Natural England Research Report NERR072

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An assessment for National Nature Reserves managed by Natural England

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Rebecca Clark, Natural England

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Project manager

Rebecca Clark

Natural England
Dragonfly House
2 Gilders Way
Norwich, NR3 1UB, UK.
rebecca.clark@naturalengland.org.uk

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Please note:

This is an internal document that has been published as an external research report in the interests of sharing the findings of the study. It was written to address the specific needs of colleagues in Natural England and has not been re-drafted for an external audience.

The findings of this study are likely to be more relevant to management of land primarily for nature conservation than for management of land for other purposes.

Abstract

Corporate Natural Capital Accounting, a new monitoring framework, was applied to some National Nature Reserves (NNRs) to assess whether it is an appropriate tool and useful source of information for their management. Initial accounts were developed for a plan to deliver a long term goal for each NNR. They comprised long term projections of costs, ecological indicators, environmental goods and services provided by the NNR and their value. Reporting against the initial accounts in future would monitor progress (it was not feasible for this study).

The NNR managers who developed the accounts welcomed the opportunity to develop the projections for delivery of a long term goal. They found it helpful to identify goods and services provided by an NNR. The accounts were partial as not all services could be quantified and few could be valued. If the accounts were used to monitor NNRs, the accounts' summary information would be complex, difficult to interpret and would cover only part of the purposes of NNRs. A simple bespoke approach to monitoring the NNRs that embraces a natural capital perspective would be more appropriate.

Summary

Natural England conducted a pilot study to assess whether the Corporate Natural Capital Accounting (CNCA) framework is an appropriate monitoring tool and useful source of information for the National Nature Reserves (NNRs) that it manages. NNRs have three main purposes: to conserve habitats, species and geology; they are used for research into the natural environment; and for recreation.

Natural capital is defined by the Natural Capital Committee (2014) 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'. When a natural capital perspective is adopted[1], these elements are considered to be assets that produce flows of environmental goods and services. The value of expected future flows of the goods and services are used to estimate the monetary values of the assets. CNCA is a framework for monitoring natural capital assets for an organisation with a view to safeguarding the assets (Eftec and others 2015a and 2015b). It was developed for the UK's Natural Capital Committee.

Method

Corporate Natural Capital Accounting

In CNCA, an account is forward looking. It is a set of future projections for a plan to deliver a long term goal. Usually CNCA focuses on the operations of an organisation at a specific site or set of sites. The goal that is used determines all of the projections in an account. The projections are updated when the account is subsequently reported against. The account comprises long term projections for:

- The quantity and quality of ecosystems;
- the quantity of environmental goods and services that are provided;
- the value of the goods and services minus costs that can be attributed to their production;
- other costs.

The costs include inputs paid for by the organisation and inputs made by others (such as volunteers).

The summary monetary figures in an account are:

- the gross value of natural capital assets. This is the total monetary value of the projected flow of environmental goods and services minus costs attributed to production of the goods and services. The costs (of inputs of labour and man-made assets) are deducted to identify the environment's contribution[2] to the value of the good or service;
- the net asset value. This is the gross asset value minus the projected flow of all other costs for maintaining and improving the environment. These costs (such as the cost of employing a manager) are not specific to a good or service.

To calculate the summary figures, discounting is employed. Discounting is a process that economists use so they can add together monetary values that occur in different years.

[1] Which draws on concepts and terms used in accountancy.

[2] This calculates the gross value of the environment's contribution (before other costs are deducted).

To provide monitoring, updated projections are entered in the account annually or less frequently (known as 'reporting'). The updates are compared against projections that were made initially. The monitoring is summarised using monetary figures (presented in a 'balance sheet' and 'statement of change'). Changes in ecosystem quantity and quality are found in the detailed information in the account.

In CNCA, a healthy natural environment is assumed to underpin the sustained provision of environmental goods and services (that deliver benefits to people). It is not directly valued separately.

Approach adopted for the study

The study assessed whether CNCA is an appropriate tool for monitoring delivery of the three main purposes of NNRs, and for informing monitoring of NNRs and decisions about NNRs. It focussed on development of initial accounts. Reporting against the accounts, which would have given a more comprehensive assessment, was not feasible within the timeframe of this study.

Seven NNR senior reserve managers (SRMs) entered data in spreadsheets (produced in house) to develop an initial account for an NNR that they manage. The account was for a plan to deliver a goal that was specific to the NNR. For most of the NNRs, the plan was a detailed extension to 2035 of the NNR's current five year management plan. Such extensions had not previously been developed. For simplicity, the accounts focussed on the operations of Natural England (and did not include the operations of tenants). The views of the SRMs and other staff on CNCA and the information it supplies were collected by an analyst.

Results and discussion

Out of the seven SRMs, five completed development of an initial account. Two could not secure the additional information and time needed to develop an account sufficiently.

For the initial accounts, the SRMs selected indicators of ecosystem quantity and quality that were specific to each NNR. They identified a long list of environmental goods and services provided by the NNR. The goods and services that could be quantified were represented in the accounts. Services that could not be quantified included flood and coastal erosion risk management and contributions to the landscape. Three goods and services could be valued in monetary terms (specifically, net carbon flux[3], recreational and educational visits) as well as revenue from goods and services that are sold. Out of the purposes of NNRs (nature conservation, research and access), access was valued directly in the initial accounts; research was quantified (but not valued) and nature conservation was assessed in terms of ecological indicators (and part of its monetary value was included with access). It is unlikely that the data needed to value research and nature conservation more fully will become available.

The SRMs found that identifying the goods and services that are provided by the NNRs helped raise their awareness about benefits other than nature conservation. It also encouraged some to consider the potential to deliver more. The SRMs indicated that values of environmental goods and services that NNRs provide to society could be used in various ways, such as informing applications for external funding. Also, the value of inputs by

[3] For the study, net carbon flux was defined as the carbon uptake via net primary production by plants minus carbon losses in the form of carbon, carbon dioxide and methane via respiration by organisms.

volunteers could help demonstrate the additional inputs that are secured by NNR funding. The process of thinking strategically about the NNR, developing a long term plan, and the plan itself were welcomed by the SRMs. These could be supplied by adoption of CNCA (though not necessarily). Alternatively, the processes and information that the SRMs found useful could be delivered by other means without the additional effort of developing accounts.

Usually CNCA would report changes relative to the initial projections in an account. Because accounts developed for this study were not reported against, summary data from the initial projections are presented as the results. The gross asset values are partial (because only a few goods and services could be valued and data were not available to fully quantify one of them). All costs were included in the accounts. Because CNCA is a monitoring tool, the magnitude of the figures in the accounts is not important; what matters is how they change over time. To understand the values, it helps to consider the data used to calculate them. For all the NNRs, the monetary value of projections for recreational and educational visits (provided to society) greatly exceeded projections of the NNRs' revenue (to Natural England). The monetary value of costs not met by Natural England (for example, inputs by volunteers) was significant; for four of the NNRs, it accounted for 17% to 56% of the total present value of costs. The range reflects differences in the level and type of inputs made by volunteers.

In the initial accounts, the gross asset values (which do not include most costs) were determined by certain characteristics of the NNR and the goal if it impacted on these characteristics (for example, through planned management of woodland). The estimates were partial. Suitable estimates were not available to value provision of a resource for research or to fully estimate the value of nature conservation[4], amongst other things.

Net carbon flux dominated the gross and net asset values of the initial accounts. This is because the unit values (specified in government guidance) are large and increase in future. It resulted in relatively low gross asset values (-£0.7 million and £4 million) for the two NNRs with habitats (such as reedbed) that are net emitters of carbon dioxide and/or methane (though the lower estimate is partial as net carbon flux data were available for only 22% of the site). For the NNRs with large areas of woodland that sequester carbon, net carbon flux made a huge positive contribution to gross and net asset values (contributing 94% to 98% of the gross asset values, which were £200 million to £516 million). The other characteristics that significantly influenced the gross asset value were numbers of recreational and educational visits (which are affected by the proximity of the NNR to towns and cities and ease of access, amongst other things).

The total present value of costs (range: £6.4 million to £9.5 million) is likely to be determined by factors specific to each NNR.

The study's key findings about whether CNCA is an appropriate monitoring tool for the NNRs are as follows:

- CNCA could monitor the impacts of management on projections for: certain environmental goods and services provided by the NNRs (limited to those that could be quantified); costs to the organisation; and inputs by others (such as volunteers). It could also be used to monitor delivery of detailed long term plans and to identify some of the

[4] Estimates were not available for the non-use value (the impact that nature conservation on NNRs has on people's satisfaction even if they do not anticipate using it).

long term implications of gaps between current funding and the expenditure needed to meet a selected long term goal. These could also be supplied through mechanisms other than CNCA.

- Because CNCA employs projections, the summary information that is reported is complex and requires expertise to interpret.
- The value of the net carbon flux would have a major influence on the value of goods and services in an account for NNRs. Low confidence in estimates of net carbon flux and lack of data for some habitats would result in low confidence in estimates of the gross and net asset values for an account. For sites with significant areas of woodland that sequester carbon, the effect of the value would be so great that the account would be fairly insensitive to changes in other goods and services. This would limit CNCA's effectiveness as a monitoring tool.
- The three purposes of NNRs would be only partially represented in the summary monetary reporting figures produced by CNCA, in terms of the value of access. Monetary values would not be estimated for research or conservation (other than the value of the latter included with access). The three purposes would be recorded in the detail of non-monetary components of the account.
- Though CNCA could be employed for monitoring, risks could arise if undue emphasis was placed on the summary monetary values in strategic management of the NNRs. This is because the account presents only a partial picture of the NNRs. Also, if management of NNRs was driven by a desire to report increases in net asset values and involved actions that were not consistent with the long term goals for the sites, it would not deliver the goal or the formal standard for NNR management.

Conclusions

The study found that CNCA could supply useful information and processes with partial monitoring of goods and services the NNRs provide to society.

CNCA currently has high salience. Nevertheless, if Natural England wishes to monitor delivery of the three purposes of NNRs, an approach that is designed for the NNRs would be more appropriate. Like CNCA, this would involve investment of resources. However, the approach could be relatively simple, transparent and embrace a natural capital perspective.

Contents

1 Introduction

Corporate Natural Capital Accounting (CNCA) is a tool that has been developed to monitor natural capital assets over the long term to help safeguard them. Natural capital is defined by the Natural Capital Committee (2014) 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'. When a natural capital perspective is adopted[5], these elements are considered to be assets that produce flows of environmental goods and services[6]. Monetary values of assets are estimated in terms of the value of anticipated future flows of the goods and services[7]. CNCA is a tool that aims to monitor natural capital assets for an organisation and support investment to maintain or improve the assets (Eftec and others 2015a).

CNCA was developed by Eftec[8], the Royal Society for the Protection of Birds (RSPB) and PwC[9] for the UK's Natural Capital Committee in 2015. It is a relatively novel area of accounting and is not yet subject to agreed principles (so may be subject to change in future). CNCA is one of several approaches adopted for natural capital accounting[10].

This pilot study was undertaken to investigate whether CNCA is an appropriate monitoring tool and useful source of information for National Nature Reserves (NNRs) managed by Natural England. There are 224 NNRs in England, of which Natural England manages 142 on its own or jointly with others (the rest are managed by Approved Bodies). NNRs were established for 'preserving flora, fauna or geological or physiographical features of special interest in the area and/or for providing opportunities for the study of, and research into, those features' under the National Parks and Access to the Countryside Act (1949). Their role was extended to include the provision of opportunities for public enjoyment of nature and/or open-air recreation by the Natural Environment & Rural Communities Act (2006). This legislation specifies the three main purposes of NNRs: nature conservation, research and access (also known as the 'three pillars' (Natural England 2016)), though not all NNRs are available for research or access. Management of NNRs also encompasses other principles that include community and stakeholder involvement and helping to safeguard and restore

[5] which draws on concepts and terms used in accountancy.

[6] Environmental goods and services are outputs and processes provided by the environment that supply benefits to people (the latter may involve inputs of labour and machinery). The goods and services may be consumed directly by people (such as a place for recreation, improved air quality) or they may be inputs to human production processes (such as production of timber for use in construction). The goods and services provided by NNRs could also be described as ecosystem services. A brief introduction to the concept can be found in Parliamentary Office of Science and Technology (2007).

[7] Stocks at a specific point in time are measured in terms of the condition and extent of ecosystems and expected flows of environmental goods and services (United Nations and others 2014).

[8] An environmental economics consultancy firm.

[9] A multinational firm that has expertise in accountancy, amongst other things.

[10] The approach employed by the Office of National Statistics in its development of a UK natural capital account is different. It monitors change in natural capital from a national perspective and does not employ projections for a reference scenario in the way that CNCA does. CNCA is designed to monitor change for a business. The UK natural capital account employs the United Nations System of Environmental-Economic Accounting which closely follows the United Nationals System of National Accounts (so it is comparable with economic indicators such as gross domestic product). CNCA also follows these principles as far as is relevant. The UK natural capital account is being incorporated into the UK's Environmental Accounts, which are satellite accounts to the main UK National Accounts (which estimate gross domestic product, amongst other things) (URL: www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/methodologies/naturalcapital [Accessed 14 September 2017].

ecosystems beyond the NNRs' boundaries, which are set out in the NNR Management Standard (Appendix A).

The purpose of the pilot study was to understand the potential of CNCA rather than to address needs identified by NNR colleagues. It was undertaken for seven NNRs in collaboration with the senior reserve managers (SRMs). This enabled the study to investigate application of the tool to individual sites as well as for Natural England.

The study undertook initial development of corporate natural capital accounts, developing the initial projections for a plan to achieve the long term goal used in the accounts (the 'reference scenario', described further in Section 2.1). This is the benchmark that the account would report against in future years. The account developed for the London Borough of Barnet in Eftec and others (2017) adopted a similar approach. For the purposes of Natural England's study, development of an initial account was sufficient to inform a preliminary assessment. Full implementation of accounts would have involved considerable additional staff resource. It would have entailed development of initial projections that covered some years in the past as well as the long term future and reporting against this for past years (this was the approach initially adopted in the CNCA for Forest Enterprise England (2016)).

The method is set out in Section 2, which presents information on CNCA, the development of the initial accounts and the approach adopted for the study. The results are presented in Section 3, findings set out in Section 4 and conclusions presented in Section 5. In the interests of making this report accessible, use of technical terms concerning CNCA is intentionally limited.

2 Method

This section gives an overview of CNCA, describes development of the initial accounts and the approach adopted for the study.

2.1 Corporate Natural Capital Accounting (CNCA)

The background to CNCA is set out below, followed by the components of the framework and its key features.

Background

Through the monitoring that it provides, CNCA aims to contribute towards the long term safeguarding of natural capital assets. It also aims to help organisations measure and establish the importance of natural capital to their business, currently and in future. The main focus of CNCA is on natural capital assets that an organisation has a stewardship role for (for example, through ownership and/or management). It was developed for use by organisations that have responsibility for large quantities of natural capital assets, amongst others. The framework usually focuses on the operations of the organisation; it does not usually incorporate information on upstream or downstream supply chain impacts[11] (Eftec and others 2015a).

In 2015, when they developed the framework, Eftec and others (2015a) piloted CNCA through a few case studies (specifically, the National Trust's management of Wimpole Hall Farm, the Crown Estate's management of the Windsor Estate, Lafarge Tarmac's management of Mancetter Quarry and United Utilities' impacts on sites on the Fylde Coast). Since then, Eftec has developed an account for Beam Parkland (Eftec 2015), parks and open spaces in the London Borough of Barnet (Eftec and others 2017) and undertaken a scoping study to develop an account for the Duchy of Cornwall (Duchy of Cornwall 2016). Forest Enterprise England worked with Eftec to develop an account for its management of the Public Forest Estate in England, which it has since reported against (Forest Enterprise England 2016, 2017). The RSPB is in the process of developing an account for the NNRs that it manages[12]. Of these, so far, detailed information on the accounts has been published only for Beam Parkland, Forest Enterprise England and the London Borough of Barnet. Forest Enterprise England has reported against its account and plans to continue to do so. It anticipates that natural capital accounting will help inform its investment and management decisions (Forest Enterprise England 2017). There is no information in the public domain yet about whether the other organisations have been reporting against the CNCAs developed by Eftec and if so, whether this has been useful.

[11] In this regard, CNCA differs from some of the other frameworks for assessing environmental impacts, such as the Environmental Profit and Loss Account applied by Puma (part of the Kering group (URL: http://www.kering.com/en/sustainability/epl [Accessed 14 September 2017]), which assesses environmental impacts along the organisation's entire value chain.

[12] The RSPB collaborated with Eftec and PwC in development of the CNCA framework.

Components[13]

CNCA provides reporting statements that an organisation can use to monitor and measure its natural capital assets. Specifically:

- A natural capital balance sheet, which reports the value of natural capital assets and the costs (liabilities) of maintaining these. Note that the term 'maintenance' is used in CNCA to refer to managing and investing in natural capital, which may include restoration or enhancement.
- A statement of change in natural capital assets, which reports change in asset values (plus the reasons for the changes) and costs over the accounting period.

These build on a set of supporting schedules (illustrated in Figure B.1 in Appendix B):

- Natural capital asset register: an inventory of the quantity and quality of the natural capital assets.
- Physical flow account: the anticipated flow over time of goods and services that is dependent on the natural capital assets (in the asset register).
- Monetary account: the expected value of the flows of goods and services identified in the physical flow account minus the production costs (if costs can be attributed to their delivery).
- Maintenance cost account: costs (referred to as liabilities) of current and future maintenance of natural capital assets (and any improvements). The costs in this cannot be attributed to specific goods and services.

Key features

The following key features of CNCA are discussed below: accounts and monitoring, reference scenario, discounting and asset values, valuing goods and services, the value of a healthy natural environment and strands of information.

Accounts and monitoring

CNCA is a framework for monitoring natural capital assets (Eftec and others 2015a). It provides understanding of changes in the value of assets over time; it is not intended for use in appraisal (Eftec personal communication 2016). If economic appraisal is sought to inform decision-making, it should be supplied separately from CNCA. This is because appraisal employs some different values[14] and a different technique to accounting (though there are aspects of CNCA that it shares with accounting, such as the use of discounting).

The CNCA framework aims to provide understanding of the value of maintaining natural capital assets, indicating the value of goods and services to society as well as the organisation (reporting the two separately). This is different to financial accounts, which record the productive assets available to a business, the means of financing them and the results of their use, assessed only in financial terms to the business.

CNCA is forward looking. Each of the supporting schedules is a set of projections. Estimated data are entered for each year over the long term future for the quantity and quality of natural capital assets, flow of goods and services, the value of those and costs. Changes are

[13] Source: Eftec and others 2015a.

[14] Economic appraisal employs economic values whereas CNCA employs exchange values. These may differ (discussed further later in the section).

reported in terms of impacts on these flows in the long run. In this regard, CNCA differs significantly from financial accounts which report what happened in the previous accounting period and focuses on the value of changes only over that period. Both types of accounting assess the value of assets. CNCA estimates the value based on projected flows in future, whereas financial accounting uses the historical purchase price of capital items and applies depreciation over the life of the asset.

In CNCA, the time frame used for the projected flows is the anticipated life of the natural capital assets or the organisation's stewardship of them. The adoption of a long term perspective aims to help safeguard natural capital assets.

CNCA provides monitoring of delivery of a plan to achieve a long term goal. In doing this, it assesses the impacts of management, changes in the land that is managed, and external factors (such as climate change, disease and new local housing development[15]) on the quality and quantity of ecosystems[16], the goods and services that they provide, and costs. The summary monetary values in the accounts are also affected by what can be valued, the valuation techniques employed and the values per unit, which are likely to change over time. In Forest Enterprise England's account, Eftec (2016) anticipate that in the short term, changes reported by the account are likely to result from refinement of the account itself, including addition of values for certain non-traded goods and services. Indeed, in 2017, Forest Enterprise England altered the way it values volunteer inputs, which alone caused a change of £11 million in the figures in the account. It also revised its estimate of recreational visits to the Public Forest Estate[17], from 73 million to 226 million per year[18].

Reference scenario

An important feature of CNCA is that changes in the quality and quantity of natural capital assets are assessed relative to a 'reference scenario'. The organisation specifies a suitable long term goal to employ in the accounts (which could be maintaining the current situation or achieving the organisation's environmental goals). Initial projections for a plan to deliver this goal are set out in all the supporting statements. These provide what is known as the reference scenario. The projections are profiles of the anticipated quantity and quality of natural capital assets, the cost of achieving them, the anticipated flow of environmental goods and services and their value over the long term. There should be total consistency between delivering the long term goal and all these elements (Eftec and others 2015a).

The long term goal that is used is important (for reasons described below). For the account to be useful as a monitoring tool, the goal should not be changed unless extenuating circumstances arise (the period over which monitoring is occurring will then restart). Guidance from Eftec and others (2015a) suggests that if the goal does not set out to improve natural capital, at a minimum, it should maintain the current situation. This issue is returned to in Section 4.

The goal that is used determines the projected values of assets and costs in the account. If the goal is to achieve significant improvement in the environment, the projections used in the account will be for a plan to deliver this. The goal also determines the change in values of goods and services and costs that appear in the account's reporting statements. This is

[15] For example, housing developments may increase numbers of recreational visits.

[16] Which could also be referred to as the quantity and quality of natural capital assets. The report employs 'quantity and quality of ecosystems' to limit the use of natural capital technical terminology.

[17] Employing data from quarterly surveys conducted with a major national market research agency, which started in 2015 (Forest Enterprise England 2017).

[18] The accounts have been updated retrospectively to employ new recreation data.

because the data that are entered when the account is reported against are updated projections for delivery of the goal. In the Forest Enterprise England account (2016, 2017), the data that were reported for 2015/16 and 2016/17 are based on delivery of the 2015 Forest Design Plans; they are compared with projections for a reference scenario that starts in 2013/14. The projections that are employed in the account for the London Borough of Barnet are for continuation of the current situation. These are a baseline against which anticipated future changes (for example, as a result of population increases and pressure on budgets) will be assessed (Eftec and others 2017).

Changes are reported in CNCA as gains or losses in the total monetary value of the updated projections relative to the initial projections (the reference scenario). These are assessed separately for the value of goods and services and for costs. If the long term goal involves ambitious changes in management, the changes that are reported in future are more likely to be negative than for a goal that is easier to achieve, such as continuation of the current situation. This does not matter in itself, though there are risks that negative changes relative to the initial projections may be interpreted as an indication of poor management.

Discounting and asset values

Discounting is a necessary feature of CNCA. It is used by economists to enable them to compare or combine benefits (or costs) that occur at different points in time. It is employed because society prefers to receive benefits now rather than in the future and to delay paying costs. HM Treasury (2011) specifies the discount rate that should be used for analysis by the public sector in the UK (3.5% for periods of up to 30 years). This is the annual rate at which values in future are assumed to fall away through time. Discounting causes values to increasingly diminish the further into the future they occur. It has the effect of placing greater weight on benefits and costs that arise in the near future and less on those that occur in the distant future. Though it may seem inconsistent with safeguarding natural capital in the long term, economic principles require the use of discounting in CNCA. The organisation's discount rate is used (Eftec and others 2015a) so the account is consistent with the organisation's other economic and financial analyses[19].

An important feature of CNCA is that it considers the stocks of assets as well as the flow of goods and services that they provide. The monetary value of stocks (and thereby assets) is calculated as the sum of the value of projected flows of goods and services over the long term. Discounting is used so that values from different years can be added together. The sum of discounted values for a projected flow over different years is known as its 'total present value'. The following summary values are presented in the CNCA balance sheet (Eftec and others 2015a):

- Gross asset value: this is the sum of discounted monetary values of environmental goods and services (minus any attributable costs) delivered by the long term goal over the period of the account. It uses data from the monetary account schedule, which draws on the physical account schedule. The deduction of costs of inputs of labour and man-made assets from the value of goods and services provides an estimate of the value of the environment's contribution (discussed further below). The figure is described as 'gross' because costs of maintaining and improving the environment that are not specific to a good or service are not deducted.

[19] The discount rate used by organisations in the UK's public sector is specified in government guidance (HM Treasury 2011).

- Liabilities: the sum of the discounted values of the costs of delivering the long term goal (excluding any costs that can be attributed to specific goods and services). This is calculated using data from the CNCA maintenance cost account schedule.
- Net natural capital asset value: this is the gross asset value minus the liabilities (as set out below). It is the net accounting value of delivery of the long term plan. It does not reflect economic appraisal of the plan (as discussed in Section 2):

Net natural capital asset value	=	Gross asset value	-	Liabilities
		Total present value of goods and services minus total present value of costs attributed to their delivery.		Total present value of costs excluding costs attributable to specific goods and services.

Valuing goods and services

To be consistent with the principles of the United Nations System of Environmental-Economic Accounting[20], in CNCA, goods and services are valued in terms of 'exchange values'. These are market prices or values that are consistent with the prices that would have been obtained if a market existed[21]. For some non-traded goods and services, exchange values may be valued using different techniques to economic values (which assess the impact on economic welfare). For example, Ricardo (2016) recommended that the exchange value of recreational visits in the national accounts is estimated using the cost of travel. This has features in common with techniques that employ travel cost as a proxy to estimate economic values of recreational visits, but differs significantly both theoretically and in terms of the method. Consequently, the monetary values in an account cannot be assumed to reflect the economic value to society. Though economic values may currently be employed in CNCA for non-traded goods and services, if greater consistency in CNCA is sought in future (which has been suggested), this could include greater adherence to the use of exchange values.

CNCA focusses on final environmental goods and services. These are used by households directly (such as places for recreation, fine views) or are inputs to the activities of businesses (such as timber and grazing). Intermediate goods and services (that are inputs to environmental processes, such as habitats for breeding, maintenance of the hydrological cycle) are not valued because they support and are integral to final goods and services[22].

In CNCA, costs that are attributable to delivery of goods and services are deducted from the value of the goods and services. These figures are set out in the monetary account and are used to calculate the gross asset value. Usually 'gross' refers to financial or economic figures prior to any deductions. However, in CNCA, costs that are specific to delivery of a good or service are deducted to calculate gross estimates of the value that is provided by the ecosystem (known as the 'resource rent'). This is because delivery of the good or service may involve inputs of labour, equipment, and other assets produced by people. Part of the value of the good or service reflects the costs of these inputs. The costs are deducted to calculate an estimate of the contribution made by the environment (United Nations and

[20] As far as is relevant, the framework for CNCA is consistent with national accounting methodologies, including the United Nations System of Environmental-Economic Accounting (Eftec and others 2015a).

[21] If suitable exchange values are not available, economic values may be used.

[22] Double counting would arise if they were also valued.

others 2014)[23]. For example, costs of labour, equipment and machinery involved in the production of timber are deducted from the price of timber to estimate the value of the environment's contribution to timber production. Costs of providing and maintaining paths, visitor centres and other visitor infrastructure are deducted from the value of recreational visits to estimate the value of the environment's contribution to recreational visits.

The value of a healthy natural environment in CNCA

CNCA calculates the monetary value of a resilient healthy natural environment in terms of the monetary value of the goods and services that the environment provides. Of this, some is omitted because not all goods and services can be quantified and few can be valued in monetary terms. Goods and services are used to estimate values because CNCA focusses on the links between the environment and economic and other human activity (following the same principles as ecosystem accounting developed as part of the United Nations System of Environmental-Economic Accounting (United Nations and others 2014)). Other values of a healthy natural environment to society (such as social and ethical) are not included in the monetary values used in the account.

In CNCA, a resilient healthy natural environment is assumed to underpin sustained provision of environmental goods and services (Eftec personal communication 2016). It is not valued separately. Whether the natural environment is healthy and resilient will have a greater effect on the quantity and value of some goods and services than others in the short term. Supply of timber, agricultural crops, and grass for use in agricultural production may not be affected by a brief slight deterioration in the health of the environment. However, the presence of certain species of wildfowl (which wildfowlers may pay to shoot) or the supply of seed of certain wild plants (which may be harvested and sold) may be highly dependent on the health of an ecosystem.

Non-use values are likely to be affected by the health of the natural environment, as well as other factors. Non-use values refer to the impact that a healthy natural environment has on people's satisfaction even if they do not anticipate using it. They also include the impact on people's satisfaction that arises from them knowing that the healthy natural environment is there for others now and in the future. These are known as existence, altruistic and bequest values. Non-use values are estimated based on willingness to pay surveys[24] (which are expensive to undertake). Compared with estimated values for recreation[25], estimates of non-use values tend to be less robust and more scarce.

Suitable data on non-use values have been available for some, but not all, other applications of CNCA:

- In the CNCA of organic conversion at the Natural Trust's Wimpole Hall Farm (Eftec and others 2015a), the impacts on wildlife and landscape were valued using estimates of society's willingness to pay for the goods and services delivered by Environmental Stewardship from a Defra-funded study undertaken by Boatman and others (2010). The

[23] Certain conditions need to be met for resource rent to represent the value of environmental goods and services. For example, goods need to be extracted sustainably and the manager of the resource needs to seek to maximise the resource rent (United Nations and others 2014).

[24] In addition to non-use values, estimates from willingness to pay surveys are likely to include values of current or potential future recreational use (resulting in double counting if separate recreation values are also used). The extent of this is influenced by the likelihood that participants in the willingness to pay survey do or will use the resource (or site) that the survey is focussed on. If necessary, it may be possible to remove values for current and potential future recreational use to estimate non-use value alone.

[25] Estimated values for recreation tend to be relatively robust if they are based on observed behaviour.

estimates from that study include not only non-use values, but also use values, including aspects of recreational value[26].

- In the CNCA for Mancetter Quarry (which is managed by Lafarge Tarmac), the non-use as well as use values of biodiversity, amenity and recreation were estimated based on a bespoke study that is not in the public domain (Eftec and others 2015a).
- For the Fylde Coast extended CNCA account developed for United Utilities, the non-use and use values of achieving minimum bathing water standards were estimated using research conducted by the water company and the Environment Agency (Eftec and others 2015a).
- Non-use values of biodiversity were not valued in the CNCA developed for each of the following: Windsor Great Park, which is managed by The Crown Estate (Eftec and others 2015a); Beam Parkland, managed by the Land Trust (Eftec 2015); Forest Enterprise England's management of the Public Forest Estate (Forest Enterprise England 2017); parks and open spaces in the London Borough of Barnet.

Strands of information

CNCA presents some information in different strands. Specifically (Eftec and others 2015a):

- values of environmental goods and services to the organisation (private value, such as revenue) are presented separately to values of goods and services to society (external value, such as net carbon sequestration). Similarly, costs incurred by the organisation are presented separately to costs incurred by others.
- Total costs may be separated into those required to deliver legal requirements and costs to deliver beyond those.
- In reporting, changes in the value of goods and services are separated into those that arise from changes in quantity, quality and value of the goods and services.
- The data in the account are compared against the data that appear in financial accounts. This flags up values of goods and services and costs that may not be adequately recognised by the organisation.

2.2 Development of the initial accounts

The technique for CNCA that was used in this study is that presented in Eftec and others (2015a and b). It was also necessary to seek advice from Eftec on specific technical aspects that are not covered in its reports. Though the framework and principles for CNCA have been published, they do not give sufficient technical detail to enable development of an account (and CNCA spreadsheets are not in the public domain). It should be noted that there is no formally agreed method for CNCA. This study employed the best available advice from Eftec based on the consultants' knowledge and expertise; it may be superseded in future as work progresses in this field.

The study developed initial accounts for the NNRs, setting out the initial projections for a plan to deliver a long term goal that would be reported against in future years (known as the reference scenario). For two of the NNRs, the term 'plan' is used to refer to the potential pursuit of an anticipated goal, which was employed in their accounts instead of a plan.

Because they wanted to make the most of the learning opportunities offered by the pilot study, the SRMs agreed between themselves at a workshop that they would each select the following (further information in Appendix C Section 5):

[26] Recreational visits were also valued separately in the account, so it is likely that adjustments in the non-use value would have been needed to avoid double counting.

- The long term goal used for the account. The workbook that the SRMs used to develop the initial accounts offered suggestions[27] and guidance on the implications of the long term goal that they adopted. The goal is important as it determines the plan that is described by the data projections in the account (in the initial account and in subsequent reporting). The SRMs chose to each identify a long term goal that they thought was most appropriate for the NNR that they were developing an initial account for. The goals are summarised in Table 3.1.
- The number of years for which data were entered in the account (beyond this, a residual value is estimated for the rest of the period covered by the account (see Appendix C Section 4)). The SRMs that completed initial accounts entered data for 20 years[28] (for reasons discussed in Appendix C Section 5).
- Whether costs of meeting legal and moral obligations were separated from costs for delivery over and above those obligations (some SRMs did this, others did not). If so, the SRMs defined legal and moral obligations. The definitions that they developed varied.

The SRMs recognised that if accounts were developed for all NNRs managed by Natural England, consistency would be needed in the above. However, they wanted to explore the implications of different approaches in the pilot.

Development of the initial accounts employed the following steps (based on Eftec and others (2015a and b)):

a. Specify the aim of the account.
b. Identify the focus and limits of the account.
c. Identify the long term goal that will be employed in the account.
d. Develop the spreadsheets that are needed.
e. Identify all environmental goods and services that will be provided with delivery of the long term goal.
f. Focussing on what can be estimated, populate the CNCA spreadsheets with projections of: the quantity of goods and services and their monetary value, and attributable costs. The projections describe a plan to deliver the long term goal. It is likely that only some goods and services can be quantified and monetary values can be estimated for even fewer.

   In the accounts, quantities were estimated for the environmental goods and services that are supported by the NNRs. This is consistent with the approach adopted in Eftec's other applications of CNCA. In contrast, assessment of the impact of a site would compare the quantities of goods and services provided by a site against the quantity in an alternative situation[29]. This was not undertaken for the accounts.

[27] In brief, the suggestions were that the long term goals that the SRMs might wish to consider using may include (but were not limited to): continuation of the current situation; maintaining favourable conservation status of Special Areas of Conservation / Special Protection Areas and improving nature conservation outcomes. The suggestions were based on development of the initial account for Lower Derwent Valley NNR, which was done first.

[28] Forest Enterprise England's account (2016, 2017) employs data projections over 50 years, which is consistent with the time horizon of Forest Design Plans (that set the management objectives for each forest block). In the account for the National Trust's Wimpole Hall Farm, projections were made over 100 years to capture the impacts of the transition to organic farming (Eftec and others 2015a).

[29] For example, the current situation might be that the public have access to the site for recreation and the alternative is a situation in which the site is not accessible to the public for some reason. If they cannot use the site, people may go to other sites instead for some of their recreational visits. To assess the impact of the site,

For this study, the following goods and services were valued in monetary units:

- Goods and services that are sold by the NNR (such as grazing that is leased, timber that is sold) were valued in terms of revenue.
- Net flux of carbon (which is defined and discussed further below) was valued using the value for non-traded carbon set out in government guidance (DECC and HM Treasury 2015)[30]. To enable this, the estimated net flux in units of carbon was converted into the units of carbon dioxide equivalent[31]. For NNRs that provided net sequestration of carbon, the monetary value was positive because they are providing a benefit to society by contributing to the mitigation of climate change. For the sites with net emissions of carbon dioxide and/or methane, the monetary value was negative because the emissions impose a cost on society (they contribute to climate change). The value per unit employed for net sequestration and net emissions was the same. In the calculations of value, the figures were converted into positive or negative values as appropriate[32].
- Recreational and educational visits were valued using prices charged by other providers (further detail in Appendix C Section 6, which also summarises the values adopted in other CNCA studies). Prices were used to estimate exchange values for the accounts. Alternative estimates may be more appropriate to use if the value to society of recreational visits (the economic value) is sought (discussed in Appendix C Section 6).

The SRMs were unable to identify costs that could be attributed to specific goods and services, with one exception (production of green hay seed source by Lower Derwent Valley NNR).

g. Identify suitable indicators of the quantity and quality of natural capital assets. Then, in the CNCA spreadsheets, enter projections for these for the plan to deliver the long term goal.
h. Populate the CNCA spreadsheets with costs of delivering the plan to achieve the long term goal, excluding any costs that were attributed to specific goods and services.

Further details can be found in Appendix C Section 2 and key assumptions are set out in Appendix C Section 4. If CNCA was adopted, subsequent reporting against CNCA would involve the steps set out in Appendix C Section 7.

information would be required on what people would do if the site was not accessible and this would be taken into account in the estimates used in the analysis.

[30] Other CNCA accounts have employed this same value (Eftec 2016, Eftec and others 2015a).

[31] by multiplying the net flux in units of carbon by the molecular weight of carbon dioxide divided by the molecular weight of carbon (44/12).

[32] Because the quantity of carbon sequestration is a negative figure (as discussed later in this section), in the calculation of the monetary value, the quantity multiplied by the unit value was converted into a positive figure. Conversely, because the quantity of net emissions of carbon dioxide and methane is a positive figure, in the calculation of the monetary value, the quantity multiplied by the unit value was converted into a negative figure.

The focus and limits of the initial accounts developed for the study are as follows:

- A focus on the NNR assets owned or rented by Natural England and the operations of Natural England (not tenants[33]). Consequently, greenhouse gas emissions from tenants' livestock were not included in the accounts.
- For the purposes of CNCA, net carbon flux is focussed on the environment; emissions from machinery and vehicles are not included (Eftec personal communication 2016). Net carbon flux[34] is defined here as the carbon uptake via net primary production by plants minus carbon losses in the form of carbon, carbon dioxide and methane via respiration by organisms (Natural England personal communication 2017). It represents the balance of positive and negative fluxes of both carbon dioxide and methane[35]. Net carbon sequestration is a negative flux[36]. Consequently, the quantity of net carbon sequestration is a negative figure. Conversely, net emissions of carbon dioxide and methane are a positive flux, so the quantity is a positive figure.
- Carbon stocks[37] are included in the account as an indicator of the quantity and quality of natural capital assets. In CNCA, their conservation is not considered to be a service (and is not included in the monetary value of services in the account) (Eftec personal communication 2016).
- The costs of maintaining and running NNR workshops, offices, classrooms and visitor centres were included. This was because they are required for NNR management and delivery of education which were included in the accounts.
- The accounts started in the year that they were developed (2016), at the suggestion of the SRMs.

In developing the initial accounts, the SRMs focussed on the main costs and goods and services, capturing the majority of information but not small details that were unlikely to have a significant effect. They developed the accounts using information that was readily available then and is likely to be readily available in future. This was necessary for it to be feasible for staff to report against the account. The effort involved would be proportionate. Development of the accounts involved making generalisations and approximations. This is consistent with the approach adopted by Eftec and others (2015a).

2.3 Approach adopted for the study

To explore whether CNCA is an appropriate monitoring tool as well as a useful source of information, a 'bottom-up approach' was adopted. For each participating NNR, the SRM developed an initial account in an Excel workbook of spreadsheets (the 'Initial Account Workbook') developed by Natural England's analyst for the study. This differs from the approach adopted by Forest Enterprise England: the organisation and Eftec developed an

[33] Tenants could have been included if the focus of the accounts was on the operations of Natural England and tenants on the NNRs.

[34] Which may also be known as net carbon equivalent flux.

[35] This is necessary as certain habitats that are net emitters of methane may be a net sink for carbon dioxide and vice versa (Natural England personal communication 2017).

[36] When the carbon uptake is greater than the carbon losses, then the environment is a net carbon sink. The net removal and storage of carbon by the environment from the atmosphere is described as 'carbon sequestration'. In England, soils, peatlands capable of forming peat and woodlands provide significant carbon sequestration (the net carbon flux for wet woodland is not known) (Natural England personal communication 2017).

[37] The amount of carbon held in the ecosystem. The data employed in the study focus on carbon that is held in vegetation above ground, biomass below ground, dead wood, litter and soil.

account centrally for its management of the Public Forest Estate in England (in a 'top-down' manner) using spreadsheets developed by Eftec (Forest Enterprise England 2016). Forest Enterprise England has since reported against the account (2017).

The study was developed and undertaken by Rebecca Clark (economist and analyst in Natural England), inspired by the case studies developed by Eftec and others (2015a). The SRMs who participated in the study were suggested based on their anticipated enthusiasm and the NNRs that they manage, which were selected to reflect a range of situations (further information in Appendix C Section 1).

The study assessed whether CNCA is an appropriate tool for monitoring NNRs managed by Natural England. The analyst collected information from the SRMs and Natural England's National NNR team to inform the assessment. She made her own assessment of the appropriateness of CNCA for monitoring the three purposes of NNRs (nature conservation, research and access (Natural England 2016)) and contributed insights into CNCA that she had gained through the study. The study also identified useful information and processes that were involved in development of the initial accounts. The assessment is initial because a full assessment would involve a more thorough identification of monitoring needs for the NNRs and the questions that such monitoring would be used to address. It would also entail reporting against an account over several years, which was not possible within the time frame of this study.

The analyst collected information[38] as follows:

- Recording each SRM's verbal running commentary as he made initial inputs of data into the workbook. The analyst accompanied each SRM for a day whilst he made this input and asked him to verbalise his thoughts about the work.
- A semi-structured interview[39] conducted with the SRM at the end of the day of initial data input (checklist in Appendix D).
- A semi-structured interview with each SRM held over the phone about nine months later (checklist in Appendix E).
- Group discussion at a day long workshop that SRMs and the analyst attended in person and at a meeting held over the phone.

In the event that Natural England wishes to adopt CNCA for the NNRs that it manages, the SRMs and analyst developed a few options that could be considered. The method for this is summarised in Appendix C Section 1 and the options are presented in Appendix K.

[38] Which was recorded in writing.

[39] Semi-structured interviews employ a list of open-ended questions that is developed in advance. They give the interviewer the opportunity to explore responses and topics further and allow the respondent to raise issues and themes not identified by the interviewer.

3 Results

The results of the study are presented below. These are focussed on the data generated by the initial accounts (Section 3.2) and whether CNCA is appropriate for the NNRs (Section 3.3). The information in the initial accounts, which gives useful background, is presented first. Discussion of the results is presented in Section 4.

3.1 Data entered in the initial accounts

The level of success in data entry is discussed below followed by summaries of the data entered.

Of the seven SRMs who participated in the study, five completed data entry for an initial account, most making an input of about three days' time in total[40]. Four of the SRMs set out projections for a detailed long term extension of the current five year NNR management plan. Such extensions had not previously been developed. One of these SRMs employed the anticipated goal of a major habitat restoration project. For the SRMs who did not have the necessary information readily available, development of the initial account was more time consuming and challenging. It transpired that two of the SRMs were not able to secure the additional information and time needed to develop the initial account sufficiently. All seven of the SRMs made valuable contributions to the study through their feedback on the workbook and their insights on the accounts.

An overview of the data entered by the SRMs who developed initial accounts is provided below. This covers indicators of ecosystem quality and quantity, costs, environmental goods and services and their value (further detail can be found in the workbooks in Appendix G and a summary for each NNR in Appendix H). Comparisons between the NNRs need to be undertaken with care.

The data entered into each account were for a plan to deliver the long term goal that the SRMs identified for the NNR (set out in Table 3.1). The goals reflected the different circumstances of the NNRs. They included current implementation of a major habitat restoration project, and anticipated goals of interventions to achieve favourable conservation status of Sites of Special Scientific Interest (SSSIs). The goals determined the data entered in the accounts.

Overall, the level of confidence in the data in the initial accounts is low to medium (a two to five out of ten chance of being correct[41]). The level of confidence in the data differs according to the variable and the year. For example, for the current year, it is high for estimates of revenue and financial costs and low for estimates of net carbon flux and visitor numbers for sites that have multiple access points and no people counters. Confidence in data projections decline further into the future.

[40] This included inputs that they made with the analyst on hand, on their own, and responses to request for further information from the analyst.

[41] Employing categories from the Intergovernmental Panel on Climate Change (2005).

Table 3.1 Long term goals employed in the initial accounts

NNR	Long term goal	Further information
Ainsdale Sand Dunes	*Anticipated goal:* Achieve and maintain favourable condition status across all units of the NNR. Develop and enable community access, education, research, health benefits and recreation.	Fully consulted management plan in place for coastal adaptation. Re-activation of dune processes in areas managed through grazing. Rear woodland managed as per Mersey Forest plan commitments.
Bure Marshes	Achieve and maintain favourable conservation status while encouraging appropriate public access and engagement.	Includes Hoveton Wetlands Restoration Project (funded by EU LIFE+ and Heritage Lottery Fund), which is underway.
Castle Eden Dene	*Anticipated goal:* Increase biodiversity within the NNR and over the connected landscape, achieve favourable condition of the Site of Special Scientific Interest and continue to offer a good visitor experience and education/events to inspire the public to want to look after nature.	Phased restoration of ancient woodland in areas of plantation and broadleaved woodland. Influence land owners to work towards biodiversity gain as part of their day to day business
East Dartmoor	Sustain high nature conservation value.	Assumes continued collaboration with local partner organisations (the Woodland Trust and Dartmoor National Park Authority).
Lower Derwent Valley	Maintain favourable condition and improve nature conservation outcomes.	Includes 3% increase in area of reedbed and continuation of current increases in numbers of recreational and educational visits and engagements with people through social media.

Indicators of ecosystem quantity and quality

The indicators of ecosystem quantity and quality identified by each SRM (listed in Appendix H) were specific to the NNR and are not likely to be applicable to other NNRs. This is because NNRs differ in terms of location and the habitats and species present, amongst other things. The quantity indicators focussed on key habitats (such as area of open dunes, heathland/moorland, open water) and important linear features (such as length of ditches, boardwalk). For the quality indicators, the SRMs identified a short list that was sufficient to indicate significant change in the quality (or health) of ecosystems in the NNR including early warnings. Examples include percentage cover of scrub in open fen, presence of yew trees suffering from pest or disease, number of waterfowl supported. The quality indicators also encompassed resources required to provide goods and services (such as safe and adequate access infrastructure, delivery of a public engagement programme). The SRMs' projections for the indicators for the next 20 years are set out in the sheet labelled 'RS Register'[42] in the workbooks in Appendix G. Carbon storage estimates were not available for all habitats.

Environmental goods and services and costs

In developing the initial accounts, the SRMs listed the environmental goods and services provided by the NNR currently and in future with delivery of the long term goal. The list for

[42] Sheets in the work book that are labelled RS are focussed on the reference scenario.

each NNR was long[43] . This is illustrated by the summary of provisioning services in Table 3.2 (information on the other goods and services is presented in Appendix I). The main services provided by the NNRs were:

- provisioning services that supply timber, grazing (and hay, for agriculture), and biomass from woodland for generating energy;
- maintenance and moderation of flows in the environment (eg flood protection) and maintenance of conditions in the environment (eg concentrations of greenhouse gases and habitats for reproduction and nurseries);
- and cultural services (eg a place for recreation, research and education).

Note that the goods and services identified for each NNR reflect not only differences in the NNRs, but also in the SRMs' interpretation of the goods and services (for example, whether events run by the NNR offer recreation or education). The SRMs found the services that offer regulation and maintenance of the environment more difficult to identify than the others.

Quantities could be estimated for relatively few goods and services (set out in the RS Phys Flow sheet in the workbooks in Appendix G). Seven goods or services that were provided by several (three or more) of the NNRs could be quantified. A snapshot of 2016 data for these can be found in Table 3.3.

For the few goods and services that could be valued, estimates for 2016 are presented in Table 3.4 (because they are for the current year when the accounts were developed, these values are not influenced by the long term goal used for the account). Ranges for these were as follows[44]:

- Total revenue in 2016 ranged from zero for two of the NNRs to £21,100 for Lower Derwent Valley (from wildfowling licences, lease of grazing, sales of firewood and green hay seed source).
- The values for net carbon flux in 2016 were -£23,000 to +£11,400,000 [45]. This reflected the range in net carbon flux (from a positive net flux of 366 tonnes of carbon dioxide equivalent to a negative net flux of 180,000 tonnes of carbon dioxide equivalent[46], Table 3.3) and the high value per unit.
- The values for recreational visits in 2016 were £19,200 to £383,000, arising from the range in numbers of visits (5,000 to 100,000, Table 3.3).
- For 2016, the value of visits with educational input from NNR staff and volunteers was £497 to £20,700. The value of visits that provided their own educational input was zero to £4,170. These ranges are based on the numbers of visits set out in Table 3.3.

Note that the above gross monetary values do not take into account production costs so should be compared between NNRs with care.

To give an indication of the costs, values for 2016 are presented in Table 3.4 (which are not affected by the goal used for the account). These figures do not include costs of capital assets (such as buildings, machinery, and equipment costing more than £5,000). In 2016, total costs met by Natural England ranged from £122,000 to £1,810,000 (excluding costs of

[43] Further details in the RS G & S sheet in the workbooks in Appendix G.

[44] Data rounded to three significant figures.

[45] The estimate for Bure Marshes is not included in this range because it is incomplete (it does not include impacts of wet woodland and shallow lakes).

[46] For explanation of negative and positive figures and why these are reversed for monetary values see Section 2.2.

capital assets) (Table 3.4). At the bottom of the range, the costs met by Natural England for Lower Derwent Valley are more than matched by inputs made by others (£182,000). The figure at the top of the range is for Bure Marshes and includes funding for the Hoveton Wetlands Restoration Project supplied by European Union (EU) LIFE+ and Heritage Lottery Fund (HLF).

3.2 Data generated by the initial accounts

The initial accounts calculated gross asset values, present values of costs and net asset values (terms described in Section 2.1) based on initial projections for delivery of the plan to achieve the long term goal. This information is presented in Table 3.5 along with the long term goal. It is illustrated in graphs that follow the table.

3.3 Is CNCA appropriate for the NNRs? Information from the initial accounts and SRMs

The results of the assessment of whether CNCA is appropriate for the NNRs focuses on the information in the initial accounts, the process of developing the accounts and the monitoring of NNRs. They employ information from the accounts and the SRMs. The results are discussed in Section 4.

Information in the initial account

The SRMs identified that the initial accounts supplied information that could be useful to Natural England as well as to them. Specifically:

- To develop the initial accounts, the SRMs identified the environmental goods and services provided by the NNR. Five of the SRMs said they did not have this recorded elsewhere and one suggested it might help inform applications for external funding.
- The accounts estimated monetary values for part of what the NNR provides to society (including recreational and educational visits). Five SRMs said they could employ these values for example in explaining what the NNR provides to society, supporting the case for investment, assisting with the development of partnership arrangements and informing applications for external funding. In the words of an SRM: “It is useful information on the benefits of the NNR to share with stakeholders and the local community”.
- Evidence on the value of inputs by volunteers (and by other external bodies) was welcomed by three of the SRMs. One SRM explained: “We are often asked what volunteers contribute but didn’t have this kind of evidence to use”. Another said: “I was surprised at the value of volunteer input. That will be of great interest”. Amongst other things, information on the inputs by volunteers secured as a result of funding for the NNRs helps demonstrate the importance of that funding.

Nine months after development of the initial accounts, three of the SRMs had not yet used information from the initial accounts. Two had used information, specifically the description of flood risk management provided by the NNR, and for the current year, numbers of people trained and the monetary value of recreational and educational visits. The SRMs had not identified how the summary monetary values calculated for the initial accounts (the present values of costs and gross and net asset values) would be of use to them.

Table 3.2. Provisioning goods & services provided by the NNRs

Key: ● One of the main goods/services relative to others provided by NNR; ○ Provided at low levels relative to other goods/services provided by NNR.

Categories used are based on the Common International Classification of Ecosystem Services (European Environment Agency 2013).

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Provisioning					
Inputs to food for human consumption (not inputs to animal or crop production):					
Cultivated crops.					
Reared animals and their outputs.			○		
Wild plants, algae and their outputs.	○		○		
Wild animals and their outputs.	○		○		○
Plants and algae from on-site aquaculture.					
Animals from on-site aquaculture.					
Drinking water for humans:					
Surface water.				○	
Ground water.					
Biomass for human use:					
Fibres and other materials for direct use or processing.	●	●	●		
Materials for agricultural use.	●			●	●
Genetic materials from all organisms.	○	○			
Water for human use (not drinking):					
Surface water.			○	○	○
Ground water.	●				
Energy for human use (other than food):					
Plant resources that generate energy.	●	○	●	○	○
Animal resources that generate energy.					
Draught power provided by animals.					

Table 3.3. Snapshot of the quantity of some environmental goods and services provided by the NNRs in 2016

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Area	492 ha	293 ha	221 ha	365 ha	452 ha
Habitats	Sand dunes and slacks, grassland, woodland, plantation, beach.	Lakes, fen, reed and sedge beds, fen meadow, wet woodland, grassland.	Ancient woodland, plantations, grassland.	Woodland, lowland heathland, lowland bog.	Grassland, reedbed.
Proximity to centres of population	Close	Not close. Access by boat.	Close	Not close	Not close
Quantity in 2016:					
Grazing	225 sheep	0	0	296 ha	453 ha
Number of recreational visits	100,000	5,000	100,000	80,000	27,500
Number of educational visits with educational input from NNR team	500	144	2,000	700	5,878 [47]
Number of educational visits providing their own tuition	820	0	2,000	700	81
Number of volunteers and trainees trained	41	Not quantified	6 [48]	Not quantified	5
Number of research projects[49]	10	6	3	Not quantified	45
Net flux of carbon (tonnes of carbon dioxide (CO_2) equivalent)[50]	-75,900	446 [51]	-155,000	-180,000	364

[47] A looser definition of educational visits is used for this NNR than that employed for others.

[48] Students gaining educational work experience.

[49] Note that the SRMs differed in the types of projects that they included under this.

[50] For explanation of negative and positive figures see Section 2.2. Data rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

[51] This estimate is incomplete. It does not include the net carbon flux for wet woodland and shallow lakes because suitable data were not available.

Table 3.4. Snapshot of the value of environmental goods and services and costs for the NNRs in 2016

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Value in 2016[52]:					
Value of goods and services that are not traded:					
Recreational visits (£)	383,000	19,200	383,000	307,000	105,000
Educational visits with educational input from NNR team (£)	2,010	497	6,900	3,110	20,700[53]
Educational visits providing their own tuition (£)	2,440	0	4,170	2,300	321
Net flux of carbon[54] (£)	4,810,000	-29,500 [55]	9,820,000	11,400,000	-23,000
Revenue for goods and services that are traded (includes rent for grazing)(£):	500	0	3,040	0	21,100
Total costs excluding capital items:					
met by Natural England (£):	146,000	1,810,000[56]	195,000	192,000	122,000 [57]
met by others (£):	51,800	11,300	52,000	100,000	182,000[58]

[52] Data rounded to three significant figures.

[53] Based on a looser definition of educational visits than that used for other NNRs.

[54] For explanation of negative and positive figures see Section 2.2. Calculated using data on net carbon flux that are estimated with low confidence.

[55] This estimate is incomplete. It does not include the net carbon flux for wet woodland and shallow lakes because suitable data were not available.

[56] Includes funding for major habitat restoration project from EU LIFE+ and HLF.

[57] Includes costs attributed to producing green hay seed source.

[58] Includes costs attributed to producing green hay seed source.

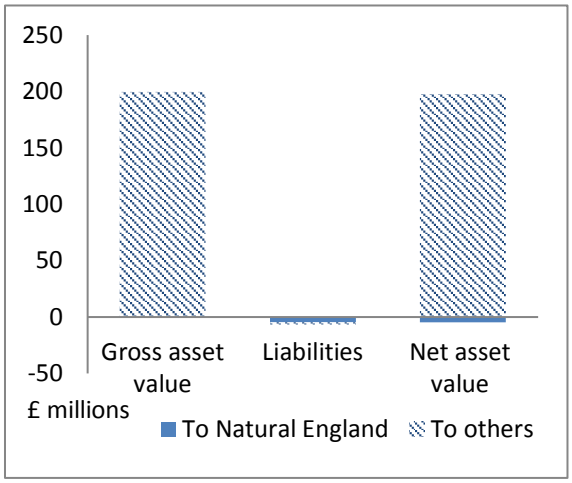
Table 3.5. Data generated for the projections in the initial accounts.

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Long term goal employed in the initial account	*Anticipated goal:* Achieve & maintain favourable condition status across all units of the NNR. Develop & enable community access, education, research, health benefits & recreation.	Achieve & maintain favourable conservation status while encouraging appropriate public access and engagement.	*Anticipated goal:* Increase biodiversity within NNR & over the connected landscape, achieve favourable condition of SSSI & continue to offer a good visitor experience & education/events to inspire the public to want to look after nature.	Sustain high nature conservation value.	Maintain favourable condition & improve nature conservation outcomes.
Gross asset value (£ millions)	**199.549**	**- 0.729**	**449.035**	**515.835**	**4.094**
to Natural England	0.253	0	0.058	0	0.644
to others	199.296	- 0.729	448.977	515.835	3.450
Total present value of costs (£ millions)	**6.338**	**8.408**	**9.193**	**9.058**	**9.527**
met by Natural England	4.896	8.100	7.656	6.101	4.190
met by others	1.442	0.308	1.538	2.957	5.338
Net natural capital asset value (total, £ millions)	**193.211**	**- 9.137**	**439.841**	**506.777**	**- 5.433**
to Natural England	- 4.643	- 8.100	- 7.598	- 6.101	- 3.546
to others	197.854	- 1.037	447.440	512.878	- 1.887

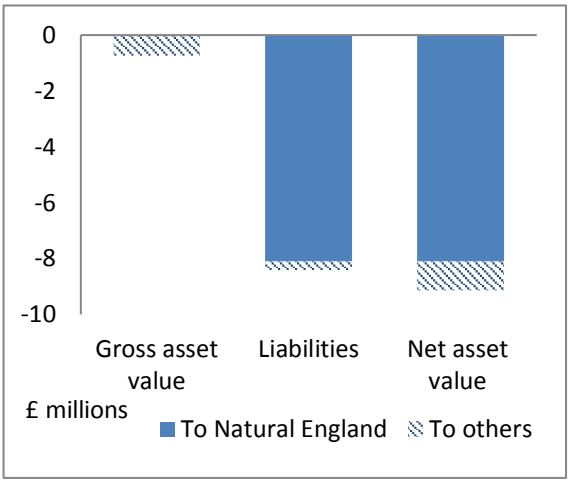
Graphs of data generated by the initial accounts

Note: the graphs have different scales.

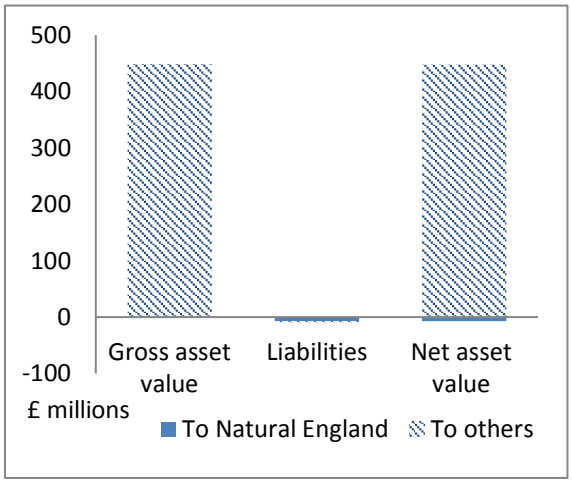
Graph 1: Ainsdale Sand Dunes NNR



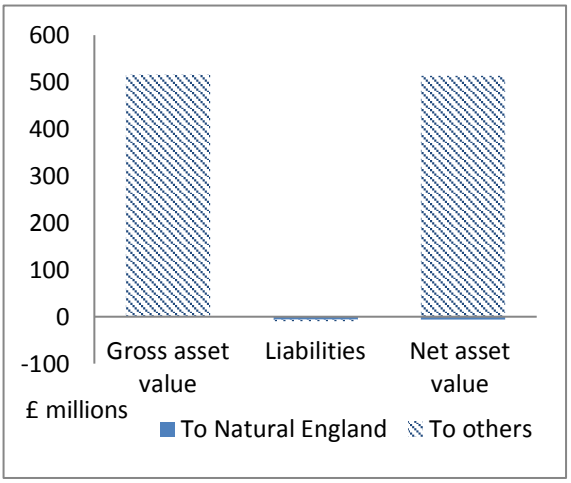
Graph 2: Bure Marshes NNR



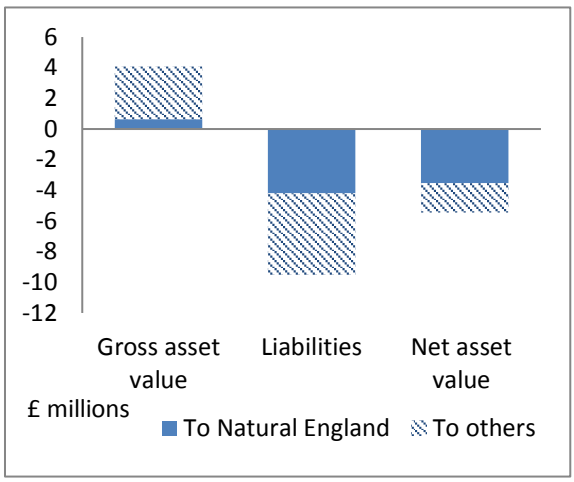
Graph 3: Castle Eden Dene NNR



Graph 4: East Dartmoor NNR



Graph 5: Lower Derwent Valley NNR



Development of a long term management plan for delivering a specified long term goal for the NNR (setting out the costs and benefits for each year over 20 years) was helpful to four of the SRMs. It enabled the SRMs to identify the information required, the funding needed, capital items required, and actions that need to be taken in the shorter term. They thought it could also help develop bids for external funding. An SRM explained: “It demonstrates the increase in asset value of a grand plan; the value to society and to Natural England”. Another said: “it provides a plan for visitors as well as ecological management”. Current practice is for each NNR to have a detailed management plan covering five years and a narrative that describes a long term vision (with a time horizon of 50 years).

The SRMs had a concern about the information in the accounts. Though nature conservation was represented in the indicators of ecosystem quantity and quality, it was only partially valued in monetary terms (as part of the value of recreational visits; discussed in Section 2.1). In group discussion, the SRMs identified a risk that users of the account may focus on monetary values which could lead to undue weight being given to goods and services that have monetary values and other benefits of nature conservation being overlooked. One SRM observed when developing the initial account: “The NNR is delivering a lot ecologically but that is not being reflected in the monetary values”.

Process of developing the initial account

The SRMs identified three main aspects of the process of developing the accounts that were helpful.

Identifying and describing environmental goods and services provided by the NNR was particularly informative:

- The SRMs found that the framework that was employed enabled them to systematically take a broad perspective on what is delivered by the NNR. It helped them consider the wider benefits that the NNR provides to society in addition to nature conservation. Five of the SRMs identified this as worthwhile. One observed: “It is useful to reflect on what we are doing. It made me think about things differently – I don’t think about the value of things like school visits”. Another said: “It made me think about things that aren’t biodiversity – I need to do that”.
- Identifying the environmental goods and services that are delivered also led the SRMs to consider whether the NNR could provide further goods and services, including those that might offer new sources of revenue. Three SRMs noted this; one said: “It makes you think what the potential is”. The process was prompted by the check list of goods and services in the workbook.
- In trying to quantify the goods and services, three of the SRMs identified information that they would record or obtain to help with this. Examples include numbers of educational visits that do not have input from the NNR team and numbers of recreational visits. As a result, one of the NNRs now collects data on participants’ postcodes in its evaluation questionnaires for educational events.

Development of the initial accounts offered an opportunity to take time to think strategically about the NNR; this was noted and welcomed by four of the SRMs. Specifying a long term goal and developing a detailed long term plan for its delivery helped them to do this. An SRM explained: “It makes you re-evaluate what we’ve got here and what we are doing and do long term strategic thinking which often we don’t have time to do”. Another said: “It makes you think differently: identify what is feasible and work that through with a plan”. One said: “It acts as a prompt for what to include in the next five year management plan review”. Having several hours set aside without interruption was also an important feature.

Participation in the study was a learning experience. Two of the SRMs said that they needed to understand what CNCA is based on and how it works before they could develop an initial account. Nine months after developing the initial accounts, three of the SRMs noted that participation in the study had built their confidence in talking about 'natural capital'.

Monitoring the NNRs

The initial accounts presented the following information on each of the three purposes of NNRs:

- Key indicators concerning delivery of nature conservation were presented in the section on ecosystem quantity and quality. These were specific to each NNR. Most were quantitative, some were qualitative. However, the monetary value of nature conservation other than that captured in the value of recreational visits was not estimated (discussed in Section 2.1).
- Data on the number of research projects were recorded, but a monetary value could not be estimated.
- Numbers of recreational visits were recorded and a monetary value estimated.

This is discussed further in Section 4.

The SRMs participating in the study were very concerned about the additional work that could be involved in reporting against the account in future. This was mentioned by five of the SRMs. They said they would struggle to report against the account if it involved additional data entry beyond what they are already encouraged to undertake.

Having invested in developing the initial accounts, nine months later, four of the SRMs said that they would like to report against the account in future. Four thought it would enable them to review what has happened on the NNR. When asked, three of the SRMs did not think the account would be a helpful monitoring tool for them to employ and two did not know if it would help monitor what their team delivers on the NNR. One SRM identified that it would help ensure that staff record useful information regarding non-wildlife aspects of delivery. The SRMs were unable to comment on their experience in undertaking reporting as they had not done so.

4 Discussion

This section discusses the results presented in Section 3 and insights from the study. First it considers data entered in the initial accounts, then data generated by the accounts, and finally whether CNCA is appropriate for the NNRs.

4.1 Data entered in the initial accounts

The discussion below considers the quantity then value of environmental goods and services, followed by costs.

Quantity of environmental goods and services

Quantities could be estimated in the initial accounts for only some environmental goods and services. Important goods and services provided by the NNRs that could be described but not easily quantified include (but are not limited to):

- Advice that NNR staff give to local land managers and conservation organisations. This contributes to improved land management in the area.
- Flood risk management and reductions in erosion risk inland and on the coast[59]. The land management on some of the NNRs reduces the risk of flooding for major infrastructure, villages and farmland.
- Improvements in air quality and water quality.
- Conservation of historical and archaeological heritage.
- Aesthetic value, including the contribution to the landscape.

The ranges in the quantities of environmental goods and services (Table 3.3) reflect differences in the NNRs. For example, the number of recreational visits in 2016 ranged from 5,000 (for the NNR that is mostly lake and wetland, accessible only by boat) to 100,000 (for the NNR close to Peterlee (a town) and the NNR that is easily accessible to people in Liverpool and Southport).

The net carbon flux in 2016 ranged from -180,000 to + 364[60] tonnes of carbon dioxide equivalent[61] (Table 3.3). For Lower Derwent Valley and Bure Marshes, estimated net carbon flux is positive. However, the estimate for Bure Marshes is only for 22% of the area of the NNR; estimates are not available for the habitats that cover 78% of the NNR (most of which is wet woodland). Both of the NNRs have reedbed (and Bure Marshes also has tall-herb fen and sedge beds) which are net emitters of carbon dioxide and/or methane. The other NNRs all have woodland that provides net sequestration of carbon (which is a negative net carbon flux). In Forest Enterprise England's account (2017), in 2016/17, woodland in the Public Forest Estate in England made a contribution to carbon sequestration of 1,677,396 tonnes of carbon dioxide equivalent. Bogs in the Estate had relatively low total emissions of 8,784 tonnes of carbon dioxide equivalent.

[59] The Environment Agency advised that quantitative estimates would need to be site specific and would be resource intensive to develop (personal communication 2016).

[60] The estimate for Bure Marshes, which is incomplete, is not included in this range.

[61] Estimated with low confidence due to use of generalised data for broad habitat types.

Value of environmental goods and services

In the initial accounts, some goods and services provided by the NNRs could be quantified but not valued in monetary units, these include the following (the first three of which are difficult to value in monetary terms):

- a resource for research (which includes academic research projects, citizen science research projects, contributions to long term monitoring projects);
- virtual access for example via social media (which, amongst other things, is important for members of society who cannot visit an NNR);
- training of volunteers and apprentices and provision of educational work experience;
- therapeutic visits for people with mental health issues and recovering drug addicts[62];
- non-use values (discussed in Section 2.1).

It is unlikely that robust estimates will become available for the goods and services that were not valued either because it is difficult or prohibitively expensive to value them in monetary terms[63] [64]. Consequently, if CNCA was adopted, the estimates of total values of goods and services provided by the NNRs would be partial. Forest Enterprise England's account (2017) is also partial. Monetary values are not included for regulating air and water quality, flood risk management and the benefits of biodiversity not captured by other services (for example, the visible diversity of flora and fauna contributes to the recreation value). Eftec (2016) explain that the benefits that are not valued include: biodiversity's non-use value and its contributions to resilience and to the long term provision of goods and services.

The absence of research and non-use values from the monetary value is important. Non-use values would reflect part of the value of the healthy natural environment that is provided by nature conservation (as discussed in Section 2.1). Nature conservation and research are two of the three purposes of NNRs (discussed further in Section 4.3). They are included in non-monetary components of the account: research features in the quantity of goods and services and nature conservation is represented in the indicators of ecosystem quantity and quality (and part of its monetary value is captured with recreation). However, there is a risk that users of the account may focus on monetary values and overlook other quantitative information.

Costs

For the initial accounts, with one exception, all costs were aggregated together for each NNR. Ideally, in CNCA the costs of delivering specific goods or services are separated out and used to calculate net asset values for the goods and services (this follows the conventions for ecosystem accounts set out in United Nations and others (2014)). However, with one exception[65], the SRMs could not easily separate out the costs in this way. In the

[62] If other providers charge for comparable therapeutic visits, their charges could be used to estimate the value of the visits. This would involve additional research, which was not undertaken for this study.

[63] It would be technically feasible to estimate the non-use value of nature conservation. However, it would be expensive to undertake a thorough study and the robustness of the estimates would be low. Amongst other things, it is difficult for people to estimate their willingness to pay for a service that they are not used to purchasing.

[64] Values that are specific to each good or service are employed in the initial accounts as these are expected to be more robust estimates of value than a generic value based solely on the condition of SSSIs. Estimates of value based on SSSI condition could be made based on the findings of GHK Consulting and others (2011). If they were used, the values from that study would replace all estimates of the value of goods and services employed in the initial accounts (otherwise double counting would arise).

[65] The costs were separated out only for production of green hay seed source at Lower Derwent Valley NNR.

account for the parks and open spaces in the London Borough of Barnet, costs are not allocated to specific goods and services (Eftec and others 2017). However, in Forest Enterprise England's account, total costs are allocated between those that can be attributed to goods and services and those that cannot. In the first year of projections, the attributable costs are allocated to delivery of specific goods and services[66]. Thereafter, allocated costs are assumed to vary in proportion to estimated outputs. Costs that cannot be attributed are assumed to remain constant (Eftec 2016).

4.2 Data generated by the accounts

Data generated by CNCA would usually be from reporting against the account. The focus would be on changes relative to initial projections for the plan to achieve the goal. The summary monetary value would be the net natural capital asset value for the year that is being reported. It would be presented alongside the net asset value for the reference scenario along with the changes in asset value and costs (discussed in Section 2.1). This information is not available because the initial accounts have not yet been reported against. Instead, summary data for initial projections are presented. The estimates of gross and net asset values are partial because not all of the goods and services provided by the NNRs can be quantified or valued.

Net asset values

For the five NNRs, the net natural capital asset value for the plans to achieve the long term goals ranged from -£9 million to +£507 million (Table 4.1). The net asset value is the present value of the projected stream of value of goods and services (gross asset value) minus the present value of the flow of all costs for delivery of the goal (Section 2.1). Because CNCA is a tool for monitoring rather than appraisal, it does not matter whether the net asset value is positive or negative, large or small, it is the changes that are reported in future that matter. However, there are risks that the account can be misinterpreted as providing appraisal or a snapshot of economic value (discussed in Section 2.1). To understand the range in net asset values (and why one of the figures is negative) it helps to look at the data used to calculate them.

Gross asset values

When considering the gross asset values calculated for this study, it is important to bear in mind that they do not include costs of delivering specific goods and services[67], so they should be compared with care. They include not only the value provided by the environment but also the value delivered by inputs of labour, equipment, machinery, buildings and visitor infrastructure (discussed in Section 2.1). The costs of these inputs may differ between NNRs. The initial accounts separate out the gross asset values to Natural England and to society. The value to Natural England is the revenue that it receives. For two NNRs this is zero. It is highest for Lower Derwent Valley which generates almost half of its revenue from production of green hay seed source. The gross asset value to 'others' (society) comprises the value of recreational and educational visits and net carbon flux. The value of these does not appear in Natural England's financial accounts for the NNRs. In the initial accounts, the gross asset value to society of recreational and educational visits alone greatly exceeds the gross asset value of revenue to Natural England for all five of the NNRs. The balance was similarly skewed in Forest Enterprise England's account (2017). In 2016/17 benefits to society (from recreation and carbon sequestration) were 98% of the gross asset value of its management of the Public Forest Estate in England, whereas 2% was from sales. In the

[66] A similar approach could potentially be adopted if accounting was adopted for the NNRs, but it would be subject to high levels of uncertainty.

[67] with the exception of production of green hay seed source by Lower Derwent Valley NNR (Section 3.1).

account for Windsor Great Park, 94% of the gross asset value was the value to society and 6% was from income (Eftec and others 2015a).

Relative to the others, two NNRs have particularly low gross asset values: Lower Derwent Valley (£4.094 million) and Bure Marshes (- £0.729 million, note that this value is partial[68]) (Table 4.1). This is because both include habitats (reedbed amongst others) that are net emitters of carbon dioxide and/or methane. Though these wetland habitats store significant stocks of carbon beneath the surface, this is not represented in the monetary values in an account (it was included in the accounts as an indicator of ecosystem quality, as discussed in Section 2.2). Net emissions of carbon dioxide and/or methane impose a cost on society, so have a negative monetary value in the accounts. The value per unit for net carbon flux (using figures from government guidance) is high and increases in future years[69]. The large negative value of net emissions overwhelms the positive value of other elements of the asset value (such as recreational visits) and diminishes the contribution that the positive values make to the gross asset value.

If the value of net carbon flux is removed from the calculations, the gross asset value is £5.248 million for Lower Derwent Valley and £0.585 million for Bure Marshes, revealing its negative influence (Table 4.1). For the two NNRs, the difference in the gross asset values excluding net carbon flux is largely explained by the lower numbers of recreational and educational visits at Bure Marshes. This is because it is accessible only by boat; the initial account assumes 5,000 visits per year in all years (based on past records). However, in 2016, visit numbers increased to 7,000 and are now expected to increase further[70] (Natural England personal communication 2017). The continuing increases in recreational and educational visits assumed in the goal for Lower Derwent Valley also contribute positively to the gross asset value in its account.

For the other three NNRs, gross asset values are relatively high, ranging from +£200 million to +£516 million. This is because all these NNRs contain large areas of woodland that provide net sequestration of carbon[71]. In these NNRs, the area of woodland is 160 ha, 194 ha, and 235 ha and the gross asset value increases in the same order (Table 4.1). Carbon sequestration is of benefit to society, so has a positive monetary value. The value per unit of carbon sequestration is high and increases in future years[72]. Consequently, the total present value of net carbon flux contributes 94% to 98% of the gross asset value for each of these three NNRs. It is the majority of the gross asset value to others (not Natural England), which also includes the value of recreational and educational visits (which together contribute 2% to 6% of the gross asset value for each of the three NNRs; revenue contributes less than 1%). In Forest Enterprise England's account (2017), in 2016/17, net carbon flux contributed 33% of the gross asset value of its management of the Public Forest Estate in England (recreation and public access contributed 65%; sales of timber 1%).

[68] It does not include net carbon flux for habitats that cover 78% of the NNR (which are mostly wet woodland) because suitable data were not available.

[69] The cost to society of emitting a tonne of carbon dioxide or the equivalent in 2016 was valued at £63; this rises to £115 in 2035 (DECC and HM Treasury (2015).

[70] If the account was reported against, these increases would appear as a positive change relative to the reference scenario.

[71] This does not include wet woodland (which covers 59% of Bure Marshes NNR). Suitable data were not available to estimate net carbon flux for wet woodland.

[72] The benefits to society of sequestering the equivalent of a tonne of carbon dioxide in 2016 was valued at £63; this rises to £115 in 2035 (DECC and HM Treasury (2015).

If the value of net carbon flux is removed, the range in asset values for the three NNRs is greatly reduced to £9.44 million to £11.7 million[73] (Table 4.1). These values exceed those for Bure Marshes and Lower Derwent Valley because the three NNRs receive significantly higher numbers of recreational visits per year (80,000 to 100,000 compared with 5,000 to 27,500, Table 3.3). For Ainsdale Sand Dunes and Castle Eden Dene, the long term goal used in the account also contributes to the gross asset value (through revenue from products (eg timber and biomass) of woodland management undertaken in future to achieve the goal). For East Dartmoor NNR, the long term goal does not entail any predicted changes in future so has no impact on the gross asset value.

Table 4.1 Gross and net asset values including and excluding net carbon flux

National Nature Reserve	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Total gross asset value (£ millions):					
including net carbon flux	199.549	- 0.729	449.035	515.835	4.094
excluding net carbon flux[a]	11.697	0.585	11.720	9.436	5.248
Net carbon flux total present value (£ millions)[a]	187.852	-1.313	437.314	506.399	- 1.154
Woodland known to sequester carbon	160 ha	0	194 ha	235 ha	0
Total present value of costs (£ millions)	6.338	8.408	9.193	9.058	9.527
Total net asset value (£ millions)					
including net carbon flux	193.211	- 9.137	439.841	506.777	- 5.433
excluding net carbon flux	5.359	- 7.823	2.527	0.377	- 4.279

[a] Note that due to rounding errors the sum of gross asset value excluding net carbon flux and total present value of net carbon flux may not equal gross asset value including net carbon flux.

For the three NNRs, removal of net carbon flux from the calculations greatly reduces the gross asset value for the initial accounts. The range in gross asset value falls to £9.4 million to £11.7 million (Table 4.1), a reduction of 94% to 98%. This reveals the enormous influence that net carbon flux has on gross asset values for NNRs with large areas of woodland known to sequester carbon.

Total present value of costs

Turning to the total present value of costs, these ranged from £6.3 million to £9.5 million (Table 4.1). The costs are determined by a number of factors including the plan and long term goal used for the account and the NNR itself (including the habitats, location, size, ease of access, staffing, input by volunteers, and maintenance of buildings and infrastructure needed). Analysis of the differences in the costs between the NNRs' initial accounts would be complex and is not undertaken here. The main determining factors of the total present value of costs are likely to be specific to each NNR.

The percentage of the present value of costs that were met externally ranged from 17% to 56%. This range excludes Bure Marshes NNR (for which the statistic is 4%) because, for the purposes of the account, costs met by Natural England include those covered by funding

[73] Rounded to three significant figures.

from European Union LIFE+ and the Heritage Lottery Fund for its major habitat restoration project (discussed in Appendix C Section 4). The range largely reflects differences in the level and type of inputs made by volunteers. These are affected by the work that is undertaken on the NNR, the number of people volunteering to make input and the amount and type of inputs that they make. In Forest Enterprise England's account (2017), in 2016/17, external inputs were 11% of the present value of costs that were not attributed to specific goods and services. For Wimpole Hall Farm, managed by the National Trust, 29% of the present value of costs not attributed to specific goods and services were met by volunteers (Eftec and others 2015a).

4.3 Is CNCA appropriate for monitoring NNRs managed by Natural England?

This section draws on the results and insights from the study to consider whether CNCA is an appropriate tool to employ for NNRs managed by Natural England. It discusses information and processes supplied by CNCA followed by the application of CNCA for monitoring and to inform decisions.

Information and processes supplied by CNCA

Useful information provided by CNCA is discussed below, including valuation of inputs, goods and services, and helpful processes.

CNCA compiles information that might not otherwise be drawn together in the same place. The initial accounts developed for this study presented some data on nature conservation, research and access that are not currently formally reported for all NNRs managed by Natural England, though most of the information was held by NNR staff[74]. For the goods and services that are valued in monetary terms, the effects of changes in management can be aggregated in a common unit and the impact on society as well as the business can be assessed.

The account estimates the value of inputs made by others. It helpfully separates these from costs paid for by the organisation (Section 4.2). The account also estimates the monetary value of some non-traded goods and services that are provided to society and separates this from the financial revenue to the organisation. However, non-traded goods and services may be valued in the account in terms of their exchange value (for reasons explained in Section 2.1). The economic value (in terms of the impacts on economic welfare) would be of greater use to SRMs and Natural England. For recreational visits, this would be estimated using different techniques to accounting values (discussed in Appendix C Section 6). It transpires that the currently available national average estimates of economic values are similar in magnitude to those used in the account. However, in the event that they change in future or more specific estimates are sought, it would be preferable if estimates of economic value were supplied separately from accounts[75].

For each NNR, development of the initial account involved providing projections for nature conservation, research, access and costs over the next 20 years for delivery of a plan to

[74] The exceptions are the estimates of monetary values of non-traded goods and services, which were supplied by the analyst.

[75] If CNCA was adopted, the approach could be altered so the account employed economic values to estimate the value of recreational visits. However, if consistency is sought in CNCA in future, use of exchange values may be necessary (discussed in Section 2.1).

achieve a long term goal. The SRMs found this helpful (Section 3.3). Currently, there are not formal mechanisms in place to record such long term projections for most NNRs. If they were sought, such projections could be supplied by CNCA. However, they could also be recorded and monitored without the additional investment needed for CNCA (for example, if NNRs developed long term plans and monitored delivery of them).

In addition to the above, development of the initial accounts involved other processes that are of use to the SRMs (Section 3.3), such as identifying the environmental goods and services provided by the NNR. It also supplied information that is helpful for the SRMs and Natural England, such as the value of what the NNR provides to society and the value of inputs by volunteers. These processes and information could be supplied by CNCA (though they would not necessarily be[76]). However, resources that would deliver them could be provided relatively easily without the additional investment required to undertake CNCA

Monitoring and decision-making for NNRs

This section presents insights from the study about the use of CNCA for monitoring NNRs and informing decision-making. That is followed by discussion of monitoring and decision-making by the national NNR team and SRMs and factors to consider if CNCA is adopted for all NNRs managed by Natural England.

Insights into monitoring NNRs with CNCA

The monitoring that CNCA provides of the three purposes of NNRs is discussed below. That is followed by insights from the study on the effects of carbon sequestration on the sensitivity of CNCA for monitoring, the impact of transfers of management of NNRs to other organisations on CNCA summary data, and insights into the impacts of funding shortfalls.

CNCA is a tool for monitoring natural capital assets. It is designed to inform environmental management by assessing changes in ecological indicators, gross asset values and costs. Changes are assessed relative to initial projections for a plan to deliver a long-term goal. The account usefully draws together information on ecological indicators, environmental goods and services and costs in one place. The monitoring summary is focussed on monetary figures (presented in a balance sheet and statement of change).

The purposes of NNRs are only partly represented in the monetary values in CNCA though more information on them is recorded elsewhere in the account. The three purposes are to provide: nature conservation, a site for research and for access (Section 1). If CNCA was adopted using the initial accounts developed for the NNRs in this study, it would supply the following monitoring of the purposes:

- Nature conservation: the accounts would monitor ecological indicators that were particularly relevant to each NNR (as these are what were used in the initial accounts). The SRMs monitor these indicators informally, if not formally, already. Natural England monitors delivery by all of the NNRs that it manages using standardised indicators. If an account was adopted for all the NNRs managed by Natural England, standardised indicators would be more appropriate to employ as they could be compared and compiled (discussed further below). The monetary value of nature conservation would be partially captured in the account in terms of its contribution to the value of access. The non-use value would not be included (discussed in Section 4.1).

[76] For example, the SRMs would not need to identify the goods and services provided by an NNR if the accounts focussed on the main goods and services provided by NNRs and drew on Natural England's records for these. Also, the SRMs would not need to develop a detailed long term plan if data for the NNR for the current year could be used to reflect the situation in future years. Both of these are discussed further in Appendix K.

- Research: the quantity of research projects would be monitored. The initial accounts focussed on the types of research that that were most relevant to each NNR (for example, student dissertations, citizen science projects), as identified by the SRMs (who keep records of them). The monetary value would not be estimated (as explained in Section 4.1).
- Access: the accounts would monitor estimates of numbers of recreational visits to the NNR, which staff already formally record each year. The monetary value of these visits would also be monitored.

In the accounts for the NNRs with significant areas of woodland that sequesters carbon, the value of carbon sequestration dominated the gross and net asset values. Because of this, monitoring the NNRs using the accounts' summary figures would be fairly insensitive to changes in the other goods and services. For the NNRs with habitats that are net emitters of carbon dioxide and/or methane, the value of the net carbon flux was negative. The negative figure was combined with the positive value of other goods and services to calculate the gross asset value. For these NNRs, because the gross asset value combines positive and negative values, monitoring changes in goods and services (and their values) would involve a good understanding of the data.

If Natural England employed CNCA for all its NNRs, transfers of management of NNRs to other organisations would be reported as a negative change in the account (a reduction in quantity of assets). Such transfers have arisen recently largely through landowners wishing to take back management of NNRs following the expiry of leases to Natural England (Natural England personal communication 2017). If the organisation taking on the NNR had a CNCA account, the transfer would appear as a positive change in its account (an increase in assets). Such changes would require explanation to manage the risks of misinterpretation.

CNCA monitors delivery of a plan to achieve a long term goal. The monitoring is reliant on the goal remaining unchanged. If the goal is altered, the reference scenario that is employed for comparison is altered and the monitoring is restarted (Section 2.1). For CNCA to monitor NNRs effectively in the long term, the goal that was used would need to be suitable for use over the long term. It would need to withstand impacts of factors such as climate change, pests and diseases.

If shortfalls in NNR funding arose, CNCA could potentially offer helpful insights in to the long term financial implications. These would be provided by monitoring updates of projections in the account for delivering the plan to achieve a long term goal. The account would record the anticipated increase in costs in the long term[77] that would arise as a result of the funding gap. It would also indicate the anticipated impacts on projections for ecological indicators and goods and services that can be quantified. In such a situation the account would be resource-intensive to report against (as it would involve updating projections in all aspects of the account). Alternatively, in the absence of CNCA, the implications of shortfalls in funding could be provided by monitoring updates to long term plans if these were adopted by the NNRs.

In summary CNCA could offer useful monitoring of the long term financial implications of shortfalls in funding. However, other monitoring tools may be more appropriate. This is because there is a risk that people would focus on the summary monetary values from monitoring with CNCA. These values only partly represent the three purposes of NNRs and

[77] Assuming that adequate funding would be available in future and the goal remain unchanged.

may be dominated by carbon sequestration. Also, the summary data from CNCA is complex and difficult to interpret. It is presented as the discounted total value of projections.

Insights into making decisions about NNRs using information from CNCA

This section discusses insights from the study about the use of information from CNCA to inform decision-making for the NNRs. It considers the extent to which the purposes of NNRs are represented in CNCA summary data. This is followed by discussion of the impacts of net carbon flux on the data and the risks that could arise if NNR management was driven by a desire to report increases in net asset values. A further risk is discussed concerning the goal used for the account.

If CNCA was adopted for the NNRs, the three purposes of NNRs would be only partly represented in the summary monitoring data (which are monetary). Nature conservation would be partially valued in monetary terms, but not separately from access. Research would not be valued at all. This situation is not likely to change (as explained in Section 4.1). Though nature conservation and research would be assessed in the non-monetary aspects of the accounts, these may be given less attention than monetary values.

The SRMs participating in the study identified risks that could arise if undue emphasis was placed on the summary monetary values from CNCA in strategic decision-making about NNRs and allocation of NNR funding[78]. The initial accounts developed for this study suggest that the monetary values would be based on net carbon flux, recreational and educational visits, goods and services that are sold and costs. They would not reflect the many other benefits provided by the NNRs or the NNRs' effectiveness at delivering the principles of the NNR Management Standard.

For the NNRs involved in this assessment, the value of net carbon flux had a major influence on gross and net asset values (as discussed in Section 4.2). This is an issue in itself as the available data are estimated with low confidence[79] and there may not be estimates for some combinations of habitats and management (Natural England personal communication 2017). Indeed, data were not available for the habitats[80] that cover most of one of the NNRs involved in this study. These features of the net carbon flux data mean that there is a low level of confidence in estimates of net and gross asset values in the accounts. This would be of concern if the information was used to inform decisions.

Risks could arise if NNR management was driven by a desire to report increases in net asset values and it was inconsistent with delivering the goal employed in the account. Such increases might be achieved by enlarging the area of woodland that sequesters carbon and/or not removing such woodland. A similar effect would be achieved by avoiding expansion of habitats that are net emitters of carbon dioxide and/or methane (such as some fen, marsh and wetland habitats) or reducing their area[81]. These actions might all increase net asset value in CNCA reporting but if they were not compatible with the goal, they would not deliver it. The risks would also occur but at a greater scale if a single account was adopted for a number of NNRs and management was focussed on increasing the NNRs' net asset values but was inconsistent with the long term goals for the NNRs. Such management would not deliver the NNR Management Standard. It is important to note that changes in

[78] They raised it in group discussion and two mentioned it individually. One SRM explained: "I remain concerned about its possible misuse, given the unavoidable emphasis on financial and measurable aspects which can allow biodiversity benefits to be underplayed or ignored".

[79] Generalised values that are best estimates for broad habitat types would be used as site-specific data are not likely to be available (Natural England personal communication 2016).

[80] Including wet woodlands and shallow lakes which could have large fluxes.

[81] The value of net emissions of carbon dioxide and/or methane in the accounts is negative and significant.

carbon stocks, which are important to consider in climate change mitigation, are not included in the monetary values in an account (though they were employed as indicators of ecosystem quality in the initial accounts).

The SRMs who participated in the study identified[82] a further important risk in certain situations concerning the goal used for the account for an NNR. If the goal employed was an ambitious plan, the SRMs identified that any necessary discussions and engagement with stakeholders would need to take place before details could be published.

CNCA provides a framework for compiling information. This in itself is potentially useful. It supplies information on progress in delivering a long term goal for the NNRs. It might also supply data on the value of recreational and educational visits[83]. However, care would be needed in the use of the summary monitoring data to inform decisions. Expertise would be required to interpret and understand the information (the summary data are discounted total projections for delivery of a plan).

Monitoring and decision-making by the national NNR team

The national NNR team in Natural England employs a number of datasets to monitor delivery on the NNRs. The main indicator that the NNR team uses to monitor delivery of nature conservation is the condition of SSSIs, though the team also draws on a number of other datasets[84] (Natural England personal communication 2017). In addition, the team draws on data recorded by staff in the recording system that Natural England uses for the NNRs (Countryside Management System international (CMSi)) concerning numbers of recreational visits, revenue and bids for Natural England funding, amongst other things[85]. Though there is further information that the team might usefully collect to describe goods and services provided by the NNRs (for example on training and research), this could be achieved without the additional investment needed in CNCA.

Strategic decisions about NNRs made at a national level in Natural England are currently informed by NNR data recorded by staff on CMSi and other data held by the national team (such as a GIS data layer of habitats). The data in CMSi employed by the team includes SSSI condition, species abundance and distribution, numbers of recreational visits, educational events and costs (Natural England personal communication 2017). Staff in the national team have not had the opportunity to use data from CNCA reporting so there is no evidence on whether it would help inform their work. Decisions regarding NNRs are also taken by area teams in Natural England. Due to limited resources, information on their decision-making was not sought as part of this study.

The national NNR team would find estimates of the economic values of environmental goods and services provided by the NNRs useful, for example in presenting the case for funding (Natural England personal communication 2017). CNCA could be used to monitor the value of goods and services provided by NNRs, for the few that could be estimated in monetary units. Alternatively, these could be delivered separately from CNCA. In Natural England, the preferred framework for compiling information on the NNRs is CMSi, the system that is already in use (this could be an effective source of data if CNCA was adopted, as discussed in Appendix K).

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[82] In group discussion.

[83] The estimates might be exchange values, not estimates of the benefits to society (discussed in Section 2.1).

[84] Species surveillance, the butterfly monitoring scheme, breeding birds monitoring scheme, long term monitoring network, amongst others.

[85] The national NNR team encourages staff to enter in CMSi a minimum set of annual data for each NNR.

Monitoring and decision-making by SRMs

The SRMs who participated in the study had a mixture of views about how reporting against an account might be useful to them (Section 3.3). Their experience was only of developing an initial account; they had not had the opportunity to report against one. They had not yet identified a helpful contribution that CNCA would make to their monitoring of delivery on the NNR. The information that the SRMs draw on for this monitoring includes integrated site assessment, biological and ecological surveys, numbers of recreational visits, informal site checks and recording of completed projects on CMSi, amongst other things[86].

If the SRMs were to develop detailed long term extensions of their management plans for the NNRs, delivery of these would usefully be monitored. This could be supplied by CNCA, but a simpler mechanism could be employed. Currently, the NNR management plan (which is for five years) is reviewed every five years.

When they were asked nine months after development of the initial accounts, most of the SRMs did not yet know whether and if so how they would draw on the accounts to inform the decisions they make about the NNR. However, they had not used CNCA for monitoring. The information that the SRMs employ to inform their decisions includes the NNR management plan, monitoring data, staff expertise and knowledge, meetings with the NNR's community advisory group and feedback from participants in public engagement events, amongst other things[87].

Monitoring all NNRs managed by Natural England

If CNCA was adopted for all NNRs managed by Natural England, some important considerations concerning the goal, focus and limits of the account(s) are discussed briefly below.

The projections in CNCA are determined by the long term goal that is used and the plan to deliver it. For the purpose of the pilot study, the SRMs employed a goal that was most suitable for each NNR. Consequently, the projections in the accounts could not be compared between the NNRs or added together. Nevertheless, the accounts could be used to monitor delivery of the plan to achieve the goal for each NNR. If CNCA was adopted for all the NNRs managed by Natural England, the account would be more useful if it employed a single goal for all NNRs. This would be necessary for a single account for all the NNRs. If accounts were adopted for individual NNRs, use of a single goal would allow the data to be compiled[88]. Scope for comparison in the data would still be limited because of differences in the characteristics of the NNRs[89].

Development of a single goal for all the NNRs would be feasible, though would require careful consideration. It would need to reflect the range in situations for the NNRs (for example, some are not accessible to the public and/or cannot be used for research) and appropriate long term goals regarding nature conservation (for example, that reflected likely impacts of climate change). An important consideration would be the level of ambition to adopt. Eftec and others (2015a) suggest that if the goal used in an account does not set out to improve natural capital, at a minimum, it should maintain the current situation. To address

[86] Information collected through semi-structured interviews with SRMs.

[87] Information collected through semi-structured interviews with SRMs.

[88] For example, if accounts were developed for a representative sample of NNRs, the data could be drawn together to give an estimate for all of the NNRs managed by Natural England (discussed in Appendix K).

[89] The situations lie within the following ranges, amongst others: near cities or remote; large numbers of visits by the public or no public access; all SSSIs are in favourable condition or favourable condition is achievable only through major interventions that involve collaborative management by landowners at a landscape scale.

concerns that the value of biodiversity is not adequately captured in natural capital frameworks, Bolt and others (2016) suggest adoption of a more ambitious goal: achievement of biodiversity targets. Given that Natural England has not yet achieved its target for achieving favourable condition for SSSIs on the NNRs that it manages[90] and the management of NNRs should be exemplary[91], continuation of the current situation is not likely to be an appropriate goal for some of the NNRs.

The data in CNCA are also determined by the focus and limits of the account. For the pilot study, the accounts focussed on the NNR and the operations of Natural England (further details in Section 2.2). Forest Enterprise England's account is focussed on its management of the Public Forest Estate in England (which is the same as the operations of Forest Enterprise England) (Forest Enterprise England personal communication 2017). The account for the London Borough of Barnet focuses on land covered by the Borough's Parks and Open Spaces Strategy. Eftec and others (2017) note that the account could be expanded to include green belt, street trees, agricultural land or cemeteries. For the NNRs, a challenging focus would be to develop an account at a landscape scale that included the operations of all land managers. This would be reliant on all the land managers wishing to adopt CNCA and them providing the necessary data to develop the account and to report against it in future.

Understanding the changes reported in CNCA for all the NNRs would involve detailed understanding of the account(s):

- If a single account was adopted for all NNRs managed by Natural England, the projections would be for the aggregate of all the NNRs. Changes would arise not only due to shifts in the current situation on individual NNRs and for all NNRs but also modifications in projections to achieve the long term goal. Improvements in measurement and valuation would also affect figures in the account (as experienced with Forest Enterprise England's account (discussed in Section 2.1)).
- If accounts were developed for individual NNRs managed by Natural England, it would be easier to identify the shifts in the situation that were occurring on specific sites and the modifications in the projections that had been made. However, for this to inform Natural England's strategic management of the NNRs, the information would need to be compiled to create an aggregate picture for all sites. Changes in the aggregated data would be harder to understand.

Regardless of which of the above options were adopted, the summary monitoring information in the accounts would be complex (because it would be based on projections) and technical. It would need expertise to present and interpret.

[90] The target is for 70% of the SSSIs to be in favourable condition by 2020; in April 2017, 50% were in favourable condition (Natural England personal communication 2017).

[91] as specified in the NNR Management Standard (Natural England 2016).

5 Conclusions

The study found that development of initial corporate natural capital accounts for some NNRs supplied useful information, such as identification of the environmental goods and services provided by the NNR and estimates of the value of inputs made by volunteers. It also facilitated development of a detailed long term plan for delivery of a goal.

Though the initial accounts were not reported against, the study provided insights into CNCA as a tool for monitoring NNRs. The accounts could be employed to monitor delivery of goods and services (to society and to Natural England) by NNRs. However, this would be partial because not all services would be quantified and few would be valued in monetary terms (reporting is focussed on the monetary data). Delivery of the three purposes of NNRs could be assessed but only one fully valued in monetary units. In terms of costs, CNCA could be used to monitor some of the long term implications of gaps between current funding and the expenditure needed to meet a selected long term goal. The implications would be assessed in terms of effects on long term projections of costs of delivering the goal, ecological indicators, and the quantity and value of some environmental goods and services.

If Natural England wishes to monitor delivery of the three purposes of NNRs, an approach that is designed for the NNRs is likely to be more appropriate than CNCA. This could be developed in house, employing simple indicators. Such an approach could monitor delivery of all nine principles of the NNR Management Standard[92]. The approach that is adopted would also usefully monitor the quantity and quality of assets of the NNRs (ecosystems, infrastructure for visitors and management of the NNR, buildings, staff, volunteers) to assess the capacity of the NNR to deliver in the long term.

Adoption of CNCA could encourage staff to consider goods and services other than nature conservation that NNRs provide to society. It could help staff consider the NNRs as natural capital assets and facilitate them developing and monitoring long term plans for investment in those assets. However, these could be achieved through use of other tools that would adopt a natural capital perspective.

Though it currently has high salience, CNCA is a resource intensive and complex monitoring tool that only partially represents the NNRs:

- Considerable resource would be required to develop the analytical tool for the accounts (which could be within CMSi, subject to agreement with CMSi partners, or in a separate Excel workbook).
- It is likely that significant Natural England staff time would be needed to develop the initial accounts and to report against them in future. This is because, for at least some of the NNRs managed by Natural England, data for the current year could not be assumed to represent data for delivery of the long term goal in future (discussed further in Appendices K and L). For these NNRs, projections would need to be updated each time the account was reported against in future. If they were sought, a similar amount of work would be needed if the SRMs were to develop long term management plans for the NNRs and to update these periodically to monitor progress.
- CNCA is complex, technical and its summary information (which is monetary) is difficult to understand and interpret. This increases the risks that the accounts are not developed

[92] This would address the recommendation from a recent internal audit of NNRs that a central tool for monitoring delivery of the NNR Management Standard is employed for NNRs managed by Natural England (KPMG (2016) and Natural England personal communication 2017).

appropriately, do not evolve in the most suitable way, and the summary information is misused.

- Delivery of the three purposes of NNRs (nature conservation, research and access) is only partially valued in the summary monetary figures that are reported in CNCA. It is recorded in the detail of non-monetary parts of the account. The monetary values in the account are not likely to be sensitive to changes in delivery of the three purposes. The account does not monitor delivery of the principles of the NNR Management Standard.

There are alternatives for monitoring NNRs that would supply more transparent and accessible information and pose lower risks (these would require resources to develop). For example, for each NNR, staff could report against simple indicators for delivery of the NNR Management Standard and indicators of the NNRs' assets. If appropriate, they could develop a long term management plan (in CMSi) that was revised every five years (when the management plan is reviewed). If they would find it helpful, the national NNR team could access the data in the management plans to assess long term trends in costs, and anticipated future funding requirements. Compared with CNCA, these alternatives would not monitor the effects of NNR management on the total monetary net benefits to society. However, given that some important goods and services provided by the NNRs cannot be valued in monetary terms, CNCA would not offer much advantage over simpler alternatives.

The aim of CNCA is to support the long term safeguarding of natural capital assets. If Natural England wishes to employ further monitoring to help safeguard the assets in the NNRs it manages, this will be most effective if it employs an approach that is designed for the purpose, is simple and transparent.

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Appendices

A. The NNR Management Standard's Principles

The NNR Management Standard (Natural England 2016) sets out the key principles for management of all NNRs (whether they are under Natural England's responsibility or are managed by Approved Bodies). The principles were developed by Natural England in consultation with Approved Bodies to support consistency in the quality of management. In summary, the principles are as follows (further details in Natural England 2016):

1. The NNR series will seek to represent the best places for England's biodiversity and geodiversity.

2. A management plan for the NNR will be kept up-to-date and will reflect the requirements of this standard.

3. The management of designated features and the wider reserve is exemplary.

4. The NNR contributes to safeguarding and restoring ecosystems beyond its boundaries.

5. The management of the NNR provides opportunities for public enjoyment, quiet recreation and engagement.

6. Research into the natural environment at an NNR is promoted and knowledge is shared.

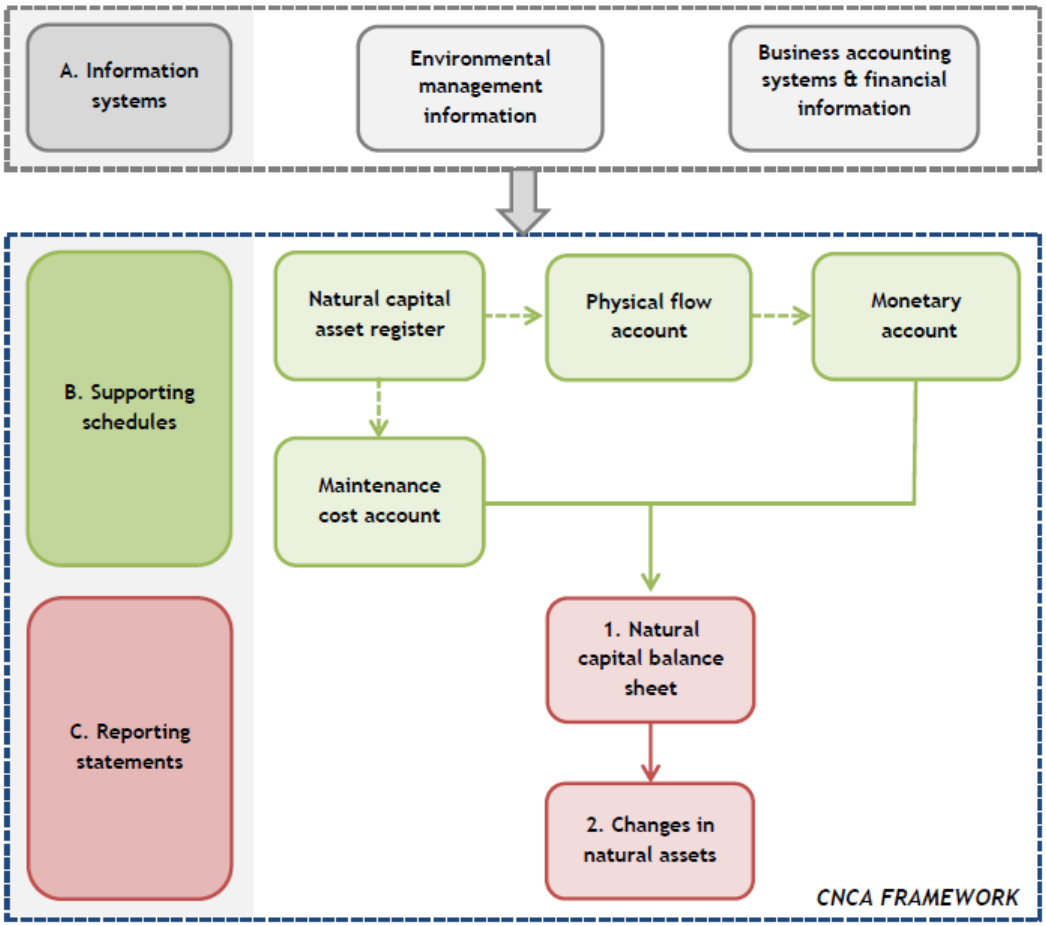
7. Communities and stakeholders are involved in the management of the NNR.

8. NNR managers will work collaboratively to promote the NNR series and wider goals.

9. NNRs will support opportunities to demonstrate exemplary conservation management to others.

B. CNCA – further information

Figure B.1: CNCA framework



Source: Eftec and others (2015a).

C. Method – further information

This appendix presents further information on the approach adopted in this study, the steps taken in developing the initial accounts and development of the workbook. It also provides additional information on key assumptions, parameters that were selected by the SRMs and the valuation of recreational and educational visits. It concludes with an overview of the steps that would be taken to report against an account.

1. Approach - further information

Initial development of the study benefitted from discussions between the analyst and colleagues with expertise in natural capital, National Nature Reserves (NNRs) managed by Natural England, and the information management system employed for the NNRs.

The NNRs that the study focussed on (Table C.1.1) were selected by knowledgeable colleagues to include a variety of habitats and a range in distances from centres of population which were expected to affect the accounts.

Table C.1.1 NNRs that participated in the pilot study

NNR	Main habitats	Distance from centres of population
South Solway Mosses (account not fully developed)	Lowland raised bog.	Not close
Castle Eden Dene	Ancient woodland, plantations, grassland.	Close
East Dartmoor	Woodland, lowland heathland, lowland bog.	Not close
Moor House-Upper Teesdale (account not fully developed)	Upland blanket bogs, heathland grassland and hay meadows, juniper woods.	Not close
Ainsdale Sand Dunes	Sand dunes, dune slacks, grassland, woodland, plantation, beach.	Close
Lower Derwent Valley	Grassland, reedbed	Not close
Bure Marshes	Natural eutrophic lakes; tall-herb fen, reed and sedge beds; fen meadow; wet woodland; grassland.	Not close

The Senior Reserve Managers (SRMs) who had been invited to participate in the study were given a brief initial introduction over the phone. They engaged enthusiastically in a workshop that shared further information. It involved an initial briefing on CNCA followed by lively discussion about opportunities, risks and constraints regarding the study and specific aspects of the accounts.

Initial development of the Excel workbook was undertaken in March and April 2016, based on information supplied by the SRM for Lower Derwent Valley NNR. The other SRMs made initial entries of data in the workbooks during a day in their office between May and July 2016 (one was assisted by a former SRM for the NNR). They were accompanied by the analyst for this, which enabled her to capture feedback from the SRM and identify issues that were arising. All SRMs said that it would have been far more difficult (and time consuming)

for them to develop the account if the analyst had not been on hand to offer advice. The presence of the analyst also helped the SRMs set aside time to work on the account. Following the initial input to the workbooks, the SRMs filled data gaps and responded to queries raised by the analyst and participated in a follow up interview with the analyst over the phone.

Following development of the initial accounts, options for adopting CNCA for all NNRs managed by Natural England were considered by the SRMs (and former-SRM) who participated in developing the initial accounts. The analyst proposed a set of options based on suggestions made by colleagues during development of the initial accounts. The SRMs shared their views on the options in writing (in the form in Appendix F). The options were narrowed down and developed further through subsequent discussions. Development of the options was also informed by discussions with Natural England's National NNR team.

2. Steps taken for development of the initial accounts

Development of the initial accounts employed the following steps (based on Eftec and others (2015a and b)). The description of these builds on the overview of CNCA in Section 2.1. To avoid unnecessary complexity, assessments of uncertainty were not included for the estimates used in the account. This would, however be possible if needed (Eftec personal communication 2016).

a. Specify the aim of the account

At the outset of the study it was established that the aims of the initial accounts were to investigate whether CNCA is an appropriate tool to apply to the NNRs, from the perspective of the SRMs and for Natural England. If CNCA was to be adopted by Natural England, the organisation would usefully identify the aim of doing so.

b. Identify the focus and limits of the account

See Section 2.2 of the report.

c. Identify the long term goal that will be employed in the account.

See Section 2.2 of the report.

d. Develop the spreadsheets that are needed

An Excel workbook of spreadsheets for the initial accounts with integral guidance was developed by the analyst (spreadsheets for CNCA are not in the public domain). The presentation and structure of the workbook were designed for clear and easy entry of data by the SRMs, who were not familiar with CNCA. It also gave the SRMs flexibility to determine the contents of the account[93]. The components and key features of CNCA discussed in Section 2.1 were integral to the workbook. However, CNCA technical terms were not used.

Initial development of the Excel workbook was undertaken using information from discussions with the SRM for Lower Derwent Valley NNR. Following this, a blank version of the workbook was revised iteratively to address feedback and issues following its use by each SRM. This gradually improved the workbook and the ease of its use by SRMs who

[93] If one CNCA account was to be developed for all NNRs managed by Natural England, the design of the workbook would be quite different to that used for this study.

were yet to enter data. Further information on development of the workbook can be found in Appendix C Section 3. Completed versions of the workbook are presented in Appendix G.

e. Identify all environmental goods and services that will be provided with delivery of the long term goal.

The SRMs described the environmental goods and services currently provided by the NNR that they were developing an account for. They also described any additional goods and services that might be provided with pursuit of the long term goal that they were employing for the account. A list of categories (with examples) based on the Common International Classification of Ecosystem Services (CICES; European Environment Agency 2013) assisted them with this. Because the CICES framework assumes that impacts on health and wellbeing are integral to the category that covers recreation and other physical activities / experiences, they were not identified separately. However, health benefits could potentially be assessed for the NNRs if the necessary data were available (discussed below). The SRMs identified the main goods and services that were provided by the NNR[94] (with 'main' assessed relative to the other goods and services provided by the NNR).

f. Focussing on what can be estimated, populate the CNCA spreadsheets with projections of: the quantity of goods and services and their monetary value, and attributable costs.

Quantification of goods and services focussed on the 'main' goods and services provided by the NNR. The SRMs selected any that could easily be quantified now and in future. They considered how provision of the good or service would change with pursuit of the long term goal used for the account. Based on this, the SRMs entered into the Initial Account Workbook estimates of the amount of those goods and services provided in the current year and in future years for a plan to deliver the long term goal[95]. This populated the physical flow account component of the account. An expert in Natural England gave advice on net carbon sequestration rates and net emissions of carbon dioxide and methane for the broad habitat types[96] in the NNRs. These were used to estimate the net carbon flux. Generalised values for broad habitat types that are best estimates were used as site-specific data were not available.

In the accounts, as far as possible, costs and goods and services were valued using market prices. This is consistent with the guidance on environmental-economic accounting (United Nations and others 2014). The monetary values used were as follows:

- For goods and services that the NNR is paid for, the SRMs entered estimates of the average amount they were paid (or would be paid) in the current year into the Initial Account Workbook[97]. This information was used to estimate the monetary value of those goods and services.
- Regarding goods and services that could be quantified but the NNRs are not paid for, monetary values were estimated by the analyst as follows:
    - Visits for recreational and educational purposes were valued using the price charged by other providers (eg the RSPB and some Wildlife Trusts) at a sample of other nature reserves that charge (though no fee is charged for recreational visits to many

[94] Information entered in sheet 'RS G & S' in the workbooks included in Appendix G.

[95] Entered in sheet 'RS Phys Flow' in the workbooks in Appendix G.

[96] Information at bottom of 'RS Phys Flow' sheet in the workbooks in Appendix G.

[97] Entered in sheet 'RS V Info' in the workbooks in Appendix G.

nature reserves). These prices estimated exchange value for purposes of the account. Further information can be found in Appendix C Section 6[98].

- The net flux of carbon was valued using the value for non-traded carbon in government guidance (DECC and HM Treasury 2015)[99]. This is a divergence from applying the principle of using market prices to estimate values but is the value that is recommended for use in UK public sector analyses. It is consistent with the approach adopted in Eftec's applications of CNCA.

Monetary values for the following were not included in the account:

- Health benefits from people using the NNRs for recreation. These were not valued because of the risks of double counting. The value of a recreational visit may be considered to include at least some of the health benefits anticipated by the individual making the visit. However, subsequent developments in CNCA (Eftec and others 2017) have valued physical activity supported by a site in terms of avoided health care costs to the public sector. Eftec and others (2017) explain that this value for physical activity can be employed in an account in addition to the value of recreational visits without significant double counting[100].
- The benefits of volunteering to people who volunteer regularly. Addition of these would give a more complete picture of the services supported by the NNR (this was identified in the review conducted by Eftec). They are not included in other published applications of CNCA. In the initial accounts for the NNRs, inputs by volunteers appear only as costs (met externally to Natural England). The best available estimate of the benefits of regular volunteering is high relative to the other values used in the account so may have a distorting effect if it is included as it stands[101]. If estimates were sought for the impact of the NNR, the benefits to volunteers would be applied only to those volunteers who would volunteer only at the NNR. That is, people who would not volunteer elsewhere if they could not volunteer at the NNR (for example, if the NNR no longer offered opportunities for volunteers). The approach adopted would usefully be informed by future developments concerning this.

Costs that could be attributed to delivery of specific goods and services were estimated if it was easy to do so (this was the case for only one good) and entered into the workbook[102]. In terms of the structure of CNCA, this information along with the monetary value of goods and services populated the monetary account schedule. The information entered by the SRMs is presented in the workbooks in Appendix G.

[98] Data entered in sheet 'X RS Gen V Info' in the workbooks in Appendix G.

[99] Entered in sheet 'X RS Gen V Info' in the workbooks in Appendix G. To enable valuation, emissions quantified in tonnes of carbon were converted to tonnes of carbon dioxide equivalent by multiplying them by the ratio of the molecular weight of carbon dioxide to carbon (44/12).

[100] The account for the London Borough of Barnet includes both the recreational and health values. It notes that the health benefits that are estimated are those supported by the use of open spaces, not necessarily the impact of those spaces. The authors explain that though there is potential for double counting of benefits from using both recreational and health values, the double counting is at a level that is not considered significant (Eftec and others 2017).

[101] Fujiwara and others (2013) estimate that adults in the UK who volunteer frequently derive a wellbeing benefit from it that has a monetary value of about £13,500 on average per year (in 2011 prices). This value has not been included in CNCA developed by Eftec to date.

[102] Entered in sheet 'RS Attrib' only in the workbook for Lower Derwent Valley NNR in Appendix G.

g. Identify suitable indicators of the quantity and quality of natural capital assets. Then, in the CNCA spreadsheets, enter projections for these for the plan to deliver the long term goal

Each SRM identified key indicators of the quantity and quality of natural capital assets that were specific to the NNR they were developing an account for. They identified as few indicators as possible, focussing on those that would be essential to indicate change. As suggested by Eftec and others (2015a and b) the SRMs were encouraged to include indicators that concerned:

- quantities (such as area of habitat, length of linear features that are critical to the NNR),
- the quality of the environment, focussing on indicators that describe the most important features of ecosystems and offer greatest insights into the quality of ecosystems (including thresholds, tipping points, capacity and major dependencies on other ecosystems),
- factors required for delivery of ecosystem services,
- early warnings that ecosystem health or delivery of goods and services would be impacted on.

The SRMs only included indicators that they will have easy access to data on in future. Indicators could be qualitative (for example, having a 'yes' or 'no' response), or quantitative. The bespoke lists of indicators developed by the SRMs for each NNR are discussed in Section 3 of this report.

The SRMs entered a brief description of each indicator and its value in the current year into the Initial Account Workbook. They then considered how the values for the indicators would change in future with delivery of the plan to achieve the long term goal. They entered estimates of the value of each indicator for future years into the spreadsheets[103]. This described pursuit of the long term goal in terms of ecological indicators. It populated the natural capital asset register component of the account. An expert from Natural England gave advice on carbon stocks for the broad habitat types[104]. Generalised estimates that are best estimates for broad habitat types were used as site-specific data were not available. Carbon stocks were employed as an indicator for all NNRs, based on the advice of Eftec (personal communication 2016) on the grounds that otherwise they would not be included in the accounts.

h. Populate the CNCA spreadsheets with costs of delivering the long term goal, excluding any costs that were attributed to specific goods and services.

The SRMs considered the costs of delivering the plan to achieve the long term goal that they used for the account, including maintenance of existing resources and additional inputs (eg equipment) that would be needed. They entered estimated costs for future years into the Initial Account Workbook[105], omitting any costs that were attributed to specific goods and services (which had been entered previously). The SRMs distinguished capital expenditure that was likely to recur in future from one-off expenditures to assist with the calculations.

Inputs to the NNR made by others[106] were valued using the market price of inputs that they supplied (eg fencing materials) or the cost to Natural England if it had delivered the input (eg

[103] Data entered in sheet 'RS Register' in the workbooks in Appendix G.

[104] Information at bottom of sheet 'RS Register' in the workbooks in Appendix G.

[105] Entered in 'RS Non-Attrib' sheet in workbooks in Appendix G.

[106] Data entered in 'RS Non-Attrib' sheet in workbooks in Appendix G.

putting out fires). Monetary values of inputs of volunteer time were estimated employing the values used by the Heritage Lottery Fund (HLF). The HLF values are for three categories of volunteer input (Table C.2.1)[107]. These are rough estimates of costs of the inputs if the inputs were being paid for (so are exchange values that are suitable for use in the account). To enable use of these estimates, the SRMs separated the amount of volunteer input into the three HLF categories when they entered it into the accounts (they do not usually separate it in this way). In the account for Wimpole Hall Farm, inputs by volunteers were valued using an adjusted cost of employment (Eftec and others 2015a). In Forest Enterprise England's 2016/17 account they were valued at £9.99 per hour (Forest Enterprise England personal communication 2017).

Table C.2.1. Valuation of volunteer inputs

Category of volunteer input	Value of input (£/day)
Unskilled (eg clearing a site)	50
Skilled (eg erection of good quality fences)	150
Professional (eg ecological survey by an expert)	350

Source: Heritage Lottery Fund website URL: https://www.hlf.org.uk/community/general-discussions/our-most-frequently-asked-questions-and-answers [Accessed 14 September 2017]

Table C.2.2. Total salary costs for Natural England staff

	Total salary costs to Natural England / year	
Role	**Basic (36 hrs / week)**	**Working 43 hrs / week**
Reserve Warden, Support Adviser	£20,390	£24,355
Reserve Manager, Adviser	£26,620	£31,796
Senior Reserve Manager, Group Coordinator, Lead Adviser	£32,744	£39,111

Source of full salary costs for basic hours: Natural England pay tool (1 April 2016). Data include Natural England's National Insurance and pension contributions.
The account assumes that for all staff involved in NNR work, the basic hours for their pay band is 36 hours / week and that they are paid the maximum salary for their pay band. This is because many NNR staff previously worked for English Nature and have worked for Natural England and legacy bodies for a long time.
Unless specified otherwise, the account assumes that NNR staff work 43 hours / week. The full salary costs are calculated pro rata using full salary costs for 36 hours / week.

In addition to the estimates provided by the SRMs, cost information was also collected from other sources and entered by the analyst[108]. Data on staff costs were supplied by a colleague who undertakes budget management. The total salary costs to Natural England used in the account are set out in Table C.2.2 and the assumptions are set out beneath the table. Data from salary ranges for staff roles were employed in the analysis (not actual salaries[109]). Information on fleet running costs, rents, leases, rates and utilities and costs of trainees were supplied by the Natural England team that works with NNRs at a national level. If costs of staff, running vehicles, rent, lease, rates and utilities applied to several NNRs, the SRM advised how they should be apportioned to the NNR that the account was being developed for.

[107] Entered in 'X RS Gen V Info' sheet in workbooks in Appendix G.

[108] In 'RS Non-Attrib' sheet in workbooks in Appendix G.

[109] To protect confidential information.

In terms of CNCA structure, all of the above costs populated the maintenance cost account schedule.

3. Workbook development – further information

The Excel workbook that was developed for the study gave flexibility for the SRMs to determine the content of the account, specifically:

- the long term goal that was used;
- the indicators used for natural capital asset quantity and quality;
- the goods and services that were quantified;
- the market prices for goods and services that are traded;
- the option to enter costs that could be attributed to a specific good or service, if these could be identified;
- the flexibility to choose whether to (i) separate maintenance costs into those required to meet legal and moral obligations and those for delivery over and above that or (ii) not do this.

Figure C.3.1 illustrates how the sheets in the initial account (which sets out the reference scenario) relate to each other[110]. It also indicates the additional sheets (in the large boxes shaded grey) that would be included in a workbook that was used in future to report against the reference scenario. Further description of the sheets in the workbook is presented in Table C.3.1. Note that the colours used in the figure and table are independent to those used in Figure B.1 in Appendix B.

For the purposes of the initial account, an additional sheet was added that calculates the value of the assets, total present value of costs (excluding attributable costs) and net asset value of the reference scenario (for explanation of these terms see Section 2.1). This information was presented in the format of the balance sheet that would be included in a full account (and used the same technical terms). It would not usually be presented in this way. In a full account, for the year that is being reported against, monetary values would be calculated relative to the reference scenario and would be presented in the balance sheet and statement of change (as described in Section 2.1).

Following data entry for initial accounts by all of the SRMs, one account in the best available version of the blank workbook[111] was submitted for review by Eftec. Following this, a blank version of the workbook was revised to address Eftec's feedback. The initial input to the accounts developed by the SRMs was transferred into the revised blank workbook, which was the final best available version. Any necessary revisions to data for individual accounts were made to address feedback from Eftec. The analyst also made finishing touches to the workbook for each NNR, which were needed as a result of the flexibility that had been built in for the purposes of the study.

The SRMs were supplied with workbooks for the initial accounts (the reference scenario). Considerable further development of the workbooks would be needed if the accounts were to

[110] The workbook included sheets that calculated, for each year, the total value of goods and services minus costs and the present value of those (present value is explained in Section 2.1). This was so that the SRMs could use this information if they wished to (none did). If accounting was to be adopted, this level of detail probably would not be useful to display in the workbook.

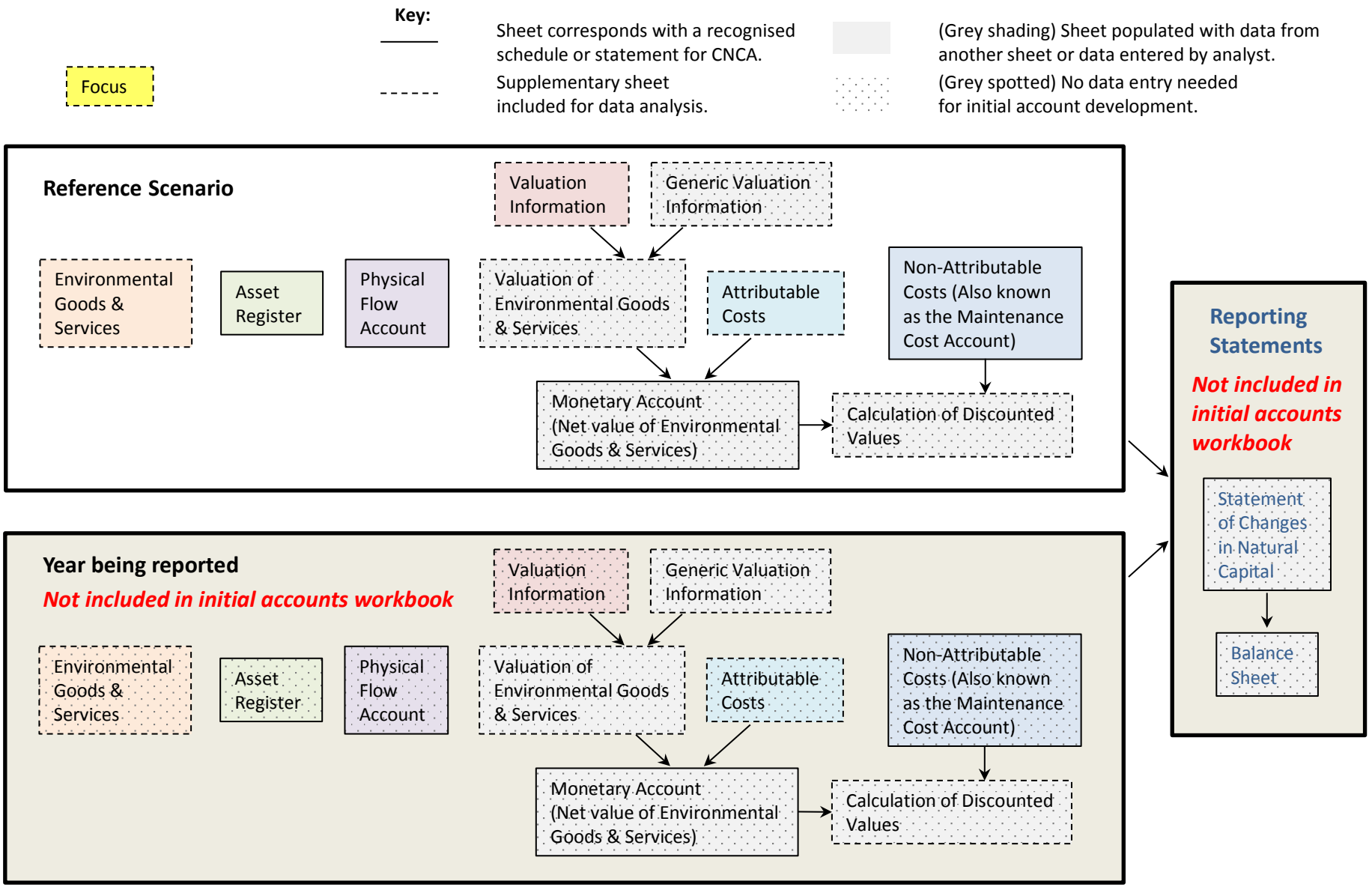
[111] that incorporated all revisions made following SRM data entry (as discussed in Appendix C Section 2).

be reported against. The SRMs were also given a two page summary (included in Appendix H) which interpreted key information in the account so they could use it to inform their work.

Table C.3.1. Overview of sheets in the workbook for initial accounts

Sheet tab label	Full title	Summary description
Focus	Introduction	Key information for the account.
Sheets for reference scenario (tab label starts 'RS')		
RS G & S	Environmental goods & services	Identifies the environmental goods and services provided by the NNR.
RS Phys Flow	Physical flow account	Quantitative estimates of the flow of environmental goods and services.
RS Register	Asset register	Indicators of the quantity, health and productivity of ecosystem(s).
RS Attrib	Attributable costs	Costs that are specific to an environmental good or service.
RS Non-Attrib	Non-attributable costs	Costs of maintaining or improving the environment that are not specific to an environmental good or service.
RS V Info	Valuation information	Information concerning the NNR that is used to value environmental goods and services (flow of goods and services is provided in RS Phys Flow).
X RS Gen V Info	Generic valuation Information	Information that applies to all NNRs that is used to value certain environmental goods and services that the NNR is not paid for but that can be valued (includes goods and services that could be traded but are not) and inputs by volunteers.
X RS G & S V	Value of environmental goods & services	Values of the environmental goods and services provided by the NNR (not considering costs).
X RS G & S Net	Monetary account	Value of flows of environmental good and services minus attributable costs.
X RS Disc	Calculation of discounted values	Application of discounting to flows of value of environmental goods and services and costs to enable calculation of present values.
X RS Net Asset Value	Calculation of asset values for the reference scenario	Calculates the total present value of assets, costs (excluding attributable costs) and net asset values for the reference scenario. Not usually provided in a full CNCA account (included for the purposes of the study).
Tips on completing the workbook (all accessed by links provided in the relevant sheets)		
Sheets with label starting 'Tip'	Various	Specific to each tip. Links that take you to the tips are provided at appropriate points in the workbook. You do not need to read them separately.

Figure C.3.1: Structure of sheets in workbook for initial CNCA accounts, plus sheets required for a full account



4. Key assumptions

This section summarises key assumptions that were employed.

The initial accounts that were developed assume that market prices and costs remain at current levels and that provision of and demand for goods and services continue at current levels unless specified otherwise. They assume that all costs (to Natural England and others) are met.

In CNCA, all monetary values per unit are the values in the first year of the projections unless changes in future values are anticipated (for reasons other than inflation). These values are applied to all future years in the projections in the account. When the account is reported against, the projections are valued using the values per unit in the year that the reporting is taking place. The projections are revised so they start in the current year. Increases in costs and the values of goods and services that arise as a result of inflation are reported as changes in values (as are changes in values that arise for other reasons) (Eftec personal communication 2016).

The time period adopted for the accounts was in perpetuity. This is because, for the purposes of the study, it was assumed that Natural England has stewardship responsibility for the NNRs in perpetuity. Forest Enterprise England's account (2016, 2017) employs the same time frame. Data were entered in the accounts for the NNRs for the first twenty years. Using the standard approaches employed for CNCA (Eftec personal communication 2016), the remaining period was covered through the calculation of residual values[112]. Similarly, residual values are also employed in Forest Enterprise England's account (2016, 2017). In the initial accounts for the NNRs, for monetary values (including costs) that occur annually, the values recorded in year 20 were assumed to continue in a steady state in perpetuity. For monetary values that do not occur annually, equivalent annual values[113] were calculated and used to calculate residual values (based on the advice of Eftec (personal communication 2016)).

The residual value of net carbon flux was calculated based on the value in year 20. This produced a significant under-estimate as the per unit values in government guidance increase exponentially with time. However, as identified in the report, there is low confidence in the estimates of net carbon flux that was used for these calculations and some of the estimates are partial (due to data gaps).

Payments of funding from the government (Grant in Aid) and other payments funded by society (eg EU LIFE+ and HLF) were not included as receipts in the accounts. This is because CNCA focuses on costs, not sources of funding or income.

The Single Farm Payment received by the NNRs was not included in the account. If it had been included, it would have had no net effect. This is because it would have been entered as a cost to society (it is funded by society) and a benefit to society (on the basis that its

[112] Residual value = A / r, where A is the value entered for year 20 and r is the discount rate.

[113] Equivalent annual value = total present value / $a_{t,r}$. where $a_{t,r}$ is the annuity factor.

$$a_{t,r} = \frac{1+r}{r}\left[1 - \frac{1}{(1+r)^t}\right]$$

where r is the discount rate and t is the time period (in years) used to calculate the total present value. Source: HM Government (2011)

value is assumed to reflect the value to society of provision of environmental goods and services (suggested by Eftec (personal communication 2017)). It should not be added to the value of goods and services estimated in the account because that would include the value of goods and services twice (Eftec personal communication 2016). If it was entered, it would be in a separate section of the account in which the cost and benefit cancelled each other out (this is the approach adopted for similar payments in Forest Enterprise England's account (Eftec 2016)). Because inclusion of the Single Farm Payment would not change the net natural capital asset value and did not add insight for this study, for simplicity, it was not included.

Remote access and entertainment provided by the NNRs through social media were included in the services where appropriate. However, it is recognised that this service is largely a product of inputs of people's time, though it is based on the natural environment.

Other key assumptions:

- Where delivery of the goal employed in the account could be influenced by the actions of other organisations (such as appropriate management by landowners upstream to address diffuse pollution) the accounts assumed that the organisations undertake the necessary actions.
- The focus of the accounts regarding climate change mitigation is on carbon, carbon dioxide and methane. Other greenhouse gases, such as nitrous oxide, were not been included.

5. Parameters that were selected by the SRMs

The time frame for data entry that the SRMs each chose to use in the accounts was twenty years. This is because it is a practical time frame for setting out planned management and beyond twenty years there is greater uncertainty (for example as a result of climate change) and data are difficult to predict. One of the SRMs (who did not complete account development) selected a time frame of fifty years because this was more realistic for delivering management outcomes in the uplands and better reflects the time frame of ecological processes there.

Table C.5.1. Definitions of legal and moral obligations used in initial accounts

NNR	Definition of legal and moral obligations
Ainsdale Sand Dunes	Health and safety (including personal protective equipment), maintaining visitor infrastructure, livestock welfare, staff and volunteer welfare, buildings maintenance and upkeep
Bure Marshes	Costs that need to be met whether or not nature conservation and public engagement take place. Health and safety expenditure and staff time are not included (because they are necessary for nature conservation and public engagement).
Lower Derwent Valley	The cost of operating as the land manager without delivering any nature conservation. Includes rent, rates, meeting health and safety requirements, cutting hedges next to the road.

Three of the SRMs chose to separate out costs for meeting legal and moral obligations from costs for delivery over and above these. To do this, each of the SRMs specified their own definition of 'legal and moral obligations' which he then used to separate out the costs (definitions in Table C.5.1). The SRMs did not find defining the term straightforward. For

example, one SRM explained that if an NNR is grazed by livestock or has input from volunteers, there are legal and moral obligations from these. However, such obligations would not arise if the NNR was not being managed using these inputs (therefore, it could be argued that they are not essential costs). The range in definitions was considerable. Two of the SRMs did not think it was helpful to separate out costs for legal and moral obligations, so did not.

6. Valuation of recreational and educational visits

Further information is presented below on the approach adopted to value recreational and educational visits.

The NNRs participating in the pilot study do not charge for admission and, at the time of the study, were not charging for educational visits. For the purpose of the accounts, visits for recreational and educational purposes were valued using estimates of exchange values.

For recreational visits, the price charged by other providers (eg the RSPB and some Wildlife Trusts) at a sample of other nature reserves that charge (though no fee is charged for recreational visits to many nature reserves)[114] were employed. Details of the prices used are set out in Table C.6.1, with sources of the estimates set out beneath the table. The value of recreational visits is based on an estimate that on average, for the five NNRs, 75% of recreational visits are by adults and 25% by children (based on estimates supplied by the SRMs[115]). If CNCA was adopted, ideally data on the percentage of recreational visits by adults and children would be used to calculate the value.

It is important to note that if the value to society (the economic impact on welfare) is sought, alternative estimates may be more appropriate to use. The recreational services provided by a site can be estimated using various techniques, including those that employ travel cost as a proxy and involve statistical analysis[116]. Currently, the best available national average estimates of the economic value of recreational visits[117] are of a similar order of magnitude to the exchange values used in this study. However, economic values for specific sites may be different.

Educational visits were separated into those that just use the site (and provide their own education) and those that have educational input from Natural England's staff or volunteers.

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[114] A single monetary value per recreational visit was adopted for all the NNRs and likewise for educational visits, at the suggestion of Eftec following review of the workbook developed for this study. This was to simplify the valuation. The approach initially adopted was to estimate the monetary value of the visits for each NNR based on the average travel cost and value of travel time, after Mourato and others (2010). Valuation of recreational visits based on travel cost (excluding travel time) has since been recommended by Ricardo Energy and Environment (2016) for the UK's national ecosystem accounts.

[115] Estimates of the percentage of recreational visits that are by children were as follows: Ainsdale: 20%; Bure Marshes: 20% (based on data collected by NNR staff); Castle Eden Dene: 20 to 30%; East Dartmoor: less than 20%; Lower Derwent Valley: 25% (Source: SRMs personal communication 2017). An average of 25% was adopted to give a conservative estimate of the value of recreational visits and avoid over-estimation (given that the value used for visits by children is lower than that for adults).

[116] These include the travel cost method (employing individual or zonal models) and approaches that employ random utility models. For a brief introduction see US Department of Agriculture (2000).

[117] At 2016 prices, these are £6.37 per visit to greenbelt and urban fringe farmlands, £5.98 per visit to mountains, moors and heathlands, £4.71 per visit to marine and coastal areas, £3.97 per visit to woodlands and forests, £2.16 per visit to freshwater and floodplains and £1.83 per visit to grasslands. The estimates are from a meta-analysis presented in Sen and others (2014) adjusted for inflation using Consumer Price Index (All Items) (URL: www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7bt/mm23 [Accessed 14 September 2017].

This enabled valuation that reflected the difference in the service provided by the NNR. Educational visits by schools, higher and further education establishments, and public interest groups were separated out. This allowed application of different prices for these categories (Table C.6.1). As for recreational visits, a sample of prices charged by other providers was used to estimate the value (details beneath Table C.6.1). However, providers such as the RSPB and Wildlife Trusts (charities that have an aim of public engagement) may subsidise their charges for educational visits. Also, the market may not be competitive (not least because no price is charged for many educational visits). Consequently, the prices may be under-estimates.

Other CNCA studies have employed a variety of approaches for valuing recreational and educational visits:

- The account for parks and open spaces in the London Borough of Barnet (Eftec and others 2017) employs estimates of recreational value generated by the Outdoor Recreation Valuation Tool (ORVal)[118] developed by the Land, Environment, Economics and Policy Institute at the University of Exeter.
- In Forest Enterprise England's account (2017), recreational visits are valued using data from a study estimating people's willingness to pay for recreational visits to woods and forests. In 2015/16, the value used was £2.17 per visit[119] (Forestry Commission personal communication 2017).
- The account for Beam Parklands (Eftec 2015) employs the estimated uplift in property values to estimate the value of environmental goods and services delivered to the local community (which include recreation, amenity, education and health benefits).
- The findings of a literature review were used to estimate the value of recreational visits in the account for the National Trust's Wimpole Hall Farm (Eftec and others 2015a).
- In the account for Windsor Estate, which is managed by the Crown Estate, the value of recreational visits was estimated using the findings of a meta-analysis of valuation studies (Eftec and others 2015a; Bateman and others 2013). This meta-analysis provided the estimates of economic value of recreational visits that are listed in the footnote earlier in this section.
- A bespoke study was employed to estimate the recreation and amenity value in the account for Lafarge Tarmac's management of Mancetter Quarry (Eftec and others 2015a).
- In the account for United Utilities' impact on four sites on the Fylde Coast, the recreation benefits were valued using findings from the water company's customer valuation research (Eftec and others 2015a).

[118] URL: //leep.exeter.ac.uk/orval/ [Accessed 14 September 2017]

[119] Employing an estimate from Willis and others (2003) adjusted for inflation.

Table C.6.1. Valuation of recreational and educational visits

The values in the table below were used based on the assumption that visitors to NNR would pay fees at the rate charged by a sample of Nature Reserves that charge.

Note that in the data below, the estimated average price for a member of the public (adult) to participate in an educational visit run by the NNR is less than the estimated average price of NNR admission. This reflects the importance placed on engagement by NNRs in general.

Nature of visit		**Value (£ per person per visit)**
Recreational visit [a]		£3.83
Educational visit: schools (half day visit)	with educational input by Natural England staff or volunteers [b]	£3.45
	no educational input from the NNR team [c]	£2.08
Educational visit: further and higher education establishments (day visit)	with educational input by Natural England staff or volunteers [d]	£6.90
	no educational input from the NNR team [e]	£3.96
Educational visit: public	with educational input by Natural England staff or volunteers [f]	£3.50
	no educational input from the NNR team [g]	£4.42

[a] Calculated using average admission fees for adults and children, assuming roughly 75% of visits are by adults and 25% by children. Savings from family admissions are not reflected in estimate.

Estimated average admission fee for an adult non-member: £4.42 based on the following sample of admission fees charged by other providers in 2016 (no fee is charged for many sites): RSPB: Dearne Valley - Old Moor £5; Rainham Marshes £5; Strumpshaw Fen £3.50. Hampshire County Council: Titchfield Haven NNR £4. Norfolk Wildlife Trust: Cley Marshes £5. Yorkshire Wildlife Trust: Potteric Carr £4).

Estimated average admission fee for a child non-member: £2.08 calculated from the following sample of admission fees charged by other providers in 2016 (no fee is charged for many sites): RSPB: Dearne Valley - Old Moor £2.50; Rainham Marshes £3; Strumpshaw Fen £2.50. Hampshire County Council: Titchfield Haven NNR £2. Norfolk Wildlife Trust: Cley Marshes free. Yorkshire Wildlife Trust: Potteric Carr £2.50).

[b] Average cost per pupil calculated from a sample of fees for a half day educational visit by a school pupil charged by other providers in 2016. Sample of fees used: Derbyshire Wildlife Trust £3 for 1.5 hrs, Durham Wildlife Trust £3, RSPB £3.50-£4 (for primary schools), Staffordshire Wildlife Trust £3.50, Warwickshire Wildlife Trust £4.

[c] Fee is assumed to be the same as for a recreational visit for a child non-member, listed under foot note for [a].

[d] Assumes that the cost of a day visit by further and higher education establishments is the same as the cost for a school pupil. Also assumes that the cost of a full day visit for school pupils is double the cost of half a day (it is for some of the providers sampled above but some charge a little less).

[e] Estimated based on admission fee for recreational visit by a student non-member. Average calculated from the following sample of admission fees charged by other providers in 2016 (no fee is charged for many sites): RSPB: Dearne Valley - Old Moor £3.50; Rainham Marshes £5 (same as adult); Strumpshaw Fen £3.50 (same as adult). Hampshire County Council: Titchfield Haven NNR £3.75. Norfolk Wildlife Trust: Cley Marshes £5 (same as adult). Yorkshire Wildlife Trust: Potteric Carr £3.

[f] Average cost based on the following sample of guided walks that are charged for by other providers in 2016 (many are provided free of charge): Leicestershire Wildlife Trust £3, Norfolk Wildlife Trust £5 for 2 hours, Northumberland Wildlife Trust £3 for 3 hrs, RSPB £2.50 for 2 hrs, Surrey Wildlife Trust £4 for 2 hours.

[g] Estimated based on admission fee for a recreational visit by an adult. Uses data for adults listed under footnote [a].

7. Steps involved in reporting against a CNCA account

If CNCA is adopted, subsequent reporting against CNCA requires further steps. These are required in addition to the initial development, as CNCA is a tool for monitoring. Reporting may be done annually or less frequently as appropriate. The steps continue the list in Appendix C Section 2 (and so start at (i)). They involve the following (based on Eftec and others (2015a and b)):

i. Enter revised projections for delivery of the long term goal in the CNCA spreadsheets (for quantity and quality of natural capital assets, costs, goods and services and their value).
j. Develop an explanatory commentary for the data in the reporting statements, setting out insights provided by the account.
k. Present the reporting statements and commentary.
l. Review the account and making improvements to increase reporting efficiency and usefulness of the account.

Because the initial accounts were not reported against in this study, the steps involved are not discussed further here.

D. Checklist for semi-structured interview, 9.5.16

Conducted with each SRM immediately following initial data entry

1. Is developing the account a useful process? If so, why?
2. Are there added benefits from developing it? If so, what?
3. Is reporting against the account likely to be useful? If so, why?
4. Might there be added benefits from the reporting? If so, what?
5. Do you think you'd report against the account in future? If not, why not?
6. If so, how frequently would you report (eg annually, every two years)?
7. Are there aspects of the account that you think are not useful and should be dropped? If so, what are they and why?
8. Are there additional features that would usefully be added to the account? If so, what and why?
9. Do you think developing an account and reporting against is likely to be useful to other NNR managers? Why?
10. If the accounting was rolled out to all NNRs managed by NE, what are the main issues that need to be addressed?

Focussing on the advice on how to complete the workbook (and accompanying diagram), please identify:

   a. sections that you do not understand;
   b. sections that you think could be removed;
   c. information that is missing;
   d. information that it would be more useful to provide in the spreadsheet instead;
   e. other ways in which it could be improved.

11. Turning to the Excel workbook, please identify:
   a. aspects of the spreadsheet that you found difficult or problematic, and suggestions as to how they could be addressed;
   b. ways in which it could be improved.
12. How did today go for you? Is there anything you would have liked to have done differently?
13. Any other feedback that you would like to provide.

E. Checklist for semi-structured interview, 22.3.17

Conducted with each SRM nine months after initial data entry

1. Was the corporate natural capital accounting (CNCA) pilot study useful for you? Why?
2. Have you used any information from the initial account that you did not already have? If so, what and how did you use it?
3. Are you likely to use any further new information from the initial account in future? If so, what and how will you use it?
4. Would you choose to report against the account in future? Why?
5. Is CNCA a useful tool for you to use? Why?
6. How do you monitor delivery on the NNR? Could CNCA help with this? Why?
7. What information do you use to inform decisions about management of the NNR? Could CNCA help with this? Why?
8. Does the information that CNCA provides justify the effort that is involved?
9. If a CNCA is developed for all NNRs managed by Natural England that employs a long term goal for all of the NNRs, such as achieve or maintain favourable condition, and it uses a common set of indicators, would this reduce the usefulness of CNCA to you?

F. Response form for initial assessment of options by SRMs

(Note: the form has been compressed to enable presentation in portrait format here).

Options for recommendations from pilot study to develop corporate natural capital accounts for a few NNRs, 23.9.16

Please consider the following options for taking forward work from the pilot study to develop corporate natural capital accounts and in the appropriate columns jot down what you see as the advantages and disadvantages. Do add other options at the end.

To help you consider the data entry needed in CMSi, the information needed for options 2 and 3 has been listed beneath the table, separated into essential and nice but not essential.

Please identify your preferred option(s) below

Your name:

Your preferred option(s):

Option	**Source of data etc**	**Advantages**	**Disadvantages**
1. Provide only estimates of value of recreational and educational visits for each NNR.	Employ data in CMSi for each NNR. Data gaps filled by requesting data from SRM.		
2. Estimate net value of assets for NNRs for continuation of current plans – adopt one of the following 4 options: (This is what is provided in the initial accounts for NNRs that adopted a goal of continuing with current plans. It will provide the values of visits offered above)			
a. for each NNR	Employ data in CMSi for each NNR (requires entry of data for each NNR). SRM attributes staff time, costs of fleet, utilities and rents to each NNR.		
b. for series of NNRs	Employ data in CMSi for each NNR (requires entry of data for each NNR).		
c. for series of NNRs	Employ data in CMSi for selected NNRs that can be assumed to be representative of others with similar characteristics (eg near urban centre, remote etc). (Requires entry of data for some NNRs).		

d. for series of NNRs	Use data in CMSi on habitat areas. Use average data for land in England for habitat management costs, numbers of recreational visits to woodland, grassland etc (won't reflect specialness of NNRs).		
3. Set up account for continuation of current plans so it is reported against in future years – adopt one of the following 4 options (same as above):			
a. for each NNR (same as 2a)	Employ data in CMSi for each NNR (requires entry of data for each NNR in future). Assume attribution of staff time, costs of fleet, utilities etc same as baseline unless significant change.		
b. for series of NNRs (same as 2b)	Employ data in CMSi for each NNR (requires entry of data for each NNR in future).		
c. for series of NNRs	Employ data in CMSi for selected NNRs that can be assumed to be representative of others with similar characteristics (eg near urban centre, remote etc). (Requires entry of data for some NNRs in future).		
d. for suite of NNRs (same as 2d)	Use data in CMSi on habitat areas. Use average data for land in England for habitat management costs, numbers of recreational visits to woodland, grassland etc (won't reflect specialness of NNRs).		
Add other options here			

Information needed for options 2 and 3:

- Area of each broadscale habitat
- Number of recreational visits / yr

G. Workbooks for initial CNCA accounts

The workbook for the initial CNCA account for each NNR can be found at Natural England Research Report NERR072.

The workbooks are Excel files saved using Microsoft Office Professional Plus 2013 (originally created in Microsoft Office Professional Plus 2010).

The workbooks are specifically for initial accounts (they do not include the sheets required to report against an account). The separate advice document that is referred to in the workbooks is not supplied. It comprised copies of the advice presented within the workbook.

Terms of use for the workbooks: *By using these data you are accepting the terms and conditions contained in the Natural England Open Data Licence, as published at https://www.gov.uk/how-to-access-natural-englands-maps-and-data#terms-and-conditions-for-use-of-data. The following statement must be used to acknowledge the source of the data:* ***© Natural England 2017.***

H. Reference scenario summaries for each NNR

For each of the five NNRs with initial accounts, a summary of the CNCA reference scenario is presented on the following pages. This presents key information from the initial projections for the long term goal employed in the account.

When reading these summaries, please note that care must be taken when making any comparison between the values of goods and services provided by an NNR. This is for the following reasons:

- The monetary values in the table summarising the CNCA reference scenario are determined by the long term goal used in the initial account for that NNR. A different long term goal was employed for each NNR.
- The estimates of asset value are partial. They were calculated only for the goods and services that could be quantified and valued (specifically recreational and educational visits, net carbon flux and goods and services that the NNR is paid for). For Bure Marshes, net carbon flux could be estimated for only 22% of the area of the NNR (due to lack of data).
- The estimates of asset values are gross values that do not reflect production costs. If the cost of delivering a good or service is high, then the net value may be low (or even negative). Ideally, net values would have been calculated for the account; this was not done because the production costs of different goods and services could not be easily identified.

H.1. CNCA reference scenario summary: Ainsdale Sand Dunes NNR

Close to centres of population.

Main habitats: Sand dunes, humid dune slacks, grassland, broadleaved woodland and scrub, pine plantation, beach.

Area: 492 ha.

Long term goal used for the account: *Anticipated goal:* Favourable condition status across all units of the NNR achieved and maintained. Fully consulted management plan in place for coastal adaptation and ongoing active management of units 20, 18 and 16. Re-activation of dune processes within the other dune units managed through grazing and other interventions. Rear woodland managed as per the forest plan commitments. Community access, education, research, health benefits, and recreation achieved and maintained.

Summary narrative:

The account calculates the present values (discounted at a rate of 3.5%) of future flows in perpetuity for initial projections for potential pursuit of the above anticipated long term goal (the reference scenario). The net value of the natural capital assets (taking costs into account) is £193 million. The net natural asset value of environmental goods and services to society (£198 million) is positive and orders of magnitude greater than the negative net asset value to Natural England (-£5 million). This is an under-estimate as some goods and services provided by the NNR could not be valued.

For the potential pursuit of the goal, the gross value of the assets (costs not taken into account) is £199.5 million. This comprises a value of goods and services to Natural England of £0.3 million from revenue (eg timber (for pulp and saw wood) and lease of land for grazing) and a value of goods and services to society of £199.3 million. The latter includes net sequestration of carbon (which has a high value) and recreational and educational visits (further information on next page). Because not all goods and services could be valued, the gross value is an under-estimate.

The present value of the liabilities (costs) of potential pursuit of the goal is £6.4 million, which comprises £5 million met by Natural England and £1.4 million met externally by volunteers and contributions in kind by others (who provide fire-fighting and beach patrol, for example).

Table summarising the CNCA reference scenario

All figures are present values of initial projections in perpetuity for potential pursuit of the goal (calculated at a discount rate of 3.5%). Negative values are shown in brackets (as in accountancy).

For potential pursuit of the anticipated long term goal:	Private (Natural England) (£ millions)	External (not Natural England) (£ million)	Total value (£ millions)		Of which reported in financial accounts (£ millions)
Gross asset value	0.253	199.296	199.549		0.229
Liabilities					
To meet legal/moral obligations	(4.042)	(0.373)	(4.415)		(4.042)
To deliver nature conservation	(0.854)	(1.069)	(1.923)		(0.854)
Total liabilities	(4.896)	(1.442)	(6.338)		(4.896)
Net natural capital asset value	(4.643)	197.854	193.211		

Definition used for costs that meet legal and/or moral obligations: costs of health and safety (including personal protective equipment), visitor infrastructure, livestock welfare, staff and volunteer welfare, buildings maintenance and upkeep.

Summary of other key information in the initial account for Ainsdale Sand Dunes NNR: Estimates for 2016 (one year only) (monetary values rounded to three significant figures)**:**

Environmental goods & services:		
Number of recreational visits:	100,000	value in account of £383,000
Number of educational visits with educational input from NNR team:		
by school pupils:	170	value in account of £587
by students[120]:	80	value in account of £552
by others:	250	value in account of £875
Number of educational visits providing their own tuition:		
by school pupils:	490	value in account of £1,020
by students:	80	value in account of £317
by others:	250	value in account of £1,100 [121]
Number of volunteers and trainees trained:	41	
Number of research projects:	10 [122]	
Net carbon sequestration:	-75,900 t CO_2 equivalent[123] [124]	value in account of £4,810,000
Revenue:	£500	
Total costs:		
met by Natural England:	£146,000	(74%)
met by others:	£51,800	(26%)
Carbon storage:	14,900 t of carbon[125] [126]	

Indicators of:

ecosystem quantity: Area of: woodland, beach, open dunes.

ecosystem quality: Percentage of open dune habitat area that is early successional dune habitat.
Native & non-native scrub controlled as required for favourable condition.
Natterjack toads breeding.
Thriving population of: red squirrels, sand lizards.
Key indicator plant species and communities present as required for favourable condition.
Linear connectivity of open dune habitats with neighbouring properties.
Beach is maintained as a safe and clean public amenity.
Appropriate & safe access routes & infrastructure throughout the NNR.
Visitor centre/classroom regularly used.

---

[120] At higher and further education establishments.

[121] This exceeds the value of visits with educational input by the NNR team because of the value per visit used for the account is higher (discussed in Appendix C Section 6).

[122] Research for undergraduate and masters dissertations and other scientific research.

[123] This does not include data for mobile (yellow) dunes, semi-fixed dunes and foreshore (beach) / intertidal habitats that are not vegetated because suitable estimates were not available. However, net carbon fluxes for these habitats are expected to be relatively low (Natural England personal communication 2017).

[124] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

[125] This estimate is partial. It does not include carbon storage for foreshore (beach) / intertidal habitats that are not vegetated (which cover 33% of the NNR area) because suitable estimates were not available.

[126] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site). Soil carbon stock data are for the top 15cm only so are likely to underestimate stocks in the entire soil profile.

H.2. CNCA reference scenario summary: Bure Marshes NNR

Not close to centres of population. Access by boat.

Main habitats: natural eutrophic lakes; tall-herb fen, reed and sedge beds; fen meadow; wet woodland; grassland.

Area covered by account: 293 ha[127]

Long term goal used for the account: achieve and maintain favourable conservation status while encouraging appropriate public access and engagement. Includes Hoveton Wetlands Restoration Project (funded by EU LIFE+ and Heritage Lottery Fund (HLF)), which is underway.

Summary narrative:

The account calculates the present values (discounted at a rate of 3.5%) of future flows in perpetuity for the initial projections for a plan to deliver the above long term goal (the reference scenario). The net value of the natural capital assets (taking costs into account) is -£9.1 million. This is an under-estimate as some goods and services provided by the NNR could not be valued at all and one was valued only in part.

For the plan to deliver the goal, the gross asset value of the environmental goods and services to society (costs not taken into account) is -£0.7 million (zero to Natural England). This comprises positive values of recreational and educational visits and a relatively large negative value for net flux of carbon. The latter could be estimated only for 22% of the NNR area[128]. The NNR does not generate revenue. The gross value is an under-estimate (for the reasons given above).

The significant liabilities (costs) of the plan to deliver the goal include costs of habitat restoration and improved access and engagement under the Hoveton Wetlands Restoration Project. The present value of the liabilities is £8.4 million, which comprises £8.1 million met by Natural England (which includes funding from EU LIFE+ and HLF[129]) and £0.3 million met by volunteers.

Table summarising the CNCA reference scenario

All figures are present values of initial projections in perpetuity for the plan to deliver the goal (calculated at a discount rate of 3.5%). Negative values are shown in brackets (as in accountancy).

For a plan to deliver the long term goal:	Private (Natural England) (£ millions)	External (not Natural England) (£ millions)	Total value (£ millions)		Of which reported in financial accounts (£ millions)
Gross asset value	0	(0.729)	(0.729)		0
Liabilities					
To meet legal/moral obligations	(0.765)	0	(0.765)		(0.765)
To deliver nature conservation	(7.335)	(0.308)	(7.643)		(7.335)
Total liabilities	(8.100)	(0.308)	(8.408)		(8.100)
Net natural capital asset value	(8.100)	(1.037)	(9.137)		

Definition used for costs that meet legal and/or moral obligations: costs that need to be met whether or not nature conservation and public engagement take place. Health and safety expenditure and staff time are not included (because they are necessary for nature conservation and public engagement).

[127] Area of NNR managed by Natural England plus additional grazing land at Dairy Farm Marshes.

[128] Based on available data (excludes net flux of carbon for wet woodland and shallow lakes). The same monetary value per unit is used as for net carbon sequestration but the monetary value is converted into a negative figure.

[129] Because receipts of funding paid for by society are not entered in the account, the costs met by society are categorised as internal, not external (as discussed in Appendix C, Section 4)

Summary of other key information in the initial account for Bure Marshes NNR:

Estimates for 2016 (one year only) (monetary values rounded to three significant figures)**:**

Environmental goods & services:

Number of recreational visits:	5,000	value in account of £19,200
Number of educational visits with educational input from NNR team[130]:	144	value in account of £497
Number of research projects:	6 [131]	
Net emissions of carbon dioxide and methane:	446 t CO_2 equivalent[132] [133]	value in account of -£29,500[134]
Revenue:	0	
Total costs:		
met by Natural England:	£1,810,000 [135]	(99%)
met by others:	£11,300	(1%)
Carbon storage:	112,000 t of carbon[136] [137]	

Indicators:

of ecosystem quantity:	Area of: open water, wet woodland, open fen and area of reed and sedge that is managed. Length of: open dykes, boardwalk.
of ecosystem quality:	Cover (%) of aquatic plant species at: Decoy Broad, Hoveton Great Broad, Hudsons Bay. Number of breeding *Odonata* species. Phosphate level in the river. Cover (%) of scrub in open fen. Presence of Himalayan balsam. Staff resource for visitor and social media engagement.

[130] Includes educational visits by school pupils, higher and further education students and the general public.

[131] Includes student projects, Hoveton Wetland Restoration Project fish and plankton surveys, and long-term monitoring projects.

[132] This estimate is partial. It is for only 22% of the area of the NNR. Suitable estimates of net carbon flux were not available for the habitats that cover the remaining 78% (most of which is wet woodland (covering 59%); shallow lakes cover a further 16%).

[133] Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

[134] This estimate is partial as explained in the footnote concerning the quantity of the net flux.

[135] Includes funding for Hoveton Wetlands Restoration Project from EU LIFE+ and HLF.

[136] This estimate is partial. It is for only 22% of the area of the NNR. Most significantly, it does not include carbon storage for wet woodland (which covers 59% of the NNR) or shallow lakes (which cover 16%) because suitable estimates were not available. Also, though some of the soil carbon stock estimates are for the entire soil profile, others are for the top 15cm only, which are likely to under-estimate stocks in the entire soil profile.

[137] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

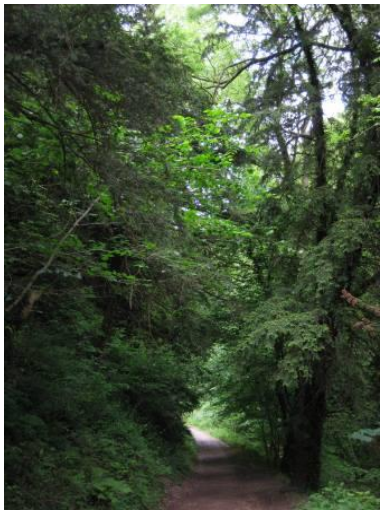
H.3. CNCA reference scenario summary: Castle Eden Dene NNR

Close to centres of population.

Main habitats: ancient woodland, plantations, grassland.

Area of NNR: 221 ha

Long term goal used for the account:
Anticipated goal: Increase biodiversity within the NNR and over the connected landscape, achieve favourable condition of the Site of Special Scientific Interest and continue to offer a good visitor experience and education/events to inspire the public to want to look after nature. This would entail continuation of the current management and success in current bids for capital funding (for new equipment) and additional staff resource.



Summary narrative:

The account calculates the present values (discounted at a rate of 3.5%) of future flows in perpetuity for initial projections for potential pursuit of the above anticipated long term goal (the reference scenario). The net value of the natural capital assets (taking costs into account) is £440million. The net natural asset value of environmental goods and services to society (£447 million) is positive and orders of magnitude greater than the negative net asset value to Natural England (-£7.6 million). These are under-estimates as some goods and services provided by the NNR could not be valued.

For potential pursuit of the goal, the gross value of the assets (costs not taken into account) is £449 million. This comprises a value of £0.06 million to Natural England from revenue (eg for firewood) and a value of goods and services to society of £449 million. The latter includes net sequestration of carbon (which has a high value), recreational and educational visits (further information on next page). Because not all goods and services could be valued, the gross value is an under-estimate.

The present value of the liabilities (costs) of potential pursuit of the goal is £9 million, which comprises £7.7 million met by Natural England and £1.5 million met externally by volunteers.

Table summarising the CNCA reference scenario

All figures are present values of initial projections in perpetuity for potential pursuit of the goal (calculated at a discount rate of 3.5%). Negative values are shown in brackets (as in accountancy).

For potential pursuit of the anticipated long term goal:	Private (Natural England) (£ millions)	External (not Natural England) (£ millions)	Total value (£ millions)		Of which reported in financial accounts (£ millions)
Gross asset value	0.058	448.977	449.035		0.058
Total liabilities	(7.656)	(1.538)	(9.193)		(7.656)
Net natural capital asset value	(7.598)	447.440	439.841		

Costs that meet legal and/or moral obligations have not been separated out.

Summary of other key information in the initial account for Castle Eden Dene NNR:

Estimates for 2016 (one year only) (monetary values rounded to three significant figures)**:**

Environmental goods & services:

Number of recreational visits:	100,000	value in account of £383,000
Number of educational visits by school pupils with educational input from NNR team:	2,000	value in account of £6,900
Number of educational visits providing their own tuition (Forest Schools):	2,000	value in account of £4,170
Number of students gaining educational work experience:	6	
Number of research projects:	3 [138]	
Net carbon sequestration:	-155,000 t CO_2 equivalent[139]	value in account of £9,820,000
Revenue:	£3,040	
Total costs:		
met by Natural England:	£195,000	(79%)
met by others:	£52,000	(21%)
Carbon storage:	38,500 t of carbon[140]	

Indicators:

of ecosystem quantity:	None.
of ecosystem quality:	Yew trees suffering from pest and disease. Yew tree regeneration across the site. Non-native species are occupying less than 5% of the NNR. Over 70% of the land in the Durham Coast Special Area of Conservation land is good quality magnesian limestone grassland. The two waymarked paths are open.

[138] Current moth, mosquito and River Life monitoring projects.

[139] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

[140] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site). Soil carbon stock data are for the top 15cm only so are likely to underestimate stocks in the entire soil profile.

H.4. CNCA reference scenario summary: East Dartmoor NNR

Not close to centres of population.

Main habitats: woodland, lowland heathland, lowland bog.

Area of NNR: 365 ha

Long term goal used for the account: sustain high nature conservation value.

Summary narrative:

The account calculates the present values (discounted at a rate of 3.5%) of future flows in perpetuity for initial projections for a plan to deliver the above long term goal (the reference scenario). The net value of the natural capital assets (taking costs into account) is £507 million. The net natural asset value of environmental goods and services to society (£513 million) is positive and orders of magnitude greater than the negative net asset value to Natural England (-£6 million). These are under-estimates as some goods and services provided by the NNR could not be valued.

For the plan to deliver the goal, the gross asset value of goods and services to society (costs not taken into account) is £516 million (zero to Natural England). This includes net sequestration of carbon (which has a high value) and recreational and educational visits (further information on next page). The NNR does not generate revenue. Because not all goods and services could be valued, the gross value is under-estimate.

The present value of the liabilities (costs) of the plan to deliver the goal is £9 million, which comprises £6 million met by Natural England and £3 million met externally by volunteers.

Table summarising the CNCA reference scenario

All figures are present values of initial projections in perpetuity for a plan to deliver the goal (calculated at a discount rate of 3.5%). Negative values are shown in brackets (as in accountancy).

For a plan to deliver the long term goal:	Private (Natural England) (£ millions)	External (not Natural England) (£ millions)	Total value (£ millions)		Of which reported in financial accounts (£ millions)
Gross asset value	0	515.835	515.835		0
Total liabilities	(6.101)	(2.957)	(9.058)		(6.101)
Net natural capital asset value	(6.101)	512.878	506.777		

Costs of meeting legal and/or moral obligations were not separated out.

Summary of other key information in the initial account for East Dartmoor NNR:

Estimates for 2016 (one year only) (monetary values rounded to three significant figures)**:**

Environmental goods & services:

Number of recreational visits:	80,000	value in account of £307,000
Number of educational visits with educational input from NNR team:		
by school pupils:	300	value in account of £1,030
by students[141]:	200	value in account of £1,380
by members of interest groups:	200	value in account of £700
Number of educational visits providing their own tuition:		
by school pupils:	300	value in account of £625
by students:	200	value in account of £792
by members of interest groups:	200	value in account of £883
Number of participants in community events:	2,000	value in account of £7,000
Net carbon sequestration:	-180,000 t CO_2 equivalent[142] [143]	value in account of £11,400,000
Revenue:	0	
Total costs:		
met by Natural England:	£192,000	(66%)
met by others:	£100,000	(34%)
Carbon storage:	46,400 t of carbon[144] [145]	

Indicators:

of ecosystem quantity:	Area of: NNR, semi-natural woodland, heathland/moorland. Percentage of site that is dynamic open space. Number of cultural heritage and artefact records.
of ecosystem quality:	Access infrastructure adequate and safe. Delivery of adequate public engagement programme. Community engagement events held. Level of volunteer input (an indicator of legacy conservation value).

[141] At higher and further education establishments.

[142] This does not include the net carbon flux for wet woodland. However, wet woodland covers less than 1% of the area of the NNR.

[143] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site).

[144] This does not include carbon storage for wet woodland. However, wet woodland covers less than 1% of the area of the NNR.

[145] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site). Soil carbon stock data are for the top 15cm only so are likely to underestimate stocks in the entire soil profile.

H.5. CNCA reference scenario summary: Lower Derwent Valley NNR

Not close to centres of population.

Main habitats: grassland, reedbed.

Area of NNR: 452 ha

Long term goal used for the account: maintain favourable condition and improve nature conservation outcomes.

Summary narrative:

The account calculates the present values (discounted at a rate of 3.5%) of future flows in perpetuity for initial projections for a plan to deliver the above long term goal (the reference scenario). The net value of the natural capital assets (taking costs into account) is -£5.4 million. This is an under-estimate as some goods and services provided by the NNR could not be valued.

For the plan to deliver the goal, the gross value of the assets (costs not taken into account) is £4 million. This comprises a value of £0.6 million to Natural England from revenue (eg leasing of land for grazing and cutting hay, sale of green hay seed source) and a value of goods and services to society of £3.4 million. The latter includes recreational and educational visits (see details on next page). It also includes a significant negative value for a negative net flux of carbon (from reedbed, further information on next page)[146]. Because not all goods and services could be valued, the gross value is under-estimate.

The present value of the liabilities (costs) of the plan to deliver the goal is £9.5 million, which comprises £4.2 million met by Natural England and £5.3 million met externally by volunteers and contributions in kind by farmers (for example, putting up fences).

Table summarising the CNCA reference scenario

All figures are present values of initial projections in perpetuity for a plan to deliver the goal (calculated at a discount rate of 3.5%). Negative values are shown in brackets (as in accountancy).

For a plan to deliver the long term goal:	Private (Natural England) (£ millions)	External (not Natural England) (£ millions)	Total value (£ millions)		Of which reported in financial accounts (£ millions)
Gross asset value	0.644	3.450	4.094		0.644
Liabilities					
To meet legal/moral obligations	(3.388)	(1.190)	(4.578)		(3.388)
To deliver nature conservation	(0.802)	(4.147)	(4.949)		(0.802)
Total liabilities	(4.190)	(5.338)	(9.527)		(4.190)
Net natural capital asset value	(3.546)	(1.887)	(5.433)		

Definition used for costs that meet legal and/or moral obligations: the cost of operating as the land manager without delivering any nature conservation. Includes rent, rates, meeting health and safety requirements, cutting hedges next to the road.

[146] The same monetary value per unit is used as for net carbon sequestration but the monetary value is converted into a negative figure.

Summary of other key information in the initial account for Lower Derwent Valley NNR: Estimates for 2016 (one year only) (monetary values rounded to three significant figures)**:**

Environmental goods and services:

Number of recreational visits:	27,500	value in account of £105,000
Number of educational visits with educational input from NNR team:		
by pupils:	437	value in account of £1,510
by students[147]:	41	value in account of £280
for others:	5,400 [148]	value in account of £18,900
Number of educational visits providing their own tuition (for students):	81	value in account of £321
Number of volunteers & apprentices trained:	5	
Number of research projects:	45 [149]	
Number of engagements with people through social media:	200,000	
Net emissions of carbon dioxide and methane:	364 t CO_2 equivalent[150]	value in account of -£23,000
Revenue:	£21,100	
Total costs (includes costs attributed to producing green hay seed source):		
met by Natural England:	£122,000	(40%)
met by others:	£182,000	(60%)
Carbon storage:	188,000 t of carbon[151]	

Indicators:

of ecosystem quantity:	Area of: NNR, MG4 grassland, of reedbed, land under agricultural management. Length of ditches.
of ecosystem quality:	Number of waterfowl supported. Number of breeding: snipe, corncrake, shoveller, barn owls. Tree cover. Percentage of willow trees that is coppiced. Delivery of planned ditch clearance programme. Whether the site floods and whether the flood banks are breached. Safe and adequate access where consistent with nature conservation. Easy access for as many user groups as possible that adds to the enjoyment of their experience. Volunteer or staff resource available to make postings on social media.

[147] Students in higher and further education.

[148] A loose definition of educational visits for 'others' is used for this NNR.

[149] Includes research projects conducted by students and partners using data on the NNR, community-led citizen science initiatives concerning the NNR, and monitoring projects contributed to by the NNR.

[150] Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site). In the absence of more accurate data, it is assumed that newly formed reedbeds emit carbon dioxide and methane at the same rate as established reedbeds.

[151] Rounded to three significant figures. Estimated with low confidence. The data used are generalised values for broad habitat types that are best estimates (not based on studies at the site). Soil carbon stock data for grassland are for the top 15cm only so are likely to underestimate stocks in the entire soil profile. For reedbed, the estimates are for the entire soil profile.

I. Summary of environmental goods & services provided by NNRs

Provisioning goods & services provided by the NNRs: these are summarised in Table 3.2.

For the tables that follow:

Key: ● One of the main goods/services relative to others provided by NNR; ○ Provided at low levels relative to other goods/services provided by NNR.

Categories used are based on the Common International Classification of Ecosystem Services (European Environment Agency 2013).

Table I.1. Cultural goods & services provided by the NNRs

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Cultural					
Recreation & other physical activities & experiences:					
Experiences that directly involve plants, animals and land/sea scapes.	●	●	●	●	●
Physical uses of land/sea scapes.	●	○	●	●	●
Intellectual activities & representations of nature (for example, in art):					
Scientific (Research)	●	●	●	●	●
Educational.	●	●	●	●	●
Heritage, cultural.	●	●	●	●	●
Access off-site and entertainment.	○	●	○	●	●
Aesthetic.	○	●	●	●	●
Spiritual, symbolic & other interactions with nature:					
Symbolic.	●	●	○	○	○
Sacred and/or religious.			○		
Existence for current generation.	●	●	●		●
Current value of conservation for future generations.	●	●	●	●	●

Table I.2. Regulation and maintenance goods & services provided by the NNRs

NNR	Ainsdale Sand Dunes	Bure Marshes	Castle Eden Dene	East Dartmoor	Lower Derwent Valley
Regulation and maintenance					
Degradation of waste and toxic materials and moderation of other nuisances:					
Bio-remediation of waste by organisms.			○		○
Filtration, sequestration, storage or accumulation of pollutants by organisms.			○		
Filtration, sequestration, storage or accumulation of waste by ecosystems.		○	○		●
Dilution of waste by the atmosphere, freshwater or marine ecosystems.			○		
Moderation of smell, noise or visual impacts.			○		
Maintenance and moderation of flows:					
Stabilisation of land masses & control of erosion rates.	●	○	●		●
Buffering and reducing the strength of mass flows of sediment.			●		○
Maintenance of the hydrological cycle and water flow.	●	●	○		○
Flood protection.	●	●		○	●
Wind protection.	●	○	●		
Ventilation and transpiration.			●		
Maintenance of physical, chemical or biological conditions:					
Pollination and seed dispersal.	●	○	●	○	○
Maintaining habitats for reproduction and nurseries.	●	●	○		●
Ecosystem provides pest control.			●		○
Ecosystem provides disease control.			○		○
Weathering processes.			○		○
Decomposition and fixing processes.	●	●	○	●	
Chemical condition of freshwaters.		●	○	○	●
Chemical condition of salt waters.			●		
Impacts on greenhouse gas concentrations.	●	●	●	●	○
Micro and regional climate regulation.	○	○	○		

J. Feasibility of reporting against the initial accounts

This section is focussed on the initial accounts that were developed for this study.

The SRMs who participated in the study were concerned about the amount of time it would take to enter data to report against the accounts in future. They suggested that this could be overcome if the reporting directly employed the minimum set of annual data that staff are already encouraged to enter in Countryside Management System international (CMSi). CMSi is the online data recording system that Natural England has introduced for the NNRs that it manages. However, recording of data in CMSi by staff has not yet been embedded effectively. The SRMs explained that they have a backlog in entering data into the system. If this continued, it would limit CMSi's usefulness for CNCA reporting.

If reporting against the accounts was to directly employ data in CMSi, CNCA would need to be integrated into CMSi. Further investigation would be needed into whether this as feasible. It would be subject to agreement with the CMSi partners and funding and would be relatively complex (and therefore resource intensive).

The discussion below first considers CNCA reporting of data for the current year, followed by updating of projections.

Information on most of the indicators of ecosystem quantity and quality used in the initial accounts (which include area of the NNR and area of habitats) is not formally recorded in CMSi, though it is held by NNR staff. This is because the indicators used in the initial accounts were specific to each NNR (they were selected by the SRM). At least some may not be relevant to other NNRs.

Regarding the reporting of the quantities of environmental goods and services, staff are currently encouraged to enter data on the following in CMSi each year:

- total revenue from goods and services that are sold;
- visitor numbers;
- number of educational events (which could be translated into numbers of educational visits using assumptions).

However, the format for entering some data in CMSi might need to be changed to enable direct use of the data[152].

The following information is not in the minimum set of data that staff are encouraged to enter in CMSi each year (and they may not enter it). These data would be required to report against the initial accounts that were developed for this study:

- quantities of goods and services sold (this is needed for the account to distinguish between changes in quantity and changes in value);
- numbers of research projects;
- numbers of individuals trained;
- changes in area of habitat (which affects the net carbon flux).

Forecasts of costs are available in CMSi but data on actual costs are held in a different information system and would need to be entered into CMSi. Reporting against the accounts

[152] For example, certain numerical data might need to be entered into specific fields so they are easy to extract (currently, they may be embedded in text in CMSi entries).

would also require updated data on total salary costs from Natural England and data from national NNR team (which supplied data for initial development of the accounts, described in Appendix C Section 2). Monetary values of goods and services that are not traded are not currently entered in CMSi, but could potentially be entered for the purposes of the accounts, subject to necessary adjustments to CMSi.

To report against the initial accounts developed for this study, updated projections for future years would be needed as well as data on the current year. This is because for four of the NNRs, data for the current year would not estimate data for future years for the plan used in the account (discussed further in Appendix L). For pursuit of the goal, the physical flow of ecosystem services and the costs differ between years. For one of the NNRs[153], it might be possible to use data for the current year to represent the situation for each year in future (in the projections) if specific conditions applied (discussed in Appendix L). For such an approach, an annual equivalent cost of capital items would need to be used.

[153] which employed a long term goal of sustaining high nature conservation value.

K. Options for adopting CNCA for the NNRs managed by Natural England

This section starts by suggesting options for representing the NNRs managed by Natural England in an account. These were developed in collaboration with the SRMs and former SRM who participated in developing the initial accounts (the method is summarised in Appendix C Section 1). That is followed by potential approaches regarding projections in the account (provided by the analyst). The information presented here is additional to the discussion of the goal, focus and limits of the account in Section 4.3 of the report.

Suggested options for representing the NNRs in an account

The SRMs suggested that if CNCA was to be rolled out to other NNRs managed by Natural England, it would be most useful to Natural England if the account was for all the NNRs that Natural England manages. This was identified in a group discussion. One SRM explained that such an account would be: "useful to Natural England because it demonstrates whether it is maintaining or increasing its asset value [in the NNRs] or highlights whether the asset value is declining and Natural England is not delivering value for money to the tax payer".

There were concerns that the development and reporting for a separate account for each NNR managed by Natural England would be very resource intensive and, in the case of some NNRs[154], would not be useful to Natural England. This was raised by three SRMs. One explained that: "doing an account in detail…certainly involves a fair amount of work setting things up, and I'm not sure what it gives us that isn't already dealt with in the NNR management planning process".

An account specific to an NNR might be helpful for certain sites, for example to inform development of applications for external funding, support bids for sponsorship by businesses, or assist development of partnership arrangements. This was identified by four SRMs. One SRM, who has led development of a major EU LIFE+ and HLF funding proposal, did not think that an account would assist in developing bids for such funders as they have their own processes and require information in specific formats. However, for big, public-facing NNRs, he thought that CNCA could be a good way of showing what Natural England is doing and the benefits to society. The information that would be needed for the purposes described here is a snapshot of information describing the NNR. This could be supplied by CNCA, or alternatively could be developed without the added investment in monitoring required for CNCA.

If CNCA was to be adopted for all NNRs managed by Natural England, the SRMs were concerned about the amount of time it would take to enter the data; this was raised by five participants in the study. Three participants suggested that ideally the account would directly employ data that staff enter into CMSi and would use only the data that they are already encouraged to enter. This would avoid any additional data entry. Two of the SRMs suggested that entry of data into two data systems (CMSi and a separate system for CNCA) should be avoided. However, two SRMs said that they would prefer to use the Initial Account Workbook (developed for the study) to report against their initial accounts because of the challenges they experience in using CMSi.

Options for implementing an account for all NNRs managed by Natural England were discussed by the analyst, the SRMs and other NNR colleagues. Two participants in the study

[154] One SRM suggested that CNCA is less likely to be helpful for small NNRs and those that are not undertaking habitat restoration.

suggested that the most suitable option to adopt depends on what the purpose is of adopting CNCA: what it is going to be used for, the questions it is going to be used to answer and the level of detail that is needed. The following main options and SRMs' views emerged:

- An account that employs data in CMSi for each NNR. Five of the participants in the study thought that such an account would be most useful. It would compile data on the NNR that could be shared with stakeholders and it would reflect the 'individuality' of the NNRs. One SRM explained the following about an account: "its value will be reduced if the information isn't accurate – the more it's generalised, the worse it will be. But if it's generalised from detailed information provided from each NNR, it will be better… let's do it properly or not at all". However, if it involved additional data entry in CMSi beyond the minimum that staff are encouraged to enter, the SRMs were concerned about the staff time that would be needed and that there could be a poor response rate by staff due to workloads.

  For it to be feasible, such an account would need to be simplified and partial. It would focus on the goods and services provided by most NNRs and would not include those that are specific to a few. By using data from the NNRs, the account would reflect the situation in the NNRs and it would be sensitive to change in the NNRs (and thereby offer more effective monitoring). The levels of uncertainty would be influenced by the assumptions used in the account. The account would supply a more accurate representation than the options discussed below. Whether it would require additional data entry in CMSi would depend on the data required and whether projections need to be entered (discussed further below).

- An account using data for a sample of NNRs. This would involve identifying a representative sample of NNRs, which the SRMs indicated would require careful consideration. The benefits of site-specific data would be lost, which was raised as a concern by four SRMs. The account would offer a poorer representation of the NNRs than the above option because of the differences between NNRs. Also, it would provide less effective monitoring than the option above. This is because the NNRs will differ in the ways in which they change in future.

- An account that used average national data for the habitats in the NNRs combined with the area of the habitats in the NNRs. The only data on the NNRs that this would use would be habitat area (so would not require data entry by staff). However, it would offer a poor representation of the NNRs, which was identified by four of the SRMs.

  Because the NNRs are not typical of the wider environment in England, use of average data for habitats would not reflect the situation in the NNRs (it would be less representative than using data from a sample of NNRs). It would not be useful for monitoring the NNRs as it would only pick up changes in ecosystem quality, goods and services and costs that arose in average national habitat data, not those that arose in the NNRs. A further issue is that some of the goods and services (such as number of recreational visits) and costs are determined by factors other than habitat type, such as provision of access and proximity to centres of population.

Regardless of the option that is adopted, the SRMs suggested that if monitoring of NNRs was undertaken through CNCA, the timing of it would ideally coincide with the SRM's review of the NNR management plan. This was identified in group discussion and separately noted by five participants in the study. When they review the management plan, the SRMs require updated data on the NNR and consider the long term vision and strategic issues, all of which

are compatible with reporting for CNCA. The review usually takes place every five years, with the review dates for NNRs staggered such that all reviews usually occur over a five year cycle.

Potential approaches regarding projections in the account

Whether it is feasible to develop and monitor an account for all the NNRs managed by Natural England using data in CMSi depends on the level of accuracy that is sought, the long term goal that is used for the account and whether additional data are needed for the future projections. Two potential approaches for the projections are set out below, based on insights from the study.

1. The least resource intensive approach would be to assume that data for the current year (added up for all the NNRs managed by Natural England) reflects the data for future years over the long term. The assumption would apply in development of the account (in providing the projections for the reference scenario) and reporting against the account in future. It would be employed for costs of managing the NNRs, ecological indicators (such as the percentage of SSSIs in favourable condition), the goods and services (such as numbers of recreational visits) and their value.

   The assumption that data for the current year represent data for future years would not apply if:

   - The long term goal employed in the account involves significant changes in future compared with the current situation for the NNRs. These could be significant changes in the total quantity or quality of main habitat types, total quantity of environmental goods and services provided by all of the NNRs, and/or total costs (including inputs made by others). Such changes would be anticipated if an ambitious goal was adopted for the account.
   - Total costs of maintaining current natural capital assets at current levels will significantly increase in future in response to external factors (such as climate change) and/or unexpected changes (such as pests and diseases).
   - Funding and inputs supplied by others are not sufficient to maintain the NNRs' assets each year and consequently additional inputs need to be made in future to maintain the condition of the assets.

   The approach would be appropriate if the following conditions applied:

   - the long term goal used in the account was to maintain the current natural capital assets (that is, total current quantity and quality of ecosystems and provision of goods and services);
   - adequate funding and inputs from others were supplied each year;
   - external factors and unexpected changes did not impact on the costs of delivering the goal;
   - significant interventions were not required to maintain the assets.

   The above approach would have relative low resource implications because projections for future years would not need to be entered. The account would assume that aggregation of data for all the NNRs would incorporate variations that happen over time. Events that occurred every few years would be accommodated as part of the total (eg an NNR that fells trees every five years may do so this year, another one may do so next year). Small scale differences in the management would also be evened out. For example, at any one time, in the long term, some NNRs would be undertaking habitat restoration, some would not.

2. If data for the current year could not be assumed to estimate data for future years, projections would need to be entered when developing the account. Updated projections would need to be entered each time the account was reported against in future. This would be far more resource intensive than the approach discussed above. However, if the aim of the account was to monitor delivery of an ambitious long term goal that improves the total quantity and quality of ecosystems and/or delivery of goods and services, such an approach would be necessary. Also, it would offer the flexibility needed to accommodate the effects of shortfalls in funding and unexpected external factors (such as increased frequency of storms).

In the event that accounts were implemented for individual NNRs, the issues that would arise if data only for the current year were used in the account (instead of projections) are slightly different to those described above. They are discussed in Appendix L.

L. Use of the current year's data in an account for one NNR: issues

For a single NNR managed by Natural England, data for the current year are not likely to be sufficient to develop a CNCA account or report against an account. This is because the account employs projections for future years for delivery of a long term goal. The issues that arise are as follows:

1. For an individual NNR, if the levels in data for the current year (such as expenditure on habitat restoration, numbers of trees felled) will not recur annually, they cannot be used to estimate levels for future years. This is the case whatever long term goal is used for the account. It is likely to be an issue for key variables for some NNRs. For these NNRs, though levels for some data may recur annually (such as vehicle running costs, numbers of educational visits), these are not sufficient to inform an account.

   For some NNRs, the levels of data in the current year may apply annually in future subject to the following conditions:

   - the long term goal of the account is to maintain the current quantity and quality of ecosystems in the NNR and current provision of environmental goods and services and these can be achieved without any additional costs (excluding capital expenditure), including inputs made by others.
   - In future, the NNR is not likely to be subject to external factors or unexpected events that will result in additional costs for maintaining current ecosystem quantity and quality and continuing current provision of goods and services.
   - In future, the NNR will receive sufficient funding and inputs from others to maintain current ecosystem quantity and quality and provision of goods and services.

   An exception to the above is expenditure on capital items. For this, long term projections need to be estimated. These would be converted into an annual equivalent value (as described in Appendix C).

   The above issue applies to development of an initial account and reporting against an account for an individual NNR. For multiple NNRs, the situation is different (discussed in Appendix K).

2. Another issue arises if the long term goal employed for the account involves significant changes in future that will alter quantity or quality of ecosystems, provision of environmental goods and services, and/or costs. Such changes are expected if the goal includes meeting ambitious targets, for example concerning SSSI condition. For delivery of such a goal, data for the current year cannot be assumed to apply to future years.

3. Even if the long term goal used in the account is to maintain the natural capital assets (which is the minimum level of aspiration that Eftec (2015a) and others suggest is used), data for the current year will not reflect data for future years if any of the following apply:

   - the costs of maintaining the natural capital assets will increase over time because of the effects of external factors such as climate change;
   - unexpected changes, such as pests or diseases, cause increased management costs;
   - the goal includes a continuation of SSSIs not being in favourable condition and that is associated with increased management costs in the future (for example, for managing increased numbers of fallen trees);

- if major shortfalls in funding or inputs by others arise and result in inadequate maintenance of the environment and/or NNR infrastructure. In this situation, if the current level of natural capital assets is to be maintained in the long term, increased expenditure on habitat management, buildings, gates etc may be needed in the medium term.

With a goal of maintaining ecosystem quantity and quality and provision of goods and services, data for the current year will reflect data for future years only if the current circumstances apply in the long term. For example:

- ecosystem quality and quantity and provision of goods and services can be maintained without additional costs despite influences of external factors and unexpected changes;
- funding and inputs supplied by others each year will be sufficient to maintain ecosystem quality and quantity and provision of goods and services.

The points raised above (in (3)) apply to development of and reporting against an account for an NNR or for all NNRs managed by Natural England.

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