Natural England Research Report NERR078

Accounting for National Nature Reserves:

A Natural Capital Account of the National Nature Reserves managed by Natural England

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Accounting for National Nature Reserves:
A Natural Capital Account of the National Nature Reserves managed by Natural England

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Published 21st February 2019

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ISBN 978-1-78354-518-6

Project details

This report should be cited as: SUNDERLAND, T., WATERS, R.D., MARSH, D. V. K., HUDSON, C., AND LUSARDI, J. (2019). *Accounting for National Nature Reserves: A natural capital account of the National Nature Reserves managed by Natural England.* Natural England Research Report, Number 078

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Acknowledgements

We would like to thank everyone who contributed to this report both within Natural England and externally.

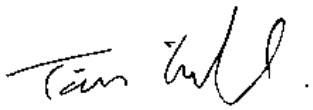
Foreword

England's National Nature Reserves (NNRs) are the crown jewels of our natural heritage. They are some of our most important sites for wildlife and geology in England. They conserve biodiversity and geodiversity, and provide 'outdoor laboratories' for research. They provide opportunities to access, enjoy and engage with our natural heritage. They also provide a much wider range of benefits to society. This makes the NNRs important natural capital assets. We need to understand them to ensure they are resilient, because we want them to continue to provide benefits for generations to come.

In this report, we have developed an innovative approach to Natural Capital Accounting (NCA). Our new approach documents the full range of benefits that the NNRs provide. We have built on our ground-breaking Natural Capital Indicators report and sought to understand:

- the state of our assets;
- what ecosystem services they provide;
- what the benefits are,
- and the economic value of the benefits.

Importantly, we report across all these components, side by side. This is to inform comprehensive decision-making and avoid the recognised pitfalls of partial accounts. I believe that these accounts demonstrate not only how important NNRs are, but also how a more inclusive approach to NCA is essential if we are to invest in, and manage, our natural capital for the full suite of benefits that they offer.



Tim Hill, Chief Scientist, Natural England

Executive Summary

Introduction

This report is a Natural Capital Account for the National Nature Reserves (NNRs). NNRs protect some of England's most important habitats, species and geology. They embody our natural diversity, from multi-layered geology to ferny woodlands, ancient grasslands and heaths, wetlands, moorlands and wild coasts. They also support research, education and recreation. They cover approximately 0.7% of England's land surface.

We have taken an innovative approach to Natural Capital Accounting (NCA). We've used an extended balance sheet, which displays the state of our assets, services, benefits and their economic value next to each other. Our account is grounded in the ecological evidence. We've highlighted evidence gaps and confidence intervals. This is all essential to support transparent decision-making.

Natural Capital

The natural environment provides a wide range of benefits to people. These include food, water, flood alleviation, thriving wildlife and places to enjoy. The Natural Capital Committee (NCC) has defined natural capital as:

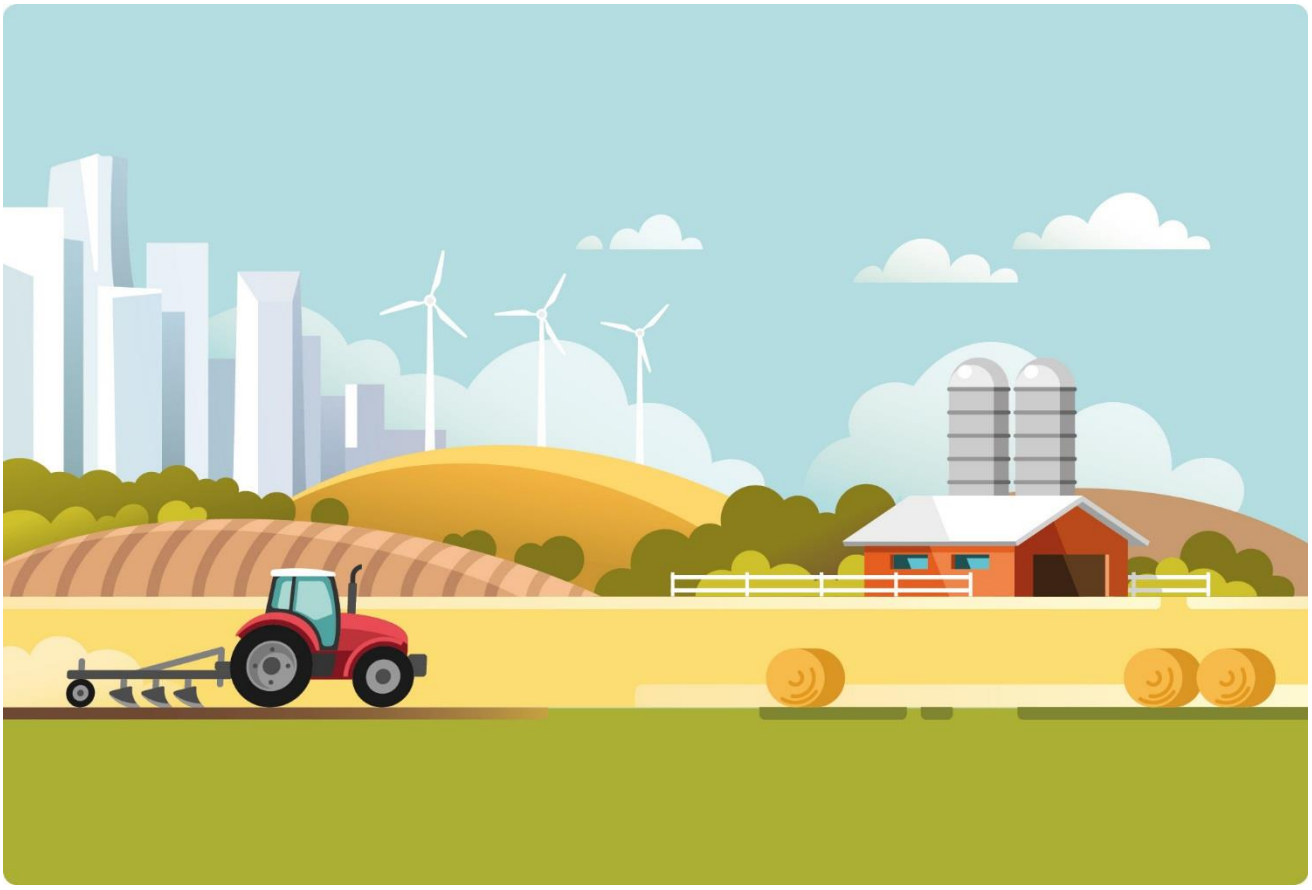
"the elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions" (Natural Capital Committee 2017).

The concept of natural capital is broad. It includes the living and non-living parts of nature, and the systems they make up. These systems sustain life on Earth. If properly managed, natural capital can provide benefits indefinitely. Some benefits of natural capital can be measured and valued, but many are difficult to define and quantify. These are therefore often invisible in decision making. This can result in natural capital being inadvertently degraded or destroyed. The solution is therefore to include information about the benefits of natural capital in decision making. Our ability to do this is improving rapidly, but is still a developing area.

Natural Capital frames the environment as a productive asset, in order to include it in economic decision-making. So it asks the same questions about land that we might ask about machinery – such as a tractor (figure 1). For example:

- What benefits does it provide?
- For how long?
- How well?
- What state is the asset in?
- What maintenance and investment is required?

Figure 1 We can ask the same questions about our natural assets as we can of our tractor



Logic chains to aid the understanding of natural capital

A natural capital approach sees the natural environment as a stock of assets. These assets enable a flow of ecosystem services to people, who benefit from them, and therefore value them.

Figure 2 Natural England Natural Capital Logic Chain

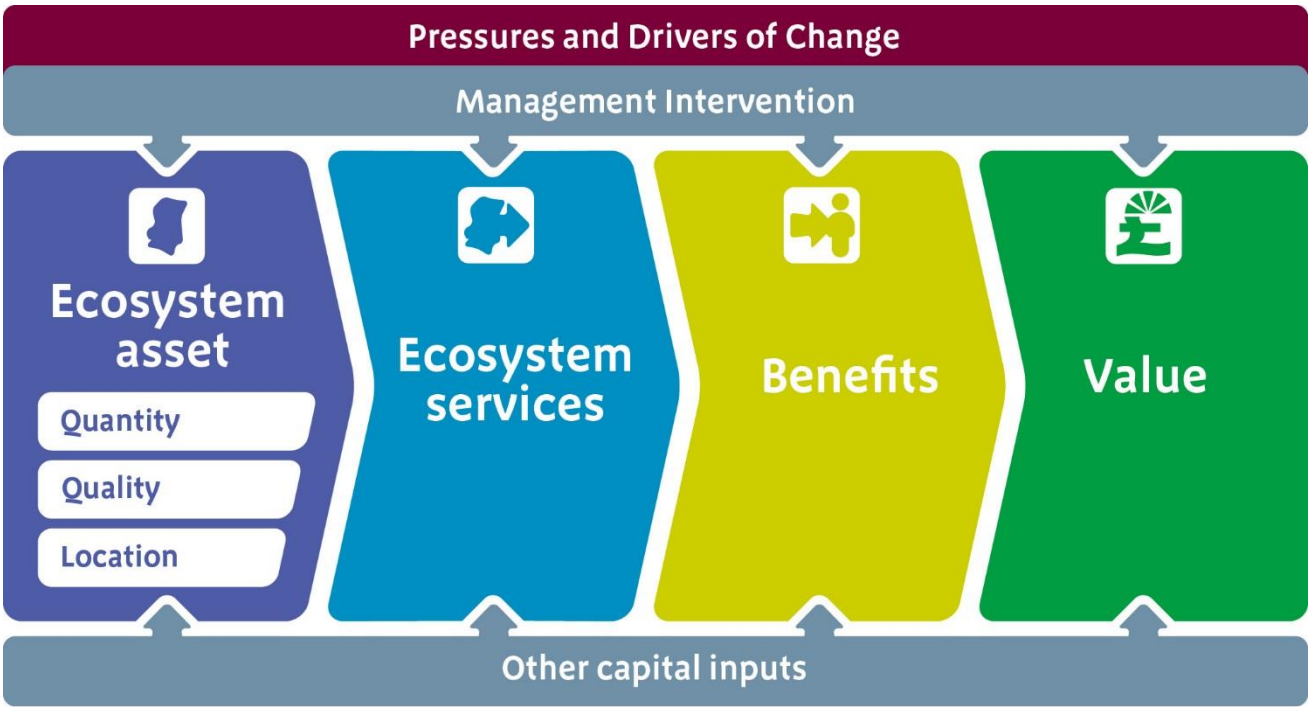


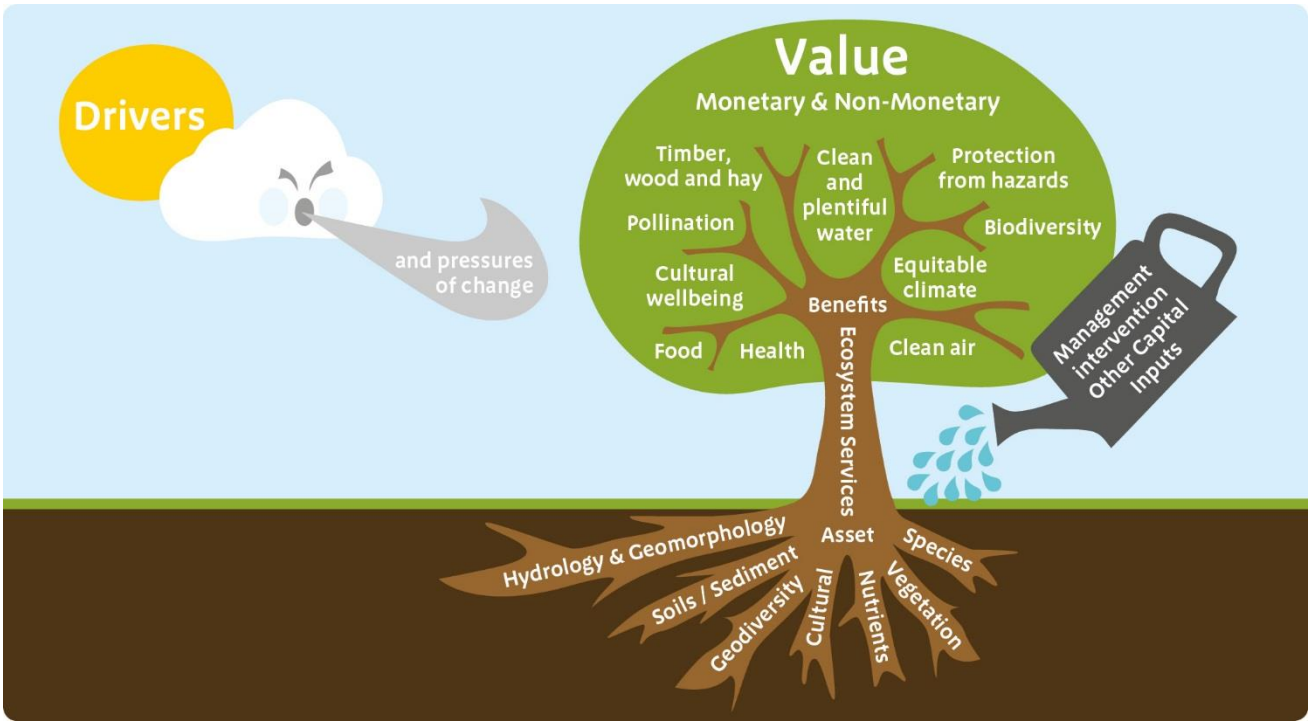
Figure 2, above, shows this flow of services from natural capital assets to people. The core of the diagram shows the flow from asset, to service, benefit and value. To give a simple example, an NNR might provide a hay crop. This can be used for animal fodder and has a market value. The three white boxes show three properties of the asset which are critical to delivery of benefits. These are quantity, quality and location. In our example, the value of hay produced will be affected by the quantity of NNR farmed for hay but also the quality of the land. Location is not critical for hay farming, but is critical for some other ecosystem services. For example recreation land is much more valuable near centres of population.

The bars on the top and bottom of the diagram illustrate factors which influence this logic chain. Starting at the top, the natural environment is subject to many pressures and drivers, such as climate change, which can alter assets and resulting services. Environmental assets are managed, and changes in management will also impact our logic chain. Finally, realising the benefits normally requires inputs of manufactured, human or social capital. For example footpaths to provide access.

This logic chain is a simplification of a highly complex system. Often many assets are contributing to each ecosystem service. Similarly, many services may be contributing to each benefit. There are synergies and trade-offs which are not captured in this logic chain. However, this simplification helps us systematically identify important relationships and asset attributes.

The work in these accounts has built on careful identification of key attributes and indicators of each part of the logic chain (see Lusardi et al. 2018 *Natural Capital Indicators: for defining and measuring change in natural capital NERR076*). Figure 3, below, illustrates the key attributes of the quality of our natural capital in the roots that enable the flows, benefits to society and values in the canopy.

Figure 3 Key attributes of Natural Capital



Natural Capital Accounting Methods

This account includes all the NNRs that are managed by Natural England - alone or in partnership with others. Natural Capital Accounts (NCAs) are a way of organising information about natural capital to inform decision making. They extend traditional accounts by putting economic values on benefits that are not provided through the market. For example, many rural areas provide recreation opportunities, but the value of these is not included in the land owner's accounts. These non-market benefits are valued using a range of techniques from environmental economics. NCAs calculate asset values for environmental assets by adding up the future stream of expected benefits.

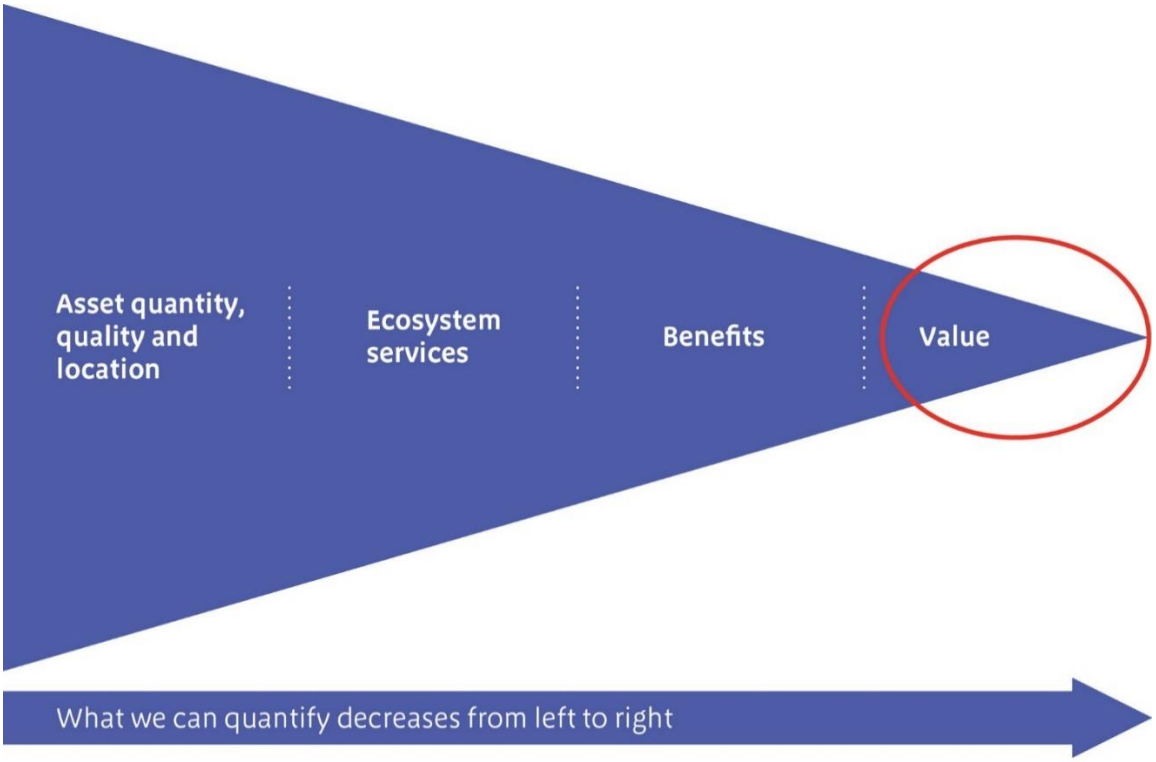
Traditional accounts play two important roles. Audited accounts are part of an organisation's external accountability, whereas management accounts support internal decision-making. In time Natural Capital Accounts may be able to play both these roles. They also have an important role in communicating environmental benefits provided by organisations.

Methods for NCAs are still developing and different approaches are being adopted by different organisations. There are not yet auditable standards like those for traditional accounting. One group of Natural Capital Accounts is strategic: it focuses on relatively large areas. The Office for National Statistics (n.d.a.) Accounts fall into this category. Another group focuses on organisational boundaries. Most of the organisational accounts use the Corporate Natural Capital Accounting (CNCA) tool (EFTEC et al. 2015). CNCA is designed to measure progress towards a future target scenario. The asset value is set based on this scenario. This means that the reader needs to understand the future target scenario to interpret the asset value and any changes to it. We cannot predict future scenarios with confidence. We also want the accounts to be understandable without significant investment in understanding the methodology. For this reason we have not used CNCA.

Public bodies and private sector organisations have different needs from NCAs. For private sector organisations NCAs may provide extra information about public benefits, which sit alongside evidence about their core market indicators. This may usefully broaden decision-making. But for public bodies their role is to provide public benefits, and these will dominate the account. There is not yet an approach to NCAs designed for public bodies, and this has been a focus for this study.

NCAs usually report using a final balance sheet that reports on the costs and monetary values of the assets. Natural England has used the natural capital logic chain as the basis for our natural capital accounts, seeking to report on each part of the chain: assets, services, benefits and values using the indicators identified in our Natural Capital Indicators report (Lusardi et al. 2018). This approach aims to provide decision makers with a more complete picture of the state of the assets, flows, benefits and the values derived from them. Often, understanding values is insufficient to know whether or not the asset is able to continue to provide benefits into the future. Figure 4 shows us that typically we lose information as we go from left to right along the logic chains, from assets through to values. This is particularly important for assets such as NNRs whose purpose is to provide a range of public goods which are difficult to value. Thriving wildlife for example. Also, values on their own, may not relate closely to the quality of the asset. For example, we can value woodland recreation based on an average trip value, but this tells us nothing about which qualities of woodlands which are important for recreation. Similarly, we can produce asset values based on the assumption that benefits will continue at current levels, but the critical question is 'will they?' To get a handle on this we need to understand the state of the assets. This can also act as an early warning to potential changes in the provision of services, benefits and values into the future.

Figure 4 Loss of information across the logic chain



We have developed an extended balance sheet which reports on the quantity and quality of the assets, the ecosystem services, benefits and values alongside each other. Where quantified data is missing, we have estimated the significance of ecosystem service provision and benefits qualitatively using expert judgement. We did this to reduce the risk of partial valuation being misinterpreted and to present a more complete picture to decision-makers.

We have used confidence levels (shown as a Red – Amber – Green traffic light rating) to indicate the quality and appropriateness of the information behind the value figures.

Table 1 Key to confidence intervals

Definition	Colour
We may have used some assumptions or estimation but consider these figures uncontroversial.	Green
We have used some assumptions or estimation and some of these may be open to question. Accuracy is better than + or -50%.	Amber
We are confident that the number is in the right order of magnitude. Order of magnitude implies that for an estimate of 5 that we are confident that the real figure is within the range 0.5 to 50.	Red
We can't offer a number which is likely to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. What we do know, and our confidence, will be discussed qualitatively.	No number

Headline results

Table 2 Headline Results

Ecosystem asset		
Natural capital asset baseline		
Asset Attribute	**Indicator**	
Extent	**Total area (ha)**	**66839.7**
Hydrology	Ground water status (% good) Water Framework Directive (WFD)	24.1
	Surface Water status (% good) WFD	18.6
Nutrient/ chemical status	Mean sulphur dioxide concentration (µg m-3)	0.32
	Mean nitrogen acid deposition (kg N ha-1 year-1)	12.3
Soil	Mean Estimates of Soil Organic Carbon in 30cm Topsoil (% of total) from NATMAP	9.13
Vegetation	% of NNR (ha) under a Site of Special Scientific Interest (SSSI) which is in favourable condition	51.3
Species composition	Nectar plant diversity – Mean Estimates of Number of Nectar Plant Species for Bees (per 2×2m plot)	5.05
	Soil Invertebrates Abundance – Mean Estimates of Total Abundance of Invertebrates in Topsoil (0–8cm depth soil core)	65.3
Cultural	Tranquillity (mean score)	13.8
	Scheduled monuments at risk (ha)	74.7

Ecosystem services			
Ecosystem service	**Significance** (1 small to 3 large)	**Indicator**	**Quantity** where available
Timber, hay and other materials	2	Sale of timber	3000t
Game and fish	1		
Water supply	1		
Livestock	1		
Water quality	1		
Air quality	1		
Erosion control	1		
Flood protection	1		
Pollination	1		
Thriving wildlife	3		
Pest and disease control	1		
Climate regulation	3	Carbon Sequestered – tonnes of CO_2 equivalent	185,000
Recreation, tourism and volunteering	3	No. of recreational visits	5.5 million
		No. of volunteering hours	150,000
Scientific and educational	3	No. of educational visits	37,000
Cultural appreciation of nature	3		

Benefits and values

Benefit	Significance (1 small to 3 large)	Indicator	Annual benefit	Asset value	Confidence in the values (RAG where red is low)
Timber, wood and hay	2	Sale of timber	£56,000	£2 million	
Food	1	Income from grazing	£281,000	£9 million	
		Sporting rights income	£28,000	£1 million	
Clean and plentiful water	1				
Clear air	1				
Protection from floods and other hazards	1				
Pollination and pest control	1				
Biodiversity	3				
Equable climate	3	Carbon sequestered	£12 million	£1 billion	
Health	2				
Cultural wellbeing	3	No. of recreational visits	£22 million	£710 million	
		No. of volunteer hours	£1.8 million	£60 million	
		No. of educational visits	£123,000	£4 million	
Total quantified monetary benefits			**£36 million**	**£1.8 billion**	
Significance of unquantified benefits			**Very large**		
Total annual costs			**£14 million**		

Assets

The NNRs managed by Natural England are spread across England and cover 0.7% of the land surface. Figure 5, below, shows their extent and location.

Figure 5 The extent of NE-managed NNRs at the national scale, with reserves outlined in red

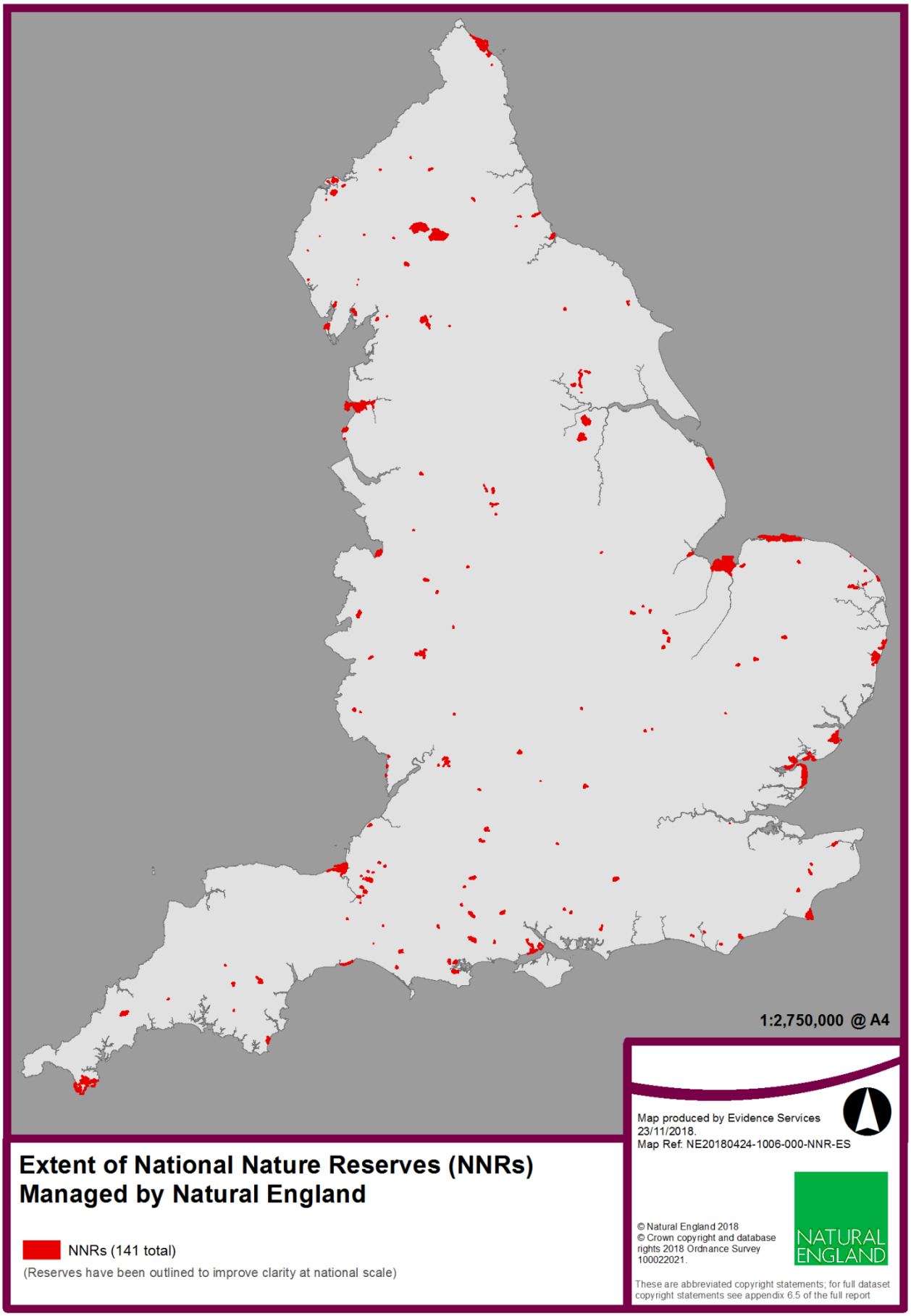


Table 3 shows the breakdown of NNRs into National Ecosystem Assessment habitat type (UKNEA, 2011). We have habitat data for 64,544 hectares of the Natural England managed NNRs estate. 2,295.7 hectares was not classified because it was below the high watermark. Some of the largest habitat types were beaches[1], saltwater and bog. On land the largest habitat types were broadleaved woodland and grassland.

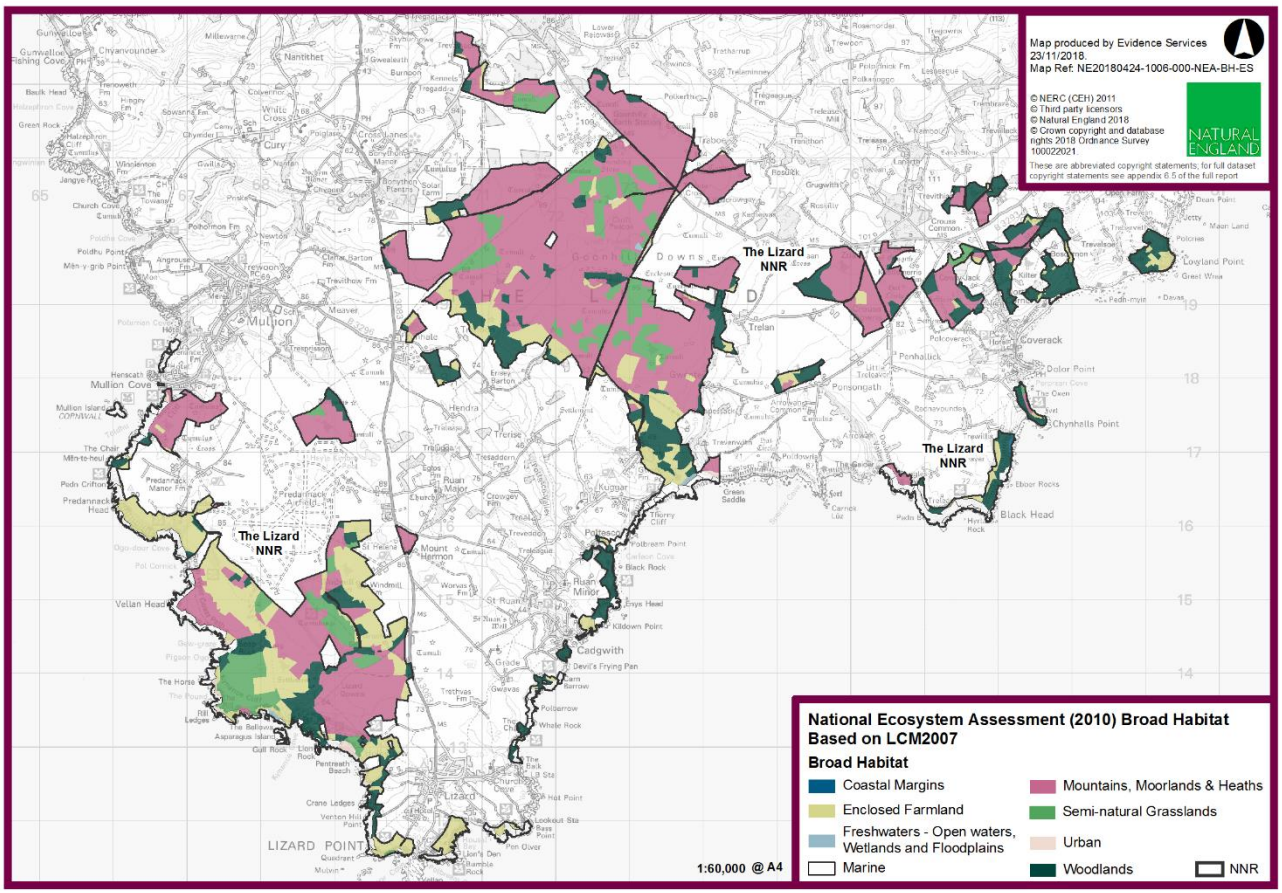
Table 3 NE-managed NNRs broken down by National Ecosystem Assessment broad habitat

National Ecosystem Assessment Broad Habitat (NEA-BH)	Area across NE NNR Estate (ha)	% of Total
Woodlands	7,843	12
Enclosed farmland	5,508	9
Semi-natural grassland	4,613	7
Open water, wetlands and floodplains	8,568	13
Mountains, moorlands, heaths	8,630	13
Marine	21,680	34
Coastal margins	7,529	12
Urban	174	0
Total	**64,544.1**	**100**

A map of the Lizard NNR is offered below as an example (figure 6).

[1] Littoral Sediment

Figure 6 The Lizard NNR by National Ecosystem Assessment broad habitat



The baseline assessment of natural capital assets uses twenty seven indicators to describe the extent and quality of the NNR assets. Using available data sources we were able to produce mapped estimates of many types of natural capital asset and benefits. Data sets have been used that describe aspects of hydrology, soils, nutrient and chemical status, vegetation, species composition and cultural benefits, as recommended in Natural England's Natural Capital Indicators Report (Lusardi et al. 2018). Where possible, we have tried to apply open data in the quantification of natural capital, under an Open Government License (OGL). However some proprietary (non-OGL) datasets have been used in instances where open data is not available for representing a particular type of natural capital asset.

We have been able to map a large number of natural capital indicators for the report. Figure 7 and figure 8, below, provide examples from the key attributes – shown earlier as the roots of the tree. See figure 7, below. The top-left shows water-quality at Stodmarsh, the bottom-left Tranquillity mapping at Moor House – Upper Teasdale and the right-hand panel average nitrogen deposition across the estate.

Figure 7 Demonstration of mapping for water quality, tranquillity and nitrogen deposition

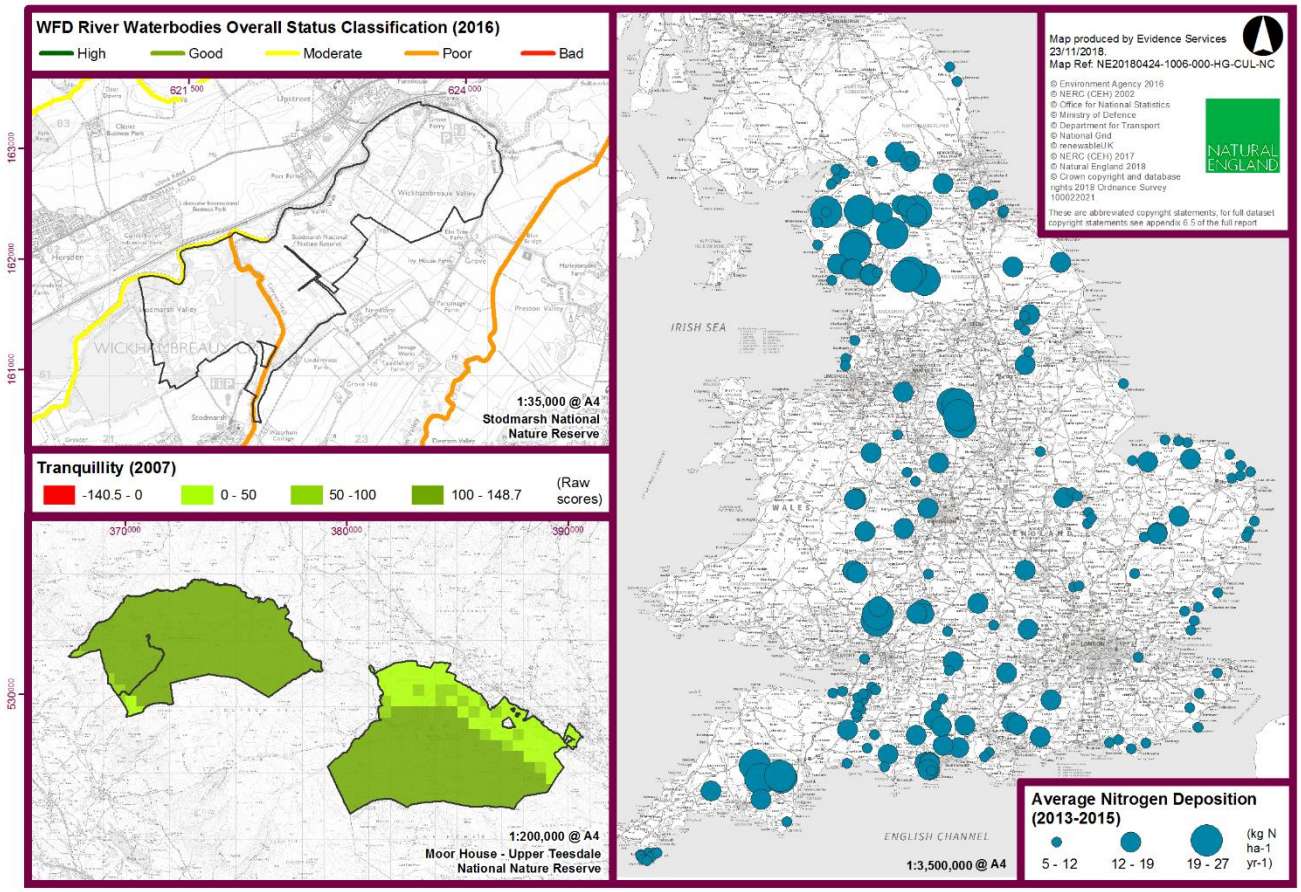
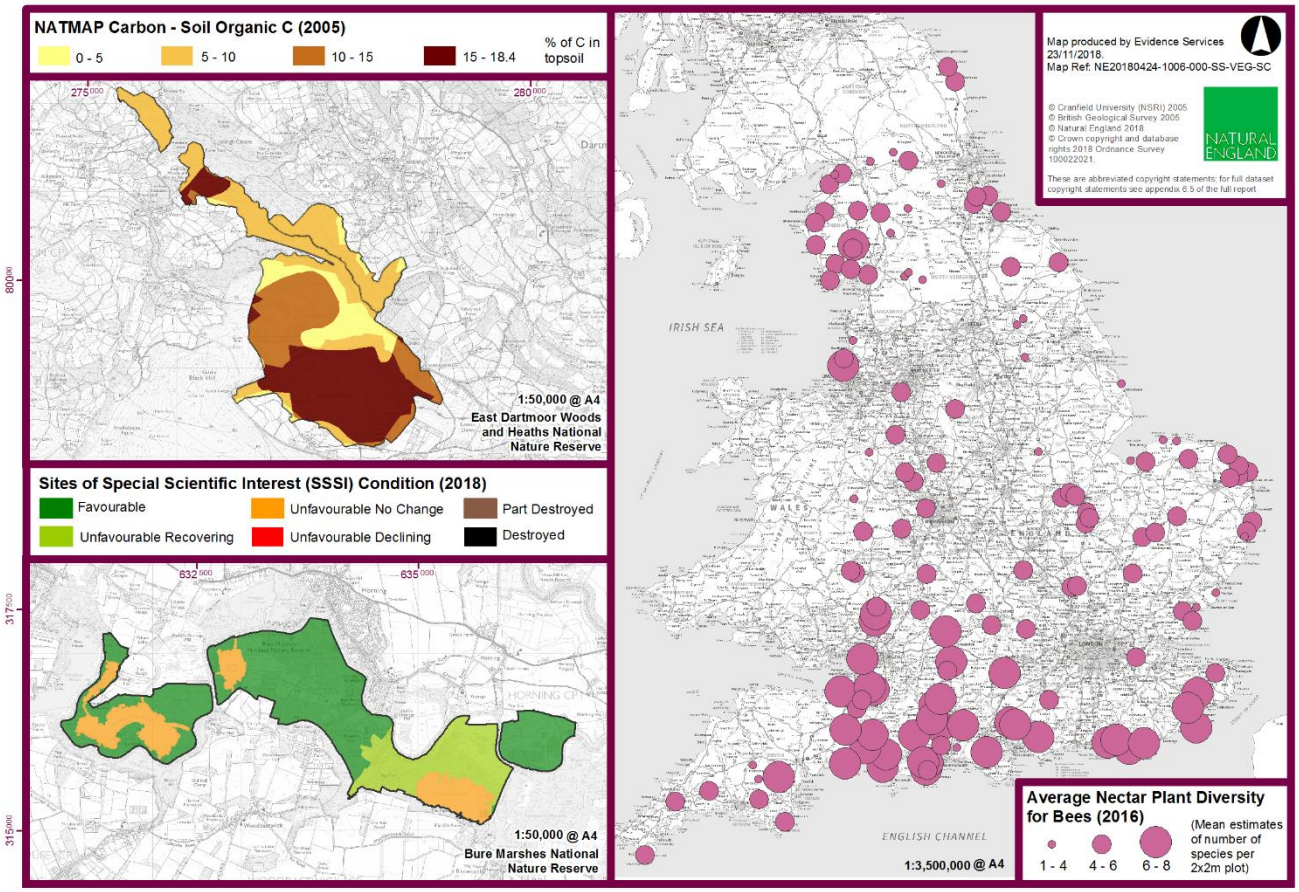


Figure 8 below, provides three more examples. The top-left shows soil organic carbon at East Dartmoor Wood and Heaths, the bottom-left Site of Special Scientific Interest (SSSI) condition at Bure Marshes and the right-hand panel shows average nectar plant diversity for bees across the estate.

Figure 8 Demonstration of mapping for soil organic carbon, vegetation and nectar plant diversity



Natural Capital Accounting is designed to be repeated on a regular basis in order to help managers keep track of their assets. Our assessment this time forms a baseline against which future accounts can be compared. Data sets that were applicable to this work are limited. They are of variable resolution, have varying intervals for repetition, and in some cases are proxies for a quality aspect we are interested in and not direct measures. Nevertheless, this provides a useful suite of information against which we can measure changes in quality and extent of the natural capital assets at a future date. We have not benchmarked the indicators of the quality of natural capital against other assets beyond NNRs but this could be a useful exercise to undertake at a later date.

Services

Thriving wildlife, recreation and scientific research are the NNRs core purposes, but they also deliver a wider range of ecosystem services. Table 4 below shows our estimates of the significance of ecosystem services provided by the assets. These are based on expert opinion. The quantity, quality and location of the assets influence this ecosystem service delivery, as does management and external pressures. The relationships between the asset features and delivery of ecosystem services is too complex to capture on a simple diagram. This also applies to the other steps in the logic chain. Interested readers should refer to our Natural Capital Indicators report (Lusardi et al. 2018).

Table 4 Ecosystem Service Significance, Indicators and Quantities

Ecosystem service	Significance (1 small to 3 large)	Indicator	Quantity where available
Timber, hay and other materials	2	Sale of timber	3000t
Game and fish	1		
Water supply	1		
Livestock	1		
Water quality	1		
Air quality	1		
Erosion control	1		
Flood protection	1		
Pollination	1		
Thriving wildlife	3		
Pest and disease control	1		
Climate regulation	3	Carbon Sequestered – tonnes of CO_2 equivalent	185,000
Recreation, tourism and volunteering	3	No. of recreational visits	5.5 million
		No. of volunteering hours	150,000
Scientific and educational	3	No. of educational visits	37,000
Cultural appreciation of nature	3		

We are able to quantify only a small proportion of these ecosystem services. Even where we are able to quantify the ecosystem services we do so based on a combination of evidence and assumptions. For example the number of recreational visits is based on point or range estimates provided by NNR staff. Similarly, there a number of ecosystem services which are not insignificant but which we do not know enough about to quantify. To give one example, land maintained as a nature reserve will hold and slow down water, reducing flooding downstream of it, but the scale of this is not currently known for our NNRs. There is an opportunity to improve the collation and collection of suitable data for future accounts.

Value and significance of benefits

Society values NNRs for the enjoyment people gain from them and the benefits they provide. They are especially valued for their role in:

1. nature conservation and protection of biodiversity
2. conservation and enhancement of the landscape
3. access to the countryside/open spaces and open-air recreation
4. access to facilities for the study, understanding and enjoyment of the natural environment.

These are all services which Natural England is responsible for providing and which are essential prerequisites for achieving the goals laid out in the Government's 25 year environment plan (HM Government 2018). All of these services are provided by natural capital which the Government is committed to protecting and growing.

We have assessed the significance of these benefits and where possible have estimated their monetary value, these results are summarised in table 5 below.

Table 5 Significance of benefits, values and confidence ratings

Benefit	Significance (1 small to 3 large)	Indicator	Annual benefit	Asset value	Confidence in the values (Red is low, Amber is Medium & Green is High)
Timber, wood and hay	2	Sale of timber	£56,000	£2 million	
Food	1	Income from grazing	£281,000	£9 million	
		Sporting rights income	£28,000	£1 million	
Clean and plentiful water	1				
Clean Air	1				
Protection from floods and other hazards	1				
Pollination and pest control	1				
Biodiversity	3				
Equable climate	3	Carbon sequestered	£12 million	£1 billion	
Health	2				
Cultural wellbeing	3	No. of recreational visits	£22 million	£710 million	
		No. of volunteer hours	£1.8 million	£60 million	
		No. of educational visits	£123,000	£4 million	
Total quantified monetary benefits			**£36 million**	**£1.8 billion**	
Significance of unquantified benefits			**Very large**		
Total annual costs			**£14 million**		

The most significant benefits provided by NNRs are thriving wildlife, equable climate and cultural services wellbeing'[2]'.

Although we are able to put a monetary value on some cultural well-being benefits, there are many more that are difficult to separate out or quantify, such as tranquillity, inspiration and sense of belonging. These are often described using the language of landscape, but we have used cultural benefits for consistency with the ecosystem service framework we are using. They also include non-use values – the fact that people value the conservation of nature, landscapes, habitats and species whether or not they visit them. We assess the significance of these benefits as 'Very Large'.

We estimate the monetary benefits to society from recreational and educational visits and volunteer work as being of the order of £24 million per annum, with an asset value of around £774 million. We are not able to estimate the magnitude of other cultural benefits or thriving wildlife, except to note that they are very significant and very likely to exceed the benefits we have been able to quantify.

The largest benefits that we can quantify in monetary terms are from carbon sequestration – resulting in less damage from climate change in the future. We estimate that NE managed NNRs sequester around 185,000 tonnes of CO_2 equivalent per year. This provides annual benefits of around £12 million. The value of carbon sequestration is expected to rise sharply over the next 50 years such that annual benefits will reach £65 million in 2077.

The natural capital asset value for carbon sequestration over the next 100 years is expected to be around £1 billion[3], assuming that NNRs are maintained in at least their current condition. If NNR condition is allowed to decline, or if some NNRs are converted to other land uses then substantial carbon emissions could result. For example emission of 5% of the carbon stored in NNRs would amount to 600,000 tonnes. This additional 600,000 tonnes of CO_2 equivalent would cause damage with a value around £3.5 billion over the next one hundred years[4].

Overall we estimate the monetary value of quantifiable benefits from NNRs to be in excess of £36 million per year with a natural capital asset value in excess of £1.8 billion. We note the 'very large' significance of benefits that we have not been able to value in monetary terms and suggest that these are probably greater than the quantified values.

[2] Cultural benefits include:- capabilities eg knowledge, health, dexterity, judgement. Experiences eg tranquillity, inspiration, escape, and discovery. Identities eg belonging, sense of place, rootedness, spirituality, sense of history. Non-use values: existence, bequest, altruistic, option

[3] Official Carbon Price estimates are available until 2100. These assume that the carbon price slowly declines from 2077 onwards. The asset value has been calculated assuming that this price decline continues at a steady rate – from £304 in the 2100 to £217 in 2017.

[4] Damage for each future years has been discounted and then added together to produce a single 'present value' figure using Treasury guidelines).

Costs

We have attempted to estimate the cost of managing NNRs to Natural England from the financial accounts. The results are in table 6 below.

Table 6 Expenditure relating to NNRs for the 2017/18 Financial Year

Cost	£ millions	Confidence Rating
Staff costs for NNR and NNR related staff	4.5	Green
NNR running and capital costs ('direct')	4.2	Green
NNR running costs ('indirect')	3.1	Amber
NNR related expenditure by partner organisations	0.37	Green
Replacement cost of volunteers	1.8	Amber
Total	**13.97**	Amber

Natural England spent around £11.8 million on NNRs in 2017/18, this includes staff costs of £4.5 million, direct running and capital costs of £4.2 million and indirect costs of £3.1 million. The indirect costs are based on an assumption of a percentage of NE overheads and general expenses being spent on these NNRs. Further work would be required to assess appropriate percentage, hence the amber confidence rating.

Partner organisations such as the Heritage Lottery Fund and the EU spent a further £370,000 on particular NNR related projects.

The estimated market cost of replacing the work carried out by volunteers on NNRs was £1.8 million. This is based on an average value per hour per volunteer, because we do not have data on the categories of work undertaken by volunteers. For this reason we have given this estimate an Amber rating.

This brings the total economic cost of managing these NNRs in 2017/18 to around £14 million.

Discussion

The presentation of information on assets, services, benefits and values together seeks to avoid the problem of partial accounts that occurs in natural capital accounting. We believe this approach is appropriate to inform strategic decision-making about natural capital assets. It is particularly appropriate to asset owners who are concerned about the state of their assets and the long-term provision of public goods. It is therefore particularly relevant to public bodies and charities, but also private sector organisations with a commitment to corporate responsibility.

Building the accounts on key attributes of the natural capital stock itself, enables us to understand how the state of our natural capital is changing, and can act as an early warning system for future changes in the provision of ecosystem services, benefits and values.

This account is a baseline report against which future accounts can be compared. It doesn't comment on whether the assets are in good condition or otherwise, it just reports on the current state of the NNRs in natural capital terms. We have not benchmarked the results against other groups of assets.

We have used the best available open data where possible, under an Open Government Licence (OGL). Occasionally we have had to use contractor published data, where nothing else was available for representing natural capital assets. Most of the datasets used are not updated on an annual basis. This suggests that annual accounts would not be appropriate as they will not pick up on change. A frequency of every four years seems more appropriate. The limited number of relevant datasets also suggests there are huge opportunities for further data collection going forward including data collected at our NNRs themselves, through to the potential repeats of surveys such as the Tranquillity Dataset.

Our estimate of total cost to society per year is approximately £14 million. This is based on expenditure of about £12 million and a replacement cost for volunteers worth about £2 million. We have been able to put a monetary value on only a small proportion of the benefits. This is due to data and knowledge limitations, rather than the approach to this study. These were recreation (£22 million per year), carbon sequestration (£12 million per year) and benefits to volunteers (£1.8 million year). We note that due to uncertainties, these numbers could be up to ten times larger or smaller. Even at the most conservative assessment they are still significantly larger than traditional accounting asset values based only on market goods. If we could calculate the full value of the NNRs, based on all the ecosystem services the figure would be much larger. It is not appropriate to compare the costs in one year to the benefits in one year. This is because the benefits in any single year are the result of investment over many years. Working out the investment required to deliver a particular set of benefits would require detailed investigation into the specific costs of NNR management. Nevertheless, our large partial benefit values suggest this investment in managing NNRs is good value for money.

We cannot tell from this study whether benefits levels will stay the same, increase or decrease. This will depend on a complex mixture of investment in the NNRs and external drivers and pressures. Because we have no evidence about future change to benefits, we have chosen to calculate asset values based on the assumption that they will stay the same. On this basis we produce an asset value of £1.8 billion.

To ensure that the benefits continue, or increase, we need to understand, protect and invest in the ecology. We also need to understand how this delivers benefits. This is best done at site level. But it's also useful to understand it strategically. Our assessment in this report is a first pass at this. The data gaps and confidence intervals mean that the approach taken in this study is not an appropriate management tool for NNRs. But it does provide a valuable additional perspective on them. It helps to highlight the broader benefits provided by the NNRs, beyond their core role of conservation, access and research. Further data collection on NNRs, and some changes to our accounting data would improve this assessment next time. Our approach also points towards further innovation in this area. For example, we could use participatory approaches to underpin the qualitative

assessment. Or we could use approaches from complexity science to represent less than certain information about system relationships.

Conclusion

Natural England's NNRs offer significant benefits to society. The most significant benefits are in line with the NNRs core purposes of thriving wildlife, scientific research and recreation but there are many others. Benefits from climate regulation, provision of goods, health and broad cultural well-being are also significant. Beyond this there is a long list of ecosystem services where NNRs make a modest contribution. We were able to put an economic value on only a small proportion of the benefits, but even this partial valuation helps to illustrate the importance of NNRs to society.

This innovative approach to NCAs provides a baseline assessment of the quantity and quality of our natural capital assets, the services and benefits provided, and their value all reported alongside each other in an extended balance sheet. This provides comprehensive, accessible information that is available for better decision-making and avoids the problems of partial natural capital accounts. Leaving the environment in a better state for future generations will require meaningfully linking financial decisions with environmental assets and benefits. This study is a contribution to this long term task. We commend this approach to all organisations which are committed to managing their environmental assets to deliver public benefit over the long-term.

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1 Introduction

1.1 Purpose of this report

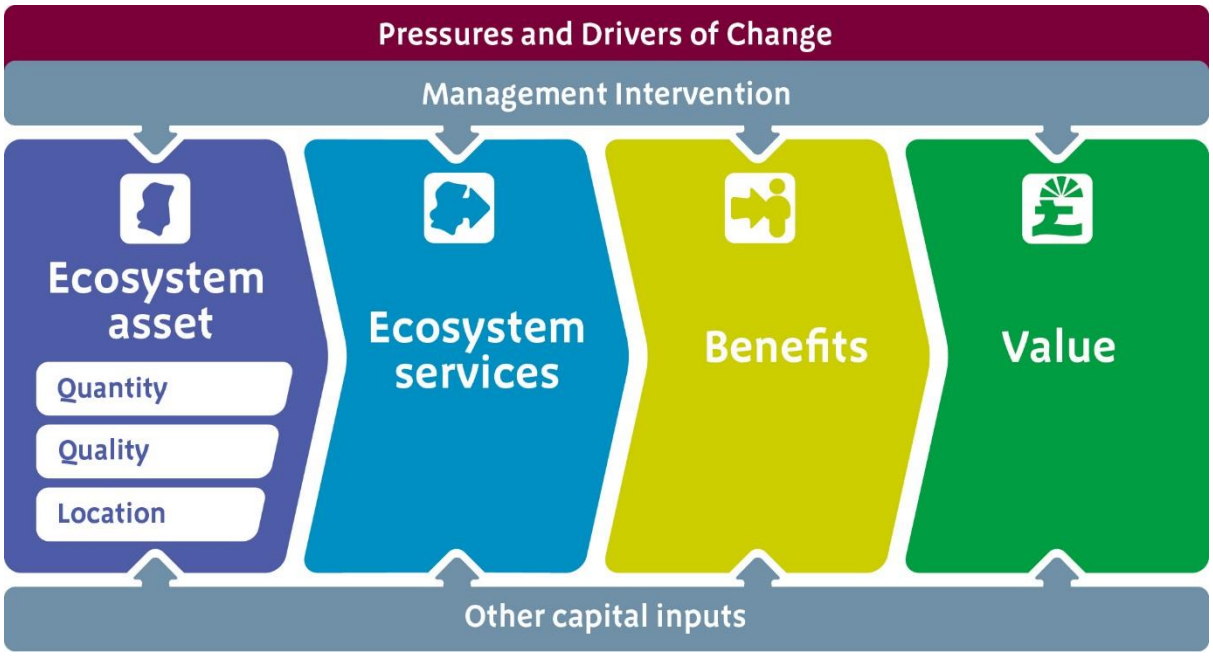
This is a Natural Capital Account (NCA) for Natural England's National Nature Reserves (NNRs). Natural England is the government's adviser for the natural environment in England. Most of our work is on land managed by others, but NCA focusses on the land an organisation manages. The focus of this report is the NNRs, which are almost all Natural England's land holdings. This report covers the NNRs which Natural England manages - alone or in partnership. This is 141 NNRs, about two thirds of the NNRs in England.

Traditional accounting allows organisations to keep track of their assets. It provides information on asset value, state and maintenance costs. But it only includes benefits which are traded in markets. Many benefits provided by the natural environment are provided for free, outside the market, and so are not captured. As a result these benefits are often undervalued, or ignored altogether, in decision-making. NCA extends accounting to non-market benefits, such as carbon sequestration or recreational values. These broader based accounts can inform and improve an organisation's decision-making. So this report sets out the value, state and maintenance costs of the NNRs.

1.2 Our approach to natural capital

The Natural Capital Committee (NCC) has defined natural capital 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". The concept of natural capital is broad and covers both living and non-living parts of the natural world as well as the processes that link these and sustain life on Earth, including humans. Natural capital considers our natural environment as a stock of assets that enable a flow of ecosystem services to people who benefit from them and therefore value them. This flow of services from natural capital assets to people is represented in the diagram below.

Figure 1 Natural England Natural Capital Logic Chain

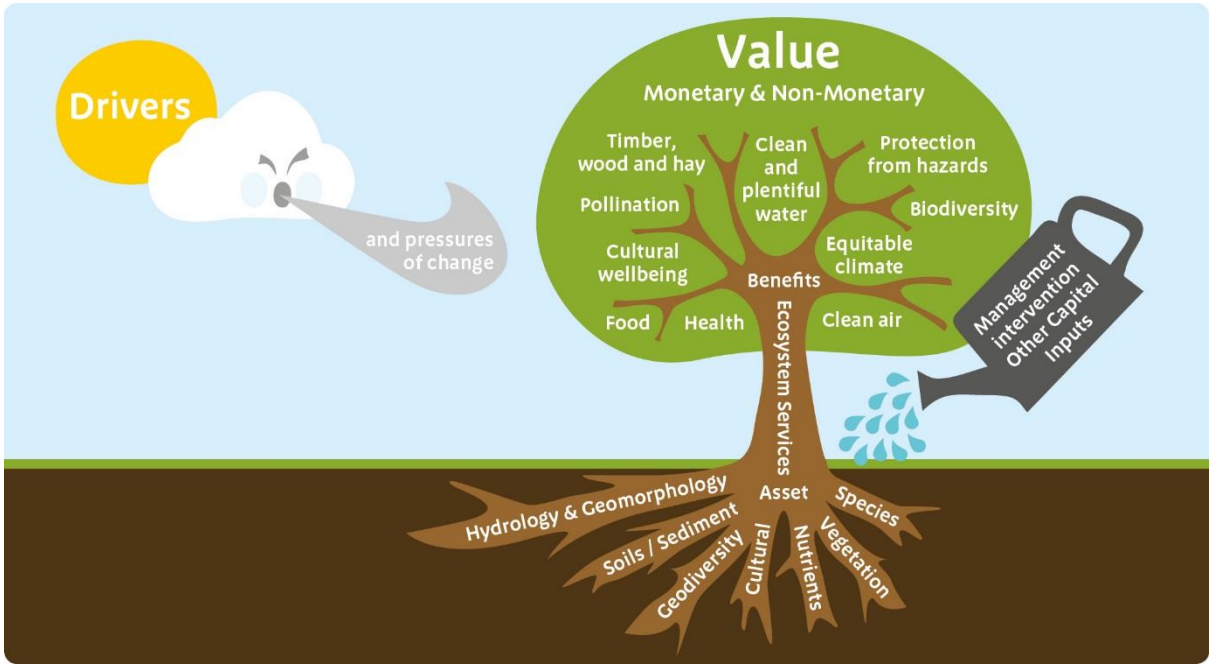


An example of this flow might be farmland (asset) that provides a crop (ecosystem service) that is turned into food (benefit) that people value and buy. Critically, it is not only the quantity of the asset that influences the potential flow of ecosystem services, but also the quality of the assets and where they are in relation to people. Our diagram also recognises that these logic chains exist in context and are influenced by management and wider pressures and drivers of change. Finally, most of the final benefits received by people are as a result of a mixture of natural capital and other capitals. For example the production of crops requires an input from nature, but also one from labour and machinery. Even recreation requires car parks, or walking routes.

This 'logic chain' is a simplistic representation of a system that in reality is highly complex and multi-dimensional. Often multiple assets are contributing to ecosystem services and similarly multiple services may be contributing to, or trading off, to provide benefits and values. However, this simplistic approach helps us to tease out some of these relationships in a systematic way and to identify important attributes of the assets, the consequential services, benefits and values. Natural England has used this natural capital logic chain as the basis for our NCA, seeking to report on each part of the chain.

This study is unusual in the percentage of our effort which has gone into understanding the ecological status of the assets. Although difficult, this work is essential, because it is the state of the asset which will control whether services continue to be delivered into the future. The tree diagram (figure 2 below) features the same system as the logic chain, but inverts it so that ecological condition is shown as the roots of the system. The detail around the roots shows the ecological indicators we have used to assess quality.

Figure 2 Logic chain 'tree diagram' showing ecological components of asset state



1.3 Background

NCAs have been promoted by the Natural Capital Committee, which sees them as a central tool in mainstreaming the value of nature. To date NCAs have been produced by Forest Enterprise, the Environment Agency and the National Trust, amongst others.

There are broadly two types of NCA; strategic and corporate. Strategic NCAs look at natural capital value across a land area. For example the Office for National Statistics work across England (ONS 2018), or the accounts for national parks (Eftec et al 2015). In contrast a corporate approach looks at the land holdings of a specific organisation, and is often more detailed. Whilst the corporate approach and the associated Corporate Natural Capital Accounting (CNCA) (EFTEC et al 2017) methodology appears initially to be a better fit for an account of NNRs, we did not choose to use it. This is because CNCA relies on a complex future projection to produce its asset values and that was not appropriate for this study. Our decision not to use CNCA is based on a trial we conducted last year, on a small sample of NNRs.[5]

1.4 Concerns about NCA that we have addressed

There are a number of significant concerns about NCA as a decision-making tool which we have addressed:

NCAs tend to report the final balance sheet as the result of the study. In other words, the financial values are upfront. If it was possible to capture all the costs and benefits in the balance sheet this would be appropriate. However, the reality is that there are many benefits relevant to NNRs that we can't quantify or value, but are important. Also, there is a consistent pattern to which benefits are easiest to put an economic value on. So NCAs often place a value on crops, carbon sequestration and recreation, but rarely on thriving wildlife, natural beauty or reduced flood risk. If the balance sheet is seen as the 'answer', decision-making will be skewed towards those that can be valued. In this study we have sought to avoid this problem by estimating the significance of benefits qualitatively as well, and drawing attention to these judgements in the summary results.

Communicating confidence levels in the results. NCAs have tended not to do this, but it's essential that they do. Without this decision-makers are likely to misinterpret the results, perhaps assuming that confidence levels are similar to those in traditional accounts. In this study we have avoided this problem by clearly marking our confidence levels on values and quantitative findings. Our confidence levels range from numbers we consider uncontroversial to numbers which could be ten times larger or smaller.

Losing sight of the natural assets themselves, and the state they are in. At the heart of the idea of natural capital is bringing natural assets into a management cycle, so that they are invested in, and maintained. We cannot do this unless we understand their condition. It is many times harder to do this for natural assets than it is for manufactured assets. Natural assets are systems we didn't design and don't fully understand. Also, it is possible to produce some economic values for benefits without really understanding how they relate to natural asset quality. For example we can value recreation based on an average trip to woodland, but this tells us nothing about which qualities of woodlands are important for recreation. Similarly we can produce asset values based on the assumption that benefits will continue at current levels, but the critical question is 'will they?' To get a handle on this we need to understand the underlying ecology. In this study we have used Natural England's Natural Capital indicators work to explore the art of the possible in understanding the underlying ecology using available data.

[5] publications.naturalengland.org.uk/file/4602824549203968

1.5 Potential roles for NCA

NCAs are an emerging tool and it is not yet clear what decision-making purposes they will be able to serve. They do not have the status of external accounts, which are used to hold an organisation to account. It will be difficult for them to assume this role because it would require achieving a greater level of objectivity than is possible at the moment. Instead they could be used as management accounts – internal information to support better decision-making. If this is the case then the sorts of innovations we have used in the study will be an essential starting point. They would need to be complemented by a broader dashboard of targets. They also have a role in communicating the wider benefits offered by natural capital assets.

2 Methodology

2.1 Assets - National Nature Reserves

2.1.1 Which NNR's are included in the accounts?

NCA is designed to account for an organisation's assets. So ideally this report would be based on the NNRs which Natural England owns. Unfortunately, ownership is a complex and changing pattern of leasehold, freehold and land managed as nature reserve by agreement (NRA), and ownership does not always relate directly to management. Therefore we decided to focus this report on the NNRs which Natural England manages, alone or in partnership with others. This is 141 NNRs, equating to around two thirds of all reserves and covering approximately 66,839.7 ha. (see appendix 6.3).

2.1.2 Identifying indicators and datasets

There have been a wide range of natural capital assessments, with a variety of approaches. The indicators and datasets used in the work are varied and often based on availability of data as opposed to suitability. Natural England undertook a review of natural capital indicators which identified the most important attributes of natural capital assets that enable the ongoing provision of ecosystem services, benefits and values (Lusardi et al. 2018). We were able to identify the ideal indicators for measuring change in natural capital and then compare these to available data, identifying gaps where there was nothing suitable. The work used the natural capital logic chain (figure 1) and described assets in terms of broad habitats. Over 80 specialists from Natural England and the Environment Agency informed this work. Indicators were identified based on a series of principles that considered how well they described the system, were sensitive to change and could infer action (see 6.2 for more detail). Desirable datasets were those that most closely described the indicators, were regularly updated, and were accessible. The work identified indicators for the natural capital assets in terms of their extent, quality and location; the ecosystem services and benefits. This work has formed the basis of the indicators and datasets used in these accounts.

2.1.3 Extent of NNR Natural Capital

The overall extent of the NNRs included in the study was derived from geographical information. This overall stock has been split into eight broad habitat types to describe the natural capital assets in greater detail. This complies with work developed by the UK National Ecosystem Assessment (UKNEA, 2011) and is consistent with the Office for National statistics UK Ecosystem Accounts (ONS, 2017b). Habitats are particularly useful for describing natural capital assets as we can attribute them to places on the ground, in this case the NNRs, and they are mutually exclusive i.e. land can't be both a woodland and a grassland, unlike some other asset typologies. In order to derive predominant Broad Habitats for each NNR, we used the Centre of Ecology and Hydrology's (CEH) Land Cover Map 2007 (LCM2007) data to map out 23 LCM classes into the 8 broader classes (see table 10). The LCM dataset is created by classifying summer-winter composite images captured by satellite to a resolution of 25 m^2 providing an overall accuracy of 83% (CEH, 2011).

2.1.4 Asset quality

Natural Capital Indicators review

Alongside the quantity of the natural capital asset (extent), the quality of the asset is also critical in determining its ability to potentially provide sustainable ecosystem services and

benefits into the future. Natural England (2018c) identified seven categories of the most important indicators illustrated in table 1.

Table 1 Key asset quality categories and associated indicators

Asset quality category	Indicator
Hydrology and geomorphology	naturalness of water levels, flows, flooding, aquifer function, lake hydrological regime and extent of artificial drainage.
Nutrient/chemical status	of water, soil and air/atmospheric deposition.
Soil/sediment processes	carbon, biota, peat depth, coastal sediment supply.
Species composition	naturalness of biological assemblage, absence of invasive non-native species, plant species diversity, presence and frequency of pollinator larval & adult food plant and marine net productivity, by species.
Vegetation	ratio of vegetation to bare soil, plant growth rate, surface vegetation roughness, proportion of peat mass actively forming peat, vegetation structure/structural diversity, extent and condition of linear features & pockets of semi-natural vegetation (in farmland) and vegetation next to water courses.
Cultural	a. Nature: visibility of wildlife, presence of flagship and/or rare species, species diversity, naturalness of watercourses, favourable condition of SSSIs and designated geosites. b. Landscape: boundary features – type, length and condition; size of environmental space. c. Culture and history: designated historic environment assets. d. Quietness: tranquillity. e. Facilities: number of organised events, presence of clubs, schools, training centres. f. Accessibility: perimeter access points, density of public rights of way / permissive paths.
Geodiversity	favourable condition of designated geosites, active geomorphological processes.

In these accounts we have sought datasets that describe each of these first six categories. Geodiversity considerations have been included in datasets on protected sites and hasn't been dealt with separately because of the lack of specific geological datasets suitable for the accounts. We have followed the principles of good indicators in accordance with the recommendations of the report (Lusardi et al. 2018). The datasets needed to be of sufficient resolution that they could be cut by NNR and, ideally, regularly updated. This combination of requirements has meant that sources of appropriate data have been limited and we have used less than ideal information. This is one of several sources of uncertainty in our study and we have scored the data used in terms of its suitability (see table 2). The overall score is a combined measure of (i) spatial resolution, (ii) temporal resolution (which may infer update frequency), and (iii) expert judgement of the extent to which each dataset can be acceptably defined as a proxy for the asset it represents. Each variable was categorised from 1 (low) to 3 (high) and summed to produce the overall scores. Overall scores between 3 and 5 represent 'poor' data sources and between 6 and 8 deemed as 'moderate'; only datasets exhibiting a total score of 9 have been classified as 'good' overall. Further detail on overall quality scoring of geographical data is provided in appendix 7.5.1.

Table 2 Data suitability score

	Spatial Resolution (A)	**Temporal Resolution (B)**	**Proxy (C)**	**Overall Score (A+B+C)**
Possible Score	1, 2 or 3	1, 2 or 3	1, 2 or 3	Between 3 and 9

Geographic Information (GI) analyses were undertaken to ascertain the extent and quality of a range of ecosystem assets and quantify natural capital within the NNRs. Environmental datasets were identified across the six asset quality categories outlined above that could suitably be used as proxies for the indicators, and were each clipped to NNR boundaries (NE, 2018a) to output disaggregated area values. These were later aggregated, providing a total area within NNRs. The aggregated tables are provided in section 3.1 of this report, and the disaggregated tables by NNR are provided in appendix 6.4.

Table 3 below summarizes the datasets we have used in this study, with the release date of each italicised. These data are categorised into the asset category that they represent. Overall scores, generated through assessment of both the quality of the data and its suitability as a proxy for representing the assets are also provided. Detail on how the scores are assigned to datasets is given in appendix section 6.6.3 and table 29. The scores have been summarised within a graded colour scheme for visual clarity and are shown for all input data in the study.

Table 3 Dataset scores for fit against ideal natural capital indicators

Indicator Type	Dataset (and release date)	Overall Score
(i) Hydrology	Headwater Stream Quality *2016 (based on Countryside survey 2007 sample data)*	4
	Water Framework Directive (WFD) River, Canal and Surface Water Transfer Waterbodies Cycle 2 *2016* Joined to WFD Classification Status Cycle 2 *2016*	8
	WFD Groundwater Bodies Cycle 2 *2015* Joined to WFD Classification Status Cycle 2 *2016*	8
(ii) Soil/ Sediment Process	AMEC Spatial Prioritisation of Land Management for Carbon *2014*	5
	Moorland Deep Peat AP Status *2008*	6
	NATMAP Carbon *2005*	6
(iii) Nutrient/ Chemical Status	Deposition and Concentration Values for Protected Sites in the UK (2013-2015) *2017*	9
	WFD River, Canal and Surface Water Transfer Waterbodies Cycle 2 *2016* Joined to WFD Classification Status Cycle 2 (Chemical attributes) *2016*	8
	WFD Groundwater Bodies Cycle 2 *2015* Joined to WFD Classification Status Cycle 2 (Chemical attributes) *2016*	8
	Nitrate Vulnerable Zones *2017*	8
(iv) Species Composition	Expected Plant Habitat Indicators *2016 (based on Countryside survey 2007 sample data)*	4
	Nectar Plant Diversity *2016 (based on Countryside survey 2007 sample data)*	4
	Soil Invertebrates Abundance *2016 (based on Countryside survey 2007 sample data)*	4
(v) Vegetation	Sites of Special Scientific Interest condition (England) *2018*	9
(vi) Cultural	Scheduled Monuments at Risk *2016*	7
	Tranquillity *2007*	5

The sections below offer further detail into the datasets used to represent the six indicator categories, including reasons for selection, key attributes quantified and overall assessment framework. Further information of the rationale and limitations behind dataset selection and analytical treatment is covered in appendix 7.5.2.

(i) Hydrology and Geomorphology

These aspects of asset quality assessed are particularly important in supporting the following ecosystem services: water quality; water supply; maintenance of nursery populations and habitats; cultural services.

Water Framework Directive (WFD) River, Canal and Surface Transfer Waterbodies Cycle 2.

Under the European Water Framework Directive (WFD), member states are obliged to monitor and report on the environmental health of their waterbodies at national scale (EC, 2000). Useful characteristics for assessing hydrological natural capital quality within this framework include the Overall, Ecological, Hydrological and Morphological status of rivers, canals and surface transfer waterbodies. The WFD Chemical status is used in the nutrient and chemical status section of this NCA. The WFD River, Canal and Surface Transfer Waterbodies Cycle 2 data (EA, 2016c) were used with the WFD Classification Status Cycle 2 data (EA, 2016a) to calculate river length for each status type across the NE-managed NNR estate. Density values were also calculated, based on the total length of all river status types present in relation to the area of NNR.

WFD Groundwater Bodies Cycle 2.

As with surface water bodies, the WFD Groundwater bodies data (EA, 2016b) was used in the analysis of hydrological natural capital assets in NE-managed NNRs. Attributes required in the quantification of groundwater body health under the Directive include Overall and Quantitative status (EC, 2000). The WFD Groundwater Bodies Cycle 2 (EA, 2016b) data were used in conjunction with the WFD Classification Status Cycle 2 data (EA, 2016a). This was then used with the NNR map layer to ascertain extent of the status of groundwater resources that fall within NE-managed NNRs.

Headwater Stream Quality.

Headwater streams are often not included in the WFD water bodies and are less likely to be monitored. This NCA used previous natural capital modelling and mapping work by CEH/NE (2016), which statistically extrapolated headwater stream quality across England, based on Countryside Survey (2007) sample data. The headwater stream quality layer offers a comparison of the observed and expected presence of particular invertebrate species based on Biological Monitoring Working Party (BMWP) scores. Higher scores indicate better quality when invertebrate communities are used as a proxy for health. Mean quality scores were calculated from this dataset for the NE-managed NNR estate.

(ii) Nutrient/Chemical Status

The aspects of asset quality assessed for nutrient/chemical status are important in supporting the following ecosystem services: wild animals & their outputs; wild plants, algae and their outputs; aquaculture; water quality; air quality; pollination & seed dispersal; maintenance of nursery populations and habitats; and cultural services.

Deposition and concentration values in protected sites (2013-15)

For characterising the chemical quality of natural capital across NE-managed NNRs, in relation to air quality, the 'Deposition and concentration values for protected sites in the UK (2013-15)' dataset was used (Bealey et al., 2017). This is the most recent national data for air pollutant composition across Sites of Special Scientific Interest (SSSIs), Special Areas for Conservation (SAC) and Special Protection Areas (SPAs). 97.7% of the area of NE-managed NNR is designated as SSSI. As such, values assigned to SSSIs have been used

to estimate deposition and concentration values across the reserves. The datasets provide calculated concentrations of ammonia, nitrogen oxide and sulphur dioxide and deposition values for nitrogen and sulphur.

WFD River, Canal and Surface Transfer Waterbodies Cycle 2

As with the Hydrology asset theme, WFD River, Canal and Surface Transfer Waterbodies Cycle 2 (EA, 2016c) and WFD Classification Status Cycle 2 data (EA, 2016a) data were used to assess Nutrient/Chemical status. WFD status data are expressed as river length and mean density (river length divided by the area of the NE-managed NNRs), across the NNRs.

WFD Groundwater Bodies Cycle 2

The chemical status of groundwater bodies is another important element under the WFD. Chemical status is used in the calculation of Overall status, with the WFD Groundwater Bodies (EA, 2016b) and WFD Classification Status Cycle 2 (EA, 2016a) layer. The outputs offer insight into the extent and chemical status of groundwater resources beneath NE-managed NNRs.

Nitrate Vulnerable Zones (NVZ)

Nitrate Vulnerable Zone (NVZ) extents (EA, 2016d; EA, 2016e; EA, 2016f) (developed following the Council Directive 91/676/EEC concerning the Protection of Waters against Pollution caused by Nitrates from Agricultural Sources (EEC, 1991)), have been used in the NCA in relation to nutrient and chemical status. NVZs extend across much of England and are designated in areas where nitrate inputs from agricultural sources are currently or could potentially result in water pollution. The NNR map layer was used with the NVZ layer to calculate areas of zone types within the NE-managed NNR estate.

(iii) Soil/Sediment Process

The aspects of asset quality assessed for soil/sediment processes are important in supporting the following ecosystem services: cultivated crops; reared animals & their outputs; water quality; mass stabilisation and control of erosion rates; maintenance of nursery populations and habitats; global, regional & local climate regulation.

AMEC Spatial Prioritisation of Land Management for Carbon

Figures for both carbon stock and Greenhouse Gas (GHG) flux were calculated by assigning a factor derived from the NE commissioned report ‘Spatial Prioritisation of Land Management for Carbon’ (AMEC, 2014) and ‘Accounting for Nature’ (RSPB, 2017) to each LCM habitat class. This was then multiplied by the area of each habitat class within the NE-managed NNR estate. The results cover stocks and fluxes from habitats and land use only. Data was not available on the types of management approaches used (for example livestock, machinery, fertiliser use) which may offset fluxes.

NATMap Carbon (Soil Carbon)

Derived from the National Soil Map, NATMAPcarbon (Cranfield University, 2005) data provide estimates of soil carbon stock per unit area within specific soil depth ranges. For the purposes of quantifying soil organic carbon in this accounts, the decision was made to exploit values associated with the topsoil (0-30cm) only. This intended to minimise duplication of quantified values by separating carbon flux trends exhibited within the more dynamic topsoil layer from those exhibited across all soil horizons. Average values were calculated across the NNR estate from this layer as a percentage of the total soil carbon stock to a depth of 30cm.

(iv) Species Composition

The aspects of asset quality assessed for species composition are important in supporting the following ecosystem services: wild animals & their outputs; wild plants, algae and their

outputs; pollination & seed dispersal; maintenance of nursery populations and habitats; pest & disease control and cultural services. The species composition of soil, is important for all ecosystem services dependent on soil processes.

Expected Plant Habitat Indicators

This NCA used previous natural capital modelling work by CEH/NE (2016), which statistically extrapolated expected plant habitat indicators (EPHI), across England, based on Countryside Survey (2007) sample data. A range of positive indicator species were identified for specific habitats using the Common Standards Monitoring (CSM) guidance for SSSIs. Therefore the selected species from the Countryside Survey 2007 data represent habitats of good quality. Mean scores were calculated using the EPHI data and the NNR boundary layer to demonstrate average presence values as percentages across NE-managed reserves.

Nectar Plant Diversity for Bees

A further output from the work by CEH/NE (2016) was a spatial layer providing estimates of the presence of nectar plant species for bees, based on Countryside Survey sample data 2007. This was included as bees are important pollinators. Development of a list of optimal nectar plant species was guided by CSM standards and previous literature. This layer was used to generate mean estimates of nectar plant species for bees across the NE-managed estate.

Soil Invertebrate Abundance

The CEH/NE (2016) natural capital modelling and mapping work on the abundance of soil invertebrates, was also used in this NCA. Invertebrate abundance in the topsoil (0-8cm), is statistically extrapolated based on Countryside Survey 2007 soil core sample data. This layer was used with the NNR layer to derive mean estimates of total numbers of soil invertebrates expected in 0-8cm depth topsoil cores, within NE-managed NNRs.

(v) Vegetation

The aspects of asset quality assessed for vegetation are important in supporting the following ecosystem services: wild animals & their outputs; wild plants, algae and their outputs; water quality; air quality; mass stabilisation and control of erosion rates; flood protection; maintenance of nursery populations and habitats; global, regional & local climate regulation and cultural services.

Sites of Special Scientific Interest (SSSI)

Vegetation structure and composition is part of Common Standards monitoring for SSSIs. Favourable condition of SSSIs for biodiversity, is a proxy for appropriate vegetation composition and structure for other ecosystem services. 97.7% of the NE-managed NNR estate is designated as SSSI, with condition assigned to SSSI (sub) units. The extent of SSSI unit condition was calculated across the NE-managed estate.

(vi) Cultural

These aspects of asset quality are important in supporting cultural ecosystem services.

Scheduled Monuments at Risk (SMaR)

The importance of the historic environment in the provision of cultural ecosystem services was represented through the inclusion of Scheduled Monuments at Risk data. Historic England record information on the extents of all monuments and attribute a risk level to each, based on its sensitivity to anthropogenic and environmental pressures such as ploughing, erosion and tree growth (HE, n.d.b). The SMaR and NNR layers were used to derive areas of SMaR on the NE-managed NNR estate.

Tranquillity

We used Campaign for Protection of Rural England Tranquillity data (2007a; 2007b). Factors included in the production of the tranquillity layer include viewshed and noise scores, and visitor density. Mean scores were generated for all NE-managed NNRs, estimating tranquillity.

2.2 Ecosystem services and benefits

The ecosystem service categories have been based on the Common International Classification of Ecosystem Services (CICES v. 4.3), again to ensure consistency with ONS, and international approaches. CICES does not include supporting ecosystem services but defines "*ecosystem function*" as underpinning the provision of ecosystem services. Ecosystem function is captured in the metrics for natural capital quantity and quality. We have renamed a number of the CICES categories to enable better understanding for a less technical audience. For regulating and provisioning services indicators for ecosystem services are a measure of the flow of the services. For cultural services the flow of ecosystem services are represented by the interactions people have with the natural environment (practices). The categories we have considered are those where there is a physical interaction with the environment, and those where there is an intellectual interaction. The list of services considered are in table 4.

Table 4 Ecosystem services considered with the associated descriptions of benefits

Ecosystem service	Common name	Description of benefits
Materials from plants, animals & algae	Timber, hay & other materials	Materials e.g. hay, grass for fodder, timber
Wild animals & their outputs	Game and fish	Game, freshwater fish, marine fish and shellfish. Includes commercial and subsistence fishing and hunting for food
Wild plants, algae and their outputs	Foraged plants	Wild berries, fruits, mushrooms, water cress, salicornia and seaweed for food.
Aquaculture	Cultivated fish and other products	Products from aquaculture e.g. fish, shellfish & seaweed for food, fertiliser, angling bait, medicines
Cultivated crops	Crops	Food from crops e.g. cereals, vegetables, fruit
Water supply	Water supply	Plentiful water eg water for drinking, domestic use, irrigation, livestock, industrial use including cooling, wildlife
Reared animals & their outputs	Livestock	Products from animals e.g. meat, dairy products, honey

Water quality	Water quality	Clean water, also underpinning e.g. water supply, sustainable ecosystems, cultural services, health benefits.
Air quality	Air quality	Clean air, also underpinning health benefits and sustainable ecosystems
Noise regulation	Noise reduction	Health benefits eg reduced stress, hypertension, hearing impairment; benefits to sustainable ecosystems through reduction in disturbance; reduced impacts on educational & work performance
Mass stabilisation and control of erosion rates	Erosion control	Erosion control e.g. soil/land retention, lack of transport disruption, protection of housing, businesses & infrastructure, reduced health & safety risk, reduced flood risk
Flood protection	Flood protection	Reduced flood risk, affecting e.g. reduced health & safety risk, protection of housing, businesses & infrastructure, lack of transport disruption
Pollination & seed dispersal	Pollination	Pollination underpinning cultivated crops dependent on insect pollination e.g. field beans, apples, plums, pears, cucumbers, plums, strawberries, oil seed rape
Maintenance of nursery populations and habitats	Thriving wildlife	Biodiversity, in of itself, and underpinning all other services such as recreation (including wildlife watching), tourism, research and education, food from wild populations & aquaculture, flood protection (sea grass beds, dunes), climate regulation
Pest & disease control	Pest and disease control	Natural control of agricultural pest species and diseases

Global, regional & local climate regulation	Climate regulation	Equable climate eg reduced risk of drought, flood & extreme weather events, lower summer temperatures, reduced health & safety risks, reduced flood risk, protection of infrastructure/lack of transport disruption
Experiential and physical use	Recreation, tourism and volunteering	Cultural wellbeing. This includes: Capabilities eg knowledge, health, dexterity, judgement Experiences eg tranquillity, inspiration, escape, discovery Identities eg belonging, sense of place, rootedness, spirituality, sense of history Non-use values: existence, bequest, altruistic, option
Scientific and educational use	Scientific and educational	
Aesthetic	Cultural appreciation of nature	
Spiritual		

Data sets were sought to describe the ecosystem services and benefits. Where no datasets were found, we undertook an assessment of the significance of the service and or benefit in relation to the NNRs under consideration using expert judgement from specialists within Natural England. These were scored between zero and three where zero is little or no services or benefits derived from the NNR suite (see table 5 for categories).

Table 5 Description of scores applied to the ecosystem services and benefits supplied by the NNR suite in this study that were applied using expert judgement

Score	Description
0	No provision, or a very small amount from a few sites
1	A small amount across the estate
2	A substantial amount from limited sites, or medium provision across the broader estate
3	Large amounts across the whole estate

2.3 Natural Capital Asset values

We have been able to estimate the monetary value of benefits from five categories of ecosystem services (Timber & Game, Livestock, Climate Regulation, Experiential and Physical Use and Scientific and Educational Use). The methods and assumptions that underlie these estimates are provided below. We have assessed the significance of benefits from other categories based on expert opinion (see 3.2) and provide an integrated assessment of the benefits from all service categories in section 3.3.

We estimate natural capital asset values from the value of annual ecosystem service flows as recommended by ONS (2017a), namely 100-year asset life and a declining discount rate (3.5% up to 30 years; 3.0% for 31 to 75 years; 2.5% for 76 to 100 years). These values assume that the value of flows remain at present levels giving a multiplier of 32.38 of annual value (except for carbon as detailed in 2.4.2 below).

2.3.1 Value of benefits – timber, sporting rights, grazing and livestock

Timber/Forestry

The value of ecosystem service benefits from forestry is estimated based on the revenue from timber sales as recorded in the financial accounts, this is in line with the approach detailed in ONS (2018, p. 18). NE accounts indicate revenue from NNR timber sales totalling £50,567.12 in 2016/17 and £61,475.18 in 2017/18. NE does not collate data on the quantity and type of timber sold. We note that outside parties sometimes harvest/remove timber from NNRs at zero cost/revenue as part of some NNR management regimes.

Timber sales are likely to vary from year to year so a 3-5 year rolling average is recommended – see Saraev et al. (2017). Data on the value of timber sales in previous years was unavailable because of change over to new accounting software. Timber value for 2016/17 is adjusted to 2017/18 values using the producer price index (headline inflation rate of 2.4% for the year to March 2018). We adopt an initial 2 year rolling average of (£50,567.12 x 1.024+ £61,475.18)/2 = £56,628

Saraev et al. (2017) report 12.4 million cubic metres valued at £233 million for Welsh Forest Resources eg £18.8 per cubic metre. Adjusting to 2017/2018 values suggests a value per cubic metre of ~ £20/m^3. Based on this value, the volume of timber sold from NNRs was around 3000 tonnes.

Income from Sporting Rights (shooting, fishing, wildfowling and angling)

Income from sale of sporting rights for shooting, fishing, wildfowling and angling is assumed to provide a partial proxy for the value of provisioning services provided by NNRs. We include benefits of £28,452.11 - being NNR income from shooting, fishing, wildfowling and angling.

Crops and Livestock

We follow ONS methods of natural capital accounting in assessing the value of provisioning ecosystem services from farming (ONS, 2017b, p.33). We use the concept of resource rent which is the surplus value accruing to the extractor or user of a natural capital asset, calculated after all costs (including subsidies) and normal returns have been taken into account. Recent analysis suggests that resource rent is typically low or negative in marginal farming areas. We assume that NE farming activities on NNRs typically have high costs and low returns and have a resource rent that is zero or negative after taking account of subsidies. Note that the concept of resource rent aims to assess net benefits from provisioning services. It does not include other ecosystem benefits from agricultural activities; for example biodiversity and the benefits of preservation of rare breeds.

Income from cultivated crops and raising livestock on NNRs is negligible. The main exception being Cherry Lodge Farm on Parsonage Down NNR which holds the oldest registered herd of English Longhorn cattle and rare breeds of Shropshire sheep. We assess resource rent from this activity as zero or negative as noted above.

We treat money paid by graziers to NE for grazing livestock on NNRS as a proxy for resource rent. Income from grazing in 2017/18 is reported to be £281,129.14. We note that in some cases graziers are encouraged to graze at zero rent (where management regimes require grazing and where the market value of grazing is low).

Single Farm Payment

NE receives income from NNRs under the single farm payment scheme. In 2017/18 NE received £997k of income from EU Single Farm Payments for NNRs. We treat the income from single farm payments as a transfer payment (from EU taxpayers to Natural England) and do not include it in the accounts. Given the way in which payments are administered, we do not assume that it reflects the value of provision of environmental goods and services. We note that expenditure on NNRs is partly funded using this income so inclusion of the single farm payment on the expenditure side would be double counting.

2.3.2 Gross value of carbon sequestration and storage

NNRs play a major role in carbon sequestration and storage thus reducing the expected level of damage from future climate change. The value of these benefits have been estimated based on the recommendations of the Department for Business, Energy & Industrial Strategy (2018). The estimates used to inform the carbon stock calculations are taken from the NE commissioned report 'Spatial Prioritisation of Land Management for Carbon' (AMEC, unpublished) that defined carbon storage relative to habitat and / or land use based on information presented in scientific and practitioner literature. Greenhouse gas flux is the overall cooling or warming effect caused by the uptake (sequestration) or release respectively of the main greenhouse gases (GHGs) – carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). The emission factors used to inform GHG flux calculations are taken from 'Accounting for Nature' (RSPB, 2017), the RSPBs natural capital account of their estate in England, which used values derived from a review of scientific literature.

Based on the above methods and sources the average level of carbon storage and sequestration across each LCM habitat class is presented in table 6 below.

Table 6 Carbon stocks and sequestration by LCM Habitat Class

Broad Habitat	LCM habitat class	Area of LCM habitat across NE NNR estate (ha)	Carbon density by habitat (t C / ha) (AMEC, unpublished)	Carbon stocks (t C)	C Sequestration by habitat (tCO2 eq/ha/yr)	C flux (t CO2 eq / year)
Woodlands	1 Broadleaved woodland	6,961	174	1,211,229	- 10.71	- 74,553
	2 Coniferous woodland	882	260	229,328	- 17.51	- 15,438
Enclosed farmland	3 Arable and horticulture	1,582	73	114,691	5.39	8,527
	4 Improved grassland	3,926	106	416,122	- 1.55	- 6,085
Semi-natural grassland	5 Rough grassland	1,860	107	198,473	- 1.55	- 2,883
	6 Neutral grassland	355	107	37,928	- 1.55	- 551
	7 Calcareous grassland	328	107	35,080	- 1.55	- 508
	8 Acid grassland	2,070	255	527,056	- 1.61	- 3,332
Open water, wetlands, floodplains	16 Freshwater	1,198		-	6.86	8,220
	9 Fen, marsh and swamp	940	423	397,496	- 3.91	- 3,674
	12 Bog	6,430	423	2,719,878	- 1.70	- 10,931
Mountains, moorlands, heaths	10 Heather	2,171	264	573,220	- 3.45	- 7,491

	11 Heather grassland	2,768	241	666,441	- 3.45	- 9,548
	13 Montane habitats	3,319	409	1,357,416	- 3.45	- 11,450
	14 Inland rock	372	107	39,854	-	-
Marine	15 Salt water	7,420		-	-	-
	19 Littoral rock	1,334	107	142,685	-	-
	20 Littoral sediment	12,927	180	2,326,823	- 2.34	- 30,249
Coastal margins	17 Supra-littoral rock	3	107	357	-	-
	18 Supra-littoral sediment	2,003	107	214,344	- 1.14	- 2,284
	21 Saltmarsh	5,522	180	993,969	- 4.20	- 23,193
Urban	22 Urban	62		-	-	-
	23 Suburban	112		-	-	-
Total		**64,544**		**12,202,391**		**- 185,424**

We estimate the total amount of carbon stored at NE managed NNR's at around 12 million tonnes and annual carbon sequestration at around 185,000 tonnes per year.

The benefits of reduced emissions (in tonnes of CO_2 equivalent) are valued at £64/tonne rising to £349 in 2077, as recommended by the Department for Business, Energy & Industrial Strategy (2018). On this basis the annual benefit from carbon sequestration is around £12 million in 2017/18, gradually increasing to £65 million in 2077, as the value of carbon sequestration per tonne rises. We have not been able to take account of emissions by vehicles, machinery and livestock on NNRs or from managing NNRs. After taking account of these emissions, net benefits will be somewhat lower than the above estimates.

The natural capital asset value for carbon sequestration over the next 100 years is expected to be around £1 billion[6], assuming that NNR's are maintained in at least their current condition. If NNR condition is allowed to decline, or if some NNR's are converted to other land uses then substantial carbon emissions could result. For example, emission of 5% of the carbon stored in NNR's would amount to 600,000 tonnes. This additional 600,000 tonnes of CO_2 equivalent would cause damage with a present value around £3.5 billion over the next one hundred years.

2.3.3 Benefits from recreational visists to NNRs

Number of recreational visits to NNRs

Our estimate of the number of recreational visits to NNRs is based on point or range estimates provided by NNR field staff. Where point estimates were not available, staff were asked to select the appropriate range for visitor numbers per day/year (0-9, 10-99, 100-1000, 1000+ per day).

Estimates for NNRs where data is available, total ~ 3.5 million visits per year. We estimate total recreational visits per year as being of the order of 5.5 million, after adjusting for the 40% of the NNR area where visitor data was unavailable. This estimate of total recreational visits per year has a wide margin of error and makes up a large proportion of the quantified ES benefit of NE NNRs.

Value of benefits from recreational visits

[6] Official Carbon Price estimates are available until 2100. These assume that the carbon price slowly declines from 2077 onwards. The asset value has been calculated assuming that this price decline continues at a steady rate – from £304 in the 2100 to £217 in 2017.

Recreational visits are valued at ~£4 per person per trip. This value is consistent with recent estimates in ONS (2018), Sen et al. (2014) and Day and Smith (2017).

ONS (2016) recommend valuation of recreational visits based on the "simple travel cost approach", by which they mean – based on an estimate of the exchange value of travel costs per person. This approach is not currently feasible for NNRs since we do not have information on the travel costs of visitors to NNRs. ONS (2018) reports 4.3 billion recreational hours were spent in the natural environment in 2015, valued at £5.8 billion = £1.35 per hour, assuming an average visit length of 3 hours – the 'ONS exchange value' per trip would be £4 per trip.

We note that values based on the net benefit (eg welfare or consumer surplus) per visit are of a similar order of magnitude. For example estimates in the UK NEA are based on work published by Sen et al. (2014). 2010 values updated to 2017/18 are reported below (see table 7)[7]. The simple average of these values is £4.15 or £4.21 using an area weighted approach. Welfare benefits of the same order of magnitude are obtained from the ORVal recreation demand model (Day and Smith, 2017). For example the welfare benefits from an estimated 314,653 visitors to Bridgewater Bay average £5.20 per visit, similar results (within the range £2 - £6 per day are obtained for other relevant sites).

Table 7 Value per recreational visit

Value per recreational visit	Sen et al 2014 2017/8 £s
Mountains & heathlands	5.90
Urban fringe	6.28
Woodlands and forests	3.91
Freshwater and floodplains	2.13
Coastal and marine	4.64
Wetlands	4.40
Grasslands	1.80

2.3.4 Volunteers

NE collates and reports data on volunteer time spent in conservation activities. This data contributes to the indicator reported by the Joint Nature Conservation Committee "A2 Taking Action for nature: volunteer time spend conservation" (JNCC 2016). In 2017/18 1451 volunteers put in an estimated 150,904 hours on NNRs. We assume that most of this work was in support of the 141 NNRs reported in these accounts.

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

[7] The value for wetlands has been interpolated based on other work by the same authors.

The value attributed to volunteers in various types of analysis (cost benefit analysis, social return on investment and natural capital accounts) depends very much on the question that is being addressed. These questions may include:-

i. What would it cost to employ paid workers with similar skills and capabilities for the *same number of hours*? (Replacement Cost)
ii. What would it cost to employ paid workers to carry out the *same tasks* currently carried out by volunteers? (Replacement Cost)
iii. What is the opportunity cost of the volunteers eg did they reduce their hours of paid or productive work in order to volunteer? (Opportunity Cost)
iv. What is the net benefit of volunteer activity eg the value of health, social, mental and other benefits less costs such as travel, opportunity cost and administrative costs? (Net Social Benefit)

Natural capital accounts should ideally include estimates both of the *replacement/opportunity cost* and the wider *benefits* of volunteering, both to volunteers and to society. This would allow estimation of the *net social benefit* of volunteer activity. There is widespread agreement that net benefits are usually positive and may be substantial. It is also reasonable to assume that the private benefits of volunteering exceed opportunity and other private costs (otherwise people would not volunteer).

We follow Foster (2013), who concluded that replacement cost is the best available method to value voluntary activity in the ONS household satellite accounts. Foster (2013) estimated a replacement cost of £23.9 billion for 2.29 billion hours in 2012/13 – equivalent to an average hourly cost of £11.69 in current values[8]. Clark (2017) provides a useful summary of the value of different categories of volunteer input; £50 per day for unskilled work, £150 per day for skilled work eg fence construction and £350 per day for professional work eg ecological survey by an expert. However, NE does not systematically report the categories of work undertaken by volunteers on NNRs. Accordingly we use the average value updated from Foster (2013) to estimate a replacement cost of £1.8 million for the 150,000 hours of work undertaken by volunteers on NE managed NNRs in 2017/18. This estimate should be added on the cost side of the accounts as a 'cost met by others'. In addition, NE staff supervise and train and coordinate volunteers – this spending is already included in the cost estimates for NNR staff costs.

The above estimate may be an overestimate of the actual replacement cost of volunteers since if volunteers were not available it is unlikely that NE would purchase the same quantity of hours of paid work.

The benefits of volunteering are often large but there is no established method to quantify these benefits. In these accounts we assume that the benefits of volunteering exceed the costs. We follow a conservative approach and report benefit estimates as at least equal to replacement costs. On this basis we include a value for the benefits of volunteering of £1.8 million – under the category 'benefits of experiential and physical use'.

2.3.5 Educational visits

Environmental education can have many positive benefits, including improved environmental awareness. The direct benefits are those received by the students, parents and teachers visiting NNRs; while the indirect are those gained by wider society. Clark (2017, p. 26)

[8] Foster (2013) estimates average value per hour £10.44, inflated to 2017/18 using ONS average weekly earnings index (165/147.3)x10.44=11.69
https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/averageweeklyearningsearn01

Provides detailed data on educational visits to five NNRs. Clark (2017) reports that per year there were 9,222 educational visits with inputs from the NNR team and 3,601 providing their own tuition – a total of 12,823 visits. Clark (2017) provides a detailed analysis of the exchange value of these visits and arrives at an overall value of £42,448 equivalent to an average of £3.31 per visit.

Based on data provided by NNR staff and Clark (2017) we estimate that there were around 37,000 educational visits across all included NNRs[9] in 2017/18. We do not have a breakdown of whether visits involve educational inputs by NE staff. We adopt an average value per educational visit based on Clark (2017) - £3.31. On this basis educational visits can be valued at around £123,000 per annum.

2.4 Costs

Our estimate of the cost of maintenance and capital works on NE managed NNRs is based on analysis of NE accounts carried out with the assistance of NE accounting staff. We also include estimates of expenditure by partner organisations (provided by NE accounting staff) and the estimated cost of replacing the volunteers who carry out NNR related work (see 2.4.4 above).

The overall payroll costs for all NE staff who carry out NNR related work includes staff who work entirely on NNRs and other staff based on the percentage of NNR related work for different staff categories. We include direct and indirect NNR related expenditure such as maintenance, capital works, contractors and vehicle expenses. We also includes 6 % of NE overheads and general expenses, this is based on the payroll costs of NNR staff as a percentage of all NE staff.

We assume that all NNR related expenses relate to NE managed NNRs. In practice a small percentage of this expenditure may relate to NNRs managed by approved bodies.

2.5 Uncertainty

NCA is an exercise in decision-support. It aims to gather, assess and make sense of disparate data to allow managers to better understand their assets. It is therefore essential that managers understand the confidence with which any findings are presented to them (HM Government 2010, HM Treasury 2015). This is particularly important where there is a wide range of confidence levels in the information offered, which is the case for NCA. It is equally important that managers understand the significance of evidence gaps. It is possible to explicitly consider this in marginal analysis, because the analyst knows which decision is being taken. NCA can be used to support a large number of decisions and so the best we can do is be clear about the evidence gaps.

Approaches to reporting uncertainty need to be proportionate and transparent. Many of the final results of this study are qualitative judgements. Where this is the case we have explained our confidence in the findings qualitatively. For the smaller number of quantitative judgements we have adopted two different approaches to show likely accuracy. The first approach relates the uncertainty behind GI data interrogated for this report. This has been described in the asset methodology section 2.2.

[9] NNR staff estimated educational visit numbers for 46 NNR's totalling 41,451 ha to be around 22,500. Assuming a similar rate of educational visits per hectare we estimate total visits from 134 NNRs at around 37,146.

For final quantitative judgements we have developed a traffic light system (RAG) to rate accuracy (see table 8). The methodology is set out below.

Table 8 Description of Red Amber Green (RAG) ratings

Definition	Colour
We may have used some assumptions or estimation but consider these figures uncontroversial.	Green
We have used some assumptions or estimation and some of these may be open to question. Accuracy is better than + or -50%.	Amber
We are confident that the number is in the right order of magnitude. Order of magnitude implies that for an estimate of 5 that we are confident that the real figure is within the range 0.5 to 50.	Red
We can't offer a number which is likely to be in the right order of magnitude. This is due to unquantifiable uncertainty in the science, valuation or the relationship between them. What we do know, and our confidence, will be discussed qualitatively.	No number

We have placed the RAG rating on the final number in a calculation sequence and the RAG rating represents our understanding of all the uncertainties up to that point. The reasons for our judgements are set out in the results section.

3 Results

3.1 Summary of results

Table 9 Headline results

Ecosystem asset			Ecosystem services			
Natural capital asset baseline			**Ecosystem service**	**Significance** (1 small to 3 large)	**Indicator**	**Quantity** where available
Asset Attribute	**Indicator**		**Timber, hay and other materials**	2	Sale of timber	3000t
Extent	**Total area (ha)**	**66839.7**	**Game and fish**	1		
Hydrology	Ground water status (% good) Water Framework Directive (WFD)	24.1	**Water supply**	1		
	Surface Water status (% good) WFD	18.6	**Livestock**	1		
Nutrient/ chemical status	Mean sulphur dioxide concentration (µg m-3)	0.32	**Water quality**	1		
	Mean nitrogen acid deposition (kg N ha-1 year-1)	12.3	**Air quality**	1		
Soil	Mean Estimates of Soil Organic Carbon in 30cm Topsoil (% of total) from NATMAP	9.13	**Erosion control**	1		
Vegetation	% of NNR (ha) under a Site of Special Scientific Interest (SSSI) which is in favourable condition	51.3	**Flood protection**	1		
Species composition	Nectar plant diversity – Mean Estimates of Number of Nectar Plant Species for Bees (per 2×2m plot)	5.05	**Pollination**	1		
	Soil Invertebrates Abundance – Mean Estimates of Total Abundance of Invertebrates in Topsoil (0–8cm depth soil core)	65.3	**Thriving wildlife**	3		
Cultural	Tranquillity (mean score)	13.8	**Pest and disease control**	1		
	Scheduled monuments at risk (ha)	74.7	**Climate regulation**	3	Carbon Sequestered – tonnes of CO_2 equivalent	185,000
			Recreation, tourism and volunteering	3	No. of recreational visits	5.5 million
					No. of volunteering hours	150,000
			Scientific and educational	3	No. of educational visits	37,000
			Cultural appreciation of nature	3		

Benefits and values

Benefit	Significance (1 small to 3 large)	Indicator	Annual benefit	Asset value	Confidence in the values (Red is low, Amber is Medium & Green is High)
Timber, wood and hay	2	Sale of timber	£56,000	£2 million	
Food	1	Income from grazing	£281,000	£9 million	
		Sporting rights income	£28,000	£1 million	
Clean and plentiful water	1				
Clean Air	1				
Protection from floods and other hazards	1				
Pollination and pest control	1				
Biodiversity	3				
Equable climate	3	Carbon sequestered	£12 million	£1 billion	
Health	2				
Cultural wellbeing	3	No. of recreational visits	£22 million	£710 million	
		No. of volunteer hours	£1.8 million	£60 million	
		No. of educational visits	£123,000	£4 million	
Total quantified monetary benefits			**£36 million**	**£1.8 billion**	
Significance of unquantified benefits			**Very large**		
Total annual costs			**£14 million**		

3.2 Results in full: Assets

Outputs from quantifying natural capital within NE-managed NNRs have been aggregated across all reserves and compiled into asset themes for presentation (including habitat extent in addition to the six habitat quality themes outlined in section 2.2.3). These tables are presented below.

3.2.1 Habitat Extent

Across NE-managed NNR estate, habitat data (NEA-BH) is available for 64,544 ha with the remaining 2,295.7 ha being below the high water mark and so unclassified (table 10). Amongst the predominant habitat types derived were Littoral sediment (12,926.8 ha), Saltwater (7,419.5 ha) and Bog (6,430 ha) owing to a significant number of NNRs designated in coastal regions. Broadleaved woodland (6,961.1 ha) and grassland types constitute the most extensive terrestrial areas of habitat. Despite the presence of many NNRs in coastal zones, Supra-littoral rock represents the smallest area of all classes, covering only 3.3 ha. However this under-representation is attributed to classification errors during dataset production, explained further in appendix 1 of the LCM2007 Dataset Documentation (CEH, 2011). As can be expected in NNRs, Urban and Suburban habitat types also represent insignificant terrestrial areas, at 62.1 ha and 111.8 ha respectively.

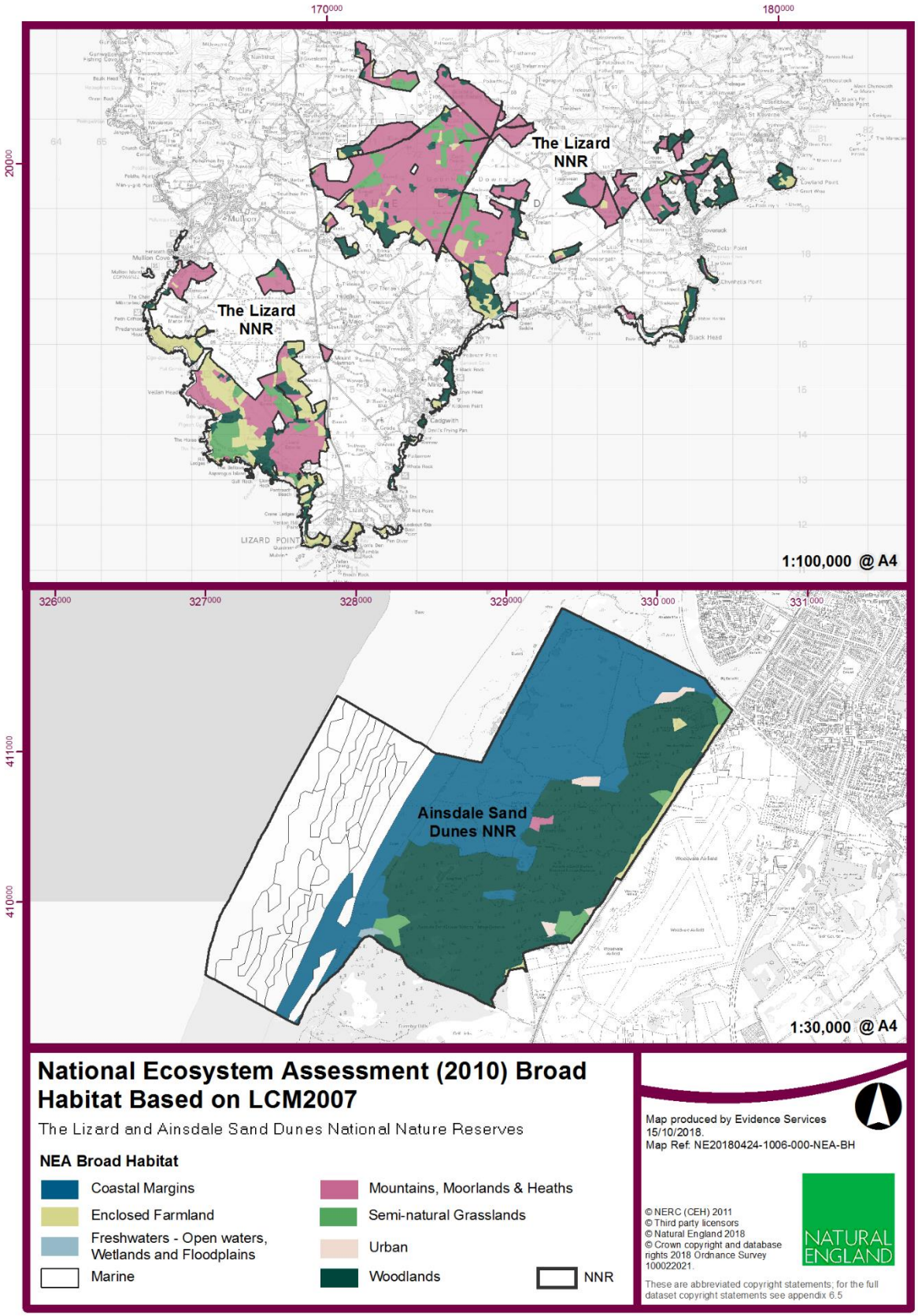
Table 10 The relationship between National Ecosystem Assessment (NEA) Broad Habitats and LCM2007 classes, and hectarage values across NE-managed NNR estate

National Ecosystem Assessment Broad Habitat (NEA-BH)	LCM2007 Class	Area across NE NNR Estate (ha)
Woodlands	1 Broadleaved woodland	6,961.1
	2 Coniferous woodland	881.7
Enclosed farmland	3 Arable and horticulture	1,581.9
	4 Improved grassland	3,925.7
Semi-natural grassland	5 Rough grassland	1,860.1
	6 Neutral grassland	355.5
	7 Calcareous grassland	327.8
	8 Acid grassland	2,069.7
Open water, wetlands, floodplains	16 Freshwater	1,198.3
	9 Fen, marsh and swamp	939.7
	12 Bog	6,430.0
Mountains, moorlands, heaths	10 Heather	2,171.3
	11 Heather grassland	2,767.6
	13 Montane habitats	3,318.9

	14 Inland rock	372.5
Marine	15 Salt water	7,419.5
	19 Littoral rock	1,333.5
	20 Littoral sediment	12,926.8
Coastal margins	17 Supra-littoral rock	3.3
	18 Supra-littoral sediment	2,003.2
	21 Saltmarsh	5,522.1
Urban	22 Urban	62.1
	23 Suburban	111.8
TOTAL		64544.0

Figure 3, below, is an example of our work mapping NNRs based on NEA broad habitats.

Figure 3 Classification of NNRs based on their NEA broad habitat is demonstrated below using The Lizard and Ainsdale Sand Dunes NNRs



3.2.2 Hydrology and Geomorphology

Following quantification of WFD river waterbody (WFD-RW) data, total length of features coinciding with NE-managed NNRs was calculated at 256.3 km, with a mean waterbody density value across the estate of 0.01. In terms of Overall and Ecological WFD-RW statuses (as displayed in table 11), most stock across NNRs is classified as 'Moderate' (~ 72%). For Hydrological and Morphological statuses, most stock is categorised as 'Supports good' (~ 39% and 44% respectively, with 49% of stock assigned 'No class' for Morphological status). Across the reserves, most groundwater bodies (WFD-GW) were classified as 'Poor' for their Overall status (~ 76% of total groundwater area), whereas most stock were classified as 'Good' for their Quantitative status (~ 74%). In relation to headwater stream quality (HSQ), mean quality across NE-managed NNR estate was derived as 0.72, within a possible data range of 0.2 and 2.1 (based on the Biological Monitoring Working Party Score system described in section 3.2.3).

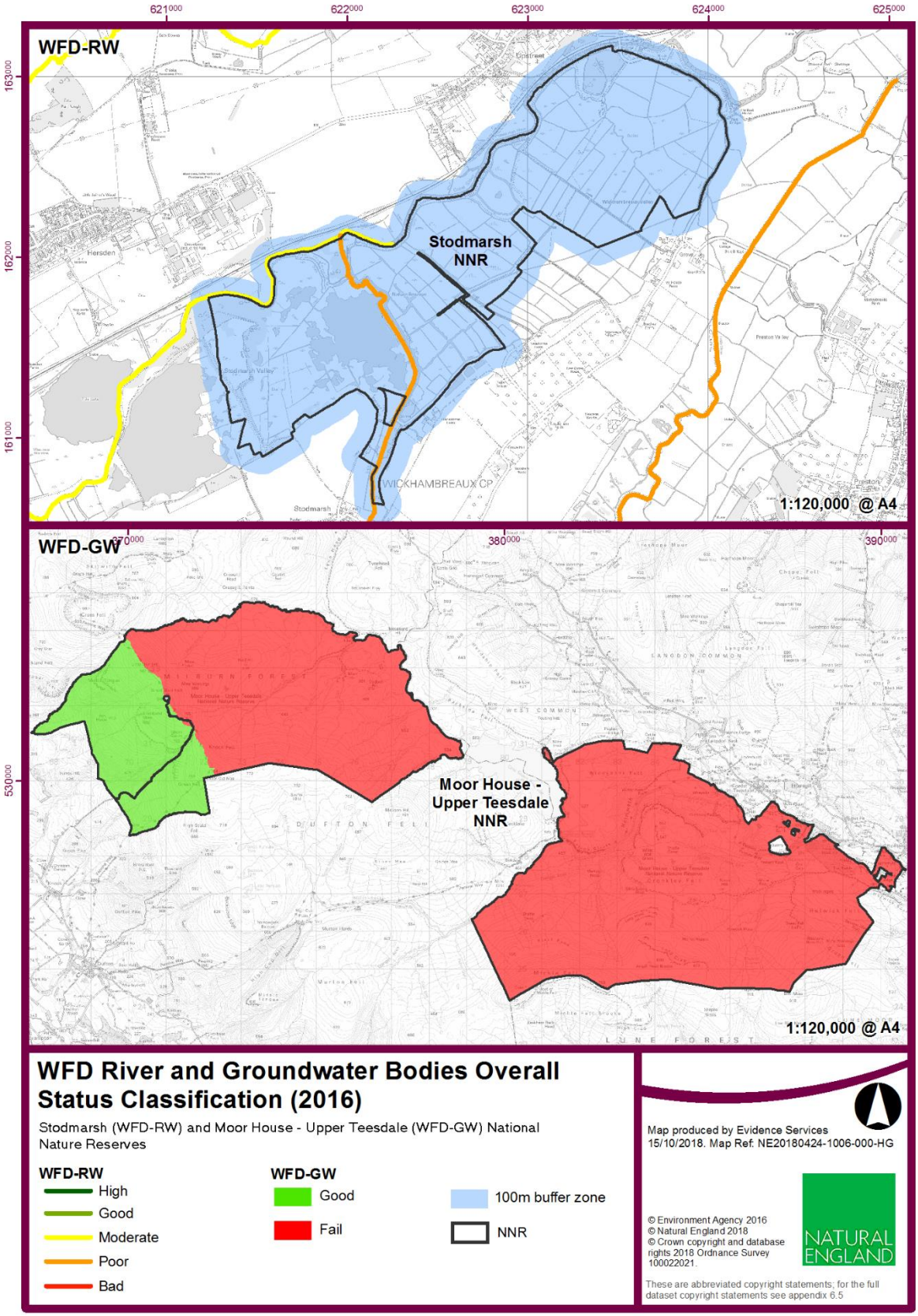
Table 11 The aggregated values for datasets applied in the hydrology and geomorphology asset theme quantification

			Stock Across NE-Managed NNR Estate
			Kilometres (km)
Water Framework Directive (WFD) River Waterbody Length by Status, and Waterbody Density - 2016 Cycle 2 **(WFD-RW)**	**Overall Status**	Good	47.6
		Moderate	186.9
		Poor	15.8
		Bad	6.1
	Ecological Status	Good	49.7
		Moderate	184.7
		Poor	15.8
		Bad	6.1
	Hydrological Status	High	74.6
		Supports Good	98.7
		Does Not Support Good	29.2
		No Class	53.7

	Morphological Status	High	18.7
		Supports Good	112.1
		No Class	125.5
		Total Waterbody Length	256.3
			Kilometres per hectare (km/ha)
		Mean River Waterbody Density	0.01
			Hectares (ha)
WFD Groundwater Area (ha) by Status - 2016 Cycle 2 **(WFD-GW)**	**Overall Status**	Good	9,002.4
		Poor	28,336.9
	Quantitative Status	Good	27,560.2
		Poor	9,779.1
		Total Groundwater Body Area	37,339.3
			Biological Monitoring Working Group Score
Headwater Stream Quality **(HSQ)**		Mean Estimates of Observed/Expected Presence of Invertebrates	0.7

Hydrology and geomorphology natural capital asset quantification is demonstrated through presentation of the WFD river waterbodies (WFD-RW) and groundwater bodies (WFD-GW) layers at Stodmarsh and Moor House – Upper Teesdale NNRs respectively (shown in figure 4). The 100m buffer zone applied to NNRs to facilitate analysis of river waterbodies that coincide with reserve boundaries has been highlighted around Stodmarsh NNR. More information on the buffer methodology applied is provided in appendix 6.7.3.

Figure 4 Hydrology and geomorphology natural capital asset quantification



3.2.3 Nutrient/Chemical Status

Following quantification of the Deposition and Concentration Values for Protected Sites in the UK (2013-2015) data (DC), across NE-managed NNRs, the mean concentration of nitrogen oxide was calculated at 10 micro grams per metre cubed (µg m-3); for sulphur dioxide, a value of 0.3 µg m-3 was derived. In relation to deposition values extracted from these data, nitrogen is calculated as having a mean deposition value across all reserves of 12.3 kg N per hectare per year (kg N ha^{-1} $year^{-1}$). Interrogation of the Chemical status of WFD river waterbodies (WFD-RW) highlighted the majority of stock (~ 97%) as having 'Good' status. In contrast, most WFD groundwater bodies were assigned a classification of 'Poor' (~ 74%) with regards to their chemical health. Total cover of Nitrate Vulnerable Zones (NVZ) across NE-managed reserves was calculated at 18,117 ha, with most zones relating to surface water vulnerability (8,912.9 ha) and the least relating to eutrophic zones (2,790.2 ha). These results are summarised in table 12 below.

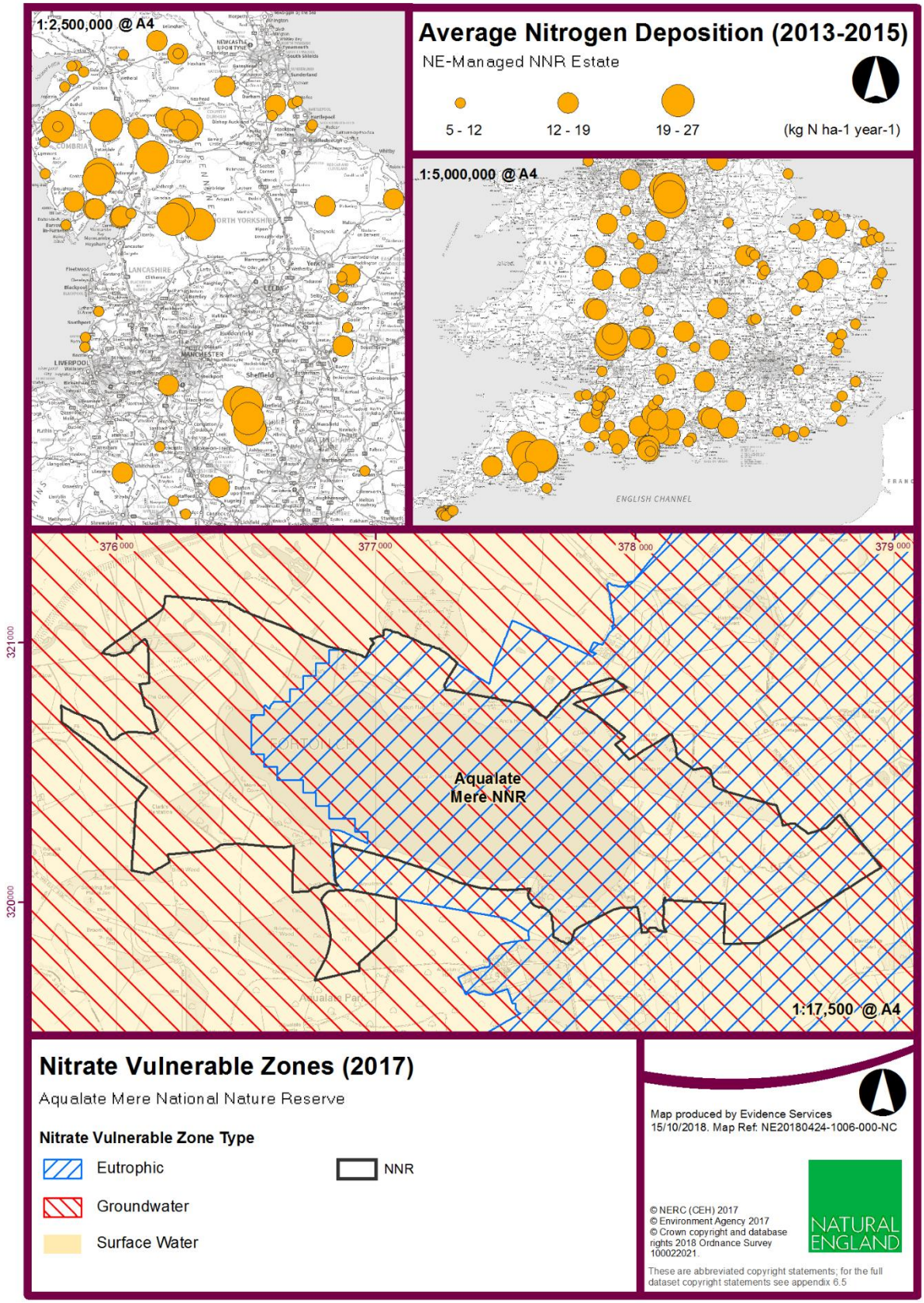
Table 12 The quantity of natural capital for each asset related to nutrient and chemical status

		Stock Across NE-Managed NNR Estate
		µg/m³
Chemical Concentrations and Deposition Values in Protected Sites 2013-2015 **(DC-AC; DC-NC; DC-SC; DC-ND; DC-SD)**	Mean Ammonia Concentration	1.5
	Mean Nitrogen Oxide Concentration	10
	Mean Sulphur Dioxide Concentration	0.3
		kg N/S ha^{-1} yr^{-1}
	Mean Nitrogen Deposition	12.3
	Mean Sulphur Deposition	3.7
		Kilometres (km)
WFD River Waterbody Length by Chemical Status - 2016 Cycle 2 **(WFD-RW)**	Good	248
	Fail	8.3
		Hectares (ha)
	Good	9,806.7

WFD Groundwater Area by Chemical Status - 2016 Cycle 2 **(WFD-GW)**	Poor	27,532.6
		Hectares (ha)
Nitrate Vulnerable Zones 2017 Area **(NVZ)**	Surface water Area	8,912.9
	Eutrophic Area	2,790.2
	Groundwater Area	6,413.9
	Total Area	18,117.0

In figure 5 below, nutrient and chemical status natural capital asset quantification is demonstrated through presentation of the Deposition and Concentration Values for Protected Sites in the UK (DC) mean scores using graduated symbology at national scale. Aqualate Mere NNR is presented to exemplify the spatial configuration of Nitrate Vulnerable Zone (NVZ) units and how these can overlap in quantification.

Figure 5 Nutrient and chemical status natural capital asset quantification



3.2.4 Soil/Sediment Process

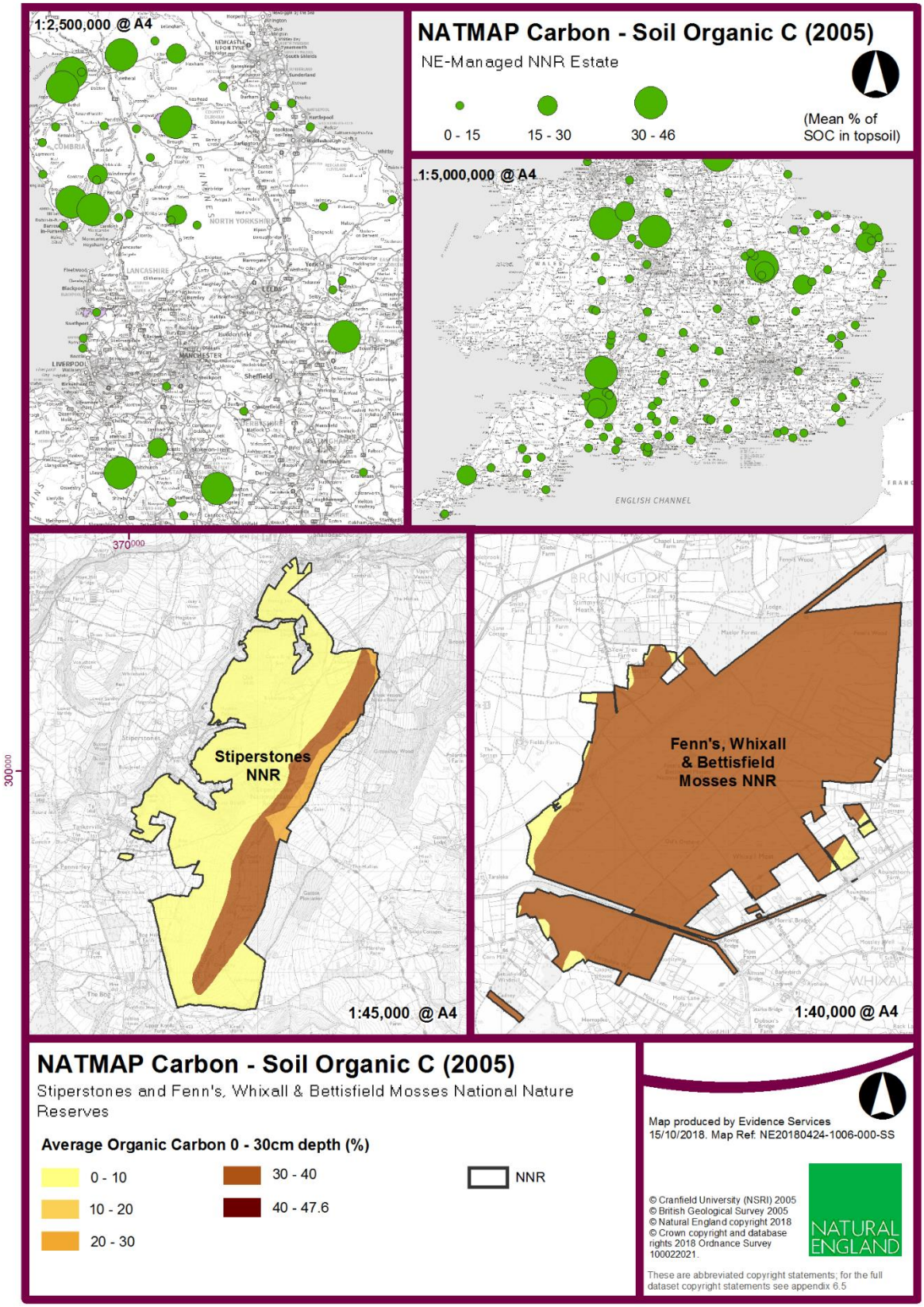
Using the NATMAP Carbon (SC) data, average organic C stock composition was calculated at 9.1% of the topsoil (0-30cm) (shown in table 13).

Table 13 The quantity of natural capital relating to soil and sediment process

		Stock Across NE-Managed NNR Estate % of total
NATMAP Carbon (Soil Organic Carbon) (SC)	Mean Estimates of Organic C in 30cm Topsoil	9.1

Soil and sediment process results are demonstrated through graduated symbolisation of the mean scores derived from the NATMAP Carbon data at national scale (displayed in figure 6).

Figure 6 Soil and sediment process natural capital asset quantification



3.2.5 Species composition

Assessment of the Expected Plant Habitat Indicators (EPHI) natural capital dataset produced an estimated value of 2.1% of indicators present within a possible data range of 0 to 11.7%. Therefore, NE-managed NNRs generally appear to host a limited number of EPHIs compared the rest of the country. Following quantification of the Nectar Plant Diversity for Bees data, a mean score of 5.1 was estimated in relation to the number of nectar plant species present in 2x2m plots during field monitoring, within a possible mean value range of 0.4 to 11. Soil Invertebrate Abundance (SIA) was also calculated across the reserves, averaging a total abundance of 65.3 within a possible data range of 11 to 192 (see table 14). The UK mean is 77 but the figures vary considerably between habitat types (Emmett et al. 2010).

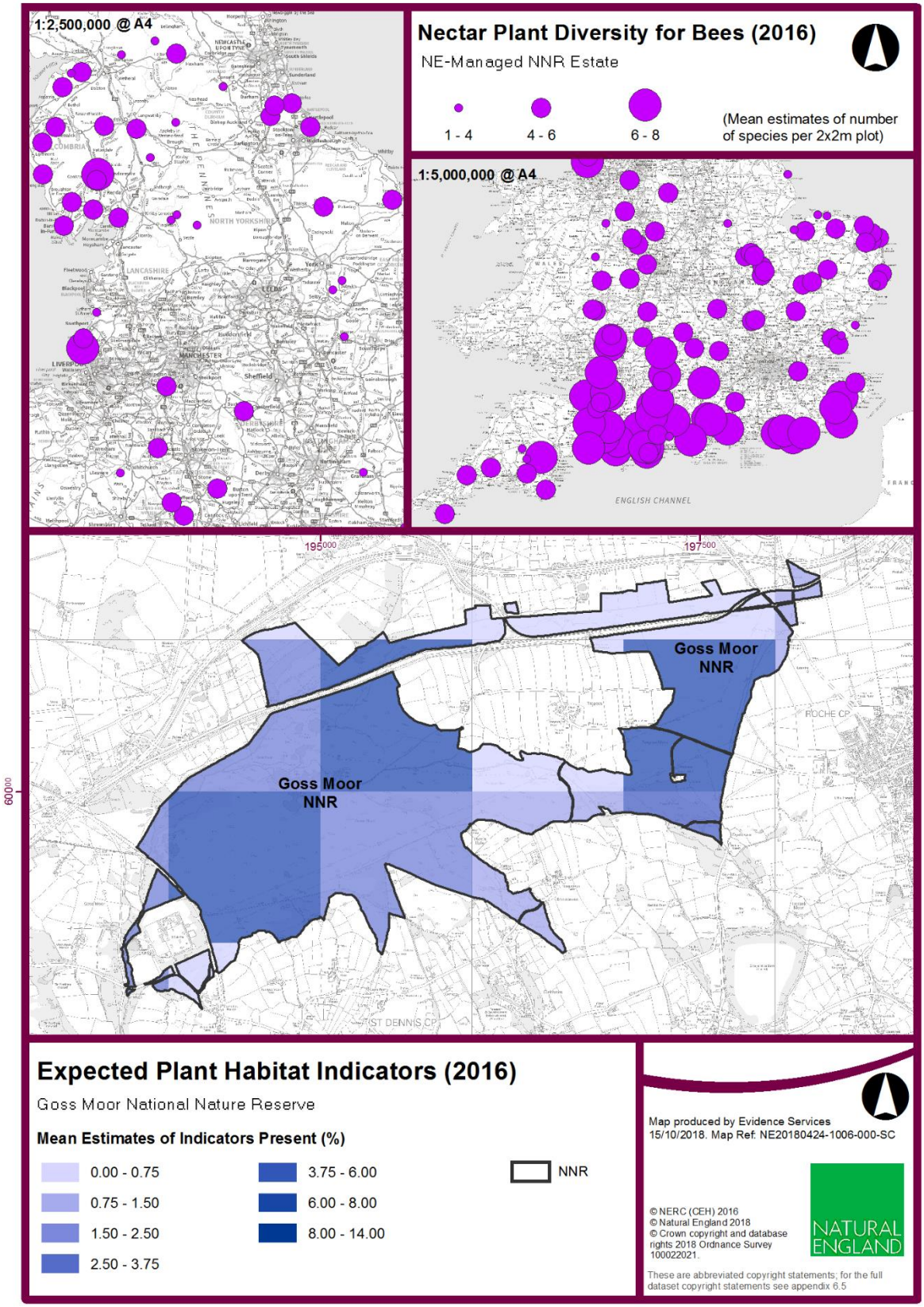
The CEH/NE (2016) data are based on a 1 km grid, statistically extrapolated from CEH Countryside Survey Sample Data 2007. A 1 km square containing an NNR, will generally also include a proportion of the square that is not an NNR. This will affect the mean figures for the square, which have then been applied to the NNR. A potential example of the effect of this is evident in the Expected Plant Habitat Indicators figures. As the species chosen are based on indicators of good habitat condition for a range of SSSI habitats, it would be expected that the NNR's, would be relatively good for these species. However, they are towards the lower end of the national range, which may be due to the other land present in a grid square, beyond the NNR.

Table 14 Mean scores of natural capital assets across NE-managed NNRs relating to species composition

		Stock Across NE-Managed NNR Estate
		% of indicators present
Expected Plant Habitat Indicators (EPHI)	Mean Estimates of Expected Plant Habitat Indicators Present	2.1
		Per 2x2 m plot
Nectar Plant Diversity for Bees (NPD)	Mean Estimates of Number of Nectar Plant Species for Bees	5.1
		Total abundance
Soil Invertebrates Abundance (SIA)	Mean Estimates of Invertebrates in Topsoil (0-8cm depth soil core)	65.3

Figure 7 below shows the national configuration of Nectar Plant Diversity for Bees (NPD). Mean values calculated for each NNR is represented in figure 7 using graduated symbolisation. The use of Expected Plant Habitat Indicators (EPHI) data has also been exemplified with respect to Goss Moor NNR.

Figure 7 Species composition natural capital asset quantification



3.2.6 Vegetation

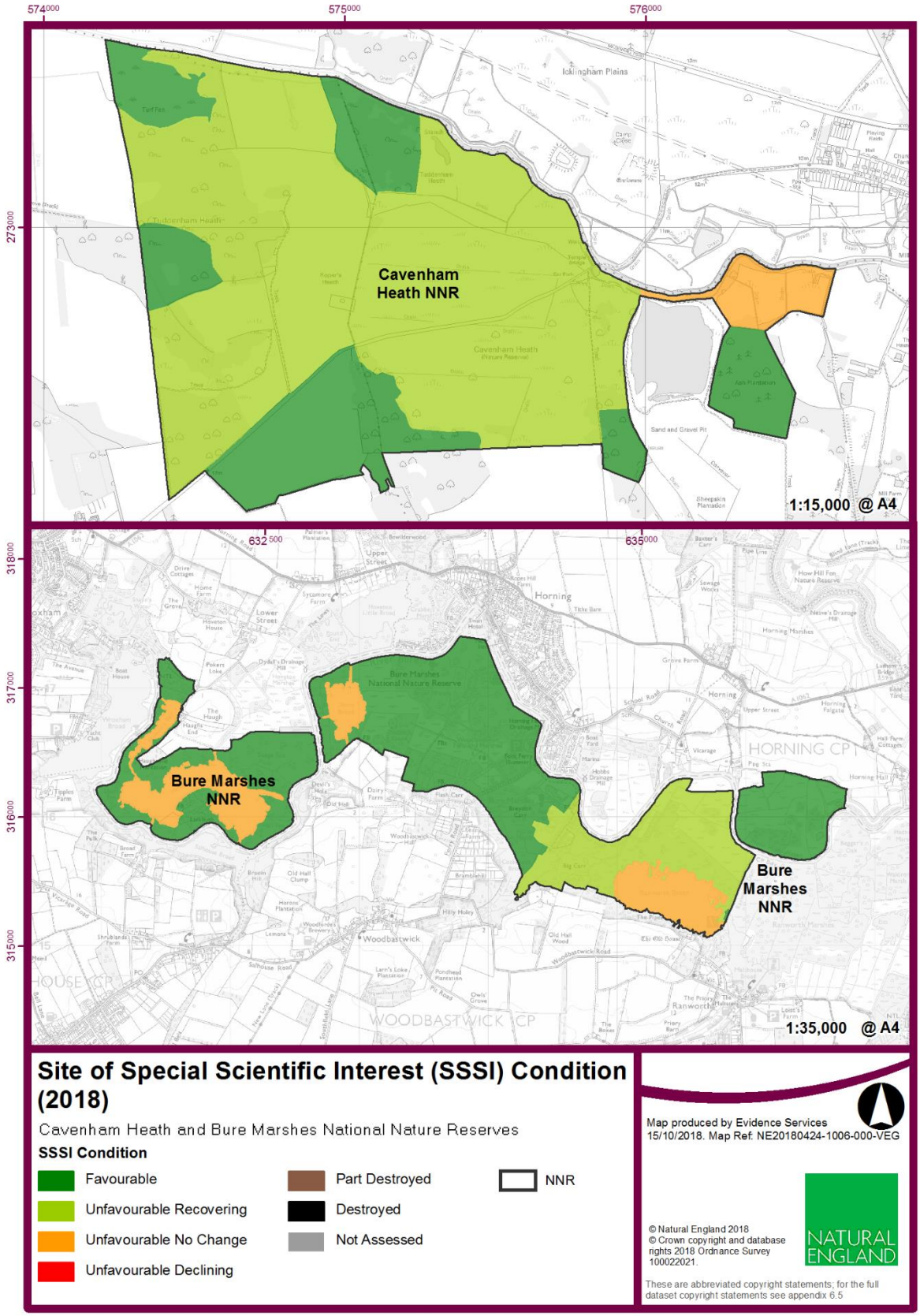
As ~ 98% of NE-managed NNRs are underpinned by a SSSI, analysis of vegetation assets utilised the Sites of Special Scientific Interest (SSSI) dataset to quantify extent of each condition unit. Across our estate, the predominant unit condition types were derived as 'Favourable' and 'Unfavourable Recovering', equalling ~ 51% and ~ 42% of all SSSI area respectively (see table 15). <0.01% of SSSI units coinciding with NE-managed reserves was classified as 'Part destroyed'.

Table 15 Eleven areas of SSSI condition units across NE-managed NNR stock for quantification of natural capital assets relating to vegetation

		Stock Across NE-Managed NNR Estate
		Hectares (ha)
Area of NNR under a Site of Special Scientific Interest (SSSI) by Unit Condition **(SSSI)**	Favourable	33,492.3
	Unfavourable Recovering	27,112.4
	Unfavourable No Change	3,139.2
	Unfavourable Declining	1,095.7
	Part Destroyed	3.5
	Unclassified	489.1
	All Conditions	65,332.3

Figure 8 exemplifies the application of SSSI condition data for quantifying natural capital vegetation assets within Cavenham Heath and Bure Marshes National Nature Reserves.

Figure 8 Demonstration of approach to quantifying vegetation assets using Sites of Special Scientific Interest (SSSI) data (Cavenham Heath and Bure Marshes NNRs)



3.2.7 Cultural

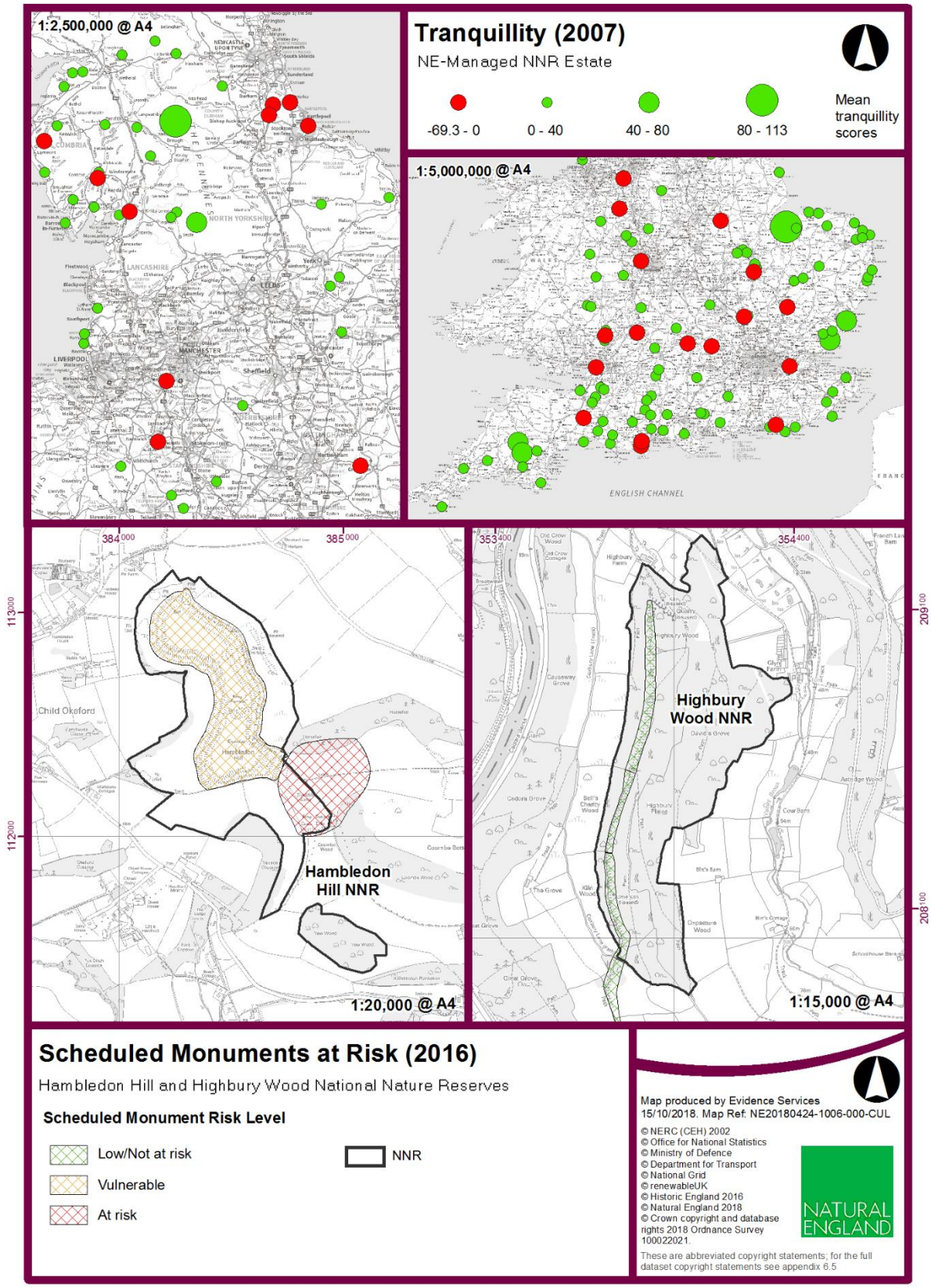
Following assessment of Scheduled Monuments at Risk (SMaR) features, ~ 60% of monuments that fall within NNRs are classified as 'Vulnerable', with ~ 9% of features categorised as 'At risk'. Calculation of mean values from the Tranquillity (TRQ) data provided an aggregated score of 13.9 across NE-managed estate (see table 16), within a possible range of -69.4 to 107.6. Furthermore, out of the 141 NNRs assessed, 117 reserves returned a positive mean tranquillity score, score indicating a moderate level of tranquillity across our NNRs.

Table 16 Quantities of natural capital calculated in relation to cultural assets

		Stock Across NE-Managed NNR Estate
		Hectares (ha)
Scheduled Monuments at Risk Area (SMaR)	Area At Risk	74.7
	Area Low/Not at Risk	226.6
	Area Vulnerable	494.1
	Area Unclassified	29.2
	Total SMaR Area	824.5
		Mean Scores (-69.4 to 107.6)
Tranquillity (TRQ)	Tranquillity	13.9

Figure 9 displays tranquillity (TRQ) data that has been graded and symbolised at the national scale, with negative values depicted in red. The application of Scheduled Monuments at Risk (SMaR) data has also been exemplified with the spatial configuration of monuments within and around Hambledon Hill and Highbury Wood NNRs.

Figure 9 Cultural natural capital asset quantification is demonstrated through symbolisation of tranquillity (TRQ) data at national scale, and showing Scheduled Monuments at Risk (SMaR) (Hambledon Hill and Highbury Wood NNRs)



3.3 Services and benefits

The ecosystem services provided by the NNR suite are listed in table 17 with quantification, where possible, and expert judgement of significance.

Table 17 Ecosystem services provided by the NNRs with expert judgement of significance, associated indicator from Lusardi et al. (2018) and quanitification where possible for each service.

Ecosystem service	Significance (1 small to 3 large)	Indicator	Quantity where available
Timber, hay and other materials	2	Sale of timber	3000t
Game and fish	1		
Water supply	1		
Livestock	1		
Water quality	1		
Air quality	1		
Erosion control	1		
Flood protection	1		
Pollination	1		
Thriving wildlife	3		
Pest and disease control	1		
Climate regulation	3	Carbon Sequestered – tonnes of CO_2 equivalent	185,000
Recreation, tourism and volunteering	3	No. of recreational visits	5.5 million
		No. of volunteering hours	150,000
Scientific and educational	3	No. of educational visits	37,000
Cultural appreciation of nature	3		

3.4 Value and significance of benefits

Society values NNRs for the enjoyment people gain from them and the benefits they provide. They are especially valued for their role in:

- nature conservation and protection of biodiversity
- conservation and enhancement of the landscape,
- access to the countryside/open spaces and open-air recreation
- access to facilities for the study, understanding and enjoyment of the natural environment

These are all services which NE is responsible for providing and which are essential prerequisites for achieving the goals laid out in the Government's 25 year environment plan (HM Government 2018). All of these services are provided by natural capital which the Government is committed protecting and growing[10].

We have assessed the significance of these services and where possible have estimated their monetary value, these results are summarised in table 18 below. The most significant services provided by NNRs fall under the headings maintenance of thriving wildlife ('biodiversity'), equable climate and 'cultural services[11]'. Cultural services include a wide group of values which are hard to separate. This includes experiences (such as tranquillity and inspiration) and identity (such as belonging). These values are often described using the language of landscape, but we have used cultural services for consistency with the ecosystem service framework we are using. It also includes non-use values (such as people's value for species they will never see or use. We assess the significance of these services as 'Very Large'.

We estimate the monetary benefits to society from recreational and educational visits and volunteer work (which fall under the heading services from cultural capital) as being of the order of £24 million per annum, with an asset value of around £774 million. We are not able to estimate the magnitude of other benefits from cultural capital or thriving wildlife, except to note that they are very significant and very likely to exceed the benefits we have been able to quantify.

The largest benefits that we can quantify in monetary terms are from carbon sequestration – resulting in less damage from climate change in the future. We estimate that NE managed NNRs sequester around 185,000 tonnes of CO2 equivalent per year providing an annual benefits of around £12 million per year. The value of carbon sequestration is expected to rise sharply over the next 50 years such that annual benefits will reach £65 million in 2077. The natural capital asset value for carbon sequestration over the next 100 years is expected to be around £1 billion[12], assuming that NNRs are maintained in at least their current condition. If NNR condition is allowed to decline, or if some NNRs are converted to other land uses then substantial carbon emissions could result. For example emission of 5% of the carbon stored in NNRs would amount to 600,000 tonnes. This additional 600,000 tonnes of CO_2 equivalent would cause damage with a value around £3.5 billion over the next one hundred years (damage for each future years has been discounted and then added together to produce a single 'present value' figure using Treasury guidelines).

Overall we estimate the monetary value of quantifiable benefits from NNRs to be in excess of £36 million per year with a natural capital asset value in excess of £1.8 billion. We note the 'very large' significance of benefits that we have not been able to value in monetary terms and suggest that these are probably greater than the quantified values.

[10] 25 Year Environment Plan, page 9.

[11] Cultural values include:- capabilities e.g. knowledge, health, dexterity, judgement. Experiences e.g. tranquillity, inspiration, escape, and discovery. Identities e.g. belonging, sense of place, rootedness, spirituality, sense of history. Non-use values: existence, bequest, altruistic, option

[12] Official Carbon Price estimates are available until 2100. These assume that the carbon price slowly declines from 2077 onwards. The asset value has been calculated assuming that this price decline continues at a steady rate – from £304 in the 2100 to £217 in 2017.

Table 18 The benefits from the NNRs and their significance

Benefit	Significance (1 small to 3 large)	Indicator	Annual benefit	Asset value	Confidence in the values (Red is low, Amber is Medium & Green is High)
Timber, wood and hay	2	Sale of timber	£56,000	£2 million	
Food	1	Income from grazing	£281,000	£9 million	
		Sporting rights income	£28,000	£1 million	
Clean and plentiful water	1				
Clean Air	1				
Protection from floods and other hazards	1				
Pollination and pest control	1				
Biodiversity	3				
Equable climate	3	Carbon sequestered	£12 million	£1 billion	
Health	2				
Cultural wellbeing	3	No. of recreational visits	£22 million	£710 million	
		No. of volunteer hours	£1.8 million	£60 million	
		No. of educational visits	£123,000	£4 million	
Total quantified monetary benefits			**£36 million**	**£1.8 billion**	
Significance of unquantified benefits			**Very large**		
Total annual costs			**£14 million**		

3.5 Costs

Natural England spent around £11.8 million on NNRs in 2017/18, this includes staff costs of £4.5 million and other NNR related expenses of £7.3 million. Partner organisations such as the Heritage Lottery Fund and the EU spent a further £370,000 on particular NNR related projects. The estimated market cost of replacing the work carried out by volunteers on NNRs was £1.8 million, bringing overall expenditure on NNRs in 2017/18 to around £14 million (displayed in table 19).

Major items of ‘direct’ expenditure include ‘land management works and agreements’ (£1.8 million), land rentals (£0.67 million), NNR construction supplies and materials (£0.35 million), volunteer travel expenses (£0.08 million) and technical consultancy (£0.74 million). The largest indirect expenditure is the inclusion of 6.3% of the notional corporate services recharge from Defra (£1.97 million), this covers procurement, IT, finance and HR costs.

Table 19 Expenditure relating to NNRs for the 2017/18 Financial Year

Cost	£ millions	Confidence Rating
Staff costs for NNR and NNR related staff	4.5	Green
NNR running and capital costs (‘direct’)	4.2	Green
NNR running costs (‘indirect’)	3.1	Amber
NNR related expenditure by partner organisations	0.37	Green
Replacement cost of volunteers	1.8	Amber
Total	**13.97**	Amber

Note: NE net expenditure on NNRs was around £10 million after deducting £0.73 million of NNR income and £1 million from single farm payments.

4 Discussion

4.1 Extended natural capital accounts

Natural England has developed an approach to accounts that seeks to address problems of uncertainty and partial valuation. Presenting information on asset extent and quality alongside ecosystem services, benefits and values, is really important to support decision making. This is particularly true where assets are managed for public benefits. In this case, we used data that best describes attributes of our natural capital assets and their ability to continue to provide benefits into the future. This approach acts as a baseline which future accounts can be measured against. It also provides far greater information on the system as a whole.

4.2 Difficulty in linking the logic chain

The conceptual framework describes the link between the natural environment and the provision of ecosystem services and benefits. In reality this relationship is a complex web of interactions and influences that we only partially understand. The ideal for NCA is to value all the benefits and link them back to services and to the asset state. At present this ideal is unachievable. In this study, carbon was the only benefit for which this was possible. For some benefits we have ecological information, but not enough to quantify the benefit. Water quality is an example. For others we can quantify a benefit, but we don't know how it relates to asset quality. For example we can estimate NNR visitor numbers, but we don't know how NNR quality affects this. Our simplified logic chain hides the complexity of the real system. There is a lot that we do not understand and where we have some understanding it is often at a low level of certainty. NCA sets a high-bar for quantified and proven evidence. There are alternative approaches designed for complex systems, such as Bayesian Belief Networks. These may have a complementary role in NCA or it may possible to hybridise approaches.

4.3 Asset value and costs of the Natural England managed NNRs

The total quantifiable benefit estimate is £36 million per year. This includes recreation (£22 million), carbon sequestration (£12 million) and benefits to volunteers (£1.8 million). We were also able to value timber and gaming rights, income from grazing and educational visits. But the total value of these benefits was only £488,000, so it doesn't affect the total very much. Also note that the confidence rating for most of the quantified benefits was red. This means we are confident only that the real figure is within two orders of magnitude, ie between less than ten times more and more than ten times less eg from £2.2 million to £220 million for the annual value of recreational visits.

The core purposes of NNRs are thriving wildlife, scientific research and recreation. Of these we were only able to value recreation. Our judgement is that the most significant benefits are wildlife, equable climate and cultural wellbeing (which includes a wide range of benefits such as health, inspiration, sense of place, learning and appreciation of aesthetic beauty). The contribution to health is considered a moderately important benefit from NNRs. This includes contribution from a range of services that provide clean air, equable local climate, clean water and cultural services. Clearly direct attribution from these services is difficult to make. Benefits from timber, wood and hay are also considered moderately important.

To produce an asset value we need to estimate the stream of benefits in future years. We have assumed that they will remain the same as this year. This leads to an asset value calculation of £1.8 billion. £1 billion of this figure is due to carbon sequestration. This is

because carbon values increase in future years, but other values remain the same. There are three important caveats to the asset value. First, the asset value calculation is as partial as the yearly flow calculation. Second, it's a gross value, without costs of maintenance netted off. Third, we do not know how the quantified benefits will evolve in future. There are realistic scenarios in which they could increase or decrease substantially. Many of the causes of uncertainty are beyond Natural England's control. So connecting this study to NNR planning wouldn't produce a much more confident estimate.

Natural England spent around £11.8 million in NNRs in 17/18. We estimate this at amber level of confidence. This is due to uncertainty over the proportion of Natural England overheads and indirect expenditure that should be attributed to NNRs. The estimated cost of replacing the NNR volunteers is £1.8 million. This is also at amber level of confidence. The main source of uncertainty here is the skill levels of volunteers. But the figure does serve to highlight how significant the volunteer contribution is.

Calculating the costs at headline level is easier than estimating the benefits. Our assessment of costs has no significant areas missing. We would like to be able to match up costs against which ecosystem services they were producing, but do not have the data to do this. Moreover it is not workable to apportion staff time this way.

Some discussion about the relationship between costs and benefits is necessary. We will simplify it by focussing on annual flows rather than capital figures. We estimate that society is investing around £14 million per year in NNR management. Our benefit estimate is £36 million, and we know this captures only a small part of the full benefit. So this shows that the NNRs are valuable assets. But the relationship between costs and benefits is complex. This year's benefits are from investment over decades. And this year's investment will improve benefits for decades too. Changes in investment do affect benefits, but the relationship is complex and different for different benefits. Our figures do not allow us to make a judgement about this.

4.4 Understanding the state of the assets themselves

Without our natural capital assets, there would be no ecosystem goods and services, and associated benefits and values to society and the economy. It is in our interest to understand what state our natural capital assets are in and how they are changing over time. This report has attempted to set a meaningful baseline in terms of asset extent and quality, against which we can measure change in the future. It does not however tell us whether they are currently in a good state or otherwise as we have not benchmarked the ecological data against figures from elsewhere. This is because this would be a very significant additional undertaking. These accounts are meant to be repeated and act as a form of monitoring against this baseline.

One of the biggest constraints has been data availability. We have struggled to find datasets of suitable resolution, that are repeated and describe the asset attributes that we are interested in. We have had to use some datasets which may not be repeated (tranquillity data for example). We also aimed to restrict ourselves to utilising open data sources under an Open Government Licence (OGL), despite the inclusion of some proprietary datasets. This has limited the data selection process further. However, we felt this principle was important if others wish to undertake a similar exercise. The lack of relevant data is a significant problem for work on natural capital in general and there is no quick fix. Whilst tools such as earth observation may help us in the future, we still need to maintain and increase investment in datasets that tells us information about the state of our natural environment at scales that make sense locally as well as nationally. Lusardi et al. (2018) highlights the gaps in our data in further detail. The intervals between repeat surveys for the

ecological data in this report suggests that repetition annually of this account would not be appropriate as the ecological data is not collected on an annual basis.

This lack of information means that some aspects of quality have not been included in these accounts. Consideration of landscape for example has not been possible. The NNR network represents the best places for biodiversity and geodiversity and we haven't adequately captured geodiversity in these accounts. It is partially represented in the SSSI condition data where geodiversity may be a feature of interest. Wren's Nest NNR and Horn Park NNR were specifically declared to represent their geodiversity. Others such as Axmouth to Lyme Regis Undercliffs NNR encompass one or more geodiversity features of interest. For the remainder, geodiversity is a critical attribute defining the character of the NNR. Further work is required to find datasets to capture these attributes in future accounts.

To encourage the inclusion of asset extent and quality information alongside ecosystem services, benefits and values in decision making, we summarised the results on one page (section 3.1). We could not include all the information on asset quality in this summary, but have chosen datasets across the six quality attributes. Focussing on the summary so tightly risks readers ignoring the wider data, but we felt that presenting asset data alongside valuation data was considered essential in this work.

4.5 We can improve this assessment in future, but not transform it

This report is the first attempt at a top-down NCA of the Natural England NNRs. We have identified various improvements to the way that Natural England collects data. These would either simplify the process or provide new insight. But these improvement are incremental. They would not transform what the analysis is able to do for us.

4.6 NCA does not provide appropriate headline targets for managing the NNRs

It wouldn't be appropriate to manage the NNRs by maximising the quantified asset value. This would prioritise carbon sequestration, recreation and volunteering above all else. NNRs are an important carbon sink and store. But they also contain important habitats which emit carbon when managed appropriately. Altering these to sequester carbon would be against the purposes of the NNR. Similarly, recreation is an important purpose of NNRs. But there are tensions between recreation and thriving wildlife. Maximising recreation at the cost of thriving wildlife would be inappropriate. So focussing on the quantified value and investment ratio would not be appropriate. Setting targets for the NNRs is too complex a task for NCA at its current level of development.

4.7 Even so, the detail about expenditure and benefits is helpful

Improving the data on the number of visitors to NNRs as a group is useful. So is evidence about the benefit to visitors. More detailed evidence here could support thinking about how to maximise this benefit. Provided other concerns are given due weight, it's useful to estimate carbon values. This report highlights the enormous contribution that volunteers make to NNRs. It's likely that volunteering is also beneficial to the volunteers. Understanding this data in greater detail would also be helpful.

Recognising the value of NNRs across a broad range of benefits through the lens of ecosystem services is really worthwhile to highlight the full suite of services and benefits they provide beyond their core remit. The Economics of Ecosystems and Biodiversity report (TEEB 2010) identified that often recognising value was sufficient to inform decision making and this study supports that. Similarly, previous work by Natural England (Clarke 2017) which took a bottom up approach to Corporate Natural Capital Accounting found that NNR

managers found the approach to thinking about their sites in broader terms helpful, but that the final accounts were too partial to be particularly useful.

Assessment of the significance of ecosystem services and benefits was assessed by expert judgement in a top down approach across the suite of NNRs as a whole. A more inclusive approach to the significance of the services and benefits from the NNRs could be done using a bottom up approach from each NNR and aggregated together.

The approach to understanding asset extent and quality, in line with Lusardi et al. (2018), also extends ecological interest beyond biodiversity to aspects of functioning ecosystems, their associated processes, and cultural considerations. This gives a broader perspective of the sustainability and resilience of the NNRs.

4.8 NCA has a role to play in explaining the value of NNRs as natural capital assets

Comparison of costs and benefits is not appropriate to the reasons set out above. Even so, the benefit and cost figures provide a way of engaging those unfamiliar with the NNRs. We would want to follow this with a broader conversation about the purposes of the NNRs and their role. The detailed benefit figures can also form part of a case for further investment in these areas.

5 Conclusion

Natural England NNRs offer significant benefits to society. The most significant benefits are in line with the NNRs core purposes of thriving wildlife, scientific research and recreation but there are many others. Benefits from climate regulation, provision of goods, health and broad cultural well-being are also significant. Beyond this there is a long list of ecosystem services where NNRs make a modest contribution. We were able to put an economic value on only a small proportion of the benefits, but even this partial valuation helps to illustrate the importance of NNRs to society.

This innovative approach to NCAs provides a baseline assessment of the quantity and quality of our natural capital assets, the services and benefits provided, and their value all reported alongside each other in an extended balance sheet. This provides comprehensive, accessible information that is available for better decision-making and avoids the problems of partial natural capital accounts.

Our asset values are based on the assumption that the benefits from NNRs will stay the same. To ensure that the benefits do say the same, or increase, we need to understand the ecology. We also need to understand how this delivers benefits. This is best done at site level, but it's also useful to understand it strategically. Our assessment in this report is a first pass at this and a baseline for comparison.

Leaving the environment in a better state for future generations will require meaningfully linking financial decisions with environmental assets and benefits. This study is a contribution to this long term task. We commend this approach to all organisations which are committed to managing their environmental assets to deliver public benefit over the long-term.

6 Appendices

6.1 Definitions used in the report

Natural Capital is defined by the Natural Capital Committee as:

the elements of nature that directly or indirectly produce value for people, including ecosystems, species, freshwater, land, minerals, air and oceans, as well as natural processes and functions. (Natural Capital Committee 2017)

Definitions of other terms, as used in this report:

1. **Attribute**: an environmental property.
2. **Indicator**: non-quantitative measure of an environmental property.
3. **Metric**: quantitative measure of an indicator, including the units used.
4. **Ecosystem asset**: the stock of nature which provides ecosystem services and benefits to people. In this report broad habitats are used to define the ecosystem assets. Geodiversity is also considered as a natural asset supporting abiotic and ecosystem services.
5. **Ecosystem service**: the components of nature that are directly enjoyed, consumed, or used in order to maintain or enhance human well-being.
6. **Benefit**: the benefits to people that are obtained from ecosystem services.
7. **Value**: the value that people place on the well-being benefits obtained from ecosystem services, which can be expressed in both monetary and non-monetary terms.
8. **Flow**: the links and provision from ecosystem assets to ecosystem services, benefits and value.
9. **Logic chain:** also known as a causal model, demonstrating the links in a process to deliver a particular outcome. In this report, the logic chains depict the links between ecosystem assets, services, benefits and values and the factors affecting them.

6.2 Principles for defining robust indicators

1. Transparent

The basic rationale for an indicator should be open and understandable. It should be clear how the indicator is derived from basic concepts (see 3 below): what it comprises; the data used to compile the indicator; and the limitations of and assumptions included within the indicator. The indicator should be intuitive in the sense that it is obvious what the indicator is measuring.

2. Relevant

The indicator should tell you something about the system that you want to know. It should relate as directly as possible to the issue of interest and be able to describe the state of, and changes in, a system. The indicator must be suitably sensitive to change, with a change in the indicator reflecting change in the state of the system at the required spatial and temporal scales (see 6 below). In complex systems, using proxies or a 'basket' of indicators might be necessary to describe the system state and changes.

3. Meaningful

The indicator should represent the state of and changes within the system in ways that are readily understood by users and audiences. This should then reflect a clear, evidence-based logic-chain that demonstrates how changes in the state of the system link to changes in the indicator. The frequency of monitoring should reflect the pace of system change with minimal time-lag between the collection and reporting of data.

4. Knowable

The indicator should be based on robust data capable of being either measured or modelled. The data assembled to compile and report on the indicator should be readily available; using methodologically sound monitoring or modelling methods that are clearly set out and subject to audit and review. It may be necessary to use traditional indicators while new indicators are developed and new data are collected.

5. Actionable

An indicator should be 'practically applicable' within the contexts and decision processes in which it is to be used. It should provide information that informs actions relating to the system, should these be required.

6. Scalable

The indicator must be applicable at the range of spatial and temporal scales required for evaluating the relevant issue. Spatial scale could range from local to global and temporal scale from near to long-term. Where necessary, the temporal scale could span past, present and anticipated future states of the system.

Gary Kass, Natural England Deputy Chief Scientist from Lusardi et al. (2018)

6.3 National Nature Reserves Included in the accounts

Ainsdale Sand Dunes
Aqualate Mere
Ashford Hill
Aston Rowant
Axmouth to Lyme Regis Undercliffs
Barnack Hills and Holes
Barrington Hill
Barton Hills
Beacon Hill
Benacre
Black-a-Tor Copse
Blackwater Estuary
Blelham Bog
Bredon Hill
Brettenham Heath
Bridgwater Bay
Buckingham Thick Copse
Bure Marshes
Cabin Hill
Calthorpe Broad
Cassop Vale
Castle Eden Dene
Castle Hill
Castor Hanglands
Cavenham Heath
Chartley Moss
Chippenham Fen
Clawthorpe Fell
Cliburn Moss
Collyweston Great Wood & Easton Hornstocks
Colne Estuary
Cothill
Cotswold Commons and Beechwoods
Dendles Wood
Dengie
Derbyshire Dales
Dersingham Bog
Derwent Gorge and Muggleswick Woods
Downton Gorge
Duddon Mosses
Duncombe Park
Dungeness
East Dartmoor Woods & Heaths
Ebbor Gorge
Fenn's, Whixall & Bettisfield Mosses

Finglandrigg Woods
Forge Valley Woods
Fyfield Down
Gait Barrows
Golitha Falls
Gordano Valley
Goss Moor
Gowk Bank
Great Asby Scar
Hales Wood
Hallsenna Moor
Ham Street Woods
Hambledon Hill
Hamford Water
Hardington Moor
Hartland Moor
High Leys
Highbury Wood
Hog Cliff
Holkham
Holme Fen
Holt Heath
Holton Heath
Horn Park Quarry
Humberhead Peatlands
Ingleborough
Kingley Vale
Kingston Great Common
Knocking Hoe
Lady Park Wood
Langley Wood
Lewes Downs (Mount Caburn)
Lindisfarne
Ling Gill
Lower Derwent Valley
Ludham & Potter Heigham Marshes
Lullington Heath
Martin Down
Moccas Park
Monks Wood
Moor House-Upper Teesdale
Morden Bog
Mottey Meadows
Muckle Moss
Muston Meadows
Newham Bog
North Fen
North Meadow, Cricklade
North Solent
North Walney
Old Winchester Hill
Parsonage Down
Paston Great Barn
Pevensey Levels
Pewsey Downs
Prescombe Down
Ribble Estuary
Rodney Stoke
Rostherne Mere
Roudsea Wood and Mosses
Saltfleetby - Theddlethorpe Dunes
Sandybeck Meadow
Scolt Head Island
Scoska Wood
Shapwick Heath
Skipwith Common
Slapton Ley
Somerset Levels
South Solway Mosses
Stiperstones
Stoborough Heath
Stodmarsh
Suffolk Coast
Swanscombe Skull Site
Swanton Novers
Tarn Moss
Teesmouth
The Flits
The Hudnalls
The Lizard
The Wash
Thornhill Moss & Meadows
Thrislington
Thursley
Valley of Stones
Walton Moss
Westleton Heath
Winterton Dunes
Wistman's Wood
Woodwalton Fen
Wren's Nest
Wybunbury Moss
Wychwood
Wye
Wylye Down
Wyre Forest

6.4 Natural Capital Accounts disaggregated by NNR

6.4.1 NNR Habitat Extent

Table 20 NNR area disaggregated by NNR and NEA broad habitat type. All values are given in ha

141 NNRs Extent (ha)		National Ecosystem Assessment Broad Habitats (ha) (NEA-BH)								
NNR	**Total Area**	**Coastal Margins**	**Enclosed Farmland**	**Freshwaters - Open waters, Wetlands and Floodplains**	**Marine**	**Mountains, Moorlands & Heaths**	**Semi-natural Grasslands**	**Urban**	**Woodlands**	**Total Area Across NNRs**
Ainsdale Sand Dunes	492.0	167.4	4.5	0.7	141	0.9	7.8	3.2	165.5	491.1
Aqualate Mere	214.4	0	54	86.6	0	3.7	9.6	0	60.5	214.4
Ashford Hill	23.4	0	10.6	0	0	0	0	0	12.7	23.4
Aston Rowant	159.1	0	70.5	0	0	0	43.8	0.6	44.3	159.1
Axmouth to Lyme Regis Undercliffs	305.6	7.9	7.9	1.9	43.8	0	50.3	0	192.7	304.6
Barnack Hills and Holes	23.3	0	8.9	0	0	0	5.1	0	9.2	23.3
Barrington Hill	17.7	0	17.7	0	0	0	0	0	0	17.7
Barton Hills	44.2	0	31.9	0	0	0	0	0	12.2	44.2
Beacon Hill	40.1	0	4.2	0	0	0.3	20.8	0	14.8	40.1
Benacre	372.2	11	24.9	145.9	12.4	3.5	7.7	4.3	148.8	358.4
Black-a-Tor Copse	29.9	0	0.5	0	0	0	23.7	0	5.6	29.9

Blackwater Estuary	1099.0	49.9	75.9	38	647.9	0	277	3.7	6.2	1098.6
Blelham Bog	2.2	0	0	0.1	0	0	0	0	2.1	2.2
Bredon Hill	48.6	0	34.9	0	0	0	5	0	8.7	48.6
Brettenham Heath	232.1	0	92.2	0	0	0	111.2	4.4	24.2	232.1
Bridgwater Bay	2639.1	145.2	45.1	3.3	2442.9	0	0	1.5	0	2638
Buckingham Thick Copse	45.1	0	0.5	0	0	0	0	0	44.6	45.1
Bure Marshes	450.1	0	1.2	242.2	0	0	0	3.9	202.8	450.1
Cabin Hill	28.3	17.9	6.2	0	2.6	0	0.9	0	0.7	28.3
Calthorpe Broad	43.5	0	12	0	0	0	0	0	31.5	43.5
Cassop Vale	24.7	0	5.1	0.7	0	0	10.3	0	8.5	24.7
Castle Eden Dene	225.5	3.3	24.5	0	0.4	0	3	11.6	182.7	225.5
Castle Hill	46.7	0	34	0	0	0	12.7	0	0	46.7
Castor Hanglands	89.8	0	8.6	0	0	0	4.5	0	76.7	89.8
Cavenham Heath	203.1	0	73.4	0.1	0	3.5	65.1	2.4	58.5	203.1
Chartley Moss	44.5	0	3	3.1	0	0	1.1	0	37.2	44.5
Chippenham Fen	113.0	0	5.4	0	0	0	39.9	0	67.7	113
Clawthorpe Fell	11.5	0	2	0	0	7.2	2.4	0	0	11.5
Cliburn Moss	26.5	0	0.3	0	0	0.8	1.2	0	24.1	26.5

Collyweston Great Wood & Easton Hornstocks	149.4	0	2.1	0	0	0	0.1	0.1	147.1	149.4
Colne Estuary	703.6	149.7	50.4	0.2	378.8	0	0.1	1.3	0	580.5
Cothill	1.5	0	0	0	0	0	0	0	1.5	1.5
Cotswold Commons and Beechwoods	413.2	0	121.1	0	0	0	27.7	2.3	262.1	413.2
Dendles Wood	29.3	0	0.3	0	0	0	0	0	28.9	29.3
Dengie	2547.3	7.2	0.3	0	2539.7	0	0	0	0	2547.2
Derbyshire Dales	386.3	0	123.8	0	0	4.6	102.6	2.6	152.7	386.3
Dersingham Bog	159.1	0	16.8	0	0	81.8	8.7	1.7	50	159.1
Derwent Gorge and Muggleswick Woods	69.4	0	3.2	0	0	1.8	2.1	0	62.2	69.4
Downton Gorge	48.7	0	2	2.1	0	0	0.2	0	44.5	48.7
Duddon Mosses	117.7	0	28.6	67.1	0	4.8	0	0	17.1	117.7
Duncombe Park	103.5	0	43.4	0	0	1.2	5.4	0	53.6	103.5
Dungeness	1030.9	834.9	14	160.7	7.9	0	1.7	3.2	4.7	1027.2

East Dartmoor Woods & Heaths	414.6	0	19.9	0	0	24.9	0	0.1	369.7	414.6
Ebbor Gorge	45.9	0	2	0	0	0	2.4	0	41.4	45.9
Fenn's, Whixall & Bettisfield Mosses	654.9	0	34.5	521.4	0	45.8	4	6.7	42.5	654.9
Finglandrigg Woods	79.4	0	3.6	0	0	12	14.2	0	49.7	79.4
Forge Valley Woods	67.1	0	0.7	0	0	30.9	1.2	0	34.3	67.1
Fyfield Down	228.6	0	215.9	0	0	0	4	0	8.7	228.6
Gait Barrows	121.6	0	13.1	6.4	0	2.7	12.4	0	87	121.6
Golitha Falls	17.2	0	0.3	0	0	0	0	0	16.9	17.2
Gordano Valley	126.1	0	61.3	0	0	0	27.6	0	37.2	126.1
Goss Moor	489.9	0	20.6	28.7	0	219.1	21.9	0.1	199.5	489.9
Gowk Bank	15.0	0	6.8	0	0	6.1	0.1	0	2	15
Great Asby Scar	312.3	0	0.2	0	0	234.7	77.4	0	0	312.3
Hales Wood	8.2	0	0.1	0	0	0	0	0	8.1	8.2
Hallsenna Moor	21.5	0	2.2	0	0	6.3	12.2	0	0.7	21.5
Ham Street Woods	97.1	0	2.3	0	0	0	0.1	0.3	94.3	97.1
Hambledon Hill	73.5	0	32.4	0	0	0	24.1	0	17	73.5

Hamford Water	1427.2	423.9	83.2	10.2	846.9	0	49.6	0	13.4	1427.2
Hardington Moor	8.7	0	8.7	0	0	0	0	0	0	8.7
Hartland Moor	245.0	0	1.1	44.6	0	182	9.7	0	7.7	245
High Leys	9.5	0	6.3	0	0	0	2	0	1.2	9.5
Highbury Wood	46.4	0	1.6	0	0	0	0	0	44.7	46.4
Hog Cliff	89.4	0	53.5	0	0	0	17	0	18.8	89.4
Holkham	3531.0	988.3	486.3	11.8	1855.6	0	56.8	6.6	117.1	3522.5
Holme Fen	269.4	0	10	18.8	0	0	0	0	240.6	269.4
Holt Heath	492.7	0	12.1	2.5	0	369.4	6.5	2.5	99.8	492.7
Holton Heath	162.0	37.2	12.1	0	0.2	24.6	4.7	9.6	73.6	162
Horn Park Quarry	0.3	0	0.2	0	0	0	0.1	0	0	0.3
Humberhead Peatlands	2892.9	0	62.7	2296.3	0	9.4	11.8	1.5	511.2	2892.9
Ingleborough	1024.0	0	19.2	50.4	0	538.1	400.1	0.1	16.1	1024
Kingley Vale	147.9	0	12.9	0	0	0	1.6	0	133.4	147.9
Kingston Great Common	56.9	0	0	1.2	0	39.2	5.7	0	10.7	56.9
Knocking Hoe	8.1	0	8.1	0	0	0	0	0	0	8.1
Lady Park Wood	45.3	0	0	0	0	0	0	0.1	45.2	45.3
Langley Wood	217.8	0	0.8	0	0	0	0.3	0	216.7	217.8
Lewes Downs (Mount Caburn)	48.8	0	42.6	0	0	0	0.1	0	6.1	48.8

Lindisfarne	3408.3	445.8	13.1	4.4	2932.4	0	10.7	1.2	0	3407.5
Ling Gill	5.0	0	0	0	0	3.1	1.3	0	0.5	5
Lower Derwent Valley	467.3	0	182.3	51.7	0	6.8	217.2	0.2	9.2	467.3
Ludham & Potter Heigham Marshes	84.4	0	81.3	0.1	0	0	2.3	0	0.6	84.4
Lullington Heath	62.7	0	59.1	0	0	0	0	0	3.6	62.7
Martin Down	341.0	0	190.3	0	0	0	80	0	70.7	341
Moccas Park	138.6	0	16.8	0	0	0	50	0	71.9	138.6
Monks Wood	156.3	0	9.1	0	0	0	0.4	0.2	146.5	156.3
Moor House-Upper Teesdale	8669.7	0	102.7	2761.5	0	4591.2	1176.4	15	23	8669.7
Morden Bog	146.9	0	5.5	29.9	0	85.5	3.9	0.2	21.8	146.9
Mottey Meadows	43.4	0	43.4	0	0	0	0	0	0	43.4
Muckle Moss	169.4	0	24.5	41.1	0	76.3	19.6	0	7.8	169.4
Muston Meadows	8.8	0	8.8	0	0	0	0	0	0	8.8
Newham Bog	13.6	0	0.2	0	0	0.7	4.2	0	8.5	13.6
North Fen	2.3	0	0.1	0	0	0	0	0	2.2	2.3
North Meadow, Cricklade	39.7	0	39.7	0	0	0	0	0	0	39.7

North Solent	925.0	70.8	367.4	25.1	178.1	15.4	37	13.5	215.3	922.6
North Walney	646.5	170.5	1.6	0.7	437.9	0	16.4	0.4	0	627.4
Old Winchester Hill	62.8	0	10.6	0	0	0	30.3	0	21.9	62.8
Parsonage Down	275.7	0	85	0	0	0	187.6	0.9	2.3	275.7
Paston Great Barn	1.0	0	0	0	0	0	0	0	0.9	1
Pevensey Levels	183.5	0	9.7	1.1	0	0	169	0	3.8	183.5
Pewsey Downs	167.1	0	104.2	0	0	0	62.9	0	0	167.1
Prescombe Down	47.7	0	2.5	0	0	0	43.2	0	2	47.7
Ribble Estuary	4623.4	1826.1	42.3	0.7	2529.1	0	4.1	2.8	0	4405.1
Rodney Stoke	51.5	0	12.3	0	0	0	2.3	0	36.9	51.5
Rostherne Mere	152.5	0	50.9	47.3	0	0	24.4	0	29.9	152.5
Roudsea Wood and Mosses	397.6	2.5	3.8	140.6	1.1	0	7.7	1.6	240.3	397.6
Saltfleetby - Theddlethorpe Dunes	618.9	200.4	2.1	0	360.8	0	14	0	0	577.2
Sandybeck Meadow	0.4	0	0.2	0	0	0	0.2	0	0	0.4

Scolt Head Island	737.6	316.8	0	0	402.7	0	0	0	0	719.6
Scoska Wood	11.1	0	2	0	0	0	4.8	0	4.3	11.1
Shapwick Heath	508.8	0	60.2	276.1	0	0	99.4	0.6	72.5	508.8
Skipwith Common	273.4	0	13.2	4.3	0	148.7	0.3	0.6	106.3	273.4
Slapton Ley	191.3	8.5	9.7	94.5	12.7	1.6	3.8	2.1	58.2	191.3
Somerset Levels	462.9	0	434.5	10.8	0	0	14.6	1.7	1.3	462.9
South Solway Mosses	971.0	0	14.6	843.4	0	20.7	24.3	0	68.1	971
Stiperstones	448.0	0	11.8	0	0	273.7	119.2	1	42.2	448
Stoborough Heath	177.0	0	80.4	0	0	77.3	4.3	0	14.9	177
Stodmarsh	250.1	0	51.9	124.8	0	0	27.3	2.9	43.1	250.1
Suffolk Coast	971.9	96.4	185.3	302.4	81.3	19.2	63.5	21.3	202.4	971.9
Swanscombe Skull Site	2.1	0	2.1	0	0	0	0	0	0	2.1
Swanton Novers	59.6	0	1.7	0	0	0	0	0	57.9	59.6
Tarn Moss	15.9	0	0	0	0	0	1.6	0	14.3	15.9
Teesmouth	362.5	18.2	38.4	0.8	280.7	3.7	17.9	2.3	0.6	362.5
The Flits	27.0	0	9.6	0	0	0	10.4	0	6.9	27
The Hudnalls	30.0	0	0.5	0	0	0	0.5	0	29	30
The Lizard	2403.2	1.3	406.7	3.5	137.3	1230.1	223.9	14.1	384.6	2401.3
The Wash	8777.5	1455.7	58.9	2	5405.4	0	9.1	2.9	2.8	6936.6

Thornhill Moss & Meadows	11.9	0	4.6	0	0	0	0	0	7.3	11.9
Thrislington	23.3	0	8.7	0	0	4.4	6.3	0.4	3.5	23.3
Thursley	322.6	0	7	2.5	0	179.9	0.1	2	131.1	322.6
Valley of Stones	99.1	0	79.9	0	0	0	18.2	0	1.1	99.1
Walton Moss	20.8	0	0	15.4	0	0	2.7	0	2.7	20.8
Westleton Heath	47.6	0	0	0	0	27.1	7.8	1.4	11.3	47.6
Winterton Dunes	84.4	71.9	0.3	0	0.2	0	1.1	0	11	84.4
Wistman's Wood	169.7	0	14.7	0	0	0	153.8	0	1.2	169.7
Woodwalton Fen	209.0	0	91.5	38	0	4.8	1.4	0	73.4	209
Wren's Nest	34.1	0	2	0	0	0	0	9.9	22.2	34.1
Wybunbury Moss	15.8	0	3.1	0	0	0	3.6	0.1	9	15.8
Wychwood	263.4	0	17.5	0	0	0	0	0	245.9	263.4
Wye	140.1	0	81	0	0	0	3.1	0	56	140.1
Wylye Down	33.9	0	31.2	0	0	0	2.6	0	0	33.9
Wyre Forest	420.7	0	11.5	0.1	0	0.6	2.8	0	405.7	420.7
Totals:	**66839.7**	**7528.6**	**5507.6**	**8567.9**	**21679.8**	**8630.2**	**4613.1**	**173.9**	**7842.8**	**64544**

6.4.2 Hydrology and geomorphology assets

Table 21 Hydrological and geomorphological natural capital assets disaggregated by NNR

		Hydrological Natural Capital Assets																					
		Water Framework Directive (WFD) River Waterbody Length (km) by Status, and Waterbody Density (km/ha) - 2016 Cycle 2 (WFD-RW)																WFD Groundwater Area (ha) by Status - 2016 Cycle 2 (WFD-GW)					Headwater Stream Quality (HSQ)
141 NNRs Extent (ha)		Overall Status				Ecological Status				Hydrological Status				Morphology Status						Overall Status		Quantitative Status			
NNR	Total Area	Good	Moderate	Poor	Bad	Good	Moderate	Poor	Bad	High	Supports Good	Does Not Support Good	No Class	High	Supports Good	No Class	Total Waterbody Length	Mean River Waterbody Density		Good	Poor	Good	Poor	Total Groundwater Body Area	Mean Estimates of Observed/Expected Presence of Invertebrates
Ainsdale Sand Dunes	492.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		367.06	0.00	367.06	0.00	367.06	-
Aqualate Mere	214.4	0.00	2.01	0.90	0.00	0.00	2.01	0.90	0.00	0.00	2.91	0.00	0.00	0.00	2.91	0.00	2.91	0.01		0.00	214.38	0.00	214.38	214.38	0.69
Ashford Hill	23.4	0.00	1.48	0.00	0.00	0.00	1.48	0.00	0.00	0.00	0.00	1.48	0.00	0.00	1.48	0.00	1.48	0.06		0.00	0.00	0.00	0.00	0.00	0.71
Aston Rowant	159.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	159.11	159.11	0.00	159.11	-
Axmouth to Lyme Regis Undercliffs	305.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		257.68	0.00	257.68	0.00	257.68	-
Barnack Hills and Holes	23.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	23.30	0.00	23.30	23.30	-
Barrington Hill	17.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	1.15
Barton Hills	44.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	44.18	0.00	44.18	44.18	0.57
Beacon Hill	40.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	40.06	0.00	40.06	40.06	-
Benacre	372.2	0.00	3.19	0.00	0.00	0.00	3.19	0.00	0.00	0.00	3.19	0.00	0.00	0.00	2.64	0.55	3.19	0.00		0.00	326.61	0.00	326.61	326.61	0.59
Black-a-Tor Copse	29.9	0.00	1.40	0.00	0.00	1.40	0.00	0.00	0.00	0.00	0.00	1.40	0.00	0.00	1.40	0.00	1.40	0.05		0.00	29.89	29.89	0.00	29.89	0.96
Blackwater Estuary	1099.0	0.00	1.84	0.00	0.00	0.00	1.84	0.00	0.00	0.00	1.84	0.00	0.00	0.00	0.00	1.84	1.84	0.00		0.00	0.04	0.04	0.00	0.04	0.55
Blelham Bog	2.2	0.23	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.23	0.23	0.11		0.00	2.21	2.21	0.00	2.21	1.22
Bredon Hill	48.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		48.62	0.00	48.62	0.00	48.62	0.65
Brettenham Heath	232.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	232.05	0.00	232.05	232.05	-
Bridgwater Bay	2639.1	0.00	0.19	0.00	0.00	0.00	0.19	0.00	0.00	0.03	0.16	0.00	0.00	0.00	0.05	0.14	0.19	0.00		0.00	0.00	0.00	0.00	0.00	0.73
Buckingham Thick Copse	45.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		45.13	0.00	45.13	0.00	45.13	0.51
Bure Marshes	450.1	0.00	11.90	0.00	0.00	0.00	11.90	0.00	0.00	0.00	11.90	0.00	0.00	0.00	0.00	11.90	11.90	0.00		0.00	450.10	0.00	450.10	450.10	-
Cabin Hill	28.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		27.59	0.00	27.59	0.00	27.59	0.77

Calthorpe Broad	43.5	0.82	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.00	0.00	0.82	0.82	0.02	0.00	43.54	0.00	43.54	43.54	0.50
Cassop Vale	24.7	0.00	0.00	0.23	0.00	0.00	0.00	0.23	0.00	0.00	0.23	0.00	0.00	0.00	0.23	0.00	0.23	0.01	0.00	24.70	24.70	0.00	24.70	0.82
Castle Eden Dene	225.5	0.00	7.31	0.00	0.00	0.00	7.31	0.00	0.00	0.00	0.00	7.31	0.00	0.00	7.31	0.00	7.31	0.00	0.00	224.46	224.46	0.00	224.46	0.66
Castle Hill	46.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	46.75	0.00	46.75	46.75	-
Castor Hanglands	89.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89.81	0.00	89.81	0.00	89.81	0.57
Cavenham Heath	203.1	0.00	3.02	0.00	0.00	0.00	3.02	0.00	0.00	0.00	3.02	0.00	0.00	0.00	0.00	3.02	3.02	0.01	0.00	203.06	0.00	203.06	203.06	0.56
Chartley Moss	44.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.48	0.00	44.48	0.00	44.48	0.78
Chippenham Fen	113.0	0.00	0.45	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.45	0.45	0.00	0.00	113.04	0.00	113.04	113.04	0.69
Clawthorpe Fell	11.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.50	11.50	0.00	11.50	-
Cliburn Moss	26.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.46	26.46	0.00	26.46	0.57
Collyweston Great Wood & Easton Hornstocks	149.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	149.42	96.70	52.71	149.42	0.62
Colne Estuary	703.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.51
Cothill	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.51	0.00	1.51	0.00	1.51	-
Cotswold Commons and Beechwoods	413.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	413.21	0.00	413.21	0.00	413.21	0.69
Dendles Wood	29.3	0.00	1.57	0.00	0.00	0.00	1.57	0.00	0.00	0.00	0.00	1.57	0.00	0.00	1.57	0.00	1.57	0.05	0.00	29.28	29.28	0.00	29.28	0.90
Dengie	2547.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	1.43	0.00	1.43	0.62
Derbyshire Dales	386.3	1.75	5.56	0.00	0.00	1.75	5.56	0.00	0.00	1.75	5.56	0.00	0.00	0.00	7.31	0.00	7.31	0.00	0.00	386.25	386.25	0.00	386.25	0.70
Dersingham Bog	159.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	159.13	0.00	159.13	0.00	159.13	0.65
Derwent Gorge and Muggleswick Woods	69.4	0.00	5.90	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	5.90	5.90	0.01	0.00	69.36	69.36	0.00	69.36	0.96
Downton Gorge	48.7	4.21	0.00	0.00	0.00	4.21	0.00	0.00	0.00	4.21	0.00	0.00	0.00	0.00	4.21	0.00	4.21	0.09	0.00	48.74	48.74	0.00	48.74	0.60
Duddon Mosses	117.7	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.10	0.00	0.10	0.00	0.00	117.66	117.66	0.00	117.66	0.80
Duncombe Park	103.5	0.00	3.17	0.00	0.00	0.00	3.17	0.00	0.00	0.00	3.17	0.00	0.00	0.00	0.00	3.17	3.17	0.03	0.00	103.55	0.00	103.55	103.55	0.78
Dungeness	1030.9	0.00	2.09	0.00	0.00	0.00	2.09	0.00	0.00	0.00	0.00	0.00	2.09	0.00	0.00	2.09	2.09	0.00	0.00	1020.24	0.00	1020.24	1020.24	0.65
East Dartmoor Woods & Heaths	414.6	3.50	0.00	4.82	0.00	3.50	0.00	4.82	0.00	1.43	6.89	0.00	0.00	0.00	8.32	0.00	8.32	0.00	0.00	414.57	414.57	0.00	414.57	0.83
Ebbor Gorge	45.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.88	0.00	45.88	0.00	45.88	0.83
Fenn's, Whixall & Bettisfield Mosses	654.9	6.18	0.00	0.00	0.00	6.18	0.00	0.00	0.00	0.00	0.00	0.00	6.18	0.00	0.00	6.18	6.18	0.00	652.50	2.43	654.94	0.00	654.94	0.67

Finglandrigg Woods	79.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.40	0.00	79.40	0.00	79.40	0.89
Forge Valley Woods	67.1	0.00	5.68	0.00	0.00	0.00	5.68	0.00	0.00	0.00	5.68	0.00	0.00	0.00	0.00	5.68	5.68	0.03	0.01	52.20	0.01	52.20	52.21	0.71
Fyfield Down	228.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	228.58	0.00	228.58	228.58	-
Gait Barrows	121.6	0.00	1.16	0.00	0.00	0.00	1.16	0.00	0.00	1.16	0.00	0.00	0.00	0.00	0.00	1.16	1.16	0.01	0.00	121.60	121.60	0.00	121.60	0.89
Golitha Falls	17.2	1.89	0.00	0.00	0.00	1.89	0.00	0.00	0.00	0.00	1.89	0.00	0.00	0.00	1.89	0.00	1.89	0.11	0.00	17.24	17.24	0.00	17.24	0.82
Gordano Valley	126.1	0.00	2.44	0.00	0.00	0.00	2.44	0.00	0.00	0.00	2.44	0.00	0.00	0.00	0.00	2.44	2.44	0.00	126.15	0.00	126.15	0.00	126.15	0.61
Goss Moor	489.9	0.00	8.63	0.00	0.00	0.00	8.63	0.00	0.00	0.00	8.63	0.00	0.00	0.00	8.63	0.00	8.63	0.00	0.00	489.89	489.89	0.00	489.89	0.77
Gowk Bank	15.0	0.00	0.94	1.70	0.00	0.00	0.94	1.70	0.00	2.64	0.00	0.00	0.00	0.00	2.64	0.00	2.64	0.03	14.97	0.00	14.97	0.00	14.97	0.79
Great Asby Scar	312.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	312.32	0.00	312.32	0.00	312.32	0.45
Hales Wood	8.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.20	0.00	8.20	8.20	0.61
Hallsenna Moor	21.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.45	0.00	21.45	0.00	21.45	0.82
Ham Street Woods	97.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.82	9.82	0.00	9.82	0.64
Hambledon Hill	73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.53	73.53	0.00	73.53	-
Hamford Water	1427.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.28	0.60
Hardington Moor	8.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.74	0.00	8.74	0.00	8.74	-
Hartland Moor	245.0	0.00	0.00	0.16	0.00	0.00	0.00	0.16	0.00	0.16	0.00	0.00	0.00	0.00	0.16	0.00	0.16	0.00	0.00	245.00	245.00	0.00	245.00	0.59
High Leys	9.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.46	9.46	0.00	9.46	0.87
Highbury Wood	46.4	0.00	0.35	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.35	0.00	0.35	0.01	0.00	46.43	46.43	0.00	46.43	0.85
Hog Cliff	89.4	0.11	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00	89.39	0.00	89.39	89.39	-
Holkham	3531.0	0.00	0.58	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.26	0.31	0.00	0.00	0.00	0.58	0.58	0.00	0.00	1542.84	1542.84	0.00	1542.84	0.64
Holme Fen	269.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54
Holt Heath	492.7	0.00	0.32	0.09	0.00	0.00	0.32	0.09	0.00	0.42	0.00	0.00	0.00	0.00	0.42	0.00	0.42	0.00	0.00	398.05	398.05	0.00	398.05	0.76
Holton Heath	162.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	159.52	159.52	0.00	159.52	0.62
Horn Park Quarry	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.32	0.00	0.32	-
Humberhead Peatlands	2892.9	0.00	0.08	2.25	0.00	0.00	0.08	2.25	0.00	0.08	0.00	2.25	0.00	0.00	0.00	2.32	2.32	0.00	243.50	2649.37	254.29	2638.57	2892.87	0.60
Ingleborough	1024.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1024.04	0.00	1024.04	0.00	1024.04	0.74
Kingley Vale	147.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	147.91	0.00	147.91	147.91	-
Kingston Great Common	56.9	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	1.00	0.02	16.30	0.00	16.30	0.00	16.30	-

Knocking Hoe	8.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.09	0.00	8.09	8.09	0.54
Lady Park Wood	45.3	0.00	1.41	0.00	0.00	0.00	1.41	0.00	0.00	0.00	1.41	0.00	0.00	0.00	1.41	0.00	1.41	0.03	45.29	0.00	45.29	0.00	45.29	0.89
Langley Wood	217.8	0.00	3.02	0.00	0.00	0.00	3.02	0.00	0.00	0.00	3.02	0.00	0.00	0.00	3.02	0.00	3.02	0.00	1.88	0.00	1.88	0.00	1.88	0.77
Lewes Downs (Mount Caburn)	48.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	48.82	0.00	48.82	48.82	-
Lindisfarne	3408.3	0.28	0.50	0.00	0.00	0.28	0.50	0.00	0.00	0.28	0.50	0.00	0.00	0.00	0.46	0.32	0.78	0.00	0.00	318.58	318.58	0.00	318.58	0.70
Ling Gill	5.0	0.00	1.01	0.00	0.00	0.00	1.01	0.00	0.00	1.01	0.00	0.00	0.00	0.00	1.01	0.00	1.01	0.20	5.00	0.00	5.00	0.00	5.00	0.68
Lower Derwent Valley	467.3	3.65	21.77	0.21	0.00	3.65	21.77	0.21	0.00	0.85	0.21	6.13	18.43	0.00	0.30	25.32	25.62	0.00	54.70	412.58	54.70	412.58	467.28	0.61
Ludham & Potter Heigham Marshes	84.4	0.00	2.67	0.00	0.00	0.00	2.67	0.00	0.00	0.00	2.67	0.00	0.00	0.00	0.00	2.67	2.67	0.01	0.00	84.39	0.00	84.39	84.39	0.55
Lullington Heath	62.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.68	0.00	62.68	62.68	-
Martin Down	341.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	340.99	0.00	340.99	340.99	-
Moccas Park	138.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	138.64	138.64	0.00	138.64	0.57
Monks Wood	156.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Moor House-Upper Teesdale	8669.7	12.40	35.47	0.00	0.00	13.18	34.69	0.00	0.00	28.99	0.78	0.00	18.10	18.66	10.12	19.09	47.87	0.00	1150.70	7519.04	8669.74	0.00	8669.74	0.66
Morden Bog	146.9	0.00	0.89	0.00	2.77	0.00	0.89	0.00	2.77	2.77	0.89	0.00	0.00	0.00	3.65	0.00	3.65	0.00	0.00	146.86	146.86	0.00	146.86	0.89
Mottey Meadows	43.4	0.00	0.00	1.32	0.00	0.00	0.00	1.32	0.00	0.00	1.32	0.00	0.00	0.00	0.00	1.32	1.32	0.03	43.38	0.00	43.38	0.00	43.38	0.74
Muckle Moss	169.4	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.01	0.00	169.35	169.35	0.00	169.35	0.92
Muston Meadows	8.8	0.00	0.31	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.31	0.31	0.04	0.00	8.76	8.76	0.00	8.76	0.48
Newham Bog	13.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.57	13.57	0.00	13.57	0.81
North Fen	2.3	0.00	0.00	0.42	0.00	0.00	0.00	0.42	0.00	0.00	0.42	0.00	0.00	0.00	0.42	0.00	0.42	0.18	0.00	2.30	2.30	0.00	2.30	1.47
North Meadow, Cricklade	39.7	0.00	1.46	0.00	0.67	0.00	1.46	0.00	0.67	0.00	1.46	0.67	0.00	0.00	2.13	0.00	2.13	0.01	0.00	39.72	39.72	0.00	39.72	0.62
North Solent	925.0	4.13	6.17	0.00	0.00	4.13	6.17	0.00	0.00	7.22	1.07	0.00	2.00	0.00	5.23	5.06	10.29	0.00	696.87	0.00	696.87	0.00	696.87	0.70
North Walney	646.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	169.22	1.78	171.01	0.00	171.01	-
Old Winchester Hill	62.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	62.82	0.00	62.82	62.82	-
Parsonage Down	275.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	275.74	0.00	275.74	275.74	-
Paston Great Barn	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.96	0.00	0.96	-
Pevensey Levels	183.5	0.00	0.39	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.39	0.39	0.00	178.97	0.00	178.97	0.00	178.97	0.68
Pewsey Downs	167.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	167.15	13.03	154.11	167.15	-

Prescombe Down	47.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.71	0.00	47.71	47.71	-
Ribble Estuary	4623.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1455.26	0.00	1455.26	0.00	1455.26	0.89
Rodney Stoke	51.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.50	0.00	51.50	0.00	51.50	0.76
Rostherne Mere	152.5	0.00	0.00	0.00	1.93	0.00	0.00	0.00	1.93	0.00	1.93	0.00	0.00	0.00	1.93	0.00	1.93	0.01	0.00	152.49	152.49	0.00	152.49	0.85
Roudsea Wood and Mosses	397.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	394.80	394.80	0.00	394.80	0.73
Saltfleetby - Theddlethorpe Dunes	618.9	0.00	0.00	0.46	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.46	0.46	0.00	0.00	283.08	283.08	0.00	283.08	0.63
Sandybeck Meadow	0.4	0.00	0.32	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.32	0.32	0.82	0.00	0.39	0.39	0.00	0.39	1.06
Scolt Head Island	737.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	359.25	359.25	0.00	359.25	-
Scoska Wood	11.1	0.00	0.77	0.00	0.00	0.00	0.77	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.77	0.00	0.77	0.07	0.00	11.09	11.09	0.00	11.09	0.71
Shapwick Heath	508.8	0.00	6.71	0.00	0.00	0.00	6.71	0.00	0.00	0.00	6.71	0.00	0.00	0.00	0.00	6.71	6.71	0.00	0.00	0.00	0.00	0.00	0.00	0.67
Skipwith Common	273.4	0.00	0.77	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.77	0.00	0.77	0.00	0.00	273.45	0.00	273.45	273.45	0.68
Slapton Ley	191.3	0.00	7.62	0.00	0.00	0.00	7.62	0.00	0.00	7.62	0.00	0.00	0.00	0.00	7.62	0.00	7.62	0.00	0.00	190.42	190.42	0.00	190.42	0.82
Somerset Levels	462.9	0.00	6.30	0.00	0.00	0.00	6.30	0.00	0.00	0.14	6.16	0.00	0.00	0.00	0.00	6.30	6.30	0.00	0.00	400.73	400.73	0.00	400.73	0.68
South Solway Mosses	971.0	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.03	0.00	971.04	0.00	971.04	0.00	971.04	0.90
Stiperstones	448.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	146.27	146.27	0.00	146.27	0.69
Stoborough Heath	177.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	176.99	176.99	0.00	176.99	0.52
Stodmarsh	250.1	0.00	1.46	1.90	0.00	0.00	1.46	1.90	0.00	0.00	3.36	0.00	0.00	0.00	1.90	1.46	3.36	0.01	0.00	248.13	0.00	248.13	248.13	0.62
Suffolk Coast	971.9	0.00	0.94	0.00	0.00	0.00	0.94	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.94	0.94	0.00	0.00	868.54	0.00	868.54	868.54	0.52
Swanscombe Skull Site	2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	0.00	2.09	2.09	-
Swanton Novers	59.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.58	0.00	59.58	59.58	0.57
Tarn Moss	15.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.94	0.00	15.94	0.00	15.94	0.81
Teesmouth	362.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.82	0.00	100.82	0.00	100.82	0.83
The Flits	27.0	0.00	1.30	0.00	0.00	0.00	1.30	0.00	0.00	1.30	0.00	0.00	0.00	0.00	1.30	0.00	1.30	0.05	0.00	26.98	26.98	0.00	26.98	0.72
The Hudnalls	30.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.81	29.81	0.00	29.81	0.93
The Lizard	2403.2	0.70	5.33	0.00	0.00	0.70	5.33	0.00	0.00	1.93	4.10	0.00	0.00	0.00	6.03	0.00	6.03	0.00	0.00	2369.20	2369.20	0.00	2369.20	0.74
The Wash	8777.5	0.67	0.11	0.00	0.00	0.67	0.11	0.00	0.00	0.00	0.67	0.11	0.00	0.00	0.00	0.78	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.59
Thornhill Moss & Meadows	11.9	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.07	0.01	11.95	0.00	11.95	0.00	11.95	1.06

Thrislington	23.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.33	0.00	23.33	23.33	0.59
Thursley	322.6	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.63	0.00	0.63	0.00	0.00	0.00	0.63	0.00	0.63	0.00	0.00	322.57	0.00	322.57	322.57	0.58
Valley of Stones	99.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.13	0.00	99.13	99.13	-
Walton Moss	20.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.97	4.84	20.81	0.00	20.81	1.00
Westleton Heath	47.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.62	0.00	47.62	47.62	0.63
Winterton Dunes	84.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	84.42	0.00	84.42	84.42	0.54
Wistman's Wood	169.7	0.00	3.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	2.66	0.34	0.00	2.66	0.34	3.00	0.01	0.00	169.73	169.73	0.00	169.73	0.85
Woodwalton Fen	209.0	0.00	3.72	0.00	0.00	0.00	3.72	0.00	0.00	0.00	0.00	3.72	0.00	0.00	0.00	3.72	3.72	0.02	0.00	0.00	0.00	0.00	0.00	0.64
Wren's Nest	34.1	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.10	0.10	0.00	34.14	0.00	34.14	0.00	34.14	-
Wybunbury Moss	15.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.81	15.81	0.00	15.81	-
Wychwood	263.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	263.37	263.37	0.00	263.37	0.57
Wye	140.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	140.12	0.00	140.12	140.12	0.70
Wylye Down	33.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.85	0.00	33.85	33.85	-
Wyre Forest	420.7	7.04	0.00	1.32	0.00	7.04	0.00	1.32	0.00	7.04	0.00	0.00	0.00	0.00	7.04	1.32	8.36	0.00	0.00	420.67	420.67	0.00	420.67	0.71
Total/Mean:	**66839.68**	**47.55**	**186.89**	**15.77**	**6.06**	**49.73**	**184.71**	**15.77**	**6.06**	**74.63**	**98.72**	**29.17**	**53.75**	**18.66**	**112.07**	**125.54**	**256.27**	**0.01**	**9002.45**	**28336.87**	**27560.17**	**9779.15**	**37339.32**	**0.72**

6.4.3 Nutrient/Chemical status assets

Table 22 The chemical and nutrient status natural capital assets disaggregated by NNR

		Nutrient/Chemical Status Natural Capital Assets												
141 NNRs Extent (ha)		Chemical Concentrations (µg m-3) and Deposition (kg N/S ha-1 year-1) in Protected Sites (DC-AC; DC-NC; DC-SC; DC-ND; DC-SD)					WFD River Waterbody Length (km) by Chemical Status - 2016 Cycle 2 (WFD-RW)		WFD Groundwater Area (ha) by Chemical Status - 2016 Cycle 2 (WFD-GW)		Nitrate Vulnerable Zones 2017 Area (ha) (NVZ)			
NNR	Total Area	Mean Ammonia Concentration	Mean Nitrogen Oxide Concentration	Mean Sulphur Dioxide Concentration	Mean Nitrogen Deposition	Mean Sulphur Deposition	Good	Fail	Good	Poor	Eutrophic	Ground-water	Surface Water	Total Area
Ainsdale Sand Dunes	492.0	0.57	11.43	0.46	7.98	3.52	0.00	0.00	367.06	0.00	0.00	0.00	30.26	30.26
Aqualate Mere	214.4	2.77	11.65	0.34	11.76	3.20	2.91	0.00	0.00	214.38	144.67	214.38	214.38	573.44
Ashford Hill	23.4	1.07	12.29	0.31	12.74	3.20	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aston Rowant	159.1	1.45	17.16	0.25	12.60	2.88	0.00	0.00	0.00	159.11	0.00	0.00	141.70	141.70
Axmouth to Lyme Regis Undercliffs	305.6	1.03	5.04	0.18	9.52	2.24	0.00	0.00	257.68	0.00	0.00	0.00	0.00	0.00
Barnack Hills and Holes	23.3	1.46	15.64	0.32	11.48	3.36	0.00	0.00	0.00	23.30	0.00	23.30	23.30	46.59
Barrington Hill	17.7	2.32	6.78	0.23	14.14	3.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barton Hills	44.2	1.50	16.22	0.34	11.48	3.20	0.00	0.00	0.00	44.18	0.00	44.18	44.18	88.36
Beacon Hill	40.1	1.64	10.91	0.43	12.88	4.32	0.00	0.00	0.00	40.06	0.00	40.06	41.07	81.13
Benacre	372.2	0.91	10.64	0.18	9.10	2.40	3.19	0.00	0.00	326.61	0.00	372.17	122.90	495.07
Black-a-Tor Copse	29.9	0.81	3.99	0.13	22.26	6.08	0.00	1.40	0.00	29.89	0.00	0.00	0.00	0.00
Blackwater Estuary	1099.0	0.89	11.17	0.33	8.54	2.88	1.84	0.00	0.00	0.04	0.00	0.00	5.89	5.89
Blelham Bog	2.2	0.67	5.57	0.24	25.34	9.12	0.23	0.00	0.00	2.21	0.00	0.00	0.00	0.00
Bredon Hill	48.6	1.65	10.89	0.32	8.40	2.88	0.00	0.00	48.62	0.00	0.00	0.00	48.62	48.62
Brettenham Heath	232.1	1.93	12.74	0.27	17.92	3.04	0.00	0.00	0.00	232.05	0.00	232.05	232.05	464.10
Bridgwater Bay	2639.1	1.04	6.97	0.25	8.54	2.88	0.19	0.00	0.00	0.00	0.00	0.00	0.14	0.14
Buckingham Thick Copse	45.1	1.53	12.28	0.30	14.98	3.36	0.00	0.00	45.13	0.00	0.00	45.13	45.13	90.27
Bure Marshes	450.1	1.27	15.77	0.33	11.34	3.20	11.90	0.00	0.00	450.10	419.20	450.10	0.00	869.30
Cabin Hill	28.3	0.57	11.43	0.46	7.98	3.52	0.00	0.00	27.59	0.00	0.00	0.00	0.61	0.61
Calthorpe Broad	43.5	0.91	11.83	0.28	9.52	2.88	0.82	0.00	0.00	43.54	43.54	0.00	0.00	43.54
Cassop Vale	24.7	2.36	11.91	0.48	12.88	4.80	0.23	0.00	0.00	24.70	0.00	23.16	0.00	23.16
Castle Eden Dene	225.5	1.31	15.43	0.45	10.08	4.80	7.31	0.00	0.00	224.46	0.00	0.00	0.00	0.00
Castle Hill	46.7	1.11	13.14	0.24	8.68	3.04	0.00	0.00	0.00	46.75	0.00	46.75	0.00	46.75
Castor Hanglands	89.8	1.60	15.54	0.34	11.34	3.04	0.00	0.00	89.81	0.00	0.00	86.41	89.81	176.22
Cavenham Heath	203.1	1.72	12.09	0.29	12.95	2.88	3.02	0.00	0.00	203.06	0.00	203.06	203.06	406.12
Chartley Moss	44.5	2.69	13.49	0.34	12.88	3.84	0.00	0.00	44.48	0.00	0.05	0.00	44.48	44.53
Chippenham Fen	113.0	1.33	12.86	0.48	9.66	3.04	0.45	0.00	0.00	113.04	0.00	113.04	113.04	226.09
Clawthorpe Fell	11.5	1.86	9.26	0.29	11.20	4.00	0.00	0.00	0.00	11.50	0.00	0.00	0.00	0.00
Cliburn Moss	26.5	2.00	7.03	0.27	18.62	5.44	0.00	0.00	0.00	26.46	0.00	0.00	0.00	0.00

Collyweston Great Wood & Easton Hornstocks	149.4	1.28	14.91	0.29	12.46	3.52	0.00	0.00	0.00	149.42	0.00	149.42	149.42	298.84
Colne Estuary	703.6	0.88	11.02	0.33	8.40	2.72	0.00	0.00	0.00	0.01	0.00	156.80	0.00	156.80
Cothill	1.5	1.72	14.32	0.35	9.52	2.56	0.00	0.00	1.51	0.00	0.00	0.00	1.51	1.51
Cotswold Commons and Beechwoods	413.2	1.54	11.45	0.38	14.70	3.68	0.00	0.00	413.21	0.00	0.00	368.05	367.53	735.58
Dendles Wood	29.3	0.76	6.86	0.23	15.40	4.16	1.57	0.00	0.00	29.28	0.00	0.00	0.00	0.00
Dengie	2547.3	0.98	12.05	0.26	7.91	2.88	0.00	0.00	0.00	1.43	0.00	0.00	0.00	0.00
Derbyshire Dales	386.3	2.25	13.15	0.45	24.33	7.36	2.29	5.02	0.00	386.25	0.00	0.00	0.00	0.00
Dersingham Bog	159.1	0.75	13.32	0.34	12.88	3.52	0.00	0.00	159.13	0.00	0.00	0.00	0.10	0.10
Derwent Gorge and Muggleswick Woods	69.4	1.01	7.48	0.28	14.98	4.96	5.90	0.00	0.00	69.36	0.00	0.00	0.00	0.00
Downton Gorge	48.7	1.76	6.82	0.30	13.58	3.44	4.21	0.00	0.00	48.74	0.00	0.00	0.00	0.00
Duddon Mosses	117.7	1.03	6.07	0.29	12.32	4.48	0.10	0.00	0.00	117.66	0.00	0.00	0.00	0.00
Duncombe Park	103.5	2.84	8.47	0.32	15.54	4.48	3.17	0.00	0.00	103.55	0.00	0.00	0.00	0.00
Dungeness	1030.9	0.68	10.67	0.21	8.68	3.04	2.09	0.00	0.00	1020.24	0.00	0.00	0.00	0.00
East Dartmoor Woods & Heaths	414.6	0.90	4.78	0.19	20.58	5.68	8.32	0.00	0.00	414.57	0.00	0.00	0.00	0.00
Ebbor Gorge	45.9	2.63	7.27	0.25	10.22	2.40	0.00	0.00	45.88	0.00	0.00	0.00	0.00	0.00
Fenn's, Whixall & Bettisfield Mosses	654.9	2.66	11.10	0.32	12.74	2.88	6.18	0.00	652.50	2.43	0.00	0.00	654.94	654.94
Finglandrigg Woods	79.4	2.57	5.39	0.23	9.10	2.56	0.00	0.00	79.40	0.00	0.00	0.00	0.00	0.00
Forge Valley Woods	67.1	1.20	8.90	0.46	13.30	4.64	5.68	0.00	0.01	52.20	0.00	45.43	0.00	45.43
Fyfield Down	228.6	1.87	8.85	0.18	12.18	2.88	0.00	0.00	0.00	228.58	0.00	228.58	0.00	228.58
Gait Barrows	121.6	1.06	7.81	0.29	12.04	3.84	1.16	0.00	0.00	121.60	0.00	0.00	0.00	0.00
Golitha Falls	17.2	1.97	5.44	0.22	15.40	4.48	1.89	0.00	0.00	17.24	0.00	0.00	0.00	0.00
Gordano Valley	126.1	1.24	15.96	0.45	9.94	3.04	2.44	0.00	126.15	0.00	0.00	0.00	0.00	0.00
Goss Moor	489.9	0.00	0.00	0.00	0.00	0.00	8.63	0.00	0.00	489.89	488.21	0.00	0.00	488.21
Gowk Bank	15.0	0.61	5.20	0.19	13.44	3.68	2.64	0.00	14.97	0.00	0.00	0.00	0.00	0.00
Great Asby Scar	312.3	1.23	6.53	0.23	23.66	8.48	0.00	0.00	312.32	0.00	0.00	0.00	0.00	0.00
Hales Wood	8.2	1.36	11.88	0.34	10.22	3.20	0.00	0.00	0.00	8.20	0.00	8.20	8.20	16.40
Hallsenna Moor	21.5	1.67	5.17	0.23	8.12	3.04	0.00	0.00	21.45	0.00	0.00	0.00	0.00	0.00
Ham Street Woods	97.1	1.43	11.06	0.28	9.24	2.88	0.00	0.00	0.00	9.82	0.00	0.00	97.08	97.08
Hambledon Hill	73.5	2.33	7.00	0.22	13.16	3.20	0.00	0.00	0.00	73.53	0.00	73.53	0.00	73.53
Hamford Water	1427.2	0.79	12.86	0.38	8.68	3.04	0.00	0.00	0.00	0.28	0.00	115.72	0.00	115.72
Hardington Moor	8.7	2.46	7.86	0.30	11.20	3.20	0.00	0.00	8.74	0.00	0.00	0.00	0.00	0.00
Hartland Moor	245.0	0.96	8.01	0.23	12.18	3.12	0.16	0.00	0.00	245.00	245.00	0.00	0.00	245.00
High Leys	9.5	1.23	5.82	0.29	11.20	3.84	0.00	0.00	0.00	9.46	0.00	0.00	0.00	0.00
Highbury Wood	46.4	1.48	7.48	0.37	20.16	4.32	0.35	0.00	0.00	46.43	0.00	0.00	0.00	0.00
Hog Cliff	89.4	2.84	6.49	0.19	13.86	3.20	0.11	0.00	0.00	89.39	89.39	89.39	0.00	178.77
Holkham	3531.0	0.88	11.41	0.29	8.89	3.04	0.58	0.00	0.00	1542.84	0.00	1197.60	1.65	1199.25
Holme Fen	269.4	1.38	14.68	0.35	10.36	3.20	0.00	0.00	0.00	0.00	0.00	0.00	269.41	269.41
Holt Heath	492.7	1.29	10.80	0.31	14.14	3.52	0.42	0.00	0.00	398.05	0.00	0.00	0.00	0.00
Holton Heath	162.0	0.91	10.40	0.32	12.74	3.44	0.00	0.00	0.00	159.52	161.83	0.00	0.00	161.83
Horn Park Quarry	0.3	2.48	6.51	0.23	11.90	2.72	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00
Humberhead Peatlands	2892.9	1.68	16.02	0.54	11.34	4.64	2.32	0.00	243.50	2649.37	0.00	26.84	2892.86	2919.70

Ingleborough	1024.0	0.87	7.11	0.27	19.32	6.40	0.00	0.00	1024.04	0.00	0.00	0.00	0.00	0.00
Kingley Vale	147.9	0.89	10.80	0.35	12.60	3.68	0.00	0.00	0.00	147.91	87.97	147.91	0.00	235.87
Kingston Great Common	56.9	0.79	10.82	0.28	15.54	3.52	1.00	0.00	16.30	0.00	0.00	0.00	0.00	0.00
Knocking Hoe	8.1	1.40	15.23	0.30	9.10	2.88	0.00	0.00	0.00	8.09	0.00	8.09	8.09	16.18
Lady Park Wood	45.3	1.52	7.95	0.38	16.10	4.16	1.41	0.00	45.29	0.00	0.00	0.00	0.00	0.00
Langley Wood	217.8	1.22	8.72	0.24	14.70	3.36	3.02	0.00	1.88	0.00	217.79	0.00	217.79	435.59
Lewes Downs (Mount Caburn)	48.8	1.44	14.10	0.27	10.08	3.52	0.00	0.00	0.00	48.82	0.00	0.00	0.00	0.00
Lindisfarne	3408.3	0.57	6.34	0.22	6.86	2.72	0.78	0.00	0.00	318.58	256.90	0.00	0.00	256.90
Ling Gill	5.0	0.63	6.94	0.26	20.72	7.04	1.01	0.00	5.00	0.00	0.00	0.00	0.00	0.00
Lower Derwent Valley	467.3	2.62	13.57	0.74	12.43	5.08	25.62	0.00	467.28	0.00	0.00	0.00	161.40	161.40
Ludham & Potter Heigham Marshes	84.4	1.53	15.38	0.30	8.54	2.72	2.67	0.00	0.00	84.39	0.00	0.00	0.00	0.00
Lullington Heath	62.7	0.84	10.04	0.19	9.24	3.04	0.00	0.00	0.00	62.68	0.00	62.68	0.00	62.68
Martin Down	341.0	1.81	7.37	0.19	12.46	3.04	0.00	0.00	0.00	340.99	0.00	340.99	0.00	340.99
Moccas Park	138.6	1.41	6.01	0.26	15.40	4.32	0.00	0.00	0.00	138.64	0.00	4.10	138.05	142.15
Monks Wood	156.3	1.41	15.30	0.34	9.66	3.04	0.00	0.00	0.00	0.00	0.00	0.00	156.27	156.27
Moor House-Upper Teesdale	8669.7	0.66	6.07	0.22	17.50	5.04	47.09	0.78	1150.70	7519.04	0.00	0.00	0.00	0.00
Morden Bog	146.9	1.02	7.71	0.21	14.14	3.36	3.65	0.00	0.00	146.86	146.86	0.00	0.00	146.86
Mottey Meadows	43.4	3.09	12.70	0.35	11.90	3.36	1.32	0.00	43.38	0.00	0.00	0.00	43.38	43.38
Muckle Moss	169.4	0.90	6.00	0.23	11.90	3.60	0.00	1.00	0.00	169.35	0.00	0.00	0.00	0.00
Muston Meadows	8.8	1.86	14.20	0.37	10.78	3.68	0.31	0.00	0.00	8.76	0.00	0.00	8.76	8.76
Newham Bog	13.6	1.00	7.82	0.23	7.42	3.04	0.00	0.00	0.00	13.57	13.57	0.00	0.00	13.57
North Fen	2.3	0.67	5.67	0.26	22.40	8.00	0.42	0.00	0.00	2.30	0.00	0.00	0.00	0.00
North Meadow, Cricklade	39.7	2.10	12.47	0.29	9.10	2.88	2.13	0.00	0.00	39.72	0.00	0.00	39.72	39.72
North Solent	925.0	0.65	13.66	0.37	9.66	3.60	10.29	0.00	696.87	0.00	0.00	0.00	16.25	16.25
North Walney	646.5	0.69	6.68	0.31	9.94	3.68	0.00	0.00	169.22	1.78	0.00	0.00	0.00	0.00
Old Winchester Hill	62.8	1.63	10.70	0.44	12.74	4.32	0.00	0.00	0.00	62.82	0.00	62.82	62.82	125.63
Parsonage Down	275.7	1.82	8.08	0.18	9.66	2.72	0.00	0.00	0.00	275.74	0.00	275.74	0.00	275.74
Paston Great Barn	1.0	1.03	12.94	0.27	9.52	3.04	0.00	0.00	0.00	0.96	0.00	0.00	0.00	0.00
Pevensey Levels	183.5	1.01	10.94	0.21	9.52	3.36	0.39	0.00	178.97	0.00	0.00	0.00	0.00	0.00
Pewsey Downs	167.1	1.98	8.13	0.18	11.90	2.72	0.00	0.00	0.00	167.15	0.00	167.15	0.00	167.15
Prescombe Down	47.7	1.76	7.07	0.19	12.88	3.20	0.00	0.00	0.00	47.71	0.00	47.71	0.00	47.71
Ribble Estuary	4623.4	0.97	10.43	0.39	7.70	3.36	0.00	0.00	1455.26	0.00	0.00	0.00	1154.76	1154.76
Rodney Stoke	51.5	1.97	7.77	0.26	10.50	2.56	0.00	0.00	51.50	0.00	0.00	0.00	0.00	0.00
Rostherne Mere	152.5	2.12	21.17	0.53	12.18	4.32	1.93	0.00	0.00	152.49	123.98	0.00	0.00	123.98
Roudsea Wood and Mosses	397.6	0.93	6.96	0.31	12.25	4.48	0.00	0.00	0.00	394.80	0.00	0.00	0.00	0.00
Saltfleetby - Theddlethorpe Dunes	618.9	0.91	12.96	0.39	10.22	3.52	0.46	0.00	0.00	283.08	0.00	0.00	3.67	3.67
Sandybeck Meadow	0.4	1.35	5.33	0.24	17.92	6.24	0.32	0.00	0.00	0.39	0.00	0.00	0.00	0.00
Scolt Head Island	737.6	0.65	11.54	0.30	7.98	3.04	0.00	0.00	0.00	359.25	0.00	0.00	0.00	0.00
Scoska Wood	11.1	0.59	7.28	0.26	22.82	8.16	0.77	0.00	0.00	11.09	0.00	0.00	0.00	0.00

Shapwick Heath	508.8	2.32	7.58	0.34	8.96	2.24	6.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Skipwith Common	273.4	2.01	14.19	0.73	11.06	5.12	0.77	0.00	143.54	129.90	0.00	0.00	273.44	273.44
Slapton Ley	191.3	0.92	4.67	0.15	10.36	2.72	7.62	0.00	0.00	190.42	174.27	0.00	14.38	188.65
Somerset Levels	462.9	2.66	7.88	0.31	7.96	2.42	6.30	0.00	0.00	400.73	0.00	0.00	0.00	0.00
South Solway Mosses	971.0	1.86	4.80	0.23	10.08	2.51	0.03	0.00	971.04	0.00	0.00	0.00	0.00	0.00
Stiperstones	448.0	1.95	6.04	0.32	17.01	3.20	0.00	0.00	0.00	146.27	0.00	0.00	0.00	0.00
Stoborough Heath	177.0	1.03	7.87	0.22	12.18	3.04	0.00	0.00	0.00	176.99	176.99	0.00	0.00	176.99
Stodmarsh	250.1	0.98	11.66	0.27	8.96	3.20	3.36	0.00	248.13	0.00	0.00	0.00	0.00	0.00
Suffolk Coast	971.9	1.05	10.27	0.25	10.92	2.88	0.94	0.00	0.00	868.54	0.00	42.65	27.26	69.91
Swanscombe Skull Site	2.1	1.29	24.66	0.38	10.92	3.68	0.00	0.00	0.00	2.09	0.00	0.01	0.00	0.01
Swanton Novers	59.6	1.60	11.83	0.32	15.12	3.84	0.00	0.00	0.00	59.58	0.00	59.29	0.00	59.29
Tarn Moss	15.9	1.34	6.23	0.22	25.20	8.64	0.00	0.00	15.94	0.00	0.00	0.00	0.00	0.00
Teesmouth	362.5	1.03	35.71	1.30	9.80	6.16	0.00	0.00	100.82	0.00	0.00	0.00	0.00	0.00
The Flits	27.0	1.49	6.31	0.28	12.04	3.68	1.30	0.00	0.00	26.98	0.00	26.98	26.98	53.97
The Hudnalls	30.0	1.50	7.71	0.36	21.00	4.48	0.00	0.00	0.00	29.81	0.00	0.00	0.00	0.00
The Lizard	2403.2	0.87	5.16	0.13	6.97	2.28	6.03	0.00	0.00	2369.20	0.00	373.41	0.00	373.41
The Wash	8777.5	0.63	12.72	0.33	8.82	3.04	0.78	0.00	0.00	0.00	0.00	0.00	8.15	8.15
Thornhill Moss & Meadows	11.9	3.28	4.97	0.25	8.82	2.72	0.07	0.00	11.95	0.00	0.00	0.00	0.00	0.00
Thrislington	23.3	1.86	13.31	0.56	10.36	4.32	0.00	0.00	0.00	23.33	0.00	23.33	23.33	46.66
Thursley	322.6	0.79	11.91	0.31	14.56	3.84	0.63	0.00	0.00	322.57	0.00	0.00	0.00	0.00
Valley of Stones	99.1	2.04	6.08	0.16	8.26	2.08	0.00	0.00	0.00	99.13	0.00	99.13	0.00	99.13
Walton Moss	20.8	2.36	6.02	0.52	11.20	2.88	0.00	0.00	15.97	4.84	0.00	0.00	0.00	0.00
Westleton Heath	47.6	1.05	10.27	0.25	10.92	2.88	0.00	0.00	0.00	47.62	0.00	0.00	0.00	0.00
Winterton Dunes	84.4	0.76	11.55	0.26	8.54	2.72	0.00	0.00	0.00	84.42	0.00	0.00	0.00	0.00
Wistman's Wood	169.7	0.56	3.95	0.13	21.42	6.24	3.00	0.00	0.00	169.73	0.00	0.00	0.00	0.00
Woodwalton Fen	209.0	1.30	13.56	0.35	9.52	3.04	3.72	0.00	0.00	0.00	0.00	0.00	209.05	209.05
Wren's Nest	34.1	1.59	30.19	0.60	14.00	5.12	0.00	0.10	34.14	0.00	0.00	0.00	34.14	34.14
Wybunbury Moss	15.8	3.83	13.58	0.42	11.76	3.84	0.00	0.00	0.00	15.81	0.00	15.81	15.81	31.63
Wychwood	263.4	1.20	10.14	0.38	14.14	3.36	0.00	0.00	0.00	263.37	0.00	263.37	263.37	526.74
Wye	140.1	1.28	11.41	0.30	11.90	3.52	0.00	0.00	0.00	140.12	0.00	5.53	140.12	145.65
Wylye Down	33.9	1.72	7.96	0.19	11.90	3.04	0.00	0.00	0.00	33.85	0.00	33.85	0.00	33.85
Wyre Forest	420.7	1.33	9.10	0.42	15.96	3.52	8.36	0.00	0.00	420.67	0.00	0.00	22.56	22.56
Totals/Mean:	**66839.68**	**1.45**	**10.04**	**0.32**	**12.30**	**3.74**	**247.97**	**8.30**	**9806.70**	**27532.62**	**2790.21**	**6413.88**	**8912.88**	**18116.96**

6.4.4 Soil/Sediment Process Assets

Table 23 Soil and sediment process natural capital assets disaggregated by NNR

141 NNRs Extent (ha)		NATMAP Carbon (SC)
NNR	**Total Area**	**Mean Estimates of SOC in 30cm Topsoil (% of total)**
Ainsdale Sand Dunes	492.0	1.03
Aqualate Mere	214.4	13.42
Ashford Hill	23.4	4.11
Aston Rowant	159.1	4.01
Axmouth to Lyme Regis Undercliffs	305.6	8.31
Barnack Hills and Holes	23.3	3.09
Barrington Hill	17.7	3.76
Barton Hills	44.2	3.31
Beacon Hill	40.1	4.41
Benacre	372.2	11.06
Black-a-Tor Copse	29.9	5.45
Blackwater Estuary	1099.0	4.87
Blelham Bog	2.2	19.60
Bredon Hill	48.6	3.00
Brettenham Heath	232.1	2.22
Bridgwater Bay	2639.1	2.92
Buckingham Thick Copse	45.1	4.13
Bure Marshes	450.1	24.54
Cabin Hill	28.3	1.09
Calthorpe Broad	43.5	29.90
Cassop Vale	24.7	2.93
Castle Eden Dene	225.5	2.97
Castle Hill	46.7	4.67
Castor Hanglands	89.8	3.44
Cavenham Heath	203.1	11.27
Chartley Moss	44.5	34.13
Chippenham Fen	113.0	22.02
Clawthorpe Fell	11.5	0.14
Cliburn Moss	26.5	2.50
Collyweston Great Wood & Easton Hornstocks	149.4	3.31

Colne Estuary	703.6	6.71
Cothill	1.5	1.68
Cotswold Commons and Beechwoods	413.2	4.33
Dendles Wood	29.3	8.59
Dengie	2547.3	5.60
Derbyshire Dales	386.3	4.53
Dersingham Bog	159.1	4.62
Derwent Gorge and Muggleswick Woods	69.4	3.05
Downton Gorge	48.7	3.04
Duddon Mosses	117.7	40.34
Duncombe Park	103.5	3.72
Dungeness	1030.9	0.05
East Dartmoor Woods & Heaths	414.6	11.10
Ebbor Gorge	45.9	3.77
Fenn's, Whixall & Bettisfield Mosses	654.9	31.19
Finglandrigg Woods	79.4	3.43
Forge Valley Woods	67.1	14.28
Fyfield Down	228.6	4.20
Gait Barrows	121.6	3.68
Golitha Falls	17.2	5.34
Gordano Valley	126.1	34.08
Goss Moor	489.9	15.07
Gowk Bank	15.0	12.82
Great Asby Scar	312.3	3.91
Hales Wood	8.2	2.09
Hallsenna Moor	21.5	3.44
Ham Street Woods	97.1	3.28
Hambledon Hill	73.5	4.99
Hamford Water	1427.2	6.22
Hardington Moor	8.7	4.19
Hartland Moor	245.0	14.56
High Leys	9.5	3.83
Highbury Wood	46.4	4.11
Hog Cliff	89.4	3.53
Holkham	3531.0	4.61
Holme Fen	269.4	45.62
Holt Heath	492.7	10.31
Holton Heath	162.0	8.34
Horn Park Quarry	0.3	3.77
Humberhead Peatlands	2892.9	41.38
Ingleborough	1024.0	13.90
Kingley Vale	147.9	3.80

Kingston Great Common	56.9	13.30
Knocking Hoe	8.1	3.31
Lady Park Wood	45.3	3.84
Langley Wood	217.8	3.49
Lewes Downs (Mount Caburn)	48.8	4.65
Lindisfarne	3408.3	1.32
Ling Gill	5.0	16.42
Lower Derwent Valley	467.3	3.91
Ludham & Potter Heigham Marshes	84.4	4.44
Lullington Heath	62.7	4.13
Martin Down	341.0	4.50
Moccas Park	138.6	4.03
Monks Wood	156.3	2.52
Moor House-Upper Teesdale	8669.7	34.32
Morden Bog	146.9	13.58
Mottey Meadows	43.4	3.11
Muckle Moss	169.4	16.67
Muston Meadows	8.8	2.57
Newham Bog	13.6	24.21
North Fen	2.3	2.85
North Meadow, Cricklade	39.7	4.25
North Solent	925.0	2.84
North Walney	646.5	3.14
Old Winchester Hill	62.8	3.97
Parsonage Down	275.7	4.54
Paston Great Barn	1.0	1.21
Pevensey Levels	183.5	3.65
Pewsey Downs	167.1	4.99
Prescombe Down	47.7	4.35
Ribble Estuary	4623.4	7.06
Rodney Stoke	51.5	3.87
Rostherne Mere	152.5	1.73
Roudsea Wood and Mosses	397.6	36.18
Saltfleetby - Theddlethorpe Dunes	618.9	5.08
Sandybeck Meadow	0.4	2.92
Scolt Head Island	737.6	4.45
Scoska Wood	11.1	4.67
Shapwick Heath	508.8	45.43
Skipwith Common	273.4	9.66
Slapton Ley	191.3	1.62
Somerset Levels	462.9	24.77

South Solway Mosses	971.0	42.37
Stiperstones	448.0	11.75
Stoborough Heath	177.0	12.95
Stodmarsh	250.1	3.00
Suffolk Coast	971.9	10.82
Swanscombe Skull Site	2.1	1.21
Swanton Novers	59.6	5.82
Tarn Moss	15.9	3.34
Teesmouth	362.5	2.38
The Flits	27.0	3.84
The Hudnalls	30.0	5.91
The Lizard	2403.2	3.95
The Wash	8777.5	7.14
Thornhill Moss & Meadows	11.9	34.29
Thrislington	23.3	1.18
Thursley	322.6	6.23
Valley of Stones	99.1	3.72
Walton Moss	20.8	37.68
Westleton Heath	47.6	2.84
Winterton Dunes	84.4	0.41
Wistman's Wood	169.7	8.37
Woodwalton Fen	209.0	29.64
Wren's Nest	34.1	2.79
Wybunbury Moss	15.8	28.65
Wychwood	263.4	4.20
Wye	140.1	3.93
Wylye Down	33.9	5.11
Wyre Forest	420.7	3.37
Totals/Mean:	**66839.68**	**9.13**

6.4.5 Species composition assets

Table 24 Species composition natural capital assets disaggregated by NNR

		Species Composition Natural Capital Assets		
141 NNRs Extent (ha)		**Expected Plant Habitat Indicators (EPHI)**	**Nectar Plant Diversity (NPD)**	**Soil Invertebrates Abundance (SIA)**
NNR	**Total Area**	**Mean Estimates of Expected Plant Habitat Indicators Present (%)**	**Mean Estimates of Number of Nectar Plant Species for Bees (per 2×2m plot)**	**Mean Estimates of Total Abundance of Invertebrates in Topsoil (0-8cm depth soil core)**
Ainsdale Sand Dunes	492.0	0.01	5.42	143.82
Aqualate Mere	214.4	0.36	4.62	55.13
Ashford Hill	23.4	2.87	6.38	91.60
Aston Rowant	159.1	2.41	5.32	43.37
Axmouth to Lyme Regis Undercliffs	305.6	2.45	6.58	46.38
Barnack Hills and Holes	23.3	0.42	4.17	39.17
Barrington Hill	17.7	1.68	6.74	23.34
Barton Hills	44.2	0.54	5.04	23.34
Beacon Hill	40.1	3.10	7.65	60.17
Benacre	372.2	0.65	4.61	57.40
Black-a-Tor Copse	29.9	2.62	2.13	98.33
Blackwater Estuary	1099.0	0.55	4.29	64.30
Blelham Bog	2.2	0.40	6.45	48.83
Bredon Hill	48.6	1.18	4.90	31.31
Brettenham Heath	232.1	0.40	4.78	47.28
Bridgwater Bay	2639.1	0.57	7.19	46.10
Buckingham Thick Copse	45.1	2.13	5.03	87.50
Bure Marshes	450.1	1.24	4.30	91.81
Cabin Hill	28.3	0.00	6.09	-
Calthorpe Broad	43.5	1.06	4.65	68.81
Cassop Vale	24.7	1.88	4.02	42.83
Castle Eden Dene	225.5	2.07	4.41	72.77
Castle Hill	46.7	3.08	7.97	64.19
Castor Hanglands	89.8	1.69	4.10	84.52
Cavenham Heath	203.1	0.62	4.16	79.85
Chartley Moss	44.5	0.89	4.94	55.62
Chippenham Fen	113.0	1.52	4.31	68.72
Clawthorpe Fell	11.5	-	-	-
Cliburn Moss	26.5	0.86	5.69	56.21
Collyweston Great Wood & Easton Hornstocks	149.4	1.78	4.22	94.57

Colne Estuary	703.6	0.84	3.88	38.06
Cothill	1.5	1.74	4.82	87.90
Cotswold Commons and Beechwoods	413.2	2.90	5.46	63.95
Dendles Wood	29.3	2.66	4.89	76.25
Dengie	2547.3	0.90	4.00	30.72
Derbyshire Dales	386.3	1.07	4.53	77.93
Dersingham Bog	159.1	0.96	4.19	111.35
Derwent Gorge and Muggleswick Woods	69.4	2.90	3.85	91.50
Downton Gorge	48.7	0.86	5.73	45.18
Duddon Mosses	117.7	3.24	4.83	66.75
Duncombe Park	103.5	0.88	4.52	56.14
Dungeness	1030.9	0.04	7.48	39.17
East Dartmoor Woods & Heaths	414.6	2.54	6.28	102.75
Ebbor Gorge	45.9	2.03	6.52	37.75
Fenn's, Whixall & Bettisfield Mosses	654.9	3.91	3.58	72.76
Finglandrigg Woods	79.4	2.29	5.35	50.63
Forge Valley Woods	67.1	1.09	4.03	74.95
Fyfield Down	228.6	2.55	6.24	47.08
Gait Barrows	121.6	2.52	5.44	110.88
Golitha Falls	17.2	0.59	5.72	58.76
Gordano Valley	126.1	1.87	6.12	74.07
Goss Moor	489.9	2.82	4.49	88.14
Gowk Bank	15.0	6.74	2.55	94.53
Great Asby Scar	312.3	2.85	3.15	108.97
Hales Wood	8.2	1.02	4.76	30.72
Hallsenna Moor	21.5	1.74	5.55	39.17
Ham Street Woods	97.1	2.11	6.20	64.77
Hambledon Hill	73.5	2.54	7.36	47.00
Hamford Water	1427.2	1.13	3.55	44.55
Hardington Moor	8.7	1.89	7.00	47.40
Hartland Moor	245.0	4.91	5.52	89.38
High Leys	9.5	2.78	4.23	36.70
Highbury Wood	46.4	3.04	6.38	103.61
Hog Cliff	89.4	3.06	7.30	35.24
Holkham	3531.0	1.00	3.45	52.08
Holme Fen	269.4	1.60	4.12	87.30
Holt Heath	492.7	4.80	5.32	94.43
Holton Heath	162.0	2.65	6.46	132.31
Horn Park Quarry	0.3	2.59	7.26	48.83
Humberhead Peatlands	2892.9	4.54	2.52	70.59
Ingleborough	1024.0	4.53	2.01	96.42
Kingley Vale	147.9	4.03	7.48	63.22

Kingston Great Common	56.9	6.97	3.62	110.70
Knocking Hoe	8.1	1.07	4.94	23.34
Lady Park Wood	45.3	2.81	5.77	113.53
Langley Wood	217.8	4.13	7.00	103.66
Lewes Downs (Mount Caburn)	48.8	2.34	7.66	48.83
Lindisfarne	3408.3	1.40	4.49	51.19
Ling Gill	5.0	5.51	1.91	86.64
Lower Derwent Valley	467.3	0.77	3.84	47.72
Ludham & Potter Heigham Marshes	84.4	0.34	4.81	59.07
Lullington Heath	62.7	2.68	7.94	62.63
Martin Down	341.0	3.16	7.44	53.11
Moccas Park	138.6	1.59	5.58	80.65
Monks Wood	156.3	1.12	4.16	48.77
Moor House-Upper Teesdale	8669.7	8.16	1.13	86.16
Morden Bog	146.9	3.15	6.03	141.86
Mottey Meadows	43.4	0.70	4.98	39.70
Muckle Moss	169.4	2.58	4.26	61.36
Muston Meadows	8.8	0.61	3.93	32.70
Newham Bog	13.6	1.83	4.95	55.13
North Fen	2.3	0.13	5.69	56.21
North Meadow, Cricklade	39.7	1.13	6.01	50.01
North Solent	925.0	3.08	7.08	76.63
North Walney	646.5	1.30	4.22	63.56
Old Winchester Hill	62.8	3.23	7.45	31.14
Parsonage Down	275.7	2.34	6.73	47.15
Paston Great Barn	1.0	0.69	4.61	39.17
Pevensey Levels	183.5	1.77	6.36	83.56
Pewsey Downs	167.1	2.80	5.96	37.08
Prescombe Down	47.7	3.07	6.91	23.34
Ribble Estuary	4623.4	1.81	2.63	37.13
Rodney Stoke	51.5	1.83	6.43	37.07
Rostherne Mere	152.5	0.79	4.61	31.25
Roudsea Wood and Mosses	397.6	3.30	4.82	105.73
Saltfleetby - Theddlethorpe Dunes	618.9	1.26	3.38	30.72
Sandybeck Meadow	0.4	3.34	5.24	56.21
Scolt Head Island	737.6	1.69	2.37	-
Scoska Wood	11.1	1.37	3.48	64.66
Shapwick Heath	508.8	3.38	4.32	67.83
Skipwith Common	273.4	2.43	2.96	84.61

Slapton Ley	191.3	1.27	5.99	51.12
Somerset Levels	462.9	0.62	5.84	53.72
South Solway Mosses	971.0	6.06	3.62	70.32
Stiperstones	448.0	5.44	1.91	100.37
Stoborough Heath	177.0	3.73	6.66	71.10
Stodmarsh	250.1	0.53	5.53	54.03
Suffolk Coast	971.9	0.74	4.40	87.17
Swanscombe Skull Site	2.1	0.75	5.67	-
Swanton Novers	59.6	1.20	4.79	73.88
Tarn Moss	15.9	1.39	4.78	56.31
Teesmouth	362.5	0.95	4.12	58.96
The Flits	27.0	0.59	5.61	30.92
The Hudnalls	30.0	3.38	6.42	110.88
The Lizard	2403.2	1.09	5.08	85.44
The Wash	8777.5	1.51	2.65	30.72
Thornhill Moss & Meadows	11.9	2.70	5.35	30.72
Thrislington	23.3	1.55	4.07	23.84
Thursley	322.6	3.94	5.19	110.63
Valley of Stones	99.1	2.98	7.31	48.44
Walton Moss	20.8	7.48	2.97	71.96
Westleton Heath	47.6	3.36	2.87	117.81
Winterton Dunes	84.4	0.05	5.29	59.08
Wistman's Wood	169.7	4.07	2.10	104.26
Woodwalton Fen	209.0	0.45	4.10	33.17
Wren's Nest	34.1	0.72	5.10	-
Wybunbury Moss	15.8	0.65	5.03	64.53
Wychwood	263.4	2.88	5.38	103.61
Wye	140.1	1.29	6.58	36.54
Wylye Down	33.9	2.75	7.12	41.31
Wyre Forest	420.7	2.19	4.99	98.56
Totals/Mean:	**66839.68**	**2.13**	**5.05**	**65.34**

6.4.6 Vegetation structure/function assets

Table 25 Vegetation structure/function natural capital assets disaggregated by NNR

		Vegetation Structure/Function Natural Capital Assets						
141 NNRs Extent (ha)		**Area of NNR (ha) under a Site of Special Scientific Interest (SSSI) by Unit Condition (SSSI)**						
NNR	**Total Area**	**Favourable**	**Unfavourable Recovering**	**Unfavourable No Change**	**Unfavourable Declining**	**Part Destroyed**	**Unclassified**	**Total SSSI Area**
Ainsdale Sand Dunes	492.0	267.96	189.63	33.07	0.00	0.00	0.00	490.65
Aqualate Mere	214.4	94.21	53.76	66.42	0.00	0.00	0.00	214.38
Ashford Hill	23.4	23.39	0.00	0.00	0.00	0.00	0.00	23.39
Aston Rowant	159.1	118.56	0.00	0.00	0.00	0.00	0.00	118.56
Axmouth to Lyme Regis Undercliffs	305.6	0.83	304.21	0.00	0.00	0.00	0.00	305.05
Barnack Hills and Holes	23.3	23.30	0.00	0.00	0.00	0.00	0.00	23.30
Barrington Hill	17.7	17.71	0.00	0.00	0.00	0.00	0.00	17.71
Barton Hills	44.2	44.18	0.00	0.00	0.00	0.00	0.00	44.18
Beacon Hill	40.1	39.74	0.00	0.00	0.00	0.00	0.00	39.74
Benacre	372.2	174.79	128.44	44.78	20.43	3.35	0.00	371.77
Black-a-Tor Copse	29.9	29.89	0.00	0.00	0.00	0.00	0.00	29.89
Blackwater Estuary	1099.0	404.74	694.27	0.00	0.00	0.00	0.00	1099.02
Blelham Bog	2.2	0.00	2.21	0.00	0.00	0.00	0.00	2.21
Bredon Hill	48.6	48.62	0.00	0.00	0.00	0.00	0.00	48.62
Brettenham Heath	232.1	56.08	175.98	0.00	0.00	0.00	0.00	232.05
Bridgwater Bay	2639.1	2646.93	49.66	9.76	0.00	0.00	0.00	2706.34

Buckingham Thick Copse	45.1	45.13	0.00	0.00	0.00	0.00	0.00	45.13
Bure Marshes	450.1	282.73	92.79	74.59	0.00	0.00	0.00	450.10
Cabin Hill	28.3	2.70	25.56	0.00	0.00	0.00	0.00	28.27
Calthorpe Broad	43.5	42.53	1.01	0.00	0.00	0.00	0.00	43.54
Cassop Vale	24.7	10.68	9.00	0.00	0.00	0.00	0.00	19.68
Castle Eden Dene	225.5	128.40	90.38	0.00	0.00	0.00	0.00	218.77
Castle Hill	46.7	40.34	6.41	0.00	0.00	0.00	0.00	46.75
Castor Hanglands	89.8	40.33	49.48	0.00	0.00	0.00	0.00	89.81
Cavenham Heath	203.1	51.94	143.67	7.45	0.00	0.00	0.00	203.06
Chartley Moss	44.5	0.00	44.48	0.00	0.00	0.00	0.00	44.48
Chippenham Fen	113.0	102.92	10.12	0.00	0.00	0.00	0.00	113.04
Clawthorpe Fell	11.5	6.32	2.61	0.00	0.00	0.00	0.00	8.93
Cliburn Moss	26.5	0.00	0.95	23.73	1.45	0.00	0.00	26.13
Collyweston Great Wood & Easton Hornstocks	149.4	0.00	149.42	0.00	0.00	0.00	0.00	149.42
Colne Estuary	703.6	130.30	572.77	0.00	0.00	0.00	0.00	703.07
Cothill	1.5	0.00	1.51	0.00	0.00	0.00	0.00	1.51
Cotswold Commons and Beechwoods	413.2	256.90	144.04	0.00	0.00	0.00	0.00	400.95
Dendles Wood	29.3	29.28	0.00	0.00	0.00	0.00	0.00	29.28
Dengie	2547.3	1966.13	581.20	0.00	0.00	0.00	0.00	2547.33
Derbyshire Dales	386.3	191.45	142.21	1.78	0.00	0.00	0.00	335.45
Dersingham Bog	159.1	0.00	159.13	0.00	0.00	0.00	0.00	159.13
Derwent Gorge and Muggleswick Woods	69.4	68.96	0.01	0.00	0.00	0.00	0.00	68.97
Downton Gorge	48.7	0.00	0.00	11.59	47.53	0.00	0.00	59.12
Duddon Mosses	117.7	0.00	78.41	10.42	14.49	0.00	0.00	103.31
Duncombe Park	103.5	45.17	58.37	0.00	0.00	0.00	0.00	103.54
Dungeness	1030.9	841.32	177.59	0.00	11.71	0.00	0.00	1030.63

East Dartmoor Woods & Heaths	414.6	380.40	0.72	0.00	0.00	0.00	0.00	381.12
Ebbor Gorge	45.9	44.56	0.82	0.00	0.00	0.00	0.00	45.38
Fenn's, Whixall & Bettisfield Mosses	654.9	1.78	116.24	18.87	0.02	0.00	0.00	136.91
Finglandrigg Woods	79.4	57.74	17.58	0.00	0.00	0.00	0.00	75.32
Forge Valley Woods	67.1	57.08	10.02	0.00	0.00	0.00	0.00	67.11
Fyfield Down	228.6	0.00	226.14	0.00	0.00	0.00	0.00	226.14
Gait Barrows	121.6	77.79	22.35	16.96	2.80	0.00	0.00	119.90
Golitha Falls	17.2	17.24	0.00	0.00	0.00	0.00	0.00	17.24
Gordano Valley	126.1	51.96	71.75	0.00	0.00	0.00	0.00	123.71
Goss Moor	489.9	0.00	150.98	0.00	336.84	0.00	0.00	487.82
Gowk Bank	15.0	0.00	14.97	0.00	0.00	0.00	0.00	14.97
Great Asby Scar	312.3	51.41	260.92	0.00	0.00	0.00	0.00	312.33
Hales Wood	8.2	8.20	0.00	0.00	0.00	0.00	0.00	8.20
Hallsenna Moor	21.5	0.00	21.45	0.00	0.00	0.00	0.00	21.45
Ham Street Woods	97.1	96.67	0.00	0.00	0.00	0.00	0.00	96.67
Hambledon Hill	73.5	62.35	0.00	0.00	0.00	0.00	0.00	62.35
Hamford Water	1427.2	262.41	1164.80	0.00	0.00	0.00	0.00	1427.21
Hardington Moor	8.7	8.74	0.00	0.00	0.00	0.00	0.00	8.74
Hartland Moor	245.0	236.67	8.33	0.00	0.00	0.00	0.00	245.00
High Leys	9.5	4.57	4.89	0.00	0.00	0.00	0.00	9.46
Highbury Wood	46.4	46.43	0.00	0.00	0.00	0.00	0.00	46.43
Hog Cliff	89.4	84.88	0.49	0.00	0.00	0.00	0.00	85.36
Holkham	3531.0	3514.70	0.12	0.00	0.00	0.00	0.00	3514.82
Holme Fen	269.4	268.95	0.00	0.45	0.00	0.00	0.00	269.41
Holt Heath	492.7	88.87	256.58	109.28	34.16	0.00	0.00	488.89
Holton Heath	162.0	15.97	104.03	30.60	0.00	0.18	0.00	150.78
Horn Park Quarry	0.3	0.32	0.00	0.00	0.00	0.00	0.00	0.32

Humberhead Peatlands	2892.9	92.21	2754.22	46.43	0.00	0.00	0.00	2892.87
Ingleborough	1024.0	255.57	729.01	19.20	0.00	0.00	0.00	1003.79
Kingley Vale	147.9	80.25	67.66	0.00	0.00	0.00	0.00	147.90
Kingston Great Common	56.9	2.70	0.00	0.00	54.19	0.00	0.00	56.89
Knocking Hoe	8.1	8.09	0.00	0.00	0.00	0.00	0.00	8.09
Lady Park Wood	45.3	0.00	45.26	0.00	0.00	0.00	0.00	45.26
Langley Wood	217.8	0.00	0.00	217.79	0.00	0.00	0.00	217.79
Lewes Downs (Mount Caburn)	48.8	45.86	2.91	0.00	0.00	0.00	0.00	48.77
Lindisfarne	3408.3	991.44	261.77	2141.06	0.00	0.00	0.00	3394.27
Ling Gill	5.0	5.00	0.00	0.00	0.00	0.00	0.00	5.00
Lower Derwent Valley	467.3	243.46	220.86	0.00	0.00	0.00	0.00	464.32
Ludham & Potter Heigham Marshes	84.4	84.39	0.00	0.00	0.00	0.00	0.00	84.39
Lullington Heath	62.7	17.75	44.93	0.00	0.00	0.00	0.00	62.68
Martin Down	341.0	135.72	199.98	0.00	0.00	0.00	0.00	335.71
Moccas Park	138.6	134.20	4.44	0.00	0.00	0.00	0.00	138.64
Monks Wood	156.3	0.00	155.75	0.00	0.00	0.00	0.00	155.75
Moor House-Upper Teesdale	8669.7	723.19	7914.54	0.00	0.00	0.00	0.00	8637.73
Morden Bog	146.9	67.06	79.80	0.00	0.00	0.00	0.00	146.86
Mottey Meadows	43.4	35.14	0.00	8.24	0.00	0.00	0.00	43.38
Muckle Moss	169.4	265.62	0.00	0.00	0.00	0.00	0.00	265.62
Muston Meadows	8.8	8.76	0.00	0.00	0.00	0.00	0.00	8.76
Newham Bog	13.6	13.57	0.00	0.00	0.00	0.00	0.00	13.57
North Fen	2.3	2.30	0.00	0.00	0.00	0.00	0.00	2.30
North Meadow, Cricklade	39.7	39.72	0.00	0.00	0.00	0.00	0.00	39.72
North Solent	925.0	544.25	298.27	0.00	3.07	0.00	0.00	845.59

North Walney	646.5	495.24	140.18	0.00	0.00	0.00	0.00	635.42
Old Winchester Hill	62.8	62.82	0.00	0.00	0.00	0.00	0.00	62.82
Parsonage Down	275.7	147.36	40.01	0.00	0.00	0.00	0.00	187.37
Paston Great Barn	1.0	0.96	0.00	0.00	0.00	0.00	0.00	0.96
Pevensey Levels	183.5	0.00	183.55	0.00	0.00	0.00	0.00	183.55
Pewsey Downs	167.1	77.89	76.98	0.00	0.00	0.00	0.00	154.86
Prescombe Down	47.7	47.71	0.00	0.00	0.00	0.00	0.00	47.71
Ribble Estuary	4623.4	4502.63	0.00	83.61	0.00	0.00	0.00	4586.24
Rodney Stoke	51.5	36.37	12.12	0.00	0.00	0.00	0.00	48.49
Rostherne Mere	152.5	73.49	23.05	55.94	0.00	0.00	0.00	152.49
Roudsea Wood and Mosses	397.6	11.63	233.55	0.00	151.82	0.00	0.00	397.01
Saltfleetby - Theddlethorpe Dunes	618.9	495.44	122.98	0.00	0.00	0.00	0.00	618.43
Sandybeck Meadow	0.4	0.39	0.16	0.00	0.00	0.00	0.00	0.54
Scolt Head Island	737.6	567.23	123.81	0.00	0.00	0.00	0.00	691.04
Scoska Wood	11.1	1.42	9.67	0.00	0.00	0.00	0.00	11.09
Shapwick Heath	508.8	349.40	8.33	0.00	37.67	0.00	0.00	395.41
Skipwith Common	273.4	121.76	151.69	0.00	0.00	0.00	0.00	273.44
Slapton Ley	191.3	0.00	189.81	0.00	0.00	0.00	0.00	189.81
Somerset Levels	462.9	4.70	148.35	0.00	309.75	0.00	0.00	462.80
South Solway Mosses	971.0	0.00	920.53	1.33	44.80	0.00	0.00	966.66
Stiperstones	448.0	375.73	71.25	0.53	0.00	0.00	0.00	447.51
Stoborough Heath	177.0	92.32	19.22	0.00	0.00	0.00	0.00	111.54
Stodmarsh	250.1	183.66	0.00	65.93	0.00	0.00	0.00	249.58
Suffolk Coast	971.9	447.75	429.47	3.05	2.64	0.00	0.00	882.90
Swanscombe Skull Site	2.1	2.09	0.00	0.00	0.00	0.00	0.00	2.09

Swanton Novers	59.6	0.00	59.58	0.00	0.00	0.00	0.00	59.58
Tarn Moss	15.9	15.94	0.00	0.00	0.00	0.00	0.00	15.94
Teesmouth	362.5	0.00	0.00	0.00	0.00	0.00	362.02	362.02
The Flits	27.0	21.88	0.00	5.10	0.00	0.00	0.00	26.98
The Hudnalls	30.0	29.40	0.00	0.00	0.00	0.00	0.00	29.40
The Lizard	2403.2	2029.26	56.68	0.00	0.00	0.00	127.07	2213.01
The Wash	8777.5	4640.02	4060.87	0.00	0.00	0.00	0.00	8700.89
Thornhill Moss & Meadows	11.9	11.95	0.00	0.00	0.00	0.00	0.00	11.95
Thrislington	23.3	23.33	0.00	0.00	0.00	0.00	0.00	23.33
Thursley	322.6	320.04	0.00	0.00	0.00	0.00	0.00	320.04
Valley of Stones	99.1	80.40	0.00	0.00	0.00	0.00	0.00	80.40
Walton Moss	20.8	0.00	0.00	20.81	0.00	0.00	0.00	20.81
Westleton Heath	47.6	47.52	0.10	0.00	0.00	0.00	0.00	47.62
Winterton Dunes	84.4	78.34	0.00	6.08	0.00	0.00	0.00	84.42
Wistman's Wood	169.7	169.35	0.00	0.00	0.00	0.00	0.00	169.35
Woodwalton Fen	209.0	111.47	93.20	4.38	0.00	0.00	0.00	209.05
Wren's Nest	34.1	34.03	0.00	0.00	0.00	0.00	0.00	34.03
Wybunbury Moss	15.8	1.37	14.45	0.00	0.00	0.00	0.00	15.81
Wychwood	263.4	0.00	250.80	0.00	0.00	0.00	0.00	250.80
Wye	140.1	132.86	7.26	0.00	0.00	0.00	0.00	140.12
Wylye Down	33.9	33.85	0.00	0.00	0.00	0.00	0.00	33.85
Wyre Forest	420.7	102.97	292.93	0.00	22.31	0.00	0.00	418.21
Totals/Mean:	**66839.68**	**33492.34**	**27112.41**	**3139.22**	**1095.69**	**3.52**	**489.09**	**65332.28**

6.4.7 Cultural assets

Table 26 Cultural natural capital assets disaggregated by NNR

141 NNRs Extent (ha)		Scheduled Monuments at Risk (ha) (SMaR)					Tranquillity (TRQ)
NNR	**Total Area**	**At risk**	**Low/Not at risk**	**Vulnerable**	**Unclassified**	**Total SMaR Area**	**Mean Scores (-69.35 to 107.59)**
Ainsdale Sand Dunes	492.0	0.00	0.00	0.00	0.00	0.00	14.07
Aqualate Mere	214.4	0.00	0.00	0.00	0.00	0.00	3.28
Ashford Hill	23.4	0.00	0.00	0.00	0.00	0.00	5.71
Aston Rowant	159.1	0.00	0.00	0.00	0.00	0.00	-10.26
Axmouth to Lyme Regis Undercliffs	305.6	0.00	0.00	0.00	0.00	0.00	9.59
Barnack Hills and Holes	23.3	0.00	0.00	0.00	0.00	0.00	12.37
Barrington Hill	17.7	0.00	0.00	0.00	0.00	0.00	-0.27
Barton Hills	44.2	0.00	0.00	0.00	0.00	0.00	-4.06
Beacon Hill	40.1	0.00	5.39	0.00	0.00	5.39	13.01
Benacre	372.2	0.00	0.00	0.00	0.00	0.00	15.81
Black-a-Tor Copse	29.9	0.00	0.00	0.00	0.00	0.00	48.51
Blackwater Estuary	1099.0	0.00	5.94	0.00	0.00	5.94	36.55
Blelham Bog	2.2	0.00	0.00	0.00	0.00	0.00	9.15
Bredon Hill	48.6	0.00	0.00	0.00	0.00	0.00	23.57
Brettenham Heath	232.1	0.00	0.00	0.00	0.00	0.00	17.99
Bridgwater Bay	2639.1	0.00	0.00	0.00	0.00	0.00	31.58
Buckingham Thick Copse	45.1	0.00	0.00	0.00	0.00	0.00	8.27
Bure Marshes	450.1	0.00	0.00	0.00	0.00	0.00	15.89
Cabin Hill	28.3	0.00	0.00	0.00	0.00	0.00	19.23
Calthorpe Broad	43.5	0.00	0.00	0.00	0.00	0.00	27.26
Cassop Vale	24.7	0.00	0.00	0.00	0.00	0.00	-1.92
Castle Eden Dene	225.5	0.00	0.00	0.00	0.00	0.00	-7.88
Castle Hill	46.7	0.00	0.32	0.00	0.00	0.32	11.09
Castor Hanglands	89.8	0.00	0.00	0.00	0.00	0.00	9.63
Cavenham Heath	203.1	0.00	0.00	0.00	0.00	0.00	8.34
Chartley Moss	44.5	0.00	0.00	0.00	0.00	0.00	4.98
Chippenham Fen	113.0	0.00	0.00	0.00	0.00	0.00	11.14
Clawthorpe Fell	11.5	0.00	0.00	0.00	0.00	0.00	-10.93
Cliburn Moss	26.5	0.00	0.00	0.00	0.00	0.00	11.67
Collyweston Great Wood & Easton Hornstocks	149.4	0.00	0.00	0.00	0.00	0.00	2.37
Colne Estuary	703.6	0.00	0.00	0.32	0.00	0.32	33.95
Cothill	1.5	0.00	0.00	0.00	0.00	0.00	-10.16

Cotswold Commons and Beechwoods	413.2	0.00	8.35	0.00	0.00	8.35	-0.88
Dendles Wood	29.3	0.00	0.00	0.00	0.00	0.00	39.72
Dengie	2547.3	0.00	0.01	3.64	0.00	3.64	50.33
Derbyshire Dales	386.3	0.00	9.93	0.00	21.41	31.34	8.03
Dersingham Bog	159.1	0.00	0.00	0.00	0.00	0.00	0.23
Derwent Gorge and Muggleswick Woods	69.4	0.00	0.00	0.00	0.00	0.00	8.08
Downton Gorge	48.7	0.00	0.13	0.00	0.00	0.13	15.84
Duddon Mosses	117.7	0.00	0.00	0.00	0.00	0.00	6.07
Duncombe Park	103.5	0.00	0.00	0.00	0.00	0.00	11.16
Dungeness	1030.9	0.00	0.00	0.00	0.00	0.00	34.68
East Dartmoor Woods & Heaths	414.6	0.00	0.20	0.00	0.00	0.20	20.90
Ebbor Gorge	45.9	0.00	0.06	0.00	0.00	0.06	3.24
Fenn's, Whixall & Bettisfield Mosses	654.9	0.00	0.00	0.00	0.00	0.00	22.26
Finglandrigg Woods	79.4	0.00	0.00	0.00	0.00	0.00	22.77
Forge Valley Woods	67.1	0.13	0.00	0.26	0.00	0.39	4.58
Fyfield Down	228.6	0.00	0.00	198.57	0.00	198.57	17.31
Gait Barrows	121.6	0.00	0.00	0.00	0.00	0.00	12.74
Golitha Falls	17.2	0.00	0.00	0.00	0.00	0.00	16.74
Gordano Valley	126.1	0.00	0.00	0.00	0.00	0.00	-21.42
Goss Moor	489.9	0.00	0.00	0.05	0.00	0.05	2.36
Gowk Bank	15.0	0.00	0.00	0.00	0.00	0.00	27.59
Great Asby Scar	312.3	0.00	0.67	0.00	0.00	0.67	27.81
Hales Wood	8.2	0.00	0.00	0.00	0.00	0.00	-1.85
Hallsenna Moor	21.5	0.00	0.00	0.00	0.00	0.00	10.36
Ham Street Woods	97.1	0.00	0.00	0.00	0.00	0.00	3.69
Hambledon Hill	73.5	4.22	0.00	25.60	0.00	29.82	12.79
Hamford Water	1427.2	0.00	0.54	0.00	0.00	0.54	42.61
Hardington Moor	8.7	0.00	0.00	0.00	0.00	0.00	0.69
Hartland Moor	245.0	0.00	0.00	0.00	0.00	0.00	5.10
High Leys	9.5	0.00	0.00	0.00	0.00	0.00	-10.31
Highbury Wood	46.4	0.00	3.80	0.00	0.00	3.80	-0.71
Hog Cliff	89.4	0.00	0.00	0.00	0.00	0.00	5.67
Holkham	3531.0	0.00	4.19	0.00	0.00	4.19	25.04
Holme Fen	269.4	0.00	0.00	0.00	0.00	0.00	24.81
Holt Heath	492.7	0.00	0.00	0.12	0.00	0.12	9.54
Holton Heath	162.0	49.42	0.00	0.00	0.00	49.42	-4.53
Horn Park Quarry	0.3	0.00	0.00	0.00	0.00	0.00	4.07
Humberhead Peatlands	2892.9	0.00	0.00	0.00	0.00	0.00	30.10
Ingleborough	1024.0	0.00	1.24	0.00	0.00	1.24	32.60
Kingley Vale	147.9	0.00	3.78	3.27	0.00	7.05	24.53
Kingston Great Common	56.9	0.00	0.00	0.00	0.00	0.00	26.30
Knocking Hoe	8.1	0.00	0.00	0.00	0.00	0.00	18.20
Lady Park Wood	45.3	0.00	0.00	0.00	0.00	0.00	26.75
Langley Wood	217.8	0.00	0.00	0.00	0.00	0.00	13.42

Lewes Downs (Mount Caburn)	48.8	0.00	0.00	3.12	0.00	3.12	-0.10
Lindisfarne	3408.3	0.07	1.41	0.00	0.00	1.47	22.30
Ling Gill	5.0	0.00	0.00	0.00	0.00	0.00	39.21
Lower Derwent Valley	467.3	0.00	0.00	0.00	0.00	0.00	29.71
Ludham & Potter Heigham Marshes	84.4	0.00	0.00	0.00	0.00	0.00	15.06
Lullington Heath	62.7	0.00	0.00	0.00	0.00	0.00	16.33
Martin Down	341.0	0.08	7.30	11.76	0.00	19.14	8.33
Moccas Park	138.6	0.00	0.00	0.00	0.00	0.00	25.30
Monks Wood	156.3	0.00	0.00	0.00	0.00	0.00	-0.14
Moor House-Upper Teesdale	8669.7	2.32	120.48	39.67	0.00	162.47	107.59
Morden Bog	146.9	0.00	0.03	0.01	0.00	0.04	9.02
Mottey Meadows	43.4	0.00	0.00	0.00	0.00	0.00	6.50
Muckle Moss	169.4	0.00	0.00	0.00	0.00	0.00	8.77
Muston Meadows	8.8	0.00	0.00	0.00	0.00	0.00	-1.33
Newham Bog	13.6	0.00	0.00	0.00	0.00	0.00	19.72
North Fen	2.3	0.00	0.00	0.00	0.00	0.00	-3.12
North Meadow, Cricklade	39.7	0.00	0.00	0.00	0.00	0.00	6.36
North Solent	925.0	0.00	0.00	0.00	0.00	0.00	24.99
North Walney	646.5	0.00	0.00	0.00	0.00	0.00	7.36
Old Winchester Hill	62.8	0.00	12.18	0.00	0.00	12.18	13.44
Parsonage Down	275.7	0.00	0.08	47.37	0.00	47.45	14.58
Paston Great Barn	1.0	0.00	0.05	0.00	0.05	0.09	9.49
Pevensey Levels	183.5	0.00	0.00	0.00	0.00	0.00	7.52
Pewsey Downs	167.1	0.80	2.82	2.04	0.00	5.67	24.82
Prescombe Down	47.7	0.00	0.00	0.00	0.00	0.00	16.19
Ribble Estuary	4623.4	0.00	0.00	0.00	0.00	0.00	12.05
Rodney Stoke	51.5	0.00	0.00	0.00	0.00	0.00	5.34
Rostherne Mere	152.5	0.00	0.00	0.00	0.00	0.00	-45.20
Roudsea Wood and Mosses	397.6	0.00	0.00	0.00	0.00	0.00	20.61
Saltfleetby - Theddlethorpe Dunes	618.9	0.00	0.00	0.00	0.00	0.00	17.61
Sandybeck Meadow	0.4	0.00	0.00	0.00	0.00	0.00	10.70
Scolt Head Island	737.6	0.00	0.00	0.00	0.00	0.00	30.03
Scoska Wood	11.1	0.00	0.00	0.00	0.00	0.00	42.53
Shapwick Heath	508.8	11.87	0.00	5.01	0.00	16.88	29.18
Skipwith Common	273.4	5.72	0.00	0.08	0.00	5.81	9.37
Slapton Ley	191.3	0.00	0.00	0.00	0.00	0.00	10.11
Somerset Levels	462.9	0.00	0.00	0.01	0.00	0.01	18.58
South Solway Mosses	971.0	0.00	0.00	0.00	0.00	0.00	36.21
Stiperstones	448.0	0.04	5.68	10.08	7.77	23.57	24.13
Stoborough Heath	177.0	0.00	0.00	0.00	0.00	0.00	-1.93
Stodmarsh	250.1	0.00	0.00	0.00	0.00	0.00	5.11
Suffolk Coast	971.9	0.00	0.05	0.24	0.00	0.29	16.98

Swanscombe Skull Site	2.1	0.00	0.00	0.00	0.00	0.00	-53.66
Swanton Novers	59.6	0.00	0.00	0.00	0.00	0.00	24.67
Tarn Moss	15.9	0.00	0.00	0.00	0.00	0.00	1.34
Teesmouth	362.5	0.00	0.00	0.00	0.00	0.00	-6.20
The Flits	27.0	0.00	0.00	0.00	0.00	0.00	14.83
The Hudnalls	30.0	0.00	0.00	0.00	0.00	0.00	21.65
The Lizard	2403.2	0.01	0.14	17.25	0.00	17.40	19.18
The Wash	8777.5	0.00	0.00	0.00	0.00	0.00	93.84
Thornhill Moss & Meadows	11.9	0.00	0.00	0.00	0.00	0.00	31.82
Thrislington	23.3	0.00	0.00	0.00	0.00	0.00	-14.92
Thursley	322.6	0.00	0.12	0.00	0.00	0.12	8.49
Valley of Stones	99.1	0.00	0.00	74.75	0.00	74.75	10.65
Walton Moss	20.8	0.00	0.00	0.00	0.00	0.00	34.02
Westleton Heath	47.6	0.00	0.00	0.00	0.00	0.00	23.33
Winterton Dunes	84.4	0.00	0.00	0.00	0.00	0.00	34.35
Wistman's Wood	169.7	0.00	0.54	16.44	0.00	16.98	47.81
Woodwalton Fen	209.0	0.00	0.00	0.00	0.00	0.00	31.25
Wren's Nest	34.1	0.00	0.00	33.82	0.00	33.82	-69.35
Wybunbury Moss	15.8	0.00	0.00	0.00	0.00	0.00	-20.18
Wychwood	263.4	0.00	0.00	0.55	0.00	0.55	27.81
Wye	140.1	0.00	0.07	0.00	0.00	0.07	13.81
Wylye Down	33.9	0.00	31.11	0.00	0.00	31.11	7.93
Wyre Forest	420.7	0.00	0.00	0.00	0.00	0.00	17.39
Totals/Mean:	**66839.68**	**74.66**	**226.61**	**494.05**	**29.23**	**824.54**	**13.88**

6.5 Dataset attribution/copyright statements

6.5.1 Data cited in the Executive Summary

Table 27 Comprehensive attribution statements are offered for all datasets used in the Executive Summary of the accounts

Dataset	Full Attribution Statement	Map(s)	Aggregated Table
Ordnance Survey *2018*	© Crown Copyright and database rights 2018. Ordnance Survey 100022021.	Figure 4 Figure 5 Figure 6 Figure 7	
National Nature Reserves (England) *2018*	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2018	Figure 4 Figure 5 Figure 6 Figure 7	Table 3
LCM2007 *2011*	LCM2007 © NERC (CEH) (2011). © Crown Copyright 2007, Licence number 100017572. © third party licensors.	Figure 5	Table 3
WFD Classification Status Cycle 2 *2016*	© Environment Agency copyright and/or database right 2016. All rights reserved.	Figure 7	
Water Framework Directive (WFD) River, Canal and Surface Water Transfer Waterbodies Cycle 2 *2016*	© Environment Agency copyright and/or database right 2016. All rights reserved. Contains Ordnance Survey data © Crown copyright and database right 2013.	Figure 7	
Deposition and Concentration Values for Protected Sites in the UK (2013-2015) *2017*	© NERC (Centre for Ecology & Hydrology), Natural Resources Wales, Environment Agency, the Northern Ireland Environment Agency, Natural England, the Joint Nature Conservation Committee (JNCC), Scotland and Northern Ireland Forum for Environmental Research (SNIFFER), the Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH)	Figure 7	

NATMAP Carbon *2005*	Soils Data © Cranfield University (NSRI) and for the Controller of HMSO (2005)	Figure 8	
Nectar Plant Diversity for Bees *2016*	© NERC (Centre for Ecology & Hydrology) Maskell, L.; Henrys, P.; Norton, L.; Smart, S. (2016). Bee nectar plant diversity of Great Britain. NERC Environmental Information Data Centre. https://doi.org/10.5285/623a38dd-66e8-42e2-b49f-65a15d63beb5	Figure 8	
Sites of Special Scientific Interest (England) *2018*	© Natural England (2018), reproduced with the permission of Natural England, http://www.naturalengland.org.uk/copyright/. © Crown Copyright and database right 2018. Ordnance Survey licence number 100022021.	Figure 8	
Tranquillity *2007*	National Tranquillity Mapping Data 2007 developed for the Campaign to Protect Rural England and Natural England by Northumbria University. © Crown Copyright and database rights (2007). Ordnance Survey licence number 100022021. © CEH 2002 © Office for National Statistics © Ministry of Defence © Department for Transport © National Grid © renewableUK	Figure 7	

6.5.2 Data cited in the Full Report

Table 28 Comprehensive attribution statements are offered for all datasets used in the full report of the accounts, with relevant section numbers provided in brackets

Dataset	Full Attribution Statement	Map(s)	Aggregated Table	Disaggregated Table(s)
Ordnance Survey *2018*	© Crown Copyright and database rights 2018. Ordnance Survey 100022021.	Figure 3 (2.4) Figure 4 (3.2) Figure 5 (3.2) Figure 6 (3.2) Figure 7 (3.2) Figure 8 (3.2) Figure 9 (3.2)		
National Nature Reserves (England) *2018*	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2018	Figure 3 (2.4) Figure 4 (3.2) Figure 5 (3.2) Figure 6 (3.2) Figure 7 (3.2) Figure 8 (3.2) Figure 9 (3.2)	Table 10 (3.2)	Table 20 (6.4) Table 21 (6.4) Table 22 (6.4) Table 23 (6.4) Table 24 (6.4) Table 25 (6.4) Table 26 (6.4)
LCM2007 *2011*	LCM2007 © NERC (CEH) (2011). © Crown Copyright 2007, Licence number 100017572. © third party licensors.	Figure 3 (2.4)	Table 6 (2.3) Table 10 (3.2)	Table 20 (6.4)

Headwater Stream Quality 2016	© NERC (Centre for Ecology & Hydrology) Norton, L.; Dunbar, M.; Greene, S.; Scholefield, P.A. (2016). Headwater stream quality for Britain. NERC Environmental Information Data Centre. https://doi.org/10.5285/85e7beb6-e031-4397-a090-841b8c907d1b		Table 11 (3.2)	Table 21 (6.4)
WFD Classification Status Cycle 2 *2016*	© Environment Agency copyright and/or database right 2016. All rights reserved.	Figure 4 (3.2)	Table 11 (3.2) Table 12 (3.2)	Table 21 (6.4) Table 22 (6.4)
Water Framework Directive (WFD) River, Canal and Surface Water Transfer Waterbodies Cycle 2 *2016*	© Environment Agency copyright and/or database right 2016. All rights reserved. Contains Ordnance Survey data © Crown copyright and database right 2013.	Figure 4 (3.2)	Table 11 (3.2) Table 12 (3.2)	Table 21 (6.4) Table 22 (6.4)
WFD Groundwater Bodies Cycle 2 *2016*	© Environment Agency copyright and/or database right 2016. All rights reserved. Derived in part from 1:50,000 and 1:250,000 scale digital data under permission from British Geological Survey. ©NERC. © Crown copyright and database rights 2013 Ordnance Survey 100024198.	Figure 4 (3.2)	Table 11 (3.2) Table 12 (3.2)	Table 21 (6.4) Table 22 (6.4)
AMEC Spatial Prioritisation of Land Management for Carbon *Unpublished*	Citation used for emissions factors: AMEC (unpublished) Spatial Prioritisation of Land Management for Carbon: Project Report (Final)		Table 6 (3.2)	
NATMAP Carbon *2005*	Soils Data © Cranfield University (NSRI) and for the Controller of HMSO (2005)	Figure 6 (3.2)	Table 13 (3.2)	Table 23 (6.4)
Deposition and Concentration Values for Protected Sites in the UK (2013-2015) *2017*	© NERC (Centre for Ecology & Hydrology), Natural Resources Wales, Environment Agency, the Northern Ireland Environment Agency, Natural England, the Joint Nature Conservation Committee (JNCC), Scotland and Northern Ireland Forum for Environmental Research (SNIFFER), the Scottish Environment	Figure 5 (3.2)	Table 12 (3.2)	Table 22 (6.4)

	Protection Agency (SEPA), Scottish Natural Heritage (SNH)			
Nitrate Vulnerable Zones *2016*	© Environment Agency copyright and/or database right (2016). All rights reserved. Derived in part from geological mapping data provided by the British Geological Survey © NERC. Derived in part from data provided by the National Soils Research Institute © Cranfield University. Contains Ordnance Survey data © Crown copyright and database rights 2016. Derived in part from data provided by the Department for the Environment, Farming and Rural Affairs © Crown (2016) copyright Defra. Derived in part from data provided by the Centre for Ecology and Hydrology © NERC. Derived in part from data provided by UK Water Companies.	Figure 5 (3.2)	Table 12 (3.2)	Table 22 (6.4)
Expected Plant Habitat Indicators *2016*	© NERC (Centre for Ecology & Hydrology) Maskell, L.; Henrys, P.A.; Norton, L.; Smart, S. (2016). Model estimates of expected diversity of positive plant habitat condition indicators. NERC Environmental Information Data Centre. https://doi.org/10.5285/cc5ae9b1-43a0-475e-9157-a9b7fccb24e7	Figure 7 (3.2)	Table 14 (3.2)	Table 24 (6.4)
Nectar Plant Diversity for Bees *2016*	© NERC (Centre for Ecology & Hydrology) Maskell, L.; Henrys, P.; Norton, L.; Smart, S. (2016). Bee nectar plant diversity of Great Britain. NERC Environmental Information Data Centre. https://doi.org/10.5285/623a38dd-66e8-42e2-b49f-65a15d63beb5	Figure 7 (3.2)	Table 14 (3.2)	Table 24 (6.4)
Soil Invertebrates Abundance *2016*	© NERC (Centre for Ecology & Hydrology) Henrys, P.A.; Keith, A.M.; Robinson, D.A.; Emmett, B.A. (2012). Model estimates of topsoil invertebrates [Countryside Survey]. NERC Environmental Information Data Centre.		Table 14 (3.2)	Table 24 (6.4)

	https://doi.org/10.5285/f19de821-a436-4b28-95f6-b7287ef0bf15			
Sites of Special Scientific Interest (England) *2018*	© Natural England (2018), reproduced with the permission of Natural England, http://www.naturalengland.org.uk/copyright/. © Crown Copyright and database right 2018. Ordnance Survey licence number 100022021.	Figure 8 (3.2)	Table 15 (3.2)	Table 25 (6.4)
Scheduled Monuments at Risk *2016*	© Historic England (2016). Contains Ordnance Survey data © Crown copyright and database right 2016 The Historic England GIS Data contained in this material was obtained in 2016. The most publicly available up to date Historic England GIS Data can be obtained from HistoricEngland.org.uk.	Figure 9 (3.2)	Table 16 (3.2)	Table 26 (6.4)
Tranquillity *2007*	National Tranquillity Mapping Data 2007 developed for the Campaign to Protect Rural England and Natural England by Northumbria University. © Crown Copyright and database rights (2007). Ordnance Survey licence number 100022021. © CEH 2002 © Office for National Statistics © Ministry of Defence © Department for Transport © National Grid © renewableUK	Figure 9 (3.2)	Table 16 (3.2)	Table 26 (6.4)

6.6 Recommendations for improvements in data collection

a) Establish system to collect and record data on quantity and type of timber sold as well as the quantity of other timber and forest materials removed from NNRs (see section 2.4.1).
b) Use rolling average based on past three years from 2018/19 onwards (see section 2.4.1).
c) Review accounting practice to ensure clear coding of income to defined distinct categories as required for the natural capital accounts. These may include sale of sporting rights from shooting, fishing and wild fowling (see section 2.4.1)
d) It is recommended that NE consider commissioning the design and implementation of a periodic survey to provide a more accurate estimate of visitor numbers, visit types and visitor characteristics (see section 2.4.3)
e) Collect additional information on NE volunteers. This should include:- broad task categories e.g. NNR or non NNR work, the number of days worked as well as total hours. Volunteer

work should be categorised as either unskilled, skilled (e.g. fence construction) or professional e.g. an ecological survey by an expert (see 2.4.4)

f) Collect and collate systematic information on educational visits to NNRs. This should detail whether educational input was provided by NE staff or whether visitors provided their own tuition. (see 2.4.5)
g) NE should consider developing the NE accounting system to include systematic information on expenditure related to NNRs. (2.5)
h) NE should consider how we can bring further indicators of quality into assessment of the assets. This is required across all the attributes. Concerns have been expressed about the invisibility of geodiversity and landscapes in the accounts which are absent due to lack of data.

6.7 Asset data and methods used in the accounts (Technical Detail)

Further technical detail on the datasets used and the methodological approaches taken to assessing asset stock is provided here. GI analyses were undertaken to ascertain the extent and quality of a range of ecosystem assets and quantify natural capital within the NNRs. Environmental datasets were identified across the 7 asset themes (extent, hydrology, species composition, soil/sediment process, vegetation structure, cultural and nutrient/chemical status) that could suitably be used as proxies for the indicators, and were each clipped to NE-managed reserves to output disaggregated area values. These were later aggregated, providing total areas with which an economic figure could be calculated, based on the value and extent of the asset within NNRs. Tabulated outputs are provided for all asset data in section 3. These have been calculated on a disaggregated basis by NNR, then later aggregated to account for the entire NNR estate managed by NE.

Input datasets in both vector and raster-based formats were applied to the analyses, therefore some variation in data accuracy, quality and consistency was anticipated. Where possible, inconsistences in output format have been highlighted (in Table 29) or mitigated through standardised processing methods for vector and raster-based data. The two standard approaches are outlined in section 6.7.2 (Broad methodological approaches) and detailed further within individual layer descriptions. The full range of input datasets, with information on their format, resolution and analytical treatment method can be viewed in Table 29.

6.7.1 Data quality and suitability

Assessment of these data for both their quality and their suitability for representing the range of natural capital indicators reported on was undertaken through the implementation of a coloured scoring system for each dataset. Table 29 summarises all datasets and attributes exploited for delineating the area for assessment and quantifying asset extent and quality. Table 30 provides a breakdown of the scoring system applied to each dataset in order to ascertain its quality and suitability for use in these accounts. An overall score has been calculated for each dataset which considers spatial in addition to temporal resolution, indicating data release and update frequency, and expert judgement of the extent to which each dataset can be acceptably defined as a proxy for a particular indicator. Of note are (i) the broad variation in spatial resolution of the input datasets used for the accounts, and (ii) a significant proportion of datasets were released >2 years ago, resulting in a limited number receiving a score of 3 (‘good’) for this attribute. In reality, data older than 2 years are likely representing a previous chronological period. Inconsistencies in the collection and release of the majority of the datasets that are utilised for this report highlight evidence gaps and possible issues when attempting to derive change between years for future accounting. This may be further exacerbated by UK withdrawal from the EU, with possible implications for our statutory responsibilities and thus future participation in data collection required at present under EU legislation (e.g. Water Framework Directive, Nitrate Vulnerable Zones).

Table 29 All datasets used for natural capital asset quantification and their resolution and suitability scores (see table 30 for key to colours)

Dataset/Attribute	Short Code	Indicator Theme	Data Source	Format	Analysis Method	Spatial Resolution	Release Date	Update Frequency	Indicator Proxy Score	Total Score
(i) NNR Extents	NNR	Habitat extent	https://naturalengland-defra.opendata.arcgis.com/datasets/national-nature-reserves-england	Vector	Intersection	Vector (<25 m)	07/18	Annual	3	9
(ii) LCM/NEA Broad Habitat	NEA-BH	Habitat extent	https://catalogue.ceh.ac.uk/documents/2ab0b6d8-6558-46cf-9cf0-1e46b3587f13	Vector	Intersection	~70m (MMU 0.5 ha)	07/11	6-10 years	3	6
AMEC Carbon flux	AMEC	Soil/Sediment Process	Internal – no metadata online	Tabular	Math. calc.	Based on LCM2007; ~ 70 m	03/14*	Unknown	1	5
Deposition and Concentration Values for Protected Sites in the UK (2013-2015) – Ammonia, Nitrogen Oxide and Sulphur Dioxide Concentration and Nitrogen and Sulphur Deposition	DC-AC	Nutrient/Chemical	https://data.gov.uk/dataset/3d2830c3-cd10-4465-b5af-3e820b417315/deposition-and-concentration-values-for-protected-sites-in-the-uk-2013-2015	Vector	Intersection	Vector (<25 m)	06/17	Annual	3	9
	DC-NC									
	DC-SC									
	DC-ND									
	DC-SD									

Expected Plant Habitat Indicators	EPHI	Species Composition	NE/CEH Natural Capital Maps https://eip.ceh.ac.uk/naturalengland-ncmaps	Raster	Zonal Statistics	1km	02/16 (07 data)	10+ years (Countryside Survey sample data)	2	4
Headwater Stream Quality	HSQ	Hydrology	NE/CEH Natural Capital Maps https://eip.ceh.ac.uk/naturalengland-ncmaps	Raster	Zonal Statistics	1km	02/16 (07 data)	10+ years (Countryside Survey sample data)	2	4
NATMAP Carbon (Soil Carbon)	SC	Soil/Sediment Process	Internal – metadata online: http://www.landis.org.uk/data/nmcarbon.cfm	Vector	Intersection	1:250k scale	09/05	15+ years, based on current version date	3	6
Nectar Plant Diversity	NPD	Species Composition	NE/CEH Natural Capital Maps https://eip.ceh.ac.uk/naturalengland-ncmaps	Raster	Zonal Statistics	1km	03/16 (07 data)	10+ years (Countryside Survey sample data)	2	4
Nitrate Vulnerable Zones	NVZ	Nutrient/Chemical	https://data.gov.uk/dataset/94708b1c-3b1c-4370-b509-7637431d0936/nitrate-vulnerable-zones-nvz-2017-groundwaters	Vector	Intersection	Vector (<25 m)	12/16	Within 5 years	2	8
Scheduled Monuments at Risk	SMaR	Cultural	Historic Environment Record	Vector	Intersection	Vector (<25 m)	02/16	Unknown	3	7

			http://www.heritagegateway.org.uk/gateway/chr/default.aspx							
Soil Invertebrates Abundance	SIA	Species Composition	NE/CEH Natural Capital Maps https://eip.ceh.ac.uk/naturalengland-ncmaps	Raster	Zonal Statistics	1km	03/16 (07 data)	10+ years (Countryside Survey sample data)	2	4
Sites of Special Scientific Interest	SSSI	Vegetation	https://naturalengland-defra.opendata.arcgis.com/datasets/sites-of-special-scientific-interest-england	Vector	Intersection	Polygon	07/18	Annual	3	9
Tranquillity	TRQ	Cultural	Data internal – maps and metadata online: Campaign to Protect Rural England Tranquillity Maps http://www.cpre.org.uk/resources	Raster	Zonal Statistics	500m	02/07	Unknown	2	5
WFD Groundwater Status – Overall, Chemical and Quantitative status attributes	WFD-GW-O	Hydrology	https://data.gov.uk/dataset/wfd-classification-status-cycle-2 http://environment.data.gov.uk/catchment-planning/	Vector	Intersection	Vector (<25 m)	08/16	1-5 years	3	8
	WFD-GW-Q									
	WFD-GW-C	Nutrient/Chemical								

WFD Surface Water Status – Overall, Chemical, Ecological, Hydrological and Morphological status attributes	WFD-SW-O	Hydrology		Vector	Intersection	Vector (<25 m)	04/16		3	8
	WFD-SW-E									
	WFD-SW-H									
	WFD-SW-M									
	WFD-SW-C	Nutrient/Chemical								

These have been alphabetised, with (i) and (ii) at the top of the table denoting the NNR and habitat extents data respectively. For detailed descriptions of how these and the overall quality scores were derived, see the individual layer summaries below in section 7.5.3. *The temporal quality of the AMEC emissions factors has been assessed considering the year the report was produced, although the project report remains unpublished.

Table 30 Criteria and thresholds for data quality and suitability assessment are summarised

	Criteria for Data Quality/Proxy Level Assessment			
Data Quality Score	**Spatial Resolution**	**Dataset Age**	**Proxy Level**	**Total Score**
3	<25m (vector)	<2 years	Good proxy	9 (good)
2	25-999.9m	2-5 years	Moderate proxy	6-8 (moderate)
1	≥1km	>5 years	Possible proxy	3-5 (poor)

6.7.2 Broad methodological approaches

Vector intersections

Typically digitised at a greater resolution than raster products are generated, vector data commonly exhibit greater accuracy and precision of recorded features than their grid-based counterparts, particularly if large-scale maps (i.e. Ordnance Survey) with greater detail are utilised in digitisation. The products used in these accounts are derived from a variety of sources, including satellite and aerial and traditional mapping data, and represent a range of input spatial resolutions. Map scale or the minimum mappable unit (MMU) are more commonly-used methods for ascertaining spatial resolution of vector-based products, providing a measure of accuracy in relation to where features are actually configured on the ground, but in some instances this metadata is unavailable. Vector-based features are 'smoothed' during processing, promoting greater accuracy and precision than coarser raster generalisations. Considering this in addition to the variability of input datasets utilised, spatial resolution has been given as <25m (termed 'vector') where metadata on scale or the MMU is not provided. Limitations to this approach are acknowledged, however a consistent framework for assessing the quality of all input data was desired for these accounts, and all available metadata is provided throughout the layer summaries in this appendix to support this assertion. Interrogation of the vector products (identified in Table 29) involved calculating a geometric intersection of the NNR boundary layer with the natural capital indicator input layer to derive area (recorded in ha). Intersections were undertaken based on the NNR name to derive initially disaggregated asset values, which were then later aggregated for all NE-managed NNR estate. When dealing with linear features (i.e. Water Framework Directive surface waters and Public Rights of Way data), density was also calculated on an individual NNR basis by dividing total length of intersected features by total NNR area. The tabular outputs were exported and added to the accounts for economic valuation.

Raster-based zonal statistics

The raster input datasets used for the accounts represent spatial products output from a range of projects, managed both internally and externally to Natural England. Varying sources and types of raster data have resulted in the input and subsequent output of some asset layers with differing resolutions; this range has been highlighted in Table 29, with the quality scores of low-resolution raster products reduced accordingly. For all raster products, zonal statistics were calculated on a disaggregated basis, outputting mean scores of habitat quality for each natural capital asset at a fixed resolution of 5m. As with the vector-based layers, tabular data were output and assigned an economic value across NE-managed NNR estate.

6.7.3 Technical detail on data and methods

AMEC Spatial Prioritisation of Land Management for Carbon (AMEC)

The terms and the data that underpins NE Carbon reporting on an aggregated basis are defined below:

Carbon stock: the total amount of carbon stored in a given area, within a habitats soils and vegetation. This value does not assess the direction of change (e.g. if the habitat continues to sequester carbon, or is acting as a source). The figures used to inform calculations are taken from the NE commissioned report 'Spatial Prioritisation of Land Management for Carbon' (AMEC, unpublished) that defined carbon storage relative to habitat and / or land use based on information presented in scientific and practitioner literature.

Greenhouse gas flux: the overall cooling or warming effect caused by the uptake or release respectively of the main greenhouse gases (GHGs) – carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Habitats, depending on their management and composition can either be a sink or source of GHGs. The overall effect is conveyed by reporting the equivalent amount of CO2 (tonnes of CO2 eq) with a positive value indicating a warming effect, and a negative value a cooling effect. The figures reported represent the gross sink or source, rather than the net change from a baseline. The emission factors used do not capture the dynamic nature of semi-natural habitats and that these may increase or decrease within a given year depending on many climatic, management and environmental variables. The emission factors used to inform GHG flux calculations are taken from 'Accounting for Nature' (RSPB, 2017), the RSPBs natural capital account of their estate in England, which used factors derived from a review of scientific literature. The decision to use figures from the RSPB report was taken due to the recentness of the report and the comparable habitats of the RSPB estate to NE NNRs.

RAG Rating of reported results – RED ('low' score).

There is low confidence in the results reported. This is due to the reasons summarised below:

- Factors used are based on existing literature, and are not from sites studied on the NNR estate. Factors used are taken from reports that were not designed to be used in the context of the NE NNR estate.

- Data available in the literature is often reported across broad categories and is not down to the resolution required across habitats within the NNR estate or diversity within each LCM habitat class. Often habitat categories are grouped together (e.g several of the grasslands) where in reality you would expect to see definition between them.

- While the factors used give an indication of accuracy, it should be acknowledged that there is significant levels of uncertainty regarding how these translate to other sites in different locations from the original study.

- This report does not account for GHG emissions from land management approaches that underpin conservation of the NNRs.

- The reported factors used assume consistent conservation management across habitats and does not capture where changes to land use or management has occurred. For example, habitats reach an equilibrium in the rate of carbon sequestration they can achieve. Changes to land management or use may alter the equilibrium, causing a habitat to be an enhanced GHG sink (e.g. land use change from arable to grassland) or source (e.g. draining of a wetland).

As these results were calculated using habitat areas across NE-managed estate rather than spatial data sources, C storage and flux cannot be provided on a disaggregated basis and are therefore presented in a different section within the results.

Deposition and Concentration Values in Protected Sites (2013-2015) (DC-XX)

Deposition and concentration values (Bealey et al., 2017) are calculated using a combination of modelling techniques; Concentration Based Estimated Deposition (CBED) and Pollution Climate Mapping (PCM). The former model outputs 3-year means of ammonia concentration, area-weighted for each protected site. The CBED model also produces area-weighted deposition values for nitrogen and sulphur over the 2013-15 period, using a grid average measure of moorland and woodland land covers for each protected site.

The PCM framework contributes to fulfilling commitments set out in the EU Ambient Air Directive (2008/50/EC) (EC, 2008), and outputs concentration values for nitrogen oxide and sulphur dioxide. The PCM model provides values at 1km grid resolution, whereas CBED model outputs are supplied at 5km resolution. As all 141 NE-managed NNRs are geographically underpinned by at least one SSSI, the SAC and SPA records were filtered out from the input tables and the values specifically associated with each SSSI were joined to the NNR extent layer. Where an NNR is spatially underpinned by more than one SSSI (i.e. returning more than one value per NNR), mean scores have been calculated from all SSSI values (non-spatially weighted). Concentration values for ammonia (DC-AC), nitrogen oxide (DC-NC) and sulphur dioxide (DC-SC) are output in micro grammes per metre cubed (µ m-3). Deposition values for nitrogen (DC-ND) and sulphur (DC-SD) are attributed as kilo-equivalents per hectare per year (keq ha-1 year-1). As per the dataset documentation, total nitrogen deposition was calculated by summing the oxidised and reduced deposition attributes (relating to dry and wet deposition events respectively). The nitrogen and sulphur deposition values were converted from keq ha-1 year-1 to kg N ha-1 year-1 and kg S ha-1 year-1 using the respective multiplication factors of 14 and 16.

The values output from the models offer a direct measure of the concentration and deposition values of major pollutants and as such, a ‘good’ proxy score has been derived for these data. As the outputs are based upon SSSI data, the spatial resolution of these data are inferred from this (‘vector’ resolution, <25m) and a ‘good’ score is similarly assigned. Outputs from the CBED and PCM model are aggregated on a 3-yearly basis and published annually, promoting their application in future natural capital accounts. As the SSSI and NNR extent layers are updated annually, this also supports a “good” score for the deposition and concentration dataset, with respect to temporal resolution.

Expected Plant Habitat Indicators (EPHI)

These output data (CEH/NE, 2016) were also the product of combining monitored sample plot data from the Countryside Survey 2007, before interpolating these to 1km grid areas outside of the survey using a generalised additive mixed model. This has led to the provision of a near-comprehensive dataset depicting plant indicators for habitats in good condition, despite limitations to the broad-scale resolution framework omitting a suite of finer features (i.e. hedgerows, streamsides, roadsides) which often hold significant biological diversity. More information on the overall methodological approach for producing this layer is provided in the project report (CEH/NE, 2016). Zonal Statistics were applied to the EPHI and NNR boundary layer in order to generate disaggregated mean scores. Generation of mean scores aimed to mitigate implications of the coarse spatial resolution of the input data, and provide a comparative framework for ranking NNRs in tabular form.

The coarse resolution of the natural capital input layers (EPHI, HSQ, NPD and SIA) qualified their assignment of ‘poor’ scores in terms of spatial resolution. For temporal, a ‘poor’ score was also assigned; although the statistical analysis to derive the data was undertaken in 2016, it is largely based on Countryside Survey sample data from 2007.

Headwater Stream Quality (HSQ)

A boosted regression tree model was developed and trained with the HSQ change data to estimate headwater stream quality for Strahler order 1-3 headwater streams, which were then extrapolated out to 1km grid squares (indicating in coarse terms where a headwater is present). More information on the methodology can be found in the final project report, ‘Countryside Survey: Headwater Streams Report from 2007’ (CEH/NE, 2016). Zonal Statistics were applied to these data within the NNR boundaries, generating mean scores of headwater stream quality for each reserve. See the

description beneath ‘Expected Plant Habitat Indicators (EPHI)’ above for more detail on inference of data quality scoring.

NATMAP Carbon (Soil Carbon) (SC)

Mapping out of carbon across the National Soils Map provides estimates of organic C stock at the following depth levels: (i) 0-30cm, (ii) 30-100cm and (iii) 100-150cm (Cranfield University, 2005). Taking into consideration the effect of land use variability on soil organic carbon, stock data were averaged, weighted by extent of soil typology. These were then mapped out to CORINE land cover (CLC) 2000 data parcels to provide a spatial framework for recording carbon stock held within each soil depth range. A ‘moderate’ score in terms of spatial resolution was assigned to these data, owing to the original capture of the National Soils Map at 1:250,000 scale and use of comprehensive CLC 2000 data, upon which the organic carbon layer was based. Layer production was undertaken in 2005, with implications for the validity of the data in terms of temporal resolution and subsequent assigned of a ‘poor’ temporal quality score, however limited change may be anticipated for the phenomena represented, thus minimising update requirements. In relation to the assessment of soil and sediment process asset quality for these accounts, the SC data were categorised as a ‘good’ proxy.

Nectar Plant Diversity for Bees (NPD)

The dataset for Nectar Plant Diversity for Bees comes from the CEH/NE natural capital modelling and mapping (2016). This work estimates nectar plant species diversity for bees present in 2m2 plots, based on statistical extrapolation to a national level from Countryside Survey Data. Further detail on the dataset construction is provided in the dataset report ‘Nectar plant diversity for bees’ (CEH/NE, 2016), as with the EPHI, HSQ and SIA natural capital input layers. See the description beneath ‘Expected Plant Habitat Indicators (EPHI)’ above for more detail on inference of data quality scoring.

Nitrate Vulnerable Zones (NVZ)

Under the Directive (EEC, 1991), NVZs are designated in areas of land that drain into polluted watercourses, and have been classified into the following categories; (i) Eutrophic, (ii) Groundwater or (iii) Surface Water. Intersecting the NVZ layers (EA, 2016d; 2016e; 2016f) with the NNR boundary layer provided the area of zones that coincide with NE-managed NNRs, which could then be aggregated across the entire estate. Although no specific detail on spatial resolution can be inferred from the layer metadata from source, a ‘good’ score was assigned to this dataset on account of its basis on OS, BGS and NSRI data. The ‘good’ temporal quality score of this dataset is also supported by its more frequent update term, with revisions published for 2013, then 2017. Overall, the authors deemed the NVZ data as representing nutrient and chemical status natural capital assets as a ‘suitable’ proxy for assessing land sensitivity.

Scheduled Monuments at Risk (SMaR)

Within the SMaR data (HE, n.d.a), the following risk levels are attributed to each monument unit; (i) Low/not at risk, (ii) Vulnerable, or (iii) At risk. The layer collates Historic Environment Records (HERs) at national scale, with the intention of regular updates to the polygon extents of SMaR. Historic England state that they provide access to most HERs are available to access online, disaggregated on a regional basis. However, as Local Authorities also supply access to some HERs, the spatial quality of the recorded monument geometries may be inconsistent and/or unknown, and as such, the SMaR input data has been assigned a ‘moderate’ score in this respect, despite record of ‘vector’ (<25m) resolution within Table 29. The authors derived a ‘good’ proxy score for the SMaR data when identifying significant indicators of cultural natural capital.

Soil Invertebrate Abundance (SIA)

The data set for Soil Invertebrate Abundance comes from NE/CEH (2016) natural capital mapping. Based on Countryside Survey sample data. A generalised additive mixed model was used to extrapolate values out to areas where no field values had been recorded, providing a comprehensive grid of soil invertebrate estimates across England, at 1km spatial resolution. As with the EPHI, HSQ and NPD layers, more information on the methodological framework for producing these data can be found in the Soil Invertebrates Abundance full report (CEH/NE, 2016). Zonal Statistical techniques were applied to the SIA layer as with the other aforementioned natural capital layers. See the description beneath 'Expected Plant Habitat Indicators (EPHI)' above for more detail on inference of data quality scoring.

Sites of Special Scientific Interest

Condition assessment of SSSIs, undertaken under the Common Standards Monitoring (CSM) framework, include attribution of units with 'Favourable', 'Unfavourable recovering', 'Unfavourable no change', 'Unfavourable declining', 'Part destroyed' or 'Not assessed' classifications (NE, 2018b). Annex 2 of the report 'SSSI Monitoring and Reporting (NE, 2013) includes an extract of the attributes and targets used for defining favourable condition of lowland calcareous grassland habitat types (2013, p. 11). Use of the frequently updated CSM data within a regular habitat monitoring framework warranted assignment of a 'good' proxy score to these data. SSSI units are generally mapped against OS MasterMap boundaries and as thus have been assigned a 'good' quality score in relation to spatial resolution. More information on the methodological approach to SSSI monitoring and accounting can be found in NE's (2013) report. As SSSI monitoring constitutes a statutory requirement at present, future updates may be expected which will assist with change assessment in future accounts, qualifying the data for a 'good' temporal quality score.

Tranquillity

The CPRE Tranquillity project utilised a Participatory Appraisal (PA) framework to devise a list of positive and negative factors influencing perceptions of the local environment (CPRE 2007a; 2007b). Modelling techniques were then applied to combine and associate these with national-scale datasets, offering a comprehensive characterisation of overall tranquillity which qualified the layer as a 'suitable' proxy for representing cultural natural capital. A gridded dataset at 500m resolution was output from this project, and this was used to quantify degree of tranquillity within NE-managed reserves for the Natural Capital accounts (receiving a moderate quality score in terms of spatial resolution). Despite classification of these data as offering 'moderate' spatial accuracy, CPRE's modelling framework utilised a range of datasets (of varying spatial resolutions) for associating with the responses from PA assessment, therefore a high resolution output grid at national scale was likely not feasible. These data received a 'low' score for temporal resolution as this work has not been updated since 2007, suggesting unlikely repetition of the analyses in the future.

Water Framework Directive (WFD)

These data comprise WFD Classification Cycle 2 data which were combined for the NCA with WFD Groundwater bodies Cycle 2 (WFD-GW) and WFD River, Canal and Surface Transfer Waterbodies Cycle 2 (WFD-RW) geometry layers (EA, 2016a; 2016b; 2016c). The most recent iteration of WFD classification data was published in 2016. This study calculated values for all attributes from both RW and GW(used for the hydrological asset quality), but utilised the Chemical attribute of each for quantifying nutrient/chemical status natural capital assets.

(i) WFD-RW: An important element of EU WFD legislation is the requirement for monitoring of river and canal waterbodies across a range of criteria, more information for which is provided in Annex 5 of the Directive (EC, 2000). In England, condition of river, canal and surface transfer waterbodies was most recently published in 2016. Overall status of a surface waterbody is determined by the poorer of the waterbody's Ecological and Chemical statuses, (the latter of which is applied in the quantification of Nutrient/chemical status natural capital assets) so a correlation between these attributes should be expected. For river waterbodies under the WFD, quality (excluding Chemical status) is summarised by one of five indicators; 'Bad', 'Poor', 'Moderate', 'Good' or 'High' based on

criteria within the Directive (EC, 2000). A range of indicators are also used to assess chemical quality of all waterbody types monitored under the WFD, more detail on which is set out in the Directive (EC, 2000). Using these criteria, surface waterbodies are recorded as either 'Good' or 'Fail' for Chemical status attribution. Prior to analysis, a 100m buffer was applied to the NNR extent layer to facilitate analysis of cross-boundary waterbodies. The joined classification and geometric data were clipped to the buffered boundary of the NE-managed NNR estate to calculate length and density scores.

(ii) WFD-GW: As with the WFD-RW data, various criteria set out in the Directive (EC, 2000) must be monitored and reported on by member states, for use as a basis for groundwater body status classification. The most recent iteration of data collection for groundwater status required under the WFD was 2016. Quantitative status relates to the physical amount of groundwater resource available within a unit and thus indicates sustainability of freshwater abstraction from this source. Quantitative status is combined with the Chemical status attribute (used to quantify Nutrient/chemical status assets) to comprise the Overall groundwater body status. Groundwater bodies are either assigned a value of 'Good' or 'Poor' based on the criteria outlined in the Directive (EC, 2000).

As an overall proxy for assessing hydrological and geomorphological natural capital, the authors assert the WFD data delivers an accurate representation of these assets and both datasets were thus assigned a 'good' proxy score. Owing to the use of OS-derived waterbody geometry for joining the classification data within a statutory framework, a 'good' score has been awarded to the WFD layers in terms of spatial resolution. A 'moderate' score has been assigned in relation to temporal as these data are not updated annually. WFD is likely to continue under reformed domestic policy to some degree, monitoring criteria and thus feature attribution may be expected to vary for future natural capital quantification of hydrological assets.

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