nature provides to people and the economy can go unnoticed as they are not accounted for in the nation's balance sheet. The need to account properly for our natural assets is a major theme in the Natural Capital Committee's reports.
- There is strong international momentum to accounting. The UN endorsed Experimental Ecosystem Accounting guidelines in 2013. Accounting for natural capital is expected to figure widely in the UN Sustainable Development Goals and it continues to be promoted by the World Bank through its "WAVES" programme.
- There is growing business interest in accounting for natural capital at corporate level, and strong engagement in sub-regional multi-habitat accounts from protected area authorities e.g. National Parks.
- By helping to inform and improve decision-making, natural capital accounts can be used to get the best overall outcomes for society. Natural capital accounts can:
 - shine a light on the losses, gains and relative importance of services provided by natural assets
 - highlight links with economic activity and pressures on natural capital
 - inform priorities for resourcing and management decisions

... We have achieved a lot to date ...

- ✓ Initial, partial estimates of aggregate UK Natural Capital published in May 2014
- ✓ Initial UK land use, land cover, woodland and freshwater accounts
- ✓ Exploratory spatial accounts for woodland
- ✓ Dedicated web-pages created and a suite of ecosystem accounting principles published in August 2014
- ✓ Innovative institutional partnership between ONS, Defra and the Natural Capital Committee
- ✓ The UK is a leader in international discussions on developing natural capital accounts
- ✓ Initial accounts are already furnishing a range of insights about the value of and trends in natural capital (see Box 1 below)

... And some key challenges have been identified that will need addressing in the next phase

- Developing accounts that have early policy and practical application
- Understanding how accounts can inform sustainability
- Developing and refining accounting principles in the light of experience
- Medium-term planning for evidence and research to support the improvement and timeliness of the accounts
- Building analytical and institutional capacity for natural capital accounting
- Increased user engagement to ensure greater awareness and use of the accounts

By 2017 we aim to:

- ✓ Make broad but targeted progress within available resources and data
- ✓ Develop and improve the aggregate estimates of UK Natural Capital
- ✓ Develop initial accounts for a further 2-3 habitats and make substantive progress on accounts for the remaining habitats
- ✓ Compile robust cross-cutting accounts for recreational services and carbon
- ✓ Demonstrate proof of concept for multi-habitat accounts

A further review will be held at the end of 2017 in order to finalise priorities up to 2020. By 2020 we envisage the accounts moving beyond experimental status, to be part of the UK Environmental Accounts, and integrated as far as possible.

Box 1 Some key findings from the work to date

Whilst the numbers below are subject to change as methodologies are developed and data improves, they indicate the potential range of insights that the accounts can furnish:

- Even a partial and preliminary estimate of components of **UK natural capital** produces very substantial values. Expressed as an asset value over just 25 years, the ONS estimated these limited components at £1.6 trillion, a value broadly equivalent to the national financial debt of the UK (around £1.4 trillion) and also broadly equivalent to the annual value of economic output as expressed by GDP (£1.62 trillion in 2011).
- Whilst methodologies are still to be refined, **nature-based recreation** appears to produce very high values within the aggregate UK estimates; travel costs and the value of time together make up the overall “price” that visitors are willing to pay for the recreational service.

- The initial UK natural capital estimates show that **non-renewable assets** declined between 2007 and 2011 by 30% (mainly due to a fall in the monetary value of oil and gas reserves).
- **Woodlands** – the annual accounting value of carbon sequestration and recreation for GB woodland (£2.4 billion) in 2012 is 13 times greater than the annual value of biomass for timber. For GB woodland, recreational value alone is roughly double the value of carbon and biomass services. In contrast, accounting for the **Public Forest Estate** in England – of which 78% is conifer woodland – shows that recreation is relatively less important, with stock values broadly in line with carbon sequestration.
- Asset condition of woodland generally improved between 2004 and 2012, for example:
 - Woodland area increased by 1% during 2011;
 - Biomass stock is up 10% between 2005 and 2010, with timber resources increasing in value by £200m between 2011 and 2012;
 - Woodland wild birds biodiversity indicator increased by 6 percentage points between 2007 and 2011;
 - Accessibility of woodland (defined as % of the population with access to 20 hectares or more woodland within 4 kilometres) increased from 56% in 2004 to 65% in 2009.
 - Plant health indicators of condition are, however, yet to be developed.
- The partial asset value of UK **freshwaters** is estimated at nearly £40 billion in 2012, 10% higher than in 2008. This is mainly due to an increase in the asset value of water abstraction. Freshwater ecosystems provide a range of services, of which the most important (in terms of monetary value) are the provision of water for the Public Water Supply (£1.5bn value in 2012) and the use of the ecosystem for recreational purposes (£0.5bn in 2012). For both of these services, open waters are more relevant than wetlands.
- **Marine** – Carbon sequestration is dominated by the “North Sea Carbon Pump” which sequesters over 2 million tonnes of carbon annually (around 7mt CO₂e compared to 12.5mt CO₂e for GB woodland); UK saltmarsh annually sequesters another 67,000 tonnes of carbon (247,000 tonnes CO₂e). The annual accounting value of marine carbon sequestration is £490m, in addition to recreational values of £400m.
- **Peatland** – Scoping work has highlighted that the services of peatland depend closely upon its condition, which in turn depends upon its land use, and therefore cuts across other habitat accounts (e.g. wetlands, woodlands, agriculture).
- To be consistent with other accounts, the definition of the physical flows of ecosystem goods from **farmland** should largely be restricted to production of vegetation.
- **Land use and land cover** – urban land use increased by 5.4% between 2000 and 2010; semi-natural grassland increased by 4.8% between 1998 and 2007.

1. Purpose and method of this Review

In 2011 the Government committed to working with ONS to incorporate natural capital into the UK Environmental Accounts by 2020 so that the benefits of nature would be better recognised.¹ Following consultation, and in partnership with the Department for Environment, Food and Rural Affairs (Defra), ONS published a Natural Capital Accounting Roadmap in December 2012 (see [Annex 1](#)), setting out early priorities for scoping and developing various types of accounts.

This Review presents an introduction to natural capital accounting in the UK (section 2), assesses achievements in the two years since publication of the Roadmap (section 3), outlines various challenges (section 4) and sets out priorities for the next phase of the Roadmap (section 5).

This Review has been undertaken in close collaboration with Defra, with whom ONS have formed an innovative working partnership to take forward the Roadmap. It has been informed by:

- a systematic review of Roadmap outputs,
- experience and feedback from individual Roadmap workstreams,
- structured feedback from the Natural Capital Accounting Steering Group (which is chaired by ONS and includes members of the Natural Capital Committee),
- an external stakeholder survey,
- additional expert peer review on particular accounts provided by Michael Vardon of the Australian National University.

This report, and the achievements and priorities it documents, will be of interest to a variety of audiences, including Ministers and policy-makers, the Natural Capital Committee, external stakeholders, Environmental Audit Committee, HM Treasury as well as the wider community of interest and stakeholders in environmental accounting and natural capital.

¹ HMG White Paper, *The Natural Choice: securing the value of nature* (2011)

2. The Case for Natural Capital Accounting

The strategic case for natural capital accounting is strong. Our economy's GDP only tells part of our economic story. We need also to account nationally not just for market output, buildings and roads but also for our natural capital, the ecosystems,

green spaces and landscapes that provide us with a range of non-economic benefits. This includes changes to the value of the physical environmental assets, such as fish stocks and forests, and also to the value of services provided by healthy ecosystems, such as timber, carbon sequestration, pollination and recreation. In doing so, we can end the current situation where gains and losses in the value of natural capital go unrecorded and unnoticed, with the risk that natural capital is degraded over time leading to unwanted impacts on the benefits it provides to people.

"Fresh water, clean air, fertile soil, fish stocks and forests are all examples of the natural capital on which human wellbeing and economic prosperity depend. Yet these natural assets do not appear on traditional balance sheets and can therefore be invisible in decision-making. As a result, we are losing natural capital faster than ever before." [World Forum on Natural Capital](#)

In its assessment of "response options" for sustainably managing ecosystems and their services, the **UK National Ecosystem Assessment (NEA)** considered environmental accounting to be a "foundational activity" which helps to create an appropriate scientific and institutional context within which governments and others influence decisions affecting ecosystem management across society. In turn, accounting for natural capital can build on the ground-breaking work of the NEA, as well as on widespread progress in ecosystem service mapping and modelling.²

The **Natural Capital Committee** has expressed strong support for better accounting for natural assets, both nationally and at corporate level:

Accounting offers a means of organising, structuring and comparing information over time ... Structured information on economic activity has been a fundamental element in the management of economies over the past 70 years. By systematically documenting changes, accounts can provide important insights for prioritising investments to secure performance and can therefore be a useful management tool ... (Third State of Natural Capital Report, 2015 pp. 20-21)

² The Environmental Audit Committee also recently noted that "environmental protection requires natural capital to be fully taken into account in Government policy-making, both for existing and new policy programmes". Environmental Audit Committee, *An Environmental Scorecard*, Fifth Report of Session 2014/15 (September 2014)

There is strong international momentum to accounting. Better accounting for the natural environment is a global agenda to “move beyond GDP” in assessing material progress and prosperity for developing and developed economies, to include a greater focus on the natural, produced and human capital that underpins the wealth and welfare of nations (Box 2). A major milestone was the publication of the [UN System of Environmental-Economic Accounting – Experimental Ecosystem Accounting guidelines](#) (SEEA- EEA). Following a multi-year process of revision to the System of Environmental-Economic Accounting initiated by the United Nations Statistical Commission, the Commission endorsed Experimental Ecosystem Accounting as international guidance in February 2013, following a global consultation. This guidance has been a key influence on the UK Roadmap.

Box 2 Accounting for Natural Capital – a global agenda:

- In 2010 at Nagoya, 193 countries agreed to a strategic target to incorporate the values of biodiversity into national accounting and reporting systems by 2020. This followed the United Nations (UN) led study, *The Economics of Ecosystems and Biodiversity*, which called for national accounts to be upgraded to include the value of changes in natural capital stocks and ecosystem service flows.
- The World Bank, through its “[WAVES](#)” project, is assisting a number of partner countries, with UK support, to implement natural capital accounting. There are a growing number of experiments with ecosystem accounting in various countries.
- In 2012, the Rio+20 UN Conference on Sustainable Development recognised “the need for broader measures of progress to complement GDP in order to better inform policy decisions” and requested the UN Statistical Commission to convene “a programme of work in this area building on existing initiatives.”
- At that Conference, the UN published its first [Inclusive Wealth Report](#), showing broad measures of wealth for 20 countries based on estimates of their manufactured, human and natural capital (albeit limited aspects). A second report was launched in December 2014
- A UN High Level Panel co-chaired by the UK in 2013 included environmental accounting in a proposed suite of Sustainable Development Goals; following this, a [UN Working Group in 2014](#) proposed a target to integrate ecosystem and biodiversity values into accounts as part of the Sustainable Development Goal to protect, restore and promote sustainable use of ecosystems.

There has been growing interest in **natural capital accounting for business**, in particular from the Natural Capital Committee which has piloted corporate natural capital accounts; the Natural Capital Protocol published by the Natural Capital Coalition³; and the World

³ The [Natural Capital Coalition](#) is a global, multi stakeholder open source platform for supporting the development of methods for natural and social capital valuation in business. Its aim is to achieve a shift in corporate behaviour to preserve and enhance, rather than deplete the earth’s natural capital. It is made up of early adopters from the business, policy, accounting and NGO communities.

Forum on Natural Capital.⁴ There is strong interest in **sub-national multi-habitat accounts** from protected area authorities such as National Parks and Areas of Outstanding Natural Beauty, who see accounts as supporting management planning and discussions with Local Economic Partnerships and utilities about investments and funding strategies.⁵

Natural capital accounts provide a means of systematically assessing, recording and monitoring changes in the importance of natural assets and the way they provide us with material and non-material benefits (Box 3). Natural capital accounts can:

- shine a light on the losses, gains and relative importance of services provided by natural assets;
- highlight links with economic activity and pressures on natural capital;
- inform on the overall sustainability of economic growth;
- inform priorities for investment and management decisions for the natural environment.

Box 3 What are natural capital accounts?

Natural capital accounts as envisaged by the UN SEEA guidelines offer a coherent, comprehensive and consistent framework in which to organise and analyse statistical evidence from disparate sources. Through the adoption of standard accounting conventions, reconciliation of data discrepancies and identification of gaps, an accounting approach brings immediate benefits in terms of the organisation of this information, facilitating monitoring and international comparability, as well as providing a framework within which to build ongoing capacity and improvement. In particular, such accounts cover:

- changes in the extent condition and value of a range of natural **assets** and whole ecosystems
- the non-monetary flows of **services** provided by those assets now and in the future and, where appropriate and feasible, monetary values for these flows

In doing so, natural capital accounting goes beyond conventional accounting measures in two key ways:

- i) It accounts for a **wider range of outputs and services** than does GDP (although some benefits of ecosystems will be implicit in measures of GDP).
- ii) Whereas GDP accounts only for output and income, natural capital accounting includes **wealth-based measures that focus upon the assets** which underpin current and future services.

In the December 2012 Roadmap, ONS and Defra proposed to develop three types of natural capital accounts:

- i) Broad **aggregate estimates of UK natural capital** - estimates of asset value based upon the

⁴ <http://www.naturalcapitalforum.com/about>

⁵ This project is being run by Defra as part of the Roadmap programme of work.

current and expected future flows of resource extraction and services, including non-market services such as carbon sequestration and recreation.

- ii) More detailed **habitat-based ecosystem accounts** (e.g. woodland, freshwater) based on UK NEA classification (see Annex 5)
- iii) **Cross-cutting or enabling accounts** for key natural assets such as land, carbon and water that feed into the habitat and aggregate accounts.

3. Achievements and Progress

The UK is one of the first countries to apply the UN SEEA Ecosystem Accounting guidance to its domestic context, and along with other trailblazers such as Canada and Australia is one of the first countries systematically to address the need to develop ecosystem accounts. In particular, we have:

- moved from abstract general principles for natural capital accounting (UN SEEA) to a more specific, tangible set of **principles** (published in July 2014) around what accounts should be about and look like;
- led **international discussion** on aspects of ecosystem accounting through the annual UN SEEA London Group and an international Seminar on valuation aspects. In November 2013, ONS and Defra convened a seminar of UK and international experts to discuss a range of issue papers on valuation and thrash out a number of methodological challenges (for example, on valuation methods, choice of discount rate, prioritisation criteria).
- published **initial aggregate natural capital estimates** in May 2014 which have helped to raise the profile of natural capital accounting. As of December 2014, the web-page for this work received over 2000 hits.
- produced initial **woodlands and freshwater ecosystem asset and services accounts**, with additional investigation into accounts for peatlands, marine ecosystems and spatially disaggregated accounts for woodlands;
- published initial **UK land cover** and **UK land use** accounts;
- developed a dedicated **web-page on the ONS website on Natural Capital Accounting**;
- fostered strong **partnership working** between ONS, Defra and the Natural Capital Committee, through a high-level Steering Group and Project Board. This has strengthened the institutional links between accounting expertise, ecosystems expertise

and policy relevance. Other organisations such as Forestry Commission and the Scottish Government have been closely engaged on particular workstreams.

- created strong interest in ecosystem accounting amongst many **National Parks and AONB authorities** through research to pilot multi-habitat accounts at this sub-national level.

As one of the leaders in this agenda, we are finding that we are learning by developing a significant range of accounts in parallel, which was one of the assumptions behind the Roadmap plan. We are getting a clearer sense of what the accounts should look like, what they should cover and how they should be compiled. [Annex 2](#) details the particular outputs produced in the last two years. Even at this early developmental and scoping stage, these experimental accounts are furnishing a number of insights (Box 4).

Through this progress, the UK has become recognised as an international leader in natural capital accounting by the UN Statistical Commission, World Bank and independent experts. The fact that ONS is giving significant attention to natural capital accounting, and is collaborating with Defra, is regarded by international and domestic stakeholders as an important signal of the UK Government’s commitment to this agenda.

Box 4 Some key findings from the work to date

Whilst the numbers below are subject to change as methodologies are developed and data improves, they indicate the potential range of insights that the accounts can furnish:

- Even a partial and preliminary estimate of components of **UK natural capital** produces very substantial values. Expressed as an asset value over just 25 years, ONS estimated these limited components at £1.6 trillion, a value broadly equivalent to the national financial debt of the UK (around £1.4 trillion) and also broadly equivalent to the annual value of economic output as expressed by GDP (£1.62 trillion in 2011).
- Whilst methodologies are still to be refined, **nature-based recreation** appears to produce very high values within the aggregate UK estimates; travel costs and the value of time together make up the overall “price” that visitors are willing to pay for the recreational service.
- The initial UK natural capital estimates show that **non-renewable assets** declined between 2007 and 2011 by 30% (mainly due to a fall in the monetary value of oil and gas reserves).
- **Woodlands** – the annual accounting value of carbon sequestration and recreation for GB woodland (£2.4 billion) in 2012 is 13 times greater than the annual value of biomass for timber. For GB woodland, recreational value alone is roughly double the value of carbon and biomass services. In contrast, accounting for the **Public Forest Estate** in England – of which 78% is conifer woodland – shows that recreation is relatively less important, with stock values broadly in line with carbon sequestration.

- Asset condition of woodland generally improved between 2004 and 2012, for example:
 - Woodland area increased by 1% during 2011;
 - Biomass stock is up 10% between 2005 and 2010, with timber resources increasing in value by £200m between 2011 and 2012;
 - Woodland wild birds biodiversity indicator increased by 6 percentage points between 2007 and 2011;
 - Accessibility of woodland (defined as % of the population with access to 20 hectares or more woodland within 4 kilometres) increased from 56% in 2004 to 65% in 2009.
 - Plant health indicators of condition are, however, yet to be developed.

- The partial asset value of UK **freshwaters** is estimated at nearly £40 billion in 2012, 10% higher than in 2008. This is mainly due to an increase in the asset value of water abstraction. Freshwater ecosystems provide a range of services, of which the most important (in terms of monetary value) are the provision of water for the Public Water Supply (£1.5bn value in 2012) and the use of the ecosystem for recreational purposes (£0.5bn in 2012). For both of these services, open waters are more relevant than wetlands.

- **Marine** – Carbon sequestration is dominated by the “North Sea Carbon Pump” which sequesters over 2 million tonnes of carbon annually (around 7mt CO₂e compared to 12.5mt CO₂e for GB woodland); UK saltmarsh annually sequesters another 67,000 tonnes of carbon (247,000 tonnes CO₂e). The annual accounting value of marine carbon sequestration is £490m, in addition to recreational values of £400m.

- **Peatland** – Scoping work has highlighted that the services of peatland depend closely upon its condition, which in turn depends upon its land use, and therefore cuts across other habitat accounts (e.g. wetlands, woodlands, agriculture).

- To be consistent with other accounts, the definition of the physical flows of ecosystem goods from **farmland** should largely be restricted to production of vegetation.

- **Land use and land cover** – urban land use increased by 5.4% between 2000 and 2010; semi-natural grassland increased by 4.8% between 1998 and 2007.

4. Key issues for the development of the accounts

Applying conceptual accounting frameworks within existing data constraints and in a practical and value-added way that is consistent with scientific and economic principles is a considerable task. As well as substantive progress in developing principles and nascent accounts, a number of practical and conceptual themes and challenges have emerged that

we are starting to address. These will become increasingly important in the next phase of the Roadmap.

4.1 Identifying policy and practical application

Whilst there is general agreement of the need to develop natural capital accounts and the long-term nature of this investment (as with the standard System of National Accounts), there is also a clear desire within ONS, Defra, the Natural Capital Committee, and among stakeholders, for early practical application (see Box 5).⁶ A number of generic issues need addressing if natural capital accounts are to be policy relevant:

- Producing a reasonable time series which can highlight changes and trends;
- Assessment of stocks (assets) as well as flows (services) so that accounts shed light on sustainability considerations (see section 4);
- Data limitations and methodological approaches need to be clearly understood so that they are not misinterpreted;
- Accounts and the underlying data need to reflect changes in resource management, ecosystem condition and service delivery in a timely way;
- Spatial accounts need to build on existing forms of ecosystem service mapping.
- To what extent it is practical to include restoration or maintenance cost information into the accounting framework.

Broadly speaking, natural capital accounts can inform decision-making in three different ways:

- i) The link with the System of National Accounts (SNA) and satellite accounts will provide the connection with other national level sources of data on economic activities, their use of natural resources and the pressures they put on the environment.
- ii) The development of spatially disaggregated accounts will enable the relationship between the natural asset and the delivery of ecosystem services to be better understood, and so inform resource and land management planning. Three promising areas for this application are **woodland, protected landscape areas** and **peatland**.
- iii) The development of a full suite of habitat and cross-cutting accounts will throw light on the relationships between different ecosystems and their capacity to deliver ecosystem services.

⁶ At the same time there is a need to demonstrate the added value of accounts to those familiar with existing datasets which are part of the existing evidence base for decision-making at various levels.

Box 5 The Natural Capital Committee on the role of Natural Capital Accounting

In its Third “State of Natural Capital Report” to the Cabinet Economic Affairs Committee, the Natural Capital Committee (NCC) provides strong support for the ONS–Defra partnership and assesses the role and scope of natural capital accounting:

- Accounting frameworks cannot just focus on recording changes in service flows, but must also record changes in the underpinning assets (or stocks) from which services are derived.
- Regularly updated natural capital accounts will mean that the state of the nation’s natural assets “can be monitored over time and appropriate action taken where worrying trends develop.”
- The NCC endorses the twin-track approach of the Roadmap: firstly, aggregate wealth accounts of the kind illustrated by the UK Natural Capital Estimates published in May 2014; secondly, detailed habitat-based accounts, which in time would allow refinements to the aggregate accounts.
- Ad hoc indicators and one-off accounting exercises and studies on popular themes are no substitute for proper accounting: “what is needed is a more substantial commitment to monitor, evaluate and respond to trends ... through investment in structured and comprehensive information sets encompassing the economy and natural capital”
- “Any reduction in the value of natural capital over time, as recorded in the accounts, can be seen as giving rise to a corresponding requirement for a capital maintenance provision ... to keep an asset or capital item intact through time.” Explicit accounting for such depreciation “will help to ensure that such investments actually happen in practice”.
- Development of national natural capital accounts should proceed in tandem with wider adoption and uptake of the corporate natural capital accounting framework pioneered by the NCC.

4.2 Understanding sustainability

The accounts can potentially shed light on the sustainable use of natural capital in a number of ways:

- Developing an overall indicator of sustainability
- Accounting for the extent and condition of assets as well as for flows of services,
- Providing information on both the physical and monetary assets and services. For example, the aggregate UK natural capital estimates are essentially monetary valuations – attention can easily focus on monetary aspects whilst overlooking the underlying physical trends. Fully developed accounts allow users to drill down from high level indicators to understand their component elements and also to link to the drivers of change.

- Spatially disaggregated accounts can uncover gains and losses to specific assets or within specific regions that are hidden by aggregate or average national accounts.
- Accounting for ecosystem services in the round, both across and within broad habitats (e.g. forestry ecosystems cannot be considered simply as a timber asset, as there could be trade-offs with recreational services).

Initial work on accounts has uncovered a number of related issues involved in understanding sustainability:

- Being clear about the definition or concept of sustainability that is used and how this relates to trends, values and relationships identified within the accounts.⁷
- We need to identify and close gaps in scientific understanding over ecosystem functioning, in particular in relation to the possibility of non-linear thresholds, and the relationship with service provision. Principles for the treatment of potential environmental limits and thresholds are yet to be established. The position taken in the SEEA (para 4.35) is that it does not fit well within a model based on assessment of change over successive accounting periods (see next bullet).
- The accounts do not adopt an historic reference condition by which to compare with current values, as this is not considered meaningful in a UK context. Using the previous period as the reference condition has limitations in terms of assessing whether any reduction in stock is at such a level as to cross environmental thresholds and limits. Incorporating limits and thresholds (which may include concepts of social acceptability) would require an extension to the accounts.
- Uncertainty over the sustainability of future flows of “provisioning services” (such as crops, timber, fuel, water), and what the potential future values of assets might be (e.g. fifty years ago, carbon sequestration was not considered to be a benefit from woodland).

Further work will be needed to assess how sustainability considerations can effectively be incorporated into the development of the accounts.

⁷ C. Obst and M. Vardon, “Recording environmental assets in the national accounts”, *Oxford Review of Economic Policy* (2014) note that assessment of sustainability will depend upon judgements “about which assets are relatively more important or critical, the level of risk that a society is willing to accept, and the time frames over which sustainability is being assessed”, p. 133. The authors were contributors to the SEEA-Experimental Ecosystem Accounting guidelines.

4.3 Addressing methodological issues

The Roadmap is about learning-by-doing. The starting point is the SEEA Experimental Ecosystem Accounting (SEEA –EEA) international guidelines. A number of areas within the guidelines are still under development or are part of a future international research agenda. To overcome the challenge of applying SEEA-EEA guidelines in a consistent way among various ecosystem accounts, ONS and Defra have:

- published in July 2014 a **Statement of methodological principles** to inform development of the various habitat-based accounts. These principles will be revised and updated in the light of ongoing learning and experience with the accounts.
- developed a detailed **Log of methodological issues** structured according to SEEA-EEA. This is regularly updated as we build experience with individual workstreams.

Some methodological issues are particularly notable:

- Integrating bottom-up, spatially disaggregated accounting approaches with aggregate, national approaches; so that, for example different habitat accounts can be combined in a consistent, additive way. This is a challenge partly because many sources of data are geared to land-use rather than based on consistent land cover definitions and partly owing to other data difficulties.
- The accounts need to apply accounting valuation principles in a consistent and intuitive way, whilst recognising data limitations. One key issue that we have explored with a range of international experts is the extent to which monetary accounts can apply the SEEA-EEA principle that monetised values must be conceptually equivalent to those for market goods in standard national accounts i.e. $\text{value} = \text{price} \times \text{quantity}$. By contrast, most of the environmental valuation literature is based on appraisal values of changes in economic welfare (i.e. the overall value of a shift in the demand curve from an environmental change). Exchange values will typically be lower than welfare values.⁸

A range of other ongoing cross-cutting issues that are captured in the Issues Log are summarised in Table 1 below and detailed in Annex 4. Some of these are part of a longer-term international research agenda, through which we can contribute our own thinking and experience. As our experience grows and these issues are better understood and addressed, the statement of principles will be updated, with the next update in summer 2015.

⁸ See proceedings of the international expert Valuation for Accounting Seminar convened by ONS and Defra and held in London in November 2013 . This remains an ongoing challenge as we work on various accounts.

Table 1 Selected summary of methodological issues

<p>Basic ecosystem accounting principles (SEEA-EEA Ch. 2)</p> <ul style="list-style-type: none"> • Role of spatial accounting • Accounting for land use change between habitats • Prioritising ecosystem services for inclusion • Representing uncertainty within accounts 	<p>Physical accounting for ecosystem assets (SEEA-EEA Ch. 4)</p> <ul style="list-style-type: none"> • Consistency of asset characteristics • Accounting for biodiversity and resilience • Consistent treatment of carbon storage • Accounting for connectivity / linear features
<p>Physical accounting for ecosystem services (SEEA-EEA Ch. 3)</p> <ul style="list-style-type: none"> • Disentangling service provision from human input • Distinguishing service capacity from use • Negative service flows between ecosystems • Identifying counterfactual for regulating services 	<p>Monetary accounting for ecosystem services and assets (SEEA-EEA Ch. 5 and Ch. 6)</p> <ul style="list-style-type: none"> • Standardise time period for asset valuation • Dealing with uncertainty in valuation • Appropriate values for carbon • Projecting prices for future service values

4.4 Evidence and research needs

Early experience has made clear the range of data gaps and challenges, both biophysical and economic, in implementing SEEA-EEA. For example:

- Lack of up-to-date comprehensive land cover (and ideally condition) mapping. The [Countryside Survey](#) is the best data source to compile land cover accounts but there is uncertainty as to whether it will be conducted again in its same format (ONS Land Cover Account discusses this in more detail).
- In many cases, the fundamental challenge understands how final ecosystem goods and services are functionally related to the ecosystem assets; this will be clearer in some cases (e.g. timber production) than others (e.g. marine recreation services). Careful review of scientific literature may be needed in order to establish appropriate coefficients, for example how carbon emissions / sequestration varies according to the condition of peatland.

- Available data may not be at a sufficient spatial resolution to measure actual ecosystem services. For example, the links between woodland and flood risk alleviation are subject to ongoing research; and for woodland outside the Public Forest Estate, it is not possible as yet to map in sufficient detail the characteristics that have been identified as important in determining the value of recreation.
- Time series data are critical in order to identify trends, and requires several data points. However, different data sources cover different time periods, which can lead to inconsistencies between accounts (e.g. land use and land cover data do not have the same data points for comparison)

Box 6 Ecosystem modelling (for example, using models such as LUCI, TIM, InVEST, ARIES) can in principle be used to fill biophysical data gaps that are too expensive or impractical to fill empirically (for example, woodland’s contribution to water services).⁹ On the other hand, models themselves are often only as good as the underlying data, and no model has been specifically developed with accounts in mind. This issue will be further explored in the next phase.

Annex 3 provides an overview for each of the habitat accounts of the services covered by the work to date and the range of asset condition characteristics identified. This helps to clarify research and evidence priorities. A coherent medium-term strategy will be needed to identify how individual habitat and the wider cross-cutting accounts can be robustly populated. It will involve:

- identifying how existing research programmes (e.g. such as the Natural Environment Research Council’s Valuing Nature Programme) can help to meet accounting data needs;
- mainstreaming data collection for accounting purposes;
- taking an overview of the recommendations for priorities identified in the scoping studies and ensuring a co-ordinated approach to development;
- exploring the role of ecosystem modelling (see Box 6) in developing spatially disaggregated accounts and in linking ecosystem condition, functioning and flows;
- comprehensive land cover mapping;
- making relevant links where appropriate with the NCC’s [“asset risk register”](#).

⁹ See for example, Eftec, *Developing UK Natural Capital Accounts: Woodland Accounts* (March 2015), Annex 4: Review of ecosystem service models.

4.5 Building capacity for natural capital accounting

Ecosystem accounting is an infant discipline. Scoping and developing accounts is time-consuming, conceptually demanding and can require deep knowledge across a range of disciplines, bringing together ecological, accounting and valuation expertise. So there is a need to develop and build capacity on natural capital accounting expertise both inside and outside Government. In-house development of accounts (and logging of methodological issues) builds institutional capacity and ensures consistency with SEEA guidelines; it can also be easier to be flexible, given the innovative and uncertain nature and scope of accounts. External commissioning of scoping studies and initial accounts enables us to tap into specialist knowledge and data (e.g. on marine and peatland); it has also helped to broaden awareness and expertise of ecosystem accounting principles beyond ONS and Defra. On the other hand, there may be disadvantages in becoming dependent upon externally developed systems; data sourced outside the Government Statistical Service requires contractors to meet the standards of the UK Statistics Code of Practice.

Capacity-building for ecosystem accounting is recognised by the international accounting community as a general issue and was the subject of a number of papers at the [2014 United Nations London Group Meeting on Environmental Accounting](#).

4.6 Communication and engagement

The first phase of the Roadmap has necessarily involved significant internal conceptual and technical deliberation. In the next phase of the Roadmap, there will be a greater need for engagement with the wider community of interest in accounting, based on the emerging outputs. This Review and Forward Look marks the start of this new phase of engagement.

Whilst there are good links at official level with the international community, knowledge of the work *outside* of this accounting community is limited and potentially misunderstood. A clear communications strategy to raise awareness and to manage expectations of what is still experimental work will be needed as part of project governance. We are exploring a number of avenues:

- **Newsletters** (similar to, but less frequent than, the [WAVES newsletter](#)) would enable interested experts and stakeholders and a wider audience to keep up to date with outputs, applications, issues and events. The aggregate **UK natural capital estimates** provide the best opportunity to engage a broad audience on this agenda.
- **Introductory non-technical guides** to ecosystem accounting principles;
- **Workshops** on specific issues or a conference to demonstrate broad progress and gain consensus on wider issues

- **Website** - Reviewing the structure and content of the ONS Natural Capital web-page to ensure it meets user needs and maximises its profile; identifying creative forms of presentation (infographics) to help a wider audience understand principles and insights; and consider using **social media** for dissemination.
- Continuing to **engage internationally** – for example, the UK chaired a full day session on ecosystem accounting at the 2014 UN London Group on Environmental Accounting.
- Convening a **dedicated advisory group** to provide feedback on accounts as they are developed.

5. Priorities for the next phase of the Roadmap

Section 3 and Annex 2 show that we are developing a range of initial accounts. Given limited resources, we intend to adopt a balanced strategy of making broad progress across a wide range of accounts, whilst at the same time focusing particular development effort on a few key accounts where the policy interest is likely to be greatest and real progress can be made. In addition, the aggregate UK natural capital estimates will be refined and can provide a “quick overview” of natural capital. The ultimate goal by 2020 is to move these accounts beyond experimental status to be mainstreamed as part of the UK Environmental Accounts and integrated as far as possible. The degree of progress is expected to vary between accounts depending upon relative data and methodological challenges, and we will need to be flexible to optimise progress as new issues, data and policy opportunities emerge. This section indicates the expected direction of travel, based on what has been accomplished so far and the challenges identified in section 4.

Developing the aggregate UK wealth estimates

Reflecting the advice of the NCC and the large number of website hits, a clear priority is to develop, refine and extend the aggregate UK natural capital estimates that ONS first published in May 2014. Over the next 2-3 years, this will involve:

- resolving specific issues arising from the first estimates (for example, asset life) and methodological issues for individual components such as fisheries, water and recreation;
- including additional ecosystem services arising from natural capital in the estimates, and identifying potential links with other forms of capital (for example, the value of nature implicit in the UK housing stock as identified by the NCC report);
- exploring the issues of substitutability and sustainability, with a view to developing a particular [sustainability indicator](#);

- exploring how the natural capital accounts might be combined with other wealth accounts such as human and physical capital.

Progressing detailed ecosystem accounts

Table 2 sets out a brief assessment of priorities across the habitat and cross-cutting accounts:

Table 2 Assessment of priorities for broad habitat and cross-cutting accounts

Cross-cutting / enabling accounts	
Land cover and Land use	Land cover should be the primary underlying account which supports and draws the other habitat accounts together. We can then see how the measures of the extent of different habitats relate to each other. Links with the land use accounts will need to be established. Future work should investigate the possibility of using data from the next Land Cover Maps.
Nature-based recreation	Work on a cross-cutting recreation account will be important for the development of the aggregate UK estimates (the initial account of outdoor recreation generated very substantial values for recreation) and will also ensure that the values included in different broad habitat accounts are mutually consistent. Large recreational values highlight the importance of our natural capital, so making these conceptually robust and consistent is a critical priority.
Water services	Understanding how the flow and quality of water is managed within the environment is fundamental to the process of capturing the value of the services (e.g. water supply, water filtration, flood alleviation) provided by ecosystems within the accounts. Accounting properly for water flows is also high on the EU agenda and might be part of European regulations on environmental accounts in the near future. However, producing such accounts will depend upon modelling and further scoping. It should draw upon further development of the freshwater habitat accounts.
Ecosystem carbon	Original Roadmap commitment, reflecting the need for a consistent view of carbon stocks and flows – initial accounts are currently being scoped and will be an early priority in the next phase.
Biodiversity	Biodiversity should be a key indicator of the health of the ecosystem and hence the need to establish coherent metrics to capture its role in providing benefits to society. A cross-cutting priority would be a better representation of the role of biodiversity in natural capital accounts. This would critically rely on further investment to improve our understanding of the links between biodiversity, ecosystem functioning and ecosystem services.
Soil	As with biodiversity, this is a critical element of natural capital but has data and methodological challenges and will require significant amount of scoping in the first instance. There are links with carbon accounts and peatland soils are potentially covered separately.

Broad habitat accounts	
Woodland	Original Roadmap commitment – work will be ongoing to consolidate and update the initial accounts published in 2015, focusing effort on where policy relevance is likely to be greatest. Work on recreation and water accounts will also feed in to the woodland account.
Farmland	Original Roadmap commitment – work ongoing and is an early priority for the next phase. Data is good on the production of crops and other biomass but there are challenges in presenting a balanced account of the benefits from farmland and the negative impacts of farming activities on other ecosystem services.
Freshwater	Original Roadmap commitment – initial accounts published on 20 March 2015 will need to be reviewed for further development.
Urban	In terms of recreation services, amenity and health and well-being benefits, urban green spaces are likely to be an important component of our natural capital. Urban accounting is likely to introduce new data challenges and could also provide some quite significant values so it needs early scoping. Over time, urban accounting for nature could evolve in two different ways (i) target certain urban areas (as with protected area accounts); (ii) provide high-level trends and accounts for urban areas across the UK.
Protected areas	Piloting work in progress with 3 National Parks and an AONB in England, and 2 Land Use Strategy pilot areas in Scotland.
Semi-natural grassland	Should be an important habitat for pollinators – there is a broader question about developing an asset-specific account for pollinators which could link to implementation of Defra’s Pollinators Strategy.
Peatlands	This habitat cuts across other habitats (e.g. freshwaters, farmland, moorland). Strong policy relevance, links with Peatland Code and potential to be developed within UK bid for EU LIFE Integrated Project for peatland.
Coastal and marine	In view of the challenges identified by the scoping study, detailed marine accounts are a low priority. But coastal areas are subject to development and visitor pressures and have strong links with recreation, tourism, cultural services and marine habitats.
Mountains, moorland and heath	This habitat will partly overlap with the peatland scoping study, freshwater and protected areas accounts, so could potentially follow development of those accounts. It would also be relevant in terms of water-related ecosystem services.

What is feasible?

Table 3 indicates in broad terms what we are aiming to achieve in the near and longer terms. This reflects review feedback, the potential relevance of specific accounts, and the findings from initial studies (Box 4).

Table 3 Potential future progress on natural capital accounts

	By 2017 	By 2020
Aggregate accounts	<p>Improved and higher profile aggregate estimates with increased coverage, based on a wider range of services; perhaps linking this with other capitals to develop UK's first wealth accounts.</p> <p>A further update will be provided with the next revised set of UK natural capital estimates.</p>	<p>A credible series of high-profile aggregate estimates broadly consistent with the individual habitat accounts with reasonable confidence in trends; plus possible links with other capitals as part of wealth accounts.</p> <p>Integration with National Accounts</p> <p>Aggregate sustainability indicator developed</p>
Habitat accounts	<p>Demonstrable progress on 3 accounts (woodland, farmland, freshwater) with some degree of spatial disaggregation where data allows.</p> <p>Preparatory work for urban, coastal, semi natural grassland and moorland; with initial accounts produced for 3 of these.</p> <p>A number of credible pilot accounts for multi-habitat (protected) areas</p>	<p>Substantive initial accounts for all broad habitats excluding urban and marine. Of these, 3 or 4 comprehensive accounts with reasonable time series. In addition, wider uptake of protected area and urban accounts; (protected areas and peatland accounts could underpin development of mountain / moor / heathland accounts)</p>
Cross-cutting accounts	<p>Improved Land-use and land cover accounts</p> <p>Completion of recreation account</p> <p>Scoping work on biodiversity and soil accounting.</p> <p>Put in place the processes needed to use relevant models to provide estimates of services relating to water</p>	<p>Robust carbon, water and recreation accounts</p> <p>Pollinators account</p> <p>Detailed representation of biodiversity in accounts.</p> <p>Some accounts ideally supplemented with maintenance cost information.</p>

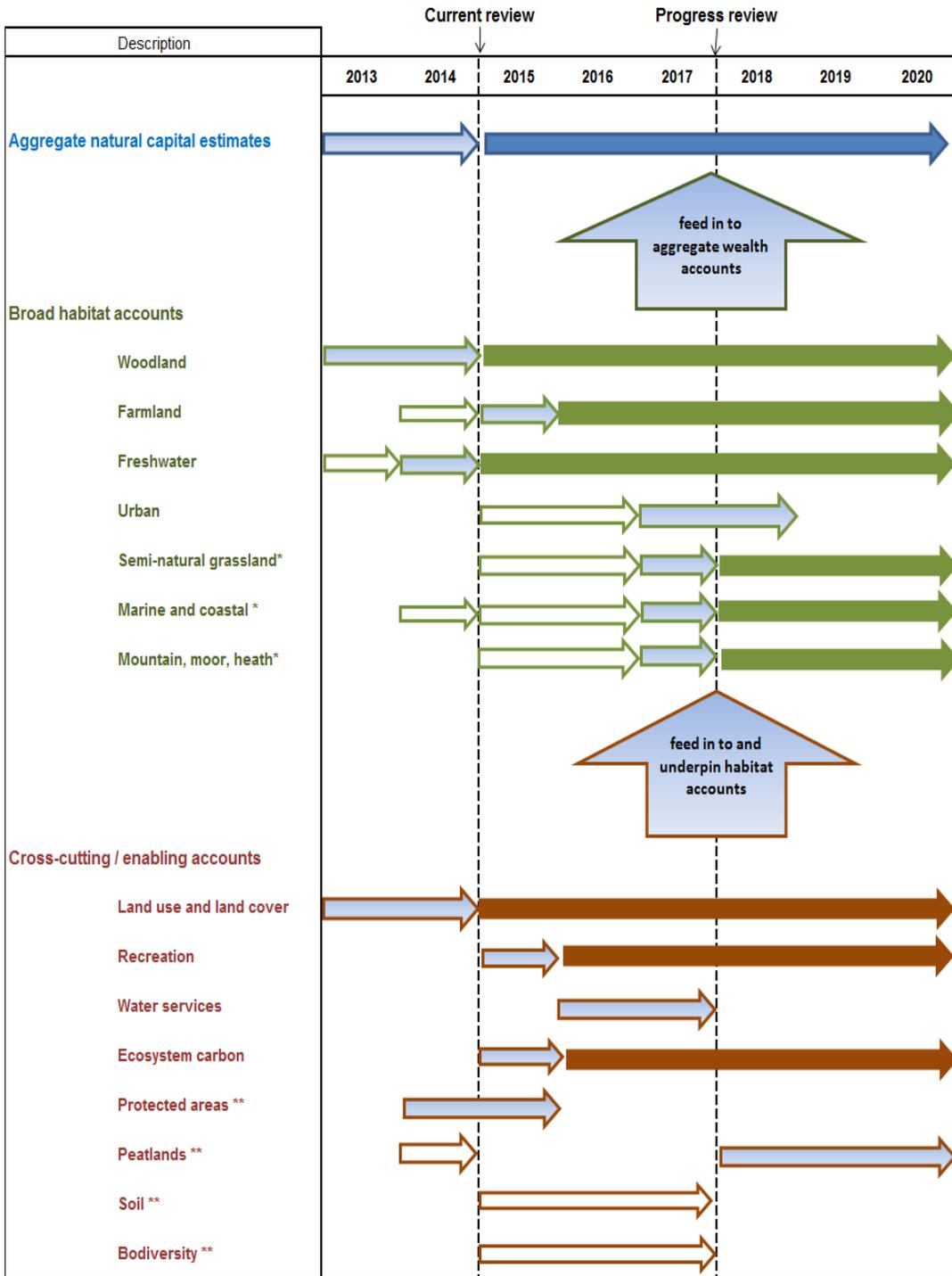
Further pre-scoping work may be required related to policy relevance and feasibility before further development work is commenced, and some flexibility will be needed as data sources, potential policy applications and funding opportunities evolve. The opportunities set out in Table 3 are summarised more formally as a GANNT chart (Figure 1). Because of the need for flexibility, **Figure 1 should be considered indicative of the nature of the progress we expect to make.** The chart indicates the different stages of developing

accounts (scoping, initial, improvement) and notes where progress is conditional on priorities and additional resources. It also highlights the importance of the range of cross-cutting accounts which ultimately need to tie in with and inform the detailed habitat accounts. In principle, these in turn should underpin the development of the aggregate natural capital accounts.

A further review will be held by the end of 2017 to take stock of progress.

Figure 1 Indicative progression of work, Natural Capital Accounting Roadmap 2015-20

Natural Capital Accounting Roadmap - phase 2



- Scoping
- Initial accounts
- Improvement and gap filling

* With current resources, we expect two of these three habitats to have initial accounts developed by 2017

** Further progress beyond 2015/17 subject to additional resources

Annex 1 Proposals in the December 2012 Roadmap

2013 to 2015

Aggregate UK Natural Capital estimates (so-called “Top down” accounts)

Improvement of natural capital aggregate estimates within the framework of comprehensive wealth accounts, in order to provide an immediate overview of the value of natural capital within the UK

Enabling/cross-cutting accounts

Land Use/Land Cover accounts: these provide the basic framework for the development of accounts relating to specific habitats

Cross-cutting carbon account, enabling changes in the UK stocks of carbon to be monitored over time

Habitat-based accounts

Woodlands - these accounts will be needed to inform the balance sheets not only of the Public Forest Estate but also private forestry

Enclosed farmland accounts, which will help us to value the flows of ecosystem services which farmland provides

An account for wetlands ecosystems, which, as the National Ecosystem Assessment (NEA) showed, have experienced a deterioration in the three highly important ecosystem services

Initial accounts for the marine environment, in order to address some of the more difficult conceptual and data challenges of developing these types of accounts

The habitat-based accounts will be exploratory in the first instance and focus on getting the physical aspects right to start with, supplemented by monetary entries where available. The Office for National Statistics (ONS) will publish these accounts at an early stage as we go along and will continue to work collaboratively with users in their development.

Annex 2 Natural Capital Accounting Outputs, 2013-15

Outputs and description	Type of output	Completion (* =published here)	Lead organisation
Aggregate natural capital accounts			
<p>Monetary valuation of UK timber resources</p> <p>This output estimates the monetary value of UK timber resources for 2011 and 2012. Using the Net Present Value method and taking different age classes of timber resources into account, this paper develops the first experimental estimates of UK timber resources.</p>	Initial accounts (balance sheet)	June 2013*	ONS
<p>Monetary valuation of UK Continental oil and gas reserves</p> <p>Using the Net Present Value method and taking different asset lives of the reserves into account, this paper presents the monetary asset account (balance sheet) for the UK Continental Shelf oil & gas reserves for 2011. The monetary value of UK Continental Shelf oil & gas reserves at 31 December 2011 was estimated to be £120 billion. This was £11 billion lower than the estimated value of the reserves at 31 December 2010. This paper also provides the methodology and the assumptions used to estimate the value of UK oil & gas reserves and compares these estimates with the previous estimates published by ONS in 2012 (using a different methodology).</p>	Balance sheet	June 2013*	ONS
<p>Initial and partial monetary estimates of UK Natural Capital</p> <p>This output is the first attempt by ONS to estimate a monetary value for components (energy and mineral reserves, farmland, timber, water, fisheries, outdoor recreation and net greenhouse gas sequestration) of UK natural capital for the period of 2007 to 2011. The ONS paper was a first attempt by a National Statistical Institute to value non-market ecosystem services. The paper was published in May 2014 and from May to December 2014, it received more than 2000 hits.</p> <p>These initial natural capital estimates were developed by including all the components of natural capital included in the wealth accounts developed by World Bank (2011) and Inclusive Wealth Report (2012): Agricultural land; Timber; Non-timber forest resources; Protected areas; Energy resources; Minerals (limited). ONS not only improved these estimates by refining the methodology and using better data sources, but also included additional components –</p>	Initial natural capital estimates at aggregate level	May 2014*	ONS

minerals, fisheries and water - which were missing from these reports. ONS also went one step further by including two non-provisioning ecosystem services - outdoor recreation and net greenhouse gas sequestration - in these initial estimates. The paper emphasises that the methodology to develop these estimates remains under development and further work will be undertaken to develop and improve them.				
Broad habitat-based ecosystem accounts				
Woodland	Measuring UK woodland area and timber resources This paper develops the initial physical asset accounts for UK woodland area and timber resources for 2011-12. These accounts were developed in accordance with the System of Environmental Economic Accounting (SEEA) Central Framework, while showing some flexibility in its implementation due to UK specific context and needs.	Initial accounts	June 2013*	ONS
	Measuring UK woodland ecosystem assets and ecosystem services In 2013 ONS developed some initial accounts on UK woodland ecosystem assets and ecosystem services, based on a flexible implementation of SEEA Experimental Ecosystem Accounting guidelines, reflecting the UK specific context. Following this, a spatially disaggregated accounting approach was explored for woodland by research for Defra, which includes specific accounts for the Public Forest Estate in England. Further work is underway to synthesise the high level and spatially disaggregated accounts into a single set of woodland accounts	Initial accounts	June 2013* March 2015*	ONS; Commissioned by Defra from Eftec
Farmland	Scoping work on ecosystem accounting framework for farmland An internal pre-scoping paper reviews a number of issues relating to the compilation of ecosystems accounts for enclosed farmland. The two main issues considered are the nature of the services that the ecosystem provides (as distinct from the final good or benefit) and the most appropriate way to define extent, given the nature of the available data on use, cover, extent and services.	Scoping	In progress	Defra
Freshwater	Freshwater ecosystem accounts – Introducing wetlands and open water ecosystems into UK natural capital This paper develops the Initial freshwater ecosystem accounts following a scoping study on developing wetland, open-water and floodplain ecosystem accounts.	Initial accounts	March 2015*	ONS

	In May 2014, ONS completed an internal scoping study for developing UK freshwater ecosystem accounts. It included the development of wetlands and open water ecosystem accounts. As part of the initial freshwater accounts, a link with peatland accounts was explored. A scoping study for developing peatland ecosystem accounts (see below)			
Marine	Scoping study on marine ecosystem accounts Original Roadmap aimed to develop by 2015 initial accounts of flows of services in monetary terms; and to explore the feasibility of developing stock accounts.	Scoping study	March 2015*	Commissioned by Defra from Eftec
Peatlands	Peatlands ecosystem accounting scoping study This scoping study assesses the potential for peatland ecosystem account (which cuts across other broad habitats) and sets out short and longer term priorities and data needs for developing an account.	Scoping study	March 2015*	Commissioned by Defra from Carbon Crichton Centre and Eftec
Cross-cutting natural capital accounts				
Land use in the UK This output is the first experimental physical asset accounts for UK Land Use for 2000-2010 to help to monitor the changes to the breakdown of UK land use. These accounts were developed in accordance with the SEEA Central Framework, while showing some flexibility in its implementation for UK specific context. The land use accounts also discuss issues in implementing SEEA and provide suggestions on improving these accounts over time.		Initial accounts	June 2013*	ONS
Land cover ecosystem accounts This paper develops the Initial land cover ecosystem accounts for 1998-2007 following a scoping study on developing these accounts.		Initial accounts	March 2015*	ONS
Pilot multi – habitat accounts for selected protected landscape areas This research aims to scope and pilot ecosystem accounts for a suite of pilot landscape areas across Great Britain; these areas feature multiple habitats which produce a range of services. It builds on existing ecosystem mapping work in the pilot areas and will test and apply spatially disaggregated accounting methodologies as well as provide a valuable tool to inform local resource management planning and engagement with Local Enterprise Partnerships.		Pilot accounts	In Progress	Commissioned by Defra from AECOM and partners

Developing accounting methodologies			
<p>Towards wealth accounting – natural capital within comprehensive wealth</p> <p>This paper provides an overview of wealth accounting and the conceptual basis of including natural capital into extended income and wealth accounts. It shares ONS plans for improving the natural capital estimates within the comprehensive wealth framework. This paper provides an approach on developing UK wealth accounts by incorporating other capital areas – physical and human - and suggests an indicator to measure the sustainability of the UK’s economy.</p>	Discussion paper	June 2013*	ONS
<p>Valuation for natural capital accounting seminar proceedings</p> <p>In order to support and advance the domestic and international agenda(s) on natural capital accounting, ONS and the UK Department of Environment, Food & Rural Affairs, in co-operation with the UK Natural Capital Committee, convened an Expert Seminar in London in November 2013 to discuss practical valuation approaches for natural capital accounting in the UK.</p> <p>This paper provides a summary note of proceedings, issue papers discussed and presentations delivered at the valuation for natural capital accounting seminar in London in November 2013.</p>	Notes of proceedings	January 2014*	Defra / ONS
<p>Principles of ecosystem accounting</p> <p>This paper sets out the basic principles to be followed when developing ecosystems accounts. It aims to establish a number of key approaches before significant further development work on the accounts is completed. It also identifies those issues on which a methodological principle cannot be established in advance of further analytical and development work. This paper is a live document which will be periodically revised from experience as progress is made.</p>	Methodological	July 2014*	Defra / ONS

Annex 3 Overview of assets and services for initial habitat accounts

This table provides a first and necessarily incomplete overview of the ecosystem characteristics, indicators and services that are covered by the habitat accounts so far. Not all characteristics and services are relevant to every habitat. Some services that are relevant may not be easily measured or monetized. This table will be expanded and populated as the habitat accounts are further developed.

	Woodland	Public Forest Estate	Marine	Freshwater	Farmland	Peatland
Stage	initial	initial	initial/scoping	initial	scoping	scoping
ASSETS						
Extent						
Geographical coverage	GB/UK	England	UK	UK	UK	UK
Country breakdown	√	n/a	n/a	Partial	√	√
Further spatial disaggregation	√	√	Feasible but not recommended	No	√	Feasible but not a strong case in short term
Included in land cover account	√	No	No	√	√	No - cuts across other habitats
Ecosystem subsets						
	Broadleaved Conifer	Broadleaved Conifer	Saltmarsh; maerl beds Inshore, offshore	Open water Wetlands Floodplains	Arable Grassland	Bog Fen
Condition/key characteristics						
Age of provisioning stock	√	√				
Biomass stock	√	√	√			
Carbon stock	√	√			√	√
Protected area designation	√	√				
Species abundance / diversity indices	√			√	√	√
Area of degraded habitat						√
Area of restored habitat						√
Accessibility to habitat	√			√		
Area with recreational facilities		√				
Area in flood risk zones	√	√				
Vegetation						√
Soil quality				√	√	
Linear features					√	
Chemical levels				√		
SERVICES						
Provisioning						
Timber	√	√				
Fish			√	√		
Peat extraction				√		√
Grass					√	
Crops					√	
Water				√		
Energy				√		
Regulating						
GHG sequestration / flux	√	√	√	√	tbd	√
Water quality regulation				√		√
Water quantity						
Water flow regulation	√	√		√		√
Erosion protection				√		
Air filtration						
Cultural						
Setting for outdoor recreation	√	√	√	√	√	
Educational services	√			√		
Landscape amenity						
Archaeological preservation						

Annex 4 Selected methodological issues

This Annex details a selected number of methodological issues and challenges that are included in our Issues Log. These are not the only detailed issues, but they do provide a flavour of the range of challenges involved in applying an accounting framework to natural capital.

Basic ecosystem accounting principles (SEEA-EEA Ch. 2)	Physical accounting for ecosystem assets (SEEA-EEA Ch. 4)
<p>Role of spatial accounting</p> <p>Ideally, accounts should have bottom-up spatial GIS units showing land cover. More broadly, this can help ensure we have distinct and consistent broad habitat definitions. There is a current risk of overlapping e.g. wetlands / peatlands / marine / coastal. In the first instance, ecosystem accounts should be constructed around the comprehensive and mutually exclusive categories of the Land Cover Map (LCM) applied to raster based BSUs. However, where there is more detailed and relevant data available on land use, such as the Forest Inventory, this should be used instead, with the results reconciled with the LCM at higher levels of aggregation.</p>	<p>Consistency of asset characteristics</p> <p>The basic asset account has a standard tabular format, although the characteristics of the stock described in the accounts may vary according to the type of asset and the availability of data. Our principles paper recognised that further work on increasing consistency between accounts for different ecosystems is required. The service-asset coverage matrix will help to identify any inconsistencies.</p>
<p>Accounting for land use change between habitats</p> <p>Displacement of ecosystem service flows due to changing land use should be captured by developing accounts in a way where assumptions made in one account follow into others. This has been highlighted by the scoping study on peatland and the initial woodland accounts. We need to look holistically, and this is important when we present individual accounts. The use of ecosystem models as a way of ensuring consistency across accounts should be explored.</p>	<p>Accounting for biodiversity</p> <p>SEEA follows the CBD and defines biodiversity at three levels – genes, species and ecosystems. Although aspects of biodiversity (e.g. wildlife and/or game; active principles for pharmaceutical products) can be viewed as services, the SEEA takes a broader view and also sees it as a characteristic of ecosystem assets as well as an indicator of condition. It therefore recommends the use of proxy indicators in the accounts e.g. bird indices. Designated areas are important to account for (e.g. SSSIs) but there is also a need to account for biodiversity outside of these areas.</p>
<p>Prioritising ecosystem services for inclusion</p> <p>For which assets and services should we prioritise (including for valuation?) SEEA recommends a number of criteria in order “initially [to] select a limited rather than a comprehensive set of ecosystem services for inclusion in ecosystem accounting”. (i) environmental policy concerns; (ii) economic context; (iii) adequate data and methods. Our principles paper stated that our starting point would be the UK NEA’s matrix of services and habitats for assessing the state / risk and relative significance of services within a habitat (P6.1), but there is need to apply this consistently and transparently across habitats.</p>	<p>Accounting for connectivity and linear features</p> <p>The importance of ecological connectivity for resilience and service provision is highlighted in the Lawton Review and the UK NEA. There are also different forms of connectivity (e.g. hedgerows, transport corridors, rivers, rights of way) How can this be captured in a habitat-based accounting framework? Spatially defined accounts may facilitate this aspect. Some connectivity features may need to be captured as asset characteristics in specific accounts, e.g. hedgerows in farmland accounts.</p>
<p>Representing uncertainty within accounts</p> <p>Accounts traditionally have point estimates. Significant uncertainty potentially for physical metrics (especially non-provisioning services) as well as monetary values. We need</p>	<p>Consistent treatment of carbon storage</p> <p>Carbon storage is not to be confused with carbon sequestration. Carbon storage has zero value in theory; the value is only realised if /when carbon crosses boundaries , i.e. if soils carbon gets</p>

<p>to communicate this effectively, transparently and consistently across accounts. There are different kinds of uncertainty that are relevant to the accounts, many of which go well beyond parametric or sampling uncertainty.</p>	<p>emitted into the atmosphere due to land use change. Relevant for woodland, saltmarsh, peatland; and in each case we need to distinguish between carbon storage and sequestration. Cross-cutting carbon accounts will need to make this clear. Sub-soil assets will also contain a liability in the form of GHG emissions when they are extracted – this needs further consideration. A separate issue is that there are 'different types of carbon' in ecosystems which may have implications for accounting and valuation.</p>
<p>Physical accounting for ecosystem services (SEEA-EEA Ch. 3)</p>	<p>Monetary accounting for ecosystem services and assets (SEEA-EEA Ch. 5 and 6)</p>
<p>Disentangling service provision from human input Need to be clear where we draw the production boundary for ecosystem services, and how far it includes human inputs - most ecosystems have been modified by people, often with the specific aim of increasing supply of outputs (e.g. crops) or benefits (e.g. walking trails), so not easy to disentangle contribution of the ecosystem to production.</p>	<p>Standardised time period for asset valuation Need to decide over what time period NPV approach takes - this could also have implications for the discount rate. UK Natural Capital estimates assumed a 25-year asset life following the World Bank, but there are strong reasons to assume a longer time frame (e.g. forestry life cycle over at least 50 years) and to adopt a single asset life for consistency across the accounts, although for non-renewables with unsustainable extraction it may be possible to calculate an expected asset life. The main challenge of a longer time-frame is the increase in uncertainty going into the future.</p>
<p>Negative service flows between ecosystems These are flows between ecosystems which impact negatively on the provision of benefits from another environmental asset e.g. agricultural run-off which pollutes water bodies; or severely degraded upland peatland which emits greenhouse gases into the atmosphere. A clear distinction would need to be made between impacts which are directly anthropogenic (for example an industrial accident which releases pollution directly to a water course) and those which arise because the ecosystem cannot manage the pollutant load. These distinctions may be difficult to make in practice and it is not yet clear how best to represent such impacts in the accounts.</p>	<p>Appropriate values for carbon Carbon sequestration values for ecosystems do not have an obvious exchange value. The carbon emissions market is volatile and subject to regulatory changes. Whilst carbon is traded on the voluntary market (e.g. through the Woodland Carbon Code) these markets are in their infancy, their transactions are limited and prices may implicitly include non-carbon values. Initial woodlands accounts use the much higher DECC non-traded carbon shadow values; these are target-based values and it is not clear how far these diverge from a concept of exchange value as set out in SEEA.</p>
<p>Identifying counterfactual for regulating services Where possible the total value of ecosystem service provision can be identified and monetised in most cases through physical metrics in absolute terms. Practical examples need to be developed to understand how ecosystem services providing a reduction in risk can be measured in relative terms (with an explicit counterfactual) within an accounting framework. Examples include the water retention services of woodland vis-à-vis farmland.</p>	<p>Projecting prices for future service values Even where we have shadow prices, we need to take a view on how these would be updated over time as accounts are repeated. Future population projection rises would increase future recreational values; future income growth can also affect real unit values, but any such modifications would need to be robust.</p>

Annex 5 Description of NEA Broad Habitats

These eight “broad habitats” as defined by the UK National Ecosystem Assessment form the basis of the habitat accounts included in the 2020 Roadmap.

Mountains, moorlands and heaths



Lowland heaths are highly fragmented, while mountains and upland moors and heaths provide the largest unfragmented semi-natural habitats in the UK. Mountains, moorlands and heaths are the source of around 70% of the UK’s drinking water, hold an estimated 40% of UK soil carbon, and include some of the country’s most iconic landscapes. They cover 18% of the UK land area.

Semi-natural grassland



Semi-natural grasslands once covered a large proportion of the UK’s land area, largely the result of low-intensity traditional farming. The extent of semi-natural grasslands is now extremely reduced, with high-diversity grasslands comprising 2% of UK grassland ($\geq 1\%$ of total land area). Semi-natural grasslands are highly valued culturally – the South Downs, dominated by chalk downland, receives around 40 million visitor days a year.

Enclosed farmland



The most extensive form of land use in the UK, accounting for around 40% of land area and producing around 70% of the UK’s food. Most is managed for cereal, cattle and sheep production. Half the area of Enclosed Farmland is arable land, mostly in eastern England; almost all the rest is nutrient enriched grassland, mostly in wetter, western parts of the UK. As well as playing a crucial role in provisioning services, Enclosed Farmland is also of great cultural significance and is a major determinant of landscape in much of lowland UK.

Woodlands



This habit type includes managed plantations as well as ancient, seminatural woodlands. Woodlands cover 12% of the UK’s land area, making the country one of the least wooded in Europe. At least 80% is less than 100 years old and just 5% is classified as ancient woodland. Much planting in the past century has been of coniferous trees (often non-native). Only in England is woodland dominated by broadleaved species. Much of the woodland estate is managed as a source of timber, but woodlands are increasingly valued for their delivery of other ecosystem services, particularly recreation and carbon storage.

Open waters, wetlands and floodplains



Freshwaters include open waters, wetlands and floodplains. In the UK there are more than 389,000 kilometres of rivers, 200,000 hectares of permanent lakes and nearly half a million small ponds. There are also estimated to be at least 390,000 hectares of fen, reedbed, lowland raised bog and grazing marsh and nearly 1 million hectares of floodplain. Freshwater habitats are a major source of water for a wide range of uses and are important for recreation, including angling, boating and other water sports, and in hazard (notably flood) regulation.

Urban environment



Urban areas in the UK cover just under 7% of land area. They are home to 8 out of 10 people, often living at extremely high population densities. Green space is very limited in extent, and access to it is unequally distributed; it thus assumes disproportionate cultural significance. Urban areas depend very largely on other habitat types for provision of most of their ecosystem services.

Coastal margins



Coastal Margins, comprising sand dunes, machair, saltmarsh, shingle, sea cliffs and coastal lagoons, cover just 0.6% of the UK's land area. Culturally, Coastal Margins are of immense significance. There are over 250 million visits per year to the UK coast, of which around one third are to natural habitats. These areas are also important in coastal defences, sediment transport and as nursery grounds for fish.

Marine



Marine habitats of the UK cover more than three and a half times the land area. They are highly variable, comprising a very wide range of sub-habitats. Inshore Marine habitats are of great cultural importance, offering many opportunities for tourism and recreation. Offshore habitats support fisheries and provide a wide range of other ecosystem services, such as avoidance of climate stress and waste breakdown and detoxification.