

An aerial photograph of a coastal town and beach. The ocean is on the left, with waves breaking onto a wide, sandy beach. To the right of the beach is a residential area with many houses, followed by a large industrial or commercial site with several large white storage tanks and buildings. The sky is overcast with grey clouds. In the foreground, there are green trees and bushes, partially obscuring the view of the town.

The State of Natural Capital

*Protecting and Improving Natural Capital
for Prosperity and Wellbeing*

Third report to the Economic Affairs Committee

Natural Capital Committee



Cover photo: Chesil beach linking the Isle of Portland to the mainland with Fortuneswell in the foreground
Credit: © Natural England/Lucy Heath. For original photo and licensing information click [here](#)
Inside cover photo: Bluebells near Box Hill, Surrey

Background to the Natural Capital Committee

The Natural Capital Committee (NCC) was a headline commitment in the Government's 2011 Natural Environment White Paper. It was established in 2012 as an independent advisory body to Government with an initial three year fixed term. This has been extended for six months to September 2015 so that the NCC can provide advice to incoming ministers following the May 2015 U.K. General Election and receive a response to its third State of Natural Capital report.

The NCC formally reports to the Economic Affairs Committee, chaired by the Chancellor of the Exchequer. The Committee's role is to advise the Government on how to ensure England's 'natural wealth' is managed efficiently and sustainably, thereby unlocking opportunities for sustained prosperity and wellbeing.

The Committee is chaired by Professor Dieter Helm and consists of seven members who collectively bring expertise and experience in the fields of ecology and environmental science, economics, accounting and business. The members are: Giles Atkinson, Ian Bateman, Rosie Hails, Kerry ten Kate, Georgina Mace, Colin Mayer and Robin Smale.

The Committee is supported by a Secretariat based in the Department for Environment, Food and Rural Affairs, headed by Nick Barter, with Julian Harlow, Alastair Paton and Natasha Hunston.

Previous State of Natural Capital reports

In April 2013, the Committee published its first State of Natural Capital report. This reviewed evidence on recent trends and drivers affecting the state of natural capital in England and proposed a number of options to measure and value changes in natural capital as an important first step towards better management. The recommendations from the first report are set out in Annex B.

The Committee's second report, published in March 2014, presented a framework for assessing which of the benefits derived from natural capital in England might be at greatest risk and estimating the potential economic gains from their recovery. It also presented the initial argument that a clear programme of prioritised action is needed to restore critical natural assets. The recommendations from the second report are included in Annex C.

The Government's responses to both of the previous State of Natural Capital reports can be accessed at www.naturalcapitalcommittee.org.

This State of Natural Capital report

This report is the Committee's third report to this Government. It summarises the progress made to date by the NCC on its mandate and can be read as a standalone report. However, it builds on the previous two reports and readers are encouraged to consider all three as part of a progressive package of advice.

The Committee would like to thank all of those who have contributed to its work. Further information on the Committee, its full Terms of Reference and other reports can be accessed on our website.

Contents

Chairman’s message	1
Executive summary	2
1. Introduction	7
2. Current context and future pressures	10
2.1 What has driven changes in natural capital in the recent past?	10
2.2 Which future pressures are of greatest concern?	10
2.3 How does natural capital benefit the economy?	12
3. The foundations: measurement, accounting and valuation	18
3.1 How should we measure natural capital assets and benefits?	18
3.2 What is the role of natural capital accounts in a long-term investment programme?	20
3.3 How can economic valuation and decision making be improved to incorporate natural capital and the services it provides?	25
4. A framework for prioritising investments in natural capital	29
4.1 How much natural capital is needed? How might levels for benefits and assets be determined?	29
4.2 Which aspects of natural capital are at greatest risk from poor use or management?	32
4.3 How do the foundations and the approach to prioritisation fit together to inform an investment programme for natural capital?	34
5. An initial assessment of investment priorities	36
5.1 Which investments in natural capital offer the greatest economic return?	37
5.2 Why is a coordinated plan of action on natural capital so important?	47
6. Incentivising and financing improvements in natural capital	50
7. Next steps	57
References	59
Annex A: Natural Capital Committee Terms of Reference	63
Annex B: Recommendations from the Committee’s first State of Natural Capital report	65
Annex C: Recommendations from the Committee’s second State of Natural Capital report ..	67
Annex D: Acknowledgements	69

Chairman's message

The Natural Capital Committee (NCC) is the product of the 2011 White Paper, *The Natural Choice*, and its work is set in the context of the objective laid out in that White Paper: *“to be the first generation to leave the natural environment in a better state than it inherited”*. This is a very bold aim and in our view a necessary one.

The NCC has over its three year term put in place the building blocks required to achieve this objective, consistent with the Committee's Terms of Reference: to identify assets which are being used unsustainably; to advise Government on how it should prioritise action to improve natural capital; and to advise on the appropriate research requirements. This third and final State of Natural Capital report completes that advice to government.

The first two State of Natural Capital reports set out the methodological, measurement and reporting frameworks, the accounting principles and their application to national and corporate accounts, the incorporation of natural capital into project appraisals, and the research agenda. These reports also provided detailed recommendations to government on how to identify and report on assets at greatest risk, and the economic benefits of doing so. I cannot stress strongly enough how important it is that these recommendations are followed through; provided we have the data and the accounts, real progress can be made.

This final State of Natural Capital report is the culmination of our work. In addition to summarising the work of the NCC over the three years, it spells out what government will need to do if it is to fulfil its ambitious objective of improving the environment. At the heart is the establishment of a clear plan to enhance natural capital, focussing on those areas with the highest economic benefits. The NCC has not had the capacity to specify the detail, but it has clearly identified what needs to be done, and where the priorities should lie.

There is now a great opportunity to improve the wellbeing and prosperity of both urban and rural populations and restore some of the natural capital that has been lost. This will enhance prospects for long-term sustainable growth and therefore bequeath to the next generation a set of properly maintained and enhanced natural assets. A future government has this opportunity. This report sets out our advice as to how to do it. It remains for the post-May 2015 government to decide whether or not to implement it.

This report and all our associated papers have been prepared thanks to the energy and commitment of the NCC members and Secretariat. The members have given generously of their time, far beyond what was initially agreed, and the Secretariat have been brilliant: an example of the civil service at its very best. My particular thanks are to Nick Barter, Julian Harlow and Alastair Paton.



Professor Dieter Helm
Chairman, The Natural Capital Committee

Executive summary

England's natural capital – the elements of the natural environment which provide valuable goods and services to people such as clean air, clean water, food and recreation – is in long-term decline. Successive 'natural capital deficits' have built up a large natural capital debt and this is proving costly to our wellbeing and the economy. If economic growth is to be sustained, natural capital has to be safeguarded.

Pressures on natural capital are already too high but they are set to intensify, with more people expected to be added to England's population over the next 25 years than in any previous similar time period. Given these increasing pressures, significant changes to past practice will be required if we are to achieve the Government's laudable commitment to be the first generation to leave the natural environment in a better state.

The good news is that significant improvements are possible with the right investments and these will open up a range of economic opportunities for enhancing quality of life for current and future generations. The way in which we manage natural capital therefore matters.

The challenge of protecting and improving natural capital is not insurmountable. This report sets out what is needed to develop a strategy to achieve the Government's objective.

To meet the Government's commitment to protect and improve the environment within a generation, we advise that Government, working closely with the private sector and non-governmental organisations (NGOs), should develop a strategy and corresponding 25 year plan. The strategy needs to have three parts: building blocks; investment; and financing.

Building blocks

A number of foundations need to be put in place to underpin the strategy:

- **Measurement** – a robust and consistent framework for measuring and monitoring changes in natural capital;
- **Accounting** – comprehensive natural capital accounts at national and corporate levels;
- **Valuation** – better economic valuation and decision making.

The report sets out how each of these should be developed. One key element is the need to identify which investments in natural capital are necessary. This requires a clear prioritisation framework that assesses:

- **Targets** – determining how much natural capital needs to be secured;
- **Risk** – identifying those natural assets and benefits at greatest risk;
- **Costs and benefits** – of alternative options for improving natural capital.

Investment

Carefully planned investments in natural capital, targeted at the best locations, will deliver significant value for money and generate large economic returns. These are competitive with the returns generated by more traditional infrastructure investments. To illustrate this, we have reviewed a suite of cases in England which could form the basis of a natural capital investment programme. We have found a strong economic case for:

- **Woodland planting** of up to 250,000 additional hectares. Located near towns and cities, such areas can generate net societal benefits in excess of £500 million per annum;
- **Peatland restoration** on around 140,000 hectares in upland areas. This would deliver net benefits of £570 million over 40 years in carbon values alone. Further work is needed to determine water quality, recreation and wildlife values. Including these will significantly increase the net benefits of such investments;
- **Wetland creation** on around 100,000 hectares, particularly in areas of suitable hydrology, upstream of major towns and cities, and avoiding areas of high grade agricultural land. Benefits cost ratios of 3:1 would be typical, with to 9:1 possible in some cases;
- **Restoring commercial fish stocks**, particularly white fish (like cod) and shellfish, which remain considerably below optimal levels. We recognise that reducing the level of fishing effort to allow these stocks to recover will have short-term impacts on the fishing industry, but the long-term gains are potentially large, securing jobs in the industry for generations to come. Investing in measures to restore certain stocks of shellfish could deliver benefit cost ratios in excess of 6:1;
- **Intertidal habitat creation** to meet objectives set out in Shoreline Management Plans. These areas provide a wide range of benefits including coastal flood protection (and can reduce costs of maintaining concrete defences), carbon storage, areas for wildlife and the provision of nursery grounds for important commercial fish stocks.

In addition, we expect there to be high return investment opportunities in:

- **Urban greenspaces** which can provide enormous recreation values, benefiting millions of people in our towns and cities. They also offer significant potential for improvements in physical and mental health which in turn will reduce health expenditures and improve labour productivity. Reduced health treatment costs alone of £2.1 billion have been estimated;
- **Urban air quality** is the top environmental risk factor for premature deaths in Europe. It causes an estimated 40,000 premature deaths a year and reduces productivity, which together costs the economy at least £20 billion per annum. It also has a significant negative impact on life prospects for children (e.g. by lowering educational achievement);
- **Improving the environmental performance of farming**. Farming is an important sector of the economy but its impacts on natural capital are substantial. Addressing these impacts would deliver significant benefits for society. Channelling subsidies towards environmental schemes that demonstrate good economic returns would be very worthwhile. Also, investing in measures to connect wildlife areas across farming landscapes, as set out in the Lawton Review, will significantly increase net benefits to wildlife from these areas.

Financing

For the 25 year plan to succeed, reliable and long-term funding arrangements are imperative. The tendency is to assume that responsibility for this lies solely with the Exchequer. There is a strong rationale for dividing responsibilities between the private and public sectors. Government controls many of the levers, be they taxes, subsidies, legislation or other, and will therefore be instrumental in ensuring the right incentives are in place. However, the private sector and civil society also have a significant part to play, because they own or are ultimately responsible for the majority of natural assets.

The report sets out a range of different funding options and levers available in order to secure improvements in natural capital. These include:

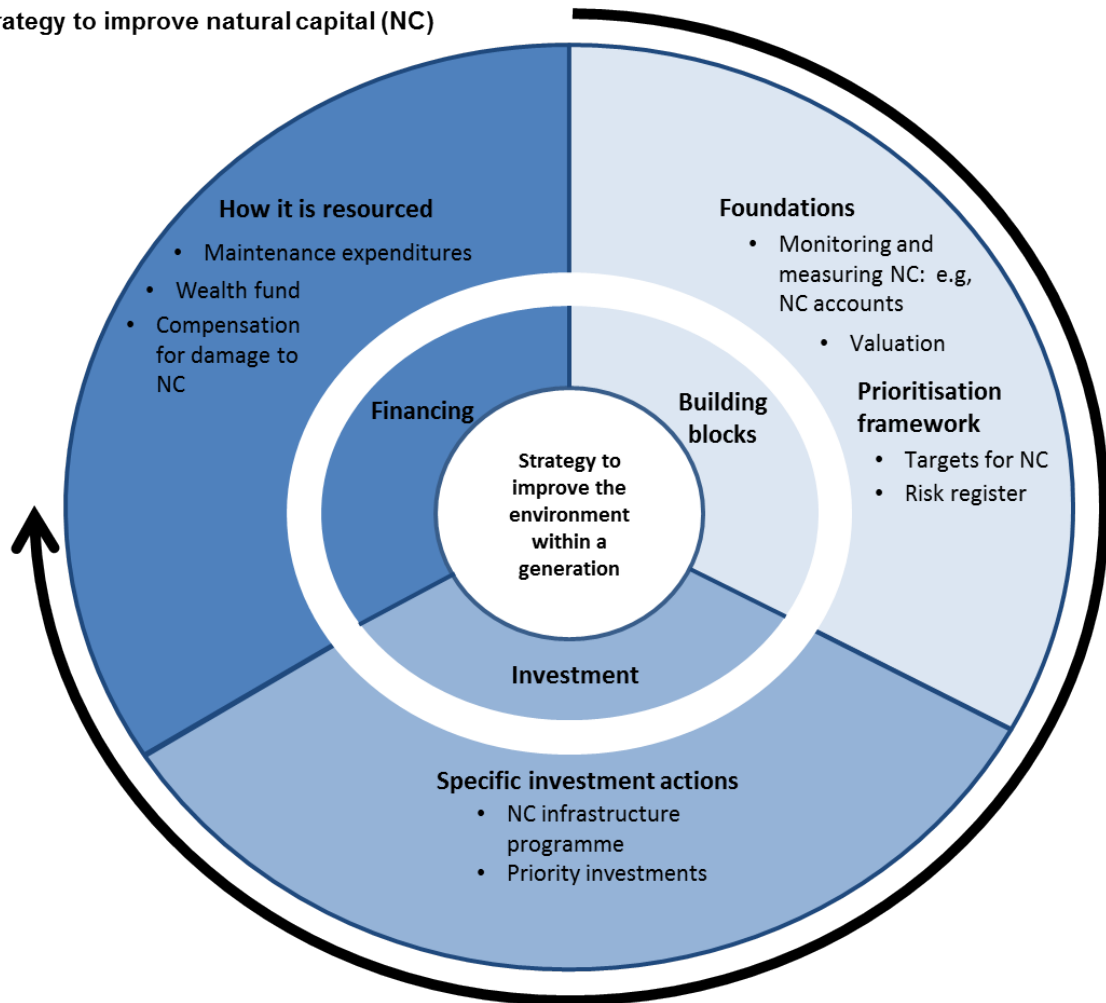
- Capital maintenance payments from public, not for profit and private sector asset owners;
- Rents from non-renewable resources (e.g. oil or shale gas);
- Compensation payments from developers;
- Greater use of economic instruments (e.g. taxes and charges);
- Reforming and eliminating perverse subsidies.

In particular, the Government should encourage private sector owners and managers of natural assets to invest in the maintenance and improvement of those assets – using the innovative corporate accounting framework developed and tested by the Committee over the course of the past year.

This accounting framework provides a basis on which the costs of sustaining and restoring natural capital can be evaluated and allocated to the private as well as the public sector. It creates a transparent means of sharing costs between corporations, landowners, local authorities, central government, non-governmental organisations and others, and determining whether these parties have adequately discharged their liabilities in maintaining natural capital within their domains.

Figure A summarises the strategy to improve natural capital and its three constituent parts: building blocks; investment; and financing.

Figure A: Strategy to improve natural capital (NC)



Recommendations

In order to be the first generation to leave the natural environment in a better state than that in which it was inherited, the NCC specifically recommends that:

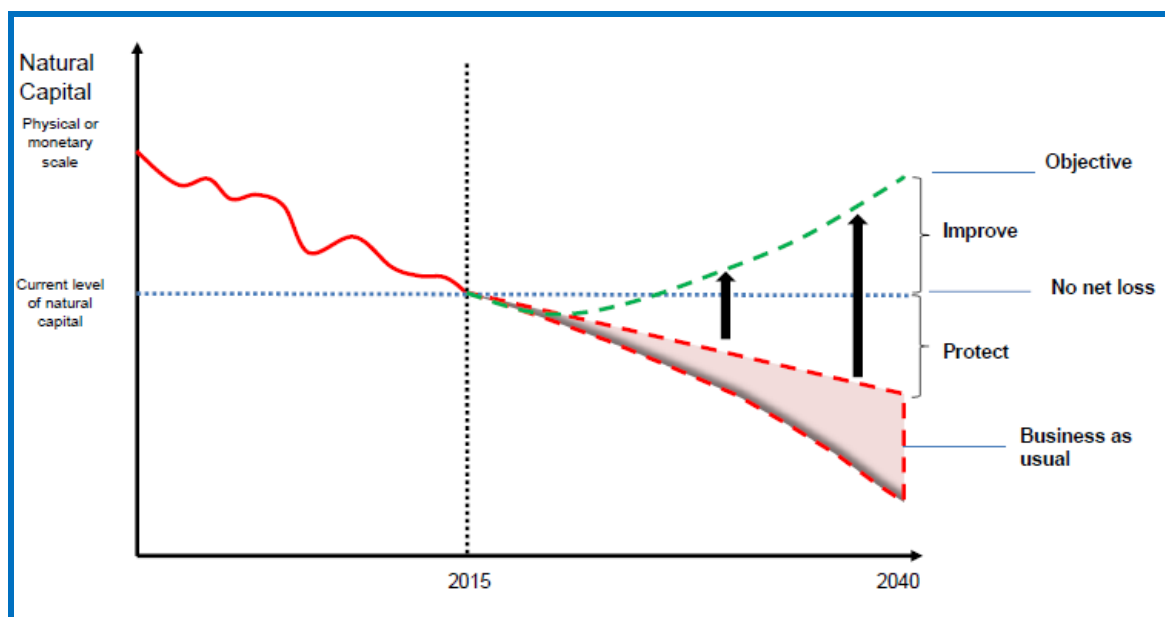
1. Government, working with the private sector and non-governmental organisations (NGOs), should develop a strategy to protect and improve natural capital and the benefits it provides. It should contain: a) clear evidence-based targets for natural capital; b) a way of prioritising actions to meet those targets which seeks to maximise their net benefits; and c) milestones against which to monitor progress. The strategy should be given effect in legislation, with regular reports on progress made to Parliament.
2. Government should assign institutional responsibility for monitoring the state of natural capital. This should build on the NCC's work to develop a risk register that systematically assesses the benefits from natural capital.
3. Organisations should create a register of natural capital for which they are responsible and use this to maintain its quality and quantity. The Government should incentivise wider adoption and uptake of the corporate natural capital accounting framework outlined in this report and consider requiring provisions to be made for the maintenance of natural capital.

4. The Government should urgently step up action to ensure that the Office for National Statistics (ONS) and the Department for Environment, Food and Rural Affairs (Defra) meet the target of incorporating natural capital into the national accounts by 2020. This should include a national balance sheet of the value of our natural assets, estimates of the depreciation of those assets (where this occurs) and a corresponding redefinition of the way in which income and savings are measured in national accounts.
5. The National Infrastructure Plan should incorporate natural capital into each of the main infrastructure sectors, following the mitigation hierarchy for managing impacts (avoid, minimise, restore, offset). An investment programme for natural capital should also explicitly feature in the National Infrastructure Plan.
6. The Government should revise its economic appraisal guidance (Green Book), implementing our advice, and as a matter of urgency, apply the revised guidance to new projects.
7. The Government should drive a substantial, long term interdisciplinary research programme on natural capital to inform future iterations of the strategy. This should be led by the Research Councils and build on existing initiatives.
8. Government should determine how the plan to protect and improve natural capital is to be funded, drawing on a combination of public and private funding as proposed by the Committee. Specifically, we recommend that Government:
 - a. Commits to capital maintenance expenditures to ensure that the real value of natural capital, as a minimum, does not decline overtime;
 - b. Ensures that damage to renewable natural capital is, where possible, avoided and minimised, but where it does occur, it is fully compensated by investment in renewable natural capital of equivalent or higher priority or value;
 - c. Establishes a 'wealth fund' derived from the depletion of non-renewable natural assets, part of which should be used to support the delivery plan.
9. Government, working with business, NGOs and other parts of society, should fully develop a 25 year plan. This plan needs to incorporate all the Committee's recommendations, detailing specific actions for all parties to deliver the strategy to protect and improve natural capital. This will need to set out who does what, when and where and how actions are to be resourced and incentivised.

1. Introduction

- 1.1 This is the Natural Capital Committee's (NCC) third report to Government, scheduled to be the last within the currently defined remit of the NCC.
- 1.2 In line with our Terms of Reference (Annex A), the report sets out a number of recommendations for achieving the Government's vision, "*to be the first generation to leave the natural environment in a better state than it inherited*". To deliver it, all interested parties (Government, business and civil society) will need to work together in new ways and with a much sharper focus. This report is about how to do this, with Government taking the lead.
- 1.3 Figure 1 illustrates the challenge which exists to both protect and improve natural capital¹. Without new interventions, we expect the declining trends of the past to continue – indicated by the dotted red lines and the shaded area between them (reflecting the uncertainty over how sharp future declines will be). We review significant past and future pressures on natural capital in Chapter 2.

Figure 1: Protecting and improving natural capital over a generation – a stylised interpretation



- 1.4 To succeed, future declines in natural capital need to be halted and reversed. Society needs to take a different path, indicated by the green dotted line which depicts natural capital improving relative to a 2015 baseline. On this trajectory, the natural capital deficit is eradicated (i.e. net loss is zero and natural capital is protected) and society starts to 'pay off' some of the accumulated natural capital debt (i.e. improvements are secured). To achieve this, a new strategy that sets out specific targets for improvements in natural capital and the benefits derived from it is needed.

¹ We have defined natural capital as 'those elements of the natural environment which provide valuable goods and services to people'. Further information is provided in a separate working paper: 'Towards a framework for defining and measuring changes in natural capital', which can be accessed at www.naturalcapitalcommittee.org.

- 1.5 To support the development of a new strategy, changes in natural capital need to be better measured and monitored, valued (see Box 1.1), and accounted for (both at a national and corporate level). We refer to these three measurement issues as the ‘foundations’ and they are discussed in Chapter 3.
- 1.6 Chapter 4 reviews other critical issues that a strategy for natural capital must include, focusing in particular on how to establish targets for different natural capital assets and benefits, how to prioritise actions to achieve those, and how a risk register can help to identify those aspects of natural capital at greatest risk.
- 1.7 Chapter 5 presents the Committee’s work looking at investments in natural capital which offer the best economic returns, highlighting the significant opportunities for synergies between investments.
- 1.8 Chapter 6 presents a range of financing options that we recommend to Government and others. A successful strategy and long-term action plan to protect and improve natural capital will need to be resourced both by the public and private sectors. Chapter 7 gives an overview of the next steps required to attain this objective.
- 1.9 A series of technical working papers² that provide the underpinning detail for general conclusions and recommendations as presented in the report will follow.
- 1.10 As always, we are keen to receive feedback on our recommendations and any aspect of the report at naturalcapitalcommittee@defra.gsi.gov.uk.

The NCC Recommends that:

Government, working with the private sector and non-governmental organisations (NGOs), should develop a strategy to protect and improve natural capital and the benefits it provides. It should contain: a) clear evidence-based targets for natural capital; b) a way of prioritising actions to meet those targets which seeks to maximise their net benefits; and c) milestones against which to monitor progress. The strategy should be given effect in legislation, with regular reports on progress made to Parliament.

² The technical working papers cover a range of issues including corporate natural capital accounting, improving Government appraisal guidance, the links between natural capital and economic growth, and the investment cases developed later in this report. All will be available at www.naturalcapitalcommittee.org.

Box 1.1: Why value natural capital?

Valuation of natural capital is unavoidable because human needs and wants exceed the resources available to satisfy them all. Therefore, every time society decides to do one thing, it is making a decision not to do another. Values on each option are implicitly being placed and trade-offs being made.

It is better to be explicit about the trade-offs and valuations inherent in decision making than to keep them implicit and invisible. By incorporating the value of natural capital into decisions made by Government, businesses and individuals, scarce resources can be used more efficiently, economic growth can be better supported, and society's wellbeing can be increased.

The reason to value natural capital is not so a 'price' can be put on it enabling it to be sold off. Valuing nature is necessary so that it is no longer ignored when deciding, for example, where to build infrastructure or whether to invest in pollution saving technology. This tendency to ignore the value of nature has been a major problem in the past and has too often resulted in our natural environment being mismanaged, over-consumed and underinvested in.

Case study example – The Crown Estate's Windsor Estate

The Windsor Estate covers around 6,400ha of parkland, woodland, and gardens, attracting around 3 million visitors a year. It is renowned for its biodiversity and has the largest collection of old oak trees in northern Europe. It is recognised as providing major environmental and cultural benefits that are not fully reflected in the Estate's financial accounts. Such benefits include:

- Recreational visits to the park;
- Trees filtering local air pollution;
- People enjoying the view of the park;
- Carbon sequestration from soils and vegetation contributing to a reduction in greenhouse gases and climate change.



The Long Walk in Windsor Great Park, part of the Windsor Estate

These external benefits are valued at £49m without even taking account of other benefits, such as the role that the Estate's natural capital plays in reducing the frequency and severity of flooding along the Thames. Being able to identify this additional value helps to inform decisions, budgeting and business planning.

2. Current context and future pressures

2.1 What has driven changes in natural capital in the recent past?

2.1.1 To date, economic progress has tended to involve the use and transformation of natural capital in order to accumulate other assets. Throughout most of human history, this process of substitution and accumulation has been gradual. What distinguishes the recent past (from 1950 onwards) is an abrupt change in the rate of conversion of natural capital to other forms. Such is the nature and scale of change that the last 60 years have been labelled the ‘Great Acceleration’³ – a period which has recorded unprecedented increases in population, consumption, waste emissions and land conversion.

“Environmental trends; both globally and nationally, paint a picture of overall decline, particularly over the last 60 years.”

2.1.2 Drivers of change such as population growth, economic growth and advances in science and technology have affected natural capital via land-use change, resource over-exploitation (e.g. in fisheries) and the introduction of invasive alien species.

2.1.3 The transformation and conversion of natural capital is altering global systems. It is not surprising, therefore, that many environmental trends; both globally and nationally, paint a picture of overall decline, particularly over the last 60 years. While there have undoubtedly been some notable successes in slowing or reversing these trends⁴, illustrating what can be achieved through concerted action, these have been the exceptions.

2.1.4 Not all drivers of change have affected the natural environment negatively, but their overall effect has been to degrade England’s natural capital.

2.2 Which future pressures are of greatest concern?

“The challenge... is how to manage natural capital so that it can continue to meet the needs of people and the economy, despite the mounting pressures.”

2.2.1 There is little indication that drivers and pressures on natural capital will lessen over the next 50 years. In fact, they are likely to grow. Nor will the rate of conversion to other forms of capital slow without targeted interventions. The challenge society faces, both domestically and globally, is how to manage natural capital so that it can continue to meet the needs of people and the

³ Steffen *et al* (2011).

⁴ Perhaps most notable are improvements in water quality over recent decades which have largely arisen through efforts to tackle point source pollution (for example the Urban Waste Water Directive). Also, the introduction of Sites of Special Scientific Interest have helped to protect some of our rarest wildlife and habitats even though biodiversity indicators more generally have recorded declining trends. Air quality, particularly in urban areas, has improved significantly too since the 1956 Clean Air Act though it remains a key issue in many cities in the UK.

economy, despite the mounting pressures.

2.2.2 Understanding individual drivers and pressures and their likely impacts is important, but so too is a clear understanding of how they might act in concert to exacerbate one another in the future. Stark warnings have been made recently about the risks posed by a series of interacting global pressures related to climate change, demands for energy, water and food that could coincide to create an unprecedented set of circumstances⁵. Energy, water and food are all vital goods and services that are derived from natural capital and are dependent to a significant extent on its condition. The solutions in this case will be highly interconnected too, so much so that to make progress in tackling one area requires careful integration with solutions in another.

2.2.3 Some existing drivers, like population growth and increases in per capita consumption, are forecast to intensify over the foreseeable future. Even at a modest long-term average 2% growth rate, the size of the UK economy can be expected to be over five times larger than it is currently by the turn of the century. The global economy is expected to grow even faster, doubling in size within just 18 years if recent historical rates of growth (4%) are maintained.

2.2.4 England's population is projected to grow by approximately 8m people over the next 25 years (reaching over 62m by 2040)⁶. This is roughly equivalent to England absorbing today's population of Austria within a generation. This will require significant expansion in the

“England’s population is projected to grow by approximately 8m people over the next 25 years.”

housing stock and other infrastructure. For example, simply to keep up with existing demand, around 200,000 new homes may be required in England every year for the next 20 years⁷. With these homes come additional demands for water and energy as well as related infrastructure such as new roads and railways. It is not, therefore, just about the

land take of the houses themselves. The indirect and cumulative impacts from the building and use of infrastructure that accompanies them are equally important when thinking about how to plan for and manage natural capital.

2.2.5 Looking at road transport alone, the Government's National Transport Model predicts traffic to increase by around 43% by 2040⁸. Even with improvements in emissions technology, this will make challenges such as improving urban air quality much more difficult.

2.2.6 Other demographic factors will be significant. England's population is ageing, household sizes are falling, and increases are unlikely to be evenly distributed across regions, with a

⁵ Professor John Beddington (2009) and the World Economic Forum's (2011) Global Risks Report. This is often referred to as the 'perfect storm'.

⁶ <http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2008-based-projections/sum-2008-based-national-population-projections.html>.

⁷ Chartered Institute of Housing, <http://www.cih.org/resources/PDF/Policy%20free%20download%20pdfs/Policy%20essay%205%20-%20How%20do%20we%20build%20200,000%20homes%20a%20year.pdf>.

⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/212474/road-transport-forecasts-2013.pdf.

greater concentration of people expected in the South-East. This will have implications for water, waste, sewerage and green space provision, as well as air quality; all of which will impact on the state of natural capital to varying degrees⁹.

- 2.2.7 New and unforeseen drivers and pressures will also emerge over the coming years and decades. These are by definition uncertain and a mixture of positive and negative effects are probable. Climate change is expected to bite as the century progresses, with average temperatures likely to increase by around 2°C over pre-industrial levels on current greenhouse gas emissions' trajectory by 2040¹⁰. As mentioned, this is likely to lead to additional challenges linked to water in particular but also to food production and energy generation. Climate change will have major impacts on habitats and species as well.
- 2.2.8 The impacts of technological developments are perhaps the most difficult to forecast and to assess. There are many examples of new technologies causing a wide range of both positive and negative environmental impacts, sometimes far removed from the technology itself. This can result in a very mixed picture once second or third order impacts are properly assessed. For example, technological developments in agriculture over the last 150 years have led to a fourfold increase in wheat yields¹¹. Pressure to expand the area of cultivation has lessened as a result and this will almost certainly have been of benefit to environmental systems generally compared to the expansion that could have happened. However, increases in yields have been driven largely by the use of fertilisers and herbicides, which are severely affecting wider environmental systems (including water and wildlife populations). In response, new technologies such as real-time crop scanners are being deployed in a move towards 'precision farming' and more efficient use of agricultural inputs.

“The decline in natural capital seen over the last 60 years will continue into the future, and is likely to accelerate, unless there is some radical departure from the approaches of the past.”

2.2.9 In summary, the decline in natural capital seen over the last 60 years will continue into the future, and is likely to accelerate, unless there is some radical departure from the approaches of the past. Costly impacts will have to be borne, people's wellbeing will suffer, and economic opportunities will be missed unless specific action is taken to invest in natural capital so that it can continue to meet people's needs and support a better quality of life for a growing number of people in the future.

2.3 How does natural capital benefit the economy?

- 2.3.1 A major reason to protect and improve natural capital lies in the benefits this can have for economic growth. Conventionally, economic growth refers to an increase in Gross Domestic

⁹ RCEP (2011).

¹⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/33717/GST4_v9_Feb10.pdf.

¹¹ Goulding *et al* (2008).

Product (GDP), either in total or on a per capita basis, but it is important to recognise that much of the value of GDP is in fact supported by natural capital. Examples include many of those services provided by ecosystems such as: natural water purification processes that provide clean water; pollination that boosts agricultural output; protection from flooding provided by wetlands, coastal habitats and other natural systems.

2.3.2 However, GDP clearly does not capture many other important benefits derived from natural capital. For example, many of the benefits from nature-based recreation are provided directly to households and are not captured in national accounts. Nor will the flood protection afforded by natural systems translate solely into commercial benefits. In both of these cases, benefits provided are intangible and escape the ways that are conventionally used to assess economic growth. Yet such intangible benefits comprise a substantial part of people's total wellbeing and its importance is likely to increase over time. As a result, economic growth must be understood not only in terms of the benefits measured in (a changing) GDP but also broader (less tangible) benefits as well.

2.3.3 It is equally - perhaps more - important to understand the underlying factors driving the process of economic growth. Future growth is determined by the portfolio of assets that a nation possesses or makes use of. While these assets include manufactured and human capital, they also include natural capital and society derives benefits for using them all.¹² A shrinking asset base implies declining benefits and lower economic growth. Boosting the asset base, by contrast, might raise economic growth, assuming that productive investments can be identified.

2.3.4 What is happening to the asset base of a country needs to be assessed through effective metrics. For example, a broad measure of changes in nations' asset bases is proposed in the recent UN System of Economic and Environmental Accounts (SEEA) statistical standard: 'depletion-adjusted net saving'. This signals how much a particular country is saving, on balance, given what is happening to its assets. Specifically, depletion-adjusted net saving deducts from gross saving¹³ the depreciation of manufactured capital as well as the depletion of non-renewable natural capital (such as oil and gas).

“For the UK, in 2010, the costs of poor air quality equated roughly to 5% of GDP.”

2.3.5 As an illustration, for the UK, the adjusted savings rate using the SEEA approach averaged about 3% of GDP from 2001 to 2010. On the face of it, this is only a relatively modest rate of asset accumulation over that decade. Moreover, dealing as it does only with non-renewable natural capital, this UN SEEA metric ignores other changes in natural capital. Taking just one example, including the impacts of poor air quality would give a more accurate picture of our economy and wellbeing. A recent study¹⁴ estimates that for the UK, in 2010, the costs of

¹² Social institutions and technology (and the way in which these factors influence productivity) are also crucial determinants of economic growth and wellbeing.

¹³ Gross saving is defined simply as GDP minus consumption (that is, it includes gross investment as well as the net trade balance).

¹⁴ New Climate Economy (2014).

poor air quality equated roughly to 5% of GDP. This too is a loss of natural capital, and there are many others that should be subtracted from any savings measure. In this case, contemporary net saving in the UK might be around zero. In fact, properly understood, it could even have been negative in some recent years.¹⁵

- 2.3.6 This assessment is discouraging overall, and is made worse by considering what is lost when various components of renewable natural capital such as air quality and other assets are depleted or degraded. In some cases, the negative impact is a diminished flow of nature-based benefits. For example, earlier in this chapter (Section 2.2), we cited the forecasted need for new investment in the UK's housing stock. House building increases assets in one important domain (manufactured or produced assets). What it contributes to the economy on balance depends on the magnitude of other impacts, notably the extent to which natural capital is lost or altered when land assets change use from green space to property development. This requires a careful consideration of how goods and services that rely on natural capital, such as recreation, wildlife, and carbon sequestration, are affected.
- 2.3.7 In other cases, the negative impact of changing natural capital is actually felt on other productive assets, for instance manufactured capital, such as physical infrastructure affected by risks of flooding. The National Ecosystem Assessment provides a further example.¹⁶ That study found that for residential properties in areas close to green space and other natural amenities, this proximity might account for more than one third of the asset value of homes. Care needs to be taken in interpreting these findings. However, what is plain is that some proportion of the roughly £4 trillion value of residential property on the UK national balance sheet is actually (capitalised) nature-based benefits. This adds a further nuance to the point made in the preceding paragraph. The attractiveness of new homes depends in part on natural capital. Similarly, the UK's tourism satellite account published by the Office for National Statistics (ONS) indicates that this sector contributes annually about 4% to GDP. How much of this is actually a return on natural capital inputs needs to be researched.
- 2.3.8 The impact of natural capital on human capital has potentially far-reaching consequences for economic growth. For example, there is increasing evidence that poor air quality is responsible for substantial adverse labour market outcomes. Most obviously, this entails lost productivity due to pollution-related absence from the workplace. However, the possible impacts on productivity could be far more subtle and extensive than this. Box 2.1 provides some examples.

Box 2.1: Air quality and human capital

In our previous State of Natural Capital 2013 report, we reported on how human activities have affected the atmosphere significantly with pollutants. The highest impacts on human health have come from particulate matter (PM), ground level ozone, sulphur dioxide, nitrogen dioxide and benzo(a)pyrene. We noted that while there has been some improvement, there remain considerable costs associated with largely detrimental changes in the natural asset that is clean air. For example, the effect of the smallest particulates (PM2.5) on mortality in the UK in 2008 was estimated to be equivalent to 29,000 premature deaths per annum.

¹⁵ There are caveats here. What depletion adjusted saving does not reflect is investment in human capital via education expenditures for example.

¹⁶ Gibbons *et al.* (2013).

As we pointed out, impacts on health of this scale have a significant effect on human wellbeing. Recent attention has also focused on lost work days. Evidence is mounting that, for the UK, pollution related illnesses are responsible for more absences from the workplace over recent years than industrial disputes. Emerging evidence is pointing to other influences too. For example, one study found that a small increase in the exposure of US agricultural workers to ground-level ozone could lead to more than a 5% reduction in productivity¹⁷. Other research points to impacts from air pollution on educational achievement (at school or even earlier). A recent study for Israel found that small changes in fine particles (i.e. PM2.5) were associated with lower school assessment grades for high-school age children. While exposure to these particles had adverse effects on health, it is manifesting also in lower learning outcomes (because of school absences and reduced productivity while learning at school)¹⁸. An earlier study of the exposure of US children to PM2.5 and its effect on maths and literacy results concluded along similar lines.

The empirical record here is in its infancy and so care must be taken with hasty generalisation. Nevertheless, some important implications for economic growth are starting to emerge. One of these is that the links between air quality and human capital are apparently numerous and pervasive.

2.3.9 Investing in natural capital, and ensuring that people have access to it, are likely to have beneficial consequences for economic growth (whether narrowly or broadly defined) over the long term.¹⁹ This is especially so given the increasing value that people are placing on benefits such as nature-based recreation. Box 2.2 gives one example, concerning how the provision of safe green spaces can lead to substantial improvements in people's physical and mental health.

Box 2.2: Green spaces and human health

Today's higher population density in urban areas means that the provision of good quality, accessible and safe urban green space is critical. As over 80% of England's population now lives in urban areas, accessible nearby urban green infrastructure is vital to our nation's wellbeing. A range of studies²⁰ have shown that living close to green space has a positive influence on a number of general health indicators (including perceived health, stress and disease morbidity).

Green space supports physical and mental health; it improves air quality, reduces the urban heat effect arising from the built infrastructure, captures and stores carbon, provides habitat and food for wildlife, and reduces flood risk. A major challenge for policy-makers and planners is that not everyone has access to good quality greenspace.

The provision of green space encourages higher physical activity levels, but this is just one of the health benefits from such areas. Approximately 7m people in England have been diagnosed with mental illness. Research in the UK has shown that dissatisfaction with local green space is associated with poorer mental health while participation in green space exercise programmes has been shown to improve confidence, self-esteem and mood. Moving closer to a green space appears to have a long-lasting positive effect on mental health. While it is important to scrutinise the causal claims in this evidence carefully, these effects are likely to be accompanied by substantial economic benefits.

Natural England estimate that if every household in England were provided with equitable access to good quality green space, then savings of £2.1bn could be achieved every year in averted health costs²¹.

¹⁷ Graff & Neidell (2012).

¹⁸ Zweig, J.S. *et al* (2009).

¹⁹ This might also be because future economic prospects are more resilient to changing circumstances.

²⁰ Hartig *et al* (2014).

²¹ NE (2009).

Investment programmes to secure this objective could therefore lead to significant resource savings. Improved physical and mental health attributable to better access to safe green space is also associated with productivity benefits through its influence on human capital, meaning there are direct benefits to GDP from good access to green space.

The Committee therefore welcomes the Mayor of London's 2050 Infrastructure Plan consultation document and its reference to the importance of green infrastructure and looks forward to seeing the analysis and final report in spring 2015. The Committee sees great benefit in other local authorities pursuing a similar stance on green infrastructure, acknowledging its value and incorporating it within planning considerations. To this end, Natural England's guidance on green infrastructure should be a central element of National Planning Policy Guidance.

2.3.10 Chapter 5 identifies a number of productive investment opportunities in natural capital. In some cases, these opportunities are reflected in high benefit cost ratios (BCRs) for environmental investments.²² Chapter 4 reviews potential priority investment cases in natural capital, but to illustrate with the case of catchment management, water companies such as South West Water are reporting benefits that exceed costs by an order of magnitude in many cases²³. This sort of finding is not a huge surprise. The scarcity or poor condition of much of our natural capital is one reason to expect that opportunities for productive investments will be relatively abundant.

2.3.11 The opportunities presented by the favourable investment cases in Chapter 4 may not remain available indefinitely. Changes in natural capital may become irreversible, typically because natural assets (the individual components of natural capital) have been degraded beyond threshold levels and can no longer be restored at reasonable cost. Fisheries provide an example here (see Box 2.3). Persistent overfishing drives down underlying stocks and diminishes the returns that can be generated from the stock which remains. Paradoxically, the unfavourable current situation means that there are likely to be substantial benefits from better management of that stock. But there are risks too. If current stocks become too low, the chance of irreversible collapse is all the higher. This would remove – perhaps permanently - the option to enjoy these increased benefits in the future.

Box 2.3: The Grand Banks – a warning for the UK

The 'Grand Banks' in Newfoundland, Canada, used to be one of the most productive fisheries in the world yet provides the most well-rehearsed cautionary tale about the misuse of a natural asset. The conditions in the fishery were particularly suited to cod and appeared to sustain relatively large harvests every year to the benefit of local fishing communities. However, increasing pressure on the fishery combined with an apparent inability to agree on access and use led to an ever-declining stock; stocks were down to perhaps as little as 1% of 1960s levels by the early 1990s. Commercial fishing was banned in 1992, but by then it was too late; the cod had been fished out.

The closure of the fishery led to substantial job losses in the fishery sector and related activities. The costs to the Canadian Government have also run into billions of dollars in social security payments and other measures. Nor, after 20 years, are there signs that cod stocks have recovered to anything near commercially exploitable levels. Indeed, they may never do so because the sea bed has been damaged so significantly.

The Grand Banks is a sobering reminder of what can happen when natural capital is not managed effectively

²² See also, Eftc (2009) Report for Natural England.

²³ <http://upstreamthinking.org/index.cfm?articleid=8692>.

or sustainably. Although it has many features of a special case, it is far from unique as evidenced, for example, by World Bank²⁴ and the Organisation for Economic Co-operation and Development (OECD²⁵) studies of global fisheries.

In our second State of Natural Capital report, the NCC estimated that if stock levels in UK waters could be returned through better management to averages that existed between 1938-1970, the value of landings could potentially be increased by £1.4bn per annum. Chapter 5 updates and extends this assessment. Notably, we conclude that the resource rent – a measure of resource profitability – from this better management is likely to be substantially higher for a range of commercial species.

An extensive study of UK fisheries by Cunningham *et al.* (2010)²⁶ makes clear that this potential opportunity compares with the current situation in which these profits are low or dissipated altogether, whether by excessive fishing effort or a dwindling stock, or some combination of the two. While catches from current stocks of species with high natural productivity such as herring may be sustainable, the present level of fishing effort means that little (if any) return is provided by the fishery. For other species, particularly white fish such as cod and haddock, better management is also likely to require currently depleted stocks to be re-established. Such investments in natural capital are not without costs; allowing stocks to recover involves some short term sacrifice. However, the returns on this sacrifice appear to represent a significant opportunity and, furthermore, substantially reduce the risks associated with current unsustainable use.

²⁴ World Bank (2008).

²⁵ Costello, C. *et al.* (2012).

²⁶ Cunningham, S. *et al.* (2010).

3. The foundations: measurement, accounting and valuation

3.0.1 So far we have set out past and probable future pressures on natural capital, as well as some of the costs and opportunities associated with inaction and action respectively. The next two chapters focus on the measures that need to be taken to improve natural capital within a generation.

“In our second report, we recommended that the Government should lead the development and coordination of a long-term programme of investment in natural capital”

3.0.2 In our second State of Natural Capital report, we recommended that the Government should lead the development and coordination of a long-term programme of investment in natural capital. The Committee maintains that this is the single most important action needed. It will focus future policy development and delivery in a way that has, so far, not been possible.

3.0.3 Certain actions are needed to identify what is happening to our natural assets and to prioritise action. In the same way that a business cannot

be run effectively without sound information on the state of its assets and their value, it is impossible to manage national balance sheets without relevant information. Some preliminary steps are so important that we have termed these ‘foundations’. They address:

- Measurement of both natural capital assets and their benefits to people;
- National and corporate accounting – recording changes in natural capital over time;
- Valuation - integrating the economic value of natural capital and the services it provides into decision making.

3.0.4 Action now on these foundations would help to ensure that a strategy to protect and improve natural capital is effective, efficient and underpinned by strong economic and scientific justifications. This chapter looks at these issues in more detail and how they fit together to support the development of a strategy. We emphasise that action should not wait until all the components of the building blocks are fully in place. We not only know enough to justify starting now but, as our risk register shows (see Section 4.2), action is urgent for various aspects of natural capital.

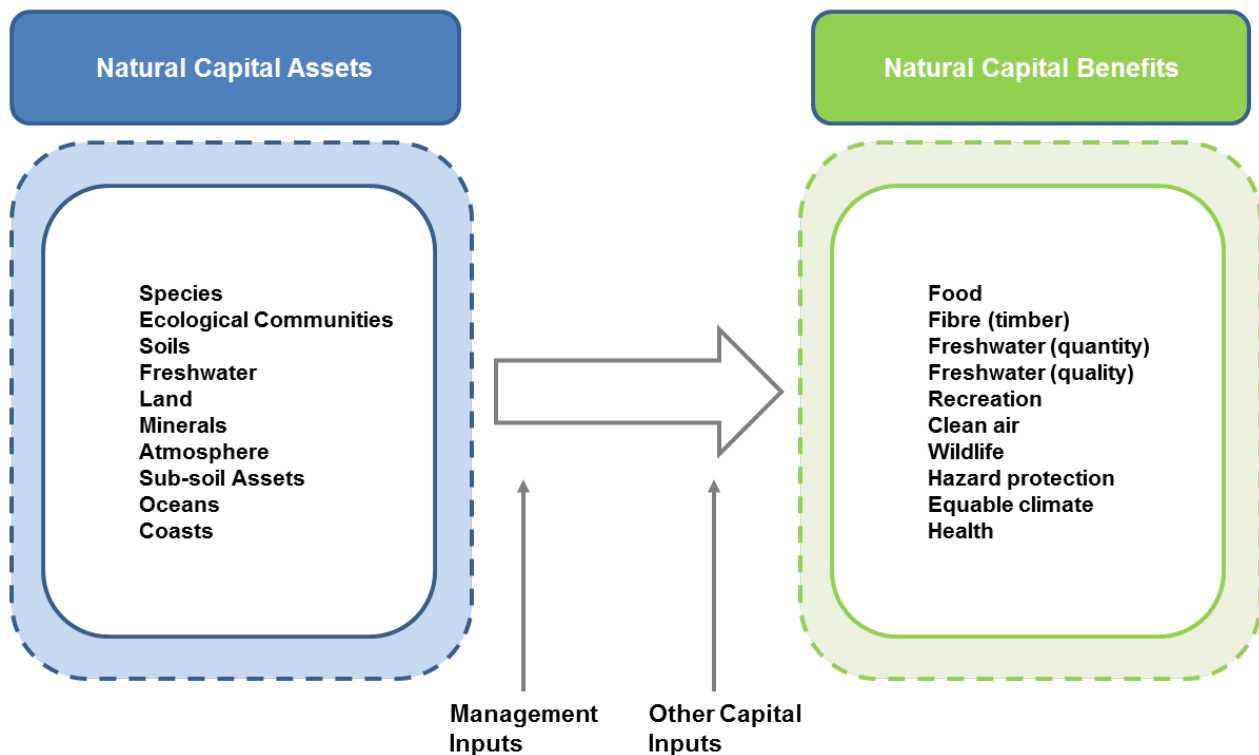
3.1 *How should we measure natural capital assets and benefits?*

3.1.1 A clear understanding of the benefits derived from natural capital and the assets that underpin them is needed to shape a long-term programme of investment. There are many reasons to monitor natural capital assets in their own right, but for management and investment purposes, we advise that the assets should be assessed with respect to the benefits that they could and do provide for people.

3.1.2 In our second State of Natural Capital report, we presented a framework that linked different benefits with natural capital assets underpinning them. The relationships between them are

multiple, interacting, complex and evolving, but as Figure 3 indicates, all are mediated both by human management of the assets, and by inputs of other capitals (manufactured and human). Note that what is generally referred to as 'biodiversity' is present in the framework in two places; as an asset and as a benefit. As an asset we are referring to the vital role that species and ecological communities play in providing many of the benefits derived from natural capital (e.g. soil organisms help crops to grow). Biodiversity as a benefit refers to the cultural and societal values society holds for charismatic wildlife (e.g. Golden Eagles) and will be partly reflected below through recreation, wildlife and health too.

Figure 3: Natural capital assets and types of benefits



3.1.3 In order to identify the most important aspects to measure and monitor, it is necessary to look at the extent to which the benefits are and can be influenced by decisions affecting the quantity, quality or location of the underpinning asset. For example, for outdoor recreation, the location of recreation areas such as woodlands near to people is a key determinant of how much they will be used and therefore the benefits derived from them (see Box 4.1). So location and quantity matter more than quality in this case²⁷. However, the contribution of woodland to an equable climate (via carbon sequestration) is mostly unaffected by its location and will instead be determined largely by its size (quantity) and to some extent by species composition (quality).

3.1.4 Exploring the relationship between location, quantity and quality of all natural capital assets and the benefits to which they give rise entails a review of many different relationships. This then provides the evidence for a more systematic approach in which suites of natural capital assets and the benefits they provide can be identified in particular geographical areas or for

²⁷ See our second State of Natural Capital report at www.naturalcapitalcommittee.org.

specific ecosystems. For example, the multiple benefits from strategically-placed and designed urban greenspaces in Box 2.2, or the many downstream and longer term benefits for water quality, soil quality, and flood control that result from upland moorland management.

- 3.1.5 The metrics required for measuring natural capital and its benefits will change over time as natural capital and the benefits arising from it for people also change. For example, the importance of carbon sequestration and urban air quality for health has become much greater in recent decades, compared to biomass for food and fuel for example that were historically a primary focus. Therefore both assessments and monitoring of natural capital stocks need to be established for the longer term with regular review and reporting.
- “The importance of carbon sequestration and urban air quality for health has become much greater in recent decades.”**
- 3.1.6 The Committee has made a start at identifying suitable metrics but these need to be developed further. Therefore, we advise that a panel of relevant experts is set up to do this.

3.2 What is the role of natural capital accounts in a long-term investment programme?

- 3.2.1 Accounting offers a means of organising, structuring and comparing information over time. In a corporate context, accounts are used to assess the health and performance of businesses. In a national context, structured information on economic activity has been a fundamental element in the management of economies over the past 70 years²⁸. By systematically documenting changes, accounts can provide important insights for prioritising investments to secure future performance and can therefore be a useful management tool, for governments and business managers.
- 3.2.2 Most accounting frameworks, in practice, focus on recording changes in flows, often neglecting changes in the underpinning assets (or stocks) from which they are derived²⁹. As discussed earlier in Section 2.3, GDP epitomises this problem. Similarly, an organisation’s profit and loss accounts alone provide few insights into the state of its productive base.
- 3.2.3 Many existing accounting frameworks also completely miss a range of important stocks and flows, particularly from an environmental perspective, and therefore provide a biased picture of change. Despite the best of intentions, there are many one-off environmental accounting projects that have had very little impact. What is needed is a more substantial commitment to monitor, evaluate and respond to trends, not through ad hoc indicators and reports on popular themes, but through investment in structured and comprehensive information sets encompassing the economy and natural capital³⁰.

²⁸ Obst & Vardon (2014)

²⁹ Note that the System of National Accounts does contain clear guidance on the operation of a national balance sheet. This is rarely implemented effectively by most countries.

³⁰ Obst & Vardon (2014).

- 3.2.4 This means that both national and corporate accounting frameworks should include changes in natural capital. The revised accounting frameworks should shape long-term investment programmes and also enable them to be carefully monitored.
- 3.2.5 Any reduction in the value of natural capital over time, as recorded in the accounts, can then be seen as giving rise to a corresponding requirement for a capital maintenance provision; the size of the provision should be the payment necessary to keep an asset or capital item intact through time. These maintenance provisions can therefore be thought of as a measure of the money that needs to be spent in order to maintain natural capital intact.
- 3.2.6 Capital maintenance provisions are commonplace in infrastructure policy and routine for many organisations. For example, machines wear out and parts need replacing, roads need repairing, and trees need replanting after felling in a commercial forestry operation. Given that the objectives of many areas of environmental policy are primarily about stopping further declines as a first step, the Committee is of the view that explicitly recording the requirement for capital maintenance provisions in accounts will help to ensure that these investments actually happen in practice.

The NCC Recommends that:

Government commits to capital maintenance expenditures to ensure that the real value of natural capital, as a minimum, does not decline overtime.

National Accounting

- 3.2.7 Fully incorporating natural capital into the national accounts and regularly updating them will mean that the state of the nation's natural assets can be monitored over time and appropriate action taken where worrying trends develop. Thus, the Government should urgently step up action to ensure that the ONS working in partnership with the Department for Environment, Food and Rural Affairs (Defra) meet the target of incorporating natural capital into the national accounts by 2020.
- 3.2.8 At the national level we recommend that accounting frameworks should be developed in two key areas. Firstly, wealth accounts are needed, including measures of natural capital (see Chapter 2). These accounts should record the picture at the aggregate level and provide insights into whether the economy is meeting basic sustainability requirements. This, in turn, requires that changes in natural capital are valued and an appreciation of how this impacts on the measurement of income and saving.
- 3.2.9 The ONS, in partnership with Defra, have recently produced initial estimates of the 'aggregate' value of natural capital in the UK, which they estimate at approximately £1.6 trillion³¹. However, key aspects of natural capital are yet to be included in these statistics

³¹ See <http://www.ons.gov.uk/ons/rel/environmental/uk-natural-capital/initial-estimates/index.html>

making them only partial and very initial estimates. Nevertheless, this is a very welcome starting point and one that has the potential to be developed much further. We strongly support such efforts, and look forward to seeing a more comprehensive account.

- 3.2.10 Wealth accounts are crucial for understanding the value of any change in natural assets and its implications for growth and wellbeing as well as ultimately indicating the amount of money that needs to be spent to maintain the assets intact. Such asset values and maintenance provisions make the link between the accounts, policy and delivery more explicit.
- 3.2.11 Secondly, a full set of national accounts for individual components of natural capital (e.g. freshwater, marine or different ‘ecosystems’) is needed which will enable the state of these assets, as well as the values derived from them, to be recorded at a more detailed level, relevant for decision making and policy formulation. Defra and the ONS have begun work that, over time, will constitute very useful additions to the national accounts. These so called ‘bottom-up’ accounts should enable further refinement of the ‘wealth accounts’ referred to above. This work should be prioritised.

The NCC Recommends that:

The Government should urgently step up action to ensure that the ONS and Defra meet the target of incorporating natural capital into the national accounts by 2020. This should include a national balance sheet of the value of our natural assets, estimates of the depreciation of those assets (where this occurs) and a redefinition of the way in which income and savings are measured in national accounts.

Corporate Accounting

- 3.2.12 The private sector owns and manages the majority of natural assets in this and many countries around the world. For example, over two thirds of land in England is privately owned. The way in which organisations manage their business can have profound impacts on England’s natural capital.

“Over two thirds of land in England is privately owned.”

- 3.2.13 Privately owned natural capital assets are typically not reflected in market prices and, therefore, the private sector has no overt financial incentive to deliver or conserve them.

- 3.2.14 Part of the NCC’s Terms of Reference requires the Committee to provide advice on how to ensure private activity is focussed where it will have the greatest impact on improving the economy and wellbeing. The Committee has undertaken a significant piece of work on Corporate Natural Capital Accounting (CNCA) to fulfil this. Corporate accounting is an important part of a long-term investment programme in natural capital, bringing in the private sector, cities, local authorities and other major land owners.



The National Trust/Simon Damant

3.2.15 The Committee's work has focused on developing a workable, consistent and robust approach to producing natural capital balance sheets for organisations to use based on a natural capital asset register. These can be used by owners of natural capital assets to record and value changes in them, providing the basis for risk management and investment decisions.

3.2.16 The NCC has worked with a consortium of efttec, the Royal Society for the Protection of Birds (RSPB) and PricewaterhouseCoopers (PwC) to develop and pilot a framework for organisations to account for the natural capital they own, depend on, or for which they are responsible. Our key aim is to encourage the adoption of the CNCA framework by organisations.

“Better management of natural capital can increase the value society derives from it.”

3.2.17 Better management of natural capital can increase the value society derives from it and CNCA provides a way to document the benefits of good management. The aim of CNCA is to establish a framework within which organisations can account for natural capital, documenting assets and liabilities in a balance sheet format that extends traditional financial reporting. The CNCA framework reports both the private value that an organisation earns from its natural capital (and for which an organisation often already accounts) and external benefits that society derives (for which an organisation does not currently account). Accompanying this report is a more detailed working paper, a full report and guidance document, illustrating the approach³².

3.2.18 CNCA is a methodology that can sit alongside an organisation's traditional financial and management accounts and should be seen as a complement to them. It enables organisations to gather natural capital information in a coherent and comparable format to aid decision-making about the management of natural assets, to the benefit of both the organisation and society. CNCA assists with determining:

- The value to an organisation of natural assets that it owns and/or manages;

³² Efttec, PwC & RSPB (2015) – see separate NCC technical report at www.naturalcapitalcommittee.org.

- The cost of maintaining them;
- Changes in their condition over time;
- Risks from depleting them;
- Opportunities from utilising them;
- Returns from investing in them;
- Their effect on interested parties and communities.

The NCC Recommends that:

Organisations should create a register of natural capital for which they are responsible use this to maintain its quality and quantity. The Government should incentivise wider adoption and uptake of the corporate natural capital accounting framework outlined in this report and consider requiring provisions to be made for the maintenance of natural capital.

Box 3.1: The Committee's corporate natural capital accounting (CNCA) pilot project

The Natural Capital Committee, working with a consortium of eftec, PWC and RSPB, has developed an innovative accounting framework which enables organisations to take better account of the natural capital they own, depend on, or for which they are responsible. Over the course of 2014, it has trialled this methodology with four organisations – Lafarge Tarmac, the National Trust, The Crown Estate and United Utilities.

Better management of natural capital can have a huge impact on the value society derives from it, and CNCA provides an accessible way to document the effects of this management. The aim of CNCA is to establish a framework within which organisations can account for natural capital, documenting assets and liabilities in a balance sheet format that extends traditional financial reporting. The CNCA framework reports both the private value that an organisation earns from its natural capital and external benefits that society derives (which is not usually currently incorporated in an organisation's accounts).

The National Trust chose to pilot CNCA on a farm on its Wimpole Estate near Cambridge. Wimpole Hall Estate consists of 1,200ha of semi-ancient woodland, open parkland, semi-natural grassland, enclosed farmland, and open water bodies. The farm had recently undergone a significant change in farming practice, from conventional arable farming to organic cropping and Higher Level Stewardship. One of the motivations for this change was a survey showing the very poor quality of its soil. The National Trust's CNCA shows that the change in farming practices results in a private value to the organisation similar to that before the management change, but a significant increase (£4.4m) in the annual value provided to society from its estate derived mainly from carbon storage.

The Crown Estate undertook CNCA on its Windsor Estate which covers around 6,400ha of parkland, woodland, and gardens. The Crown Estate's role is to make sure that the land and property it invests in and manages are sustainably worked, developed and enjoyed to deliver the best value over the long term. The Windsor Estate's CNCA demonstrates that it provides a substantial external benefit to society including recreation, landscape amenity, climate regulation and air filtration. This means that that Windsor Estate is producing more value than a traditional profit and loss account would suggest.

Lafarge Tarmac has extensive quarrying operations in the UK which often entail after-care conditions that require the company to restore the site to a pre-agreed condition. CNCA was applied to its Mancetter quarry,

a site of mining operations since 1873. The CNCA framework offered an opportunity to understand costs and benefits of the site over the accounting period and its transition from quarry to restored site. This includes a broader appreciation of the benefits the company derives from natural capital and its importance in business operations, such as water use. The CNCA reporting statements also help communicate the net benefits of the restoration to the local planning authority, local population, and other interested parties.

Compared to its existing condition, CNCA shows that the restored site will deliver significantly enhanced wildlife conservation, carbon sequestration values and recreation benefits which exceed the costs of restoration, in spite of some benefits being omitted due to incomplete data.

United Utilities examined the impact of its wastewater operations and investments on the status of four designated bathing waters in the North West of England. The pilot CNCA featured an 'extended' boundary. This was to account for these natural assets that United Utilities has a regulatory obligation to maintain, but does not own nor have complete control over the quality of, since bathing water quality is impacted by multiple sectors and sources. For a regulated utility, such as United Utilities, demonstrating the benefits associated with legal requirements for natural capital stewardship obligations is an important aspect of the regulatory framework within which it operates. In particular, through the regulatory strategic planning process United Utilities is required to demonstrate the value that is delivered by investments that are ultimately funded by customers. Hence CNCA provides a potential way for the company to report this value given the liabilities associated with statutory requirements for natural capital maintenance.

The Committee is publishing the results of the CNCA pilots alongside this report. These documents include a summary report, guidance for organisations who wish to prepare their own accounts, and the main report which details the full framework and results of the pilot.

Increasing momentum is now building behind CNCA with organisations such as the Greater London Authority and the Land Trust looking to develop an urban pilot account in London. Birmingham City Council is also considering whether to implement CNCA at a city scale, which would represent a great leap forward. This would build on Birmingham's Green Living Spaces Plan – the city's green and blue infrastructure plan – which introduced seven new planning principles, locked into the city's development plans. This was underpinned by the UK's first citywide ecosystem services assessment for its natural environment where six ecosystem services were mapped as supply and demand maps against the city's population distribution.

The Committee strongly hopes these new pilots will go ahead and looks forward to seeing the results. We think our CNCA framework is very well suited to private organisations as well as Local Authorities, and see corporate natural capital accounting as a critical step in ensuring natural capital is fully incorporated into decision making at both the private and public levels.

3.3 *How can economic valuation and decision making be improved to incorporate natural capital and the services it provides?*

3.3.1 Cost benefit analysis enables the comparison of different projects (including those involving natural capital) and the assessment of different options within projects. Importantly it takes account not only of those items which are traded in markets and therefore have prices, but also those benefits and costs that arise outside markets. Cost benefit analyses achieve this by applying methods for valuing (in monetary terms) the wellbeing gains and losses of these non-market goods and services. It is therefore crucial for guiding investments in natural capital and prioritising investment decisions.

3.3.2 Although the application of cost benefit analysis to environmental issues has developed enormously over the last 30 years, further improvements are possible and necessary to incorporate the value of natural capital fully into decision making processes.

- 3.3.3 One important improvement would be to enhance the guidance available to decision makers regarding investments involving natural capital. Government guidance on cost benefit analysis is set out in the H.M. Treasury Green Book³³. This guidance is currently being 'refreshed' and over the last year, the Committee³⁴, has looked at how the guidelines and practice of cost benefit analysis could be improved to take better account of natural capital. The Committee's recommendations are published alongside this report in a technical paper³⁵ and a summary is provided below.
- 3.3.4 A crucial initial step would be to improve the availability to decision makers of high quality economic valuations of natural capital and its services. There is always a cost associated with carrying out any such valuation, but this is almost always outweighed by the costs of failing to do so, which leads to poor decisions and inefficient or even inappropriate investments of public funds. For example, failure to assess the full costs and benefits of alternative strategies for flood defences or farm subsidies would mean that public funds would be spent inefficiently and fail to maximise the net benefits they can achieve.
- 3.3.5 A further recommendation is that the concept of natural capital should feature more prominently in the Green Book guidance. While valuation of changes in the flow of those goods and services derived from natural capital needs to be improved; consideration also needs to be given to changes in the underpinning stocks of natural capital. We recommend that new supplementary guidance is developed that outlines the general approach to valuing changes in both natural capital stocks and the flows of services they provide, supported by more detailed guidance for individual cases to illustrate specific issues.
- 3.3.6 This needs to be supplemented by a programme of work to provide decision makers with the values they need to improve investment decisions. We advise that the Government continues the work started by the Committee to develop the valuation of natural capital and the services it provides, based on research priorities communicated to the Research Councils³⁶. Ideally this would culminate in the development of readily useable valuation tools designed for use by decision makers.
- 3.3.7 Consideration needs to be given to the cumulative effects of multiple investment decisions upon stocks of natural capital. Assessing individual projects separately from their cumulative effects may result in depletion of assets.
- 3.3.8 Guidance should emphasise the crucial need to integrate natural science with economics; clarifying and quantifying the ways in which natural capital and its services combine with other capital (e.g. manufactured and human inputs) to generate changes in people's wellbeing and focussing upon changes in the latter as the measures of corresponding economic values.

³³ HMT (2003) <https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government>.

³⁴ The work was led by Professor David Maddison (Department of Economics, University of Birmingham) and Professor Brett Day (CSERGE, School of Environmental Sciences, University of East Anglia).

³⁵ Maddison & Day (2015), technical report to the NCC, www.naturalcapitalcommittee.org.

³⁶ See NCC advise paper on research priorities at www.naturalcapitalcommittee.org.

- 3.3.9 Traditionally, environmental values have been classified using the concept of Total Economic Value³⁷. Current guidance in the Green Book follows this approach. We propose that it would be more useful to distinguish different types of value according to whether they affect household wellbeing (for example through the provision of natural areas for recreation) or affect the production decisions of organisations (e.g. by ensuring uninterrupted supplies of water for manufacturing processes). This classification system would help to ensure that there are no overlooked ways in which an environmental change might affect individual and economic wellbeing.
- 3.3.10 The guidance could be significantly improved by updating and expanding the scope of methods considered for economic valuation. Current guidance focuses almost exclusively on techniques that are useful for valuing the effects of changes in environmental goods and services on households. This needs to be updated and supplemented with explanations of the techniques that exist for valuing impacts on the production side of the economy.
- 3.3.11 The future value of environmental change also needs consideration. It is common to encounter projects, the environmental impacts of which are spread over future time periods. The real value of environmental changes in the future may not be the same as those today, especially if income and consumption rise (leading to greater demand for environmental goods and services) while, at the same time, the quantity of those goods and services decreases. Cost benefit analyses need to take these factors into account.

“The value of environmental goods and services also depends on their proximity to centres of population”.

- 3.3.12 The location of environmental changes will often have significant implications for their costs and benefits. Different locations may be endowed with different quantities of environmental goods and services making them particularly suitable for generating certain values. The value of environmental goods and services also often depends on their proximity to centres of population. So, for example, the recreational

values of new woodlands (see Box 4.1) are far higher when they are established near to urban areas than in remote locations. Similarly development of England’s diverse geological assets (known as geodiversity) can generate major sources of recreational value, tourism revenues worth millions of pounds annually and large numbers of jobs³⁸. Such spatial issues need to be incorporated into economic appraisals where relevant.

- 3.3.13 Guidance should continue to encourage the postponing of irreversible decisions and building of flexibility into projects that have impacts on natural capital. More explicit treatment of risk and uncertainty and the ‘value of information concept’³⁹ should also be included.

³⁷ Pearce *et al* (1989)

³⁸ English Nature (2006)

³⁹ Information has economic value because it allows individuals to make better decisions, increasing benefits and reducing costs. Improving information regarding the wider benefits of natural capital can often highlight the value of conserving such capital and using it in sustainable ways.

3.3.14 Taking account of the distributional impacts of environmental change is an issue of growing importance. Consideration should be given to distinguishing such impacts from the wider (non-natural capital) distributional incidence of the costs and benefits of an investment. It is also important for the guidance to reflect that unless behavioural responses are taken into account, environmental investments intended to address distributional concerns might be frustrated.

3.3.15 The changes outlined above have the potential to significantly improve the way that natural capital is valued and incorporated into cost benefit analysis.

The NCC Recommends that:

Government should revise its economic appraisal guidance (Green Book), implementing our advice and, as a matter of urgency apply the revised guidance to new projects.

4. A framework for prioritising investments in natural capital

4.0.1 The previous chapter presented what we have called the foundations (measurement, accounting and valuation) that need to underpin a strategy to protect and improve natural capital. These are all to do with defining, measuring and valuing changes in natural capital assets and the benefits derived from them. They are indispensable for developing effective management strategies for our natural capital.

4.0.2 However, while accurate measurement, accounting and robust economic valuation are essential, they are not sufficient on their own. A commitment to reverse historic losses in natural capital is also required. This chapter focuses on the framework for identifying and prioritising actions as part of a strategy. In order to develop and implement the strategy successfully, answers to the following questions are also required:

- How much natural capital is needed and what targets should be adopted?
- Which natural assets and benefits need urgent action because they have the potential to deliver the greatest net benefits, are in the poorest condition or are closest to thresholds (such that benefits from them might be rapidly lost and hard to recover)?
- How should priority action be determined?

4.1 *How much natural capital is needed? How might levels for benefits and assets be determined?*

4.1.1 The Committee acknowledges that there is no single right or optimum level of natural capital for England and rather than recommending that government expends great time and resource in defining this, a more pragmatic course of action is suggested.

“Government needs to establish targets for an investment programme based on a systematic analysis of what is and will be needed in the future.”

4.1.2 Therefore, the Government needs to establish targets for an investment programme based on a systematic analysis of what is and will be needed in the future. This will mean that some assets will need to be restored or recovered to a higher condition than the present levels, while others might conceivably be left alone. The key point here is that greater attention needs to be given to the benefits derived from natural capital as well as the underpinning state of the natural assets themselves.

4.1.3 A starting point would be to establish targets for natural capital based on existing international and domestic policy. This approach has characterised international targets for biodiversity since at least the Rio Earth Summit in 1992 and there are many other international processes underway related for example, to climate change, sustainable development, wetlands and others. These existing commitments are a bare minimum. Much

more is needed to achieve the Government's stated objective of securing an overall improvement in natural capital and this can be to the benefit of the economy.

4.1.4 So, with this in mind, how might the 'targets' for natural capital be determined? Below we identify three approaches: scientific or technical analysis, economic techniques and societal preferences (including their expressions in policy and legislative commitments), although in reality a combination of all three is likely to be required.

4.1.5 Firstly, targets might be set through a *scientific or technical analysis* of the relationship between asset and benefit. This can be done most easily in cases where the relationships are direct and reasonably well understood, and is especially important where non-linearities (or thresholds) may be present. For example, an understanding of how tolerant a freshwater

“Levels of fish catch need to be informed by an understanding of the potential for those that are left to reproduce and replenish stock.”

body is to pollution will be important to inform decisions about how much pollution is permissible. Similarly, levels of fish catch need to be informed by an understanding of the potential for those that are left to reproduce and replenish stock. For wildlife species of conservation concern, it is possible to use population viability analysis to indicate the area or configuration of good quality habitat that is necessary to ensure a viable population over the long term.

4.1.6 Secondly, target setting might also be guided through more conventional economic techniques, such as cost benefit analysis, especially in situations where most of the costs and benefits can be reliably valued (see Section 3.3). Good examples that build on the underpinning scientific information about changes in the natural environment are harder to come by. The level of the aggregates tax and the landfill tax in the UK were heavily guided (at least initially) by economic analysis of costs and benefits. These policies set the tax rate at a level so that the external costs of landfill waste and aggregates activity would be reduced to points where the further abatement action (costs) would exceed benefits⁴⁰.

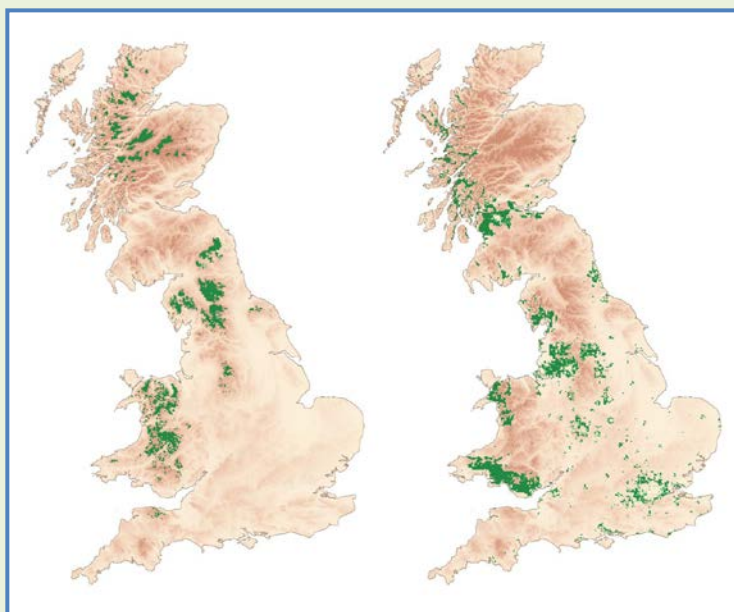
4.1.7 The Committee is of the view that there is significant potential to improve the role of good economic analysis in setting targets for natural capital. In our second state of Natural Capital report, we provided an example of how cost-benefit analysis could be used to meet woodland expansion targets in the most efficient way. The example is summarised in Box 4.1.

⁴⁰ Seely (2009).

Box 4.1: Delivering value for money from new woodland planting

In our second State of Natural Capital report, we presented analyses undertaken by the Centre for Social and Economic Research (CSERGE) at University of East Anglia (UEA) for the Natural Capital Committee and the UK National Ecosystem Assessment (NEA) Follow-on⁴¹. This research looks at *where* new woodlands might best be planted in order to meet the Government's objective of expanding afforested areas. An increase in woodland area of 250,000ha was considered for each of Wales, Scotland and England (750,000ha in total).

The analysis considered two approaches to determining where new forests should be established. The first of these only considered the market values (timber value benefits and costs to agriculture in the form of forgone production) associated with planting. As agricultural losses exceed the market value of timber this leads to new forests being confined to those areas where such losses are lowest; mainly in the uplands (including peatlands which release carbon dioxide when drained for planting trees) and away from major population centres (see left hand map). For Great Britain as a whole, this produces overall losses in excess of £65m per annum.



A second approach was to consider both these market values and a range of non-market values (including recreation and impacts on greenhouse gases).

This analysis suggested that woodlands should be planted around the periphery of major towns and cities across the country generating high recreation benefits and away from peatlands to ensure a net contribution to cutting emissions of greenhouse gases (see right hand map). This would deliver net economic benefits of nearly £550m per annum across Great Britain. Within England this yields benefit cost ratios of 5:1 using lower bound carbon values and nearly 6:1 using higher values.

Water quality improvements were also assessed as part of the model but were not valued in economic terms. Doing so would increase the economic returns and benefit cost ratios further. Similarly, wildlife impacts were considered in the model but not valued in economic terms due to a lack of robust value assessments.

4.1.8 Thirdly, a common means by which targets for aspects of natural capital have been established to date is through legislation and policies based on *societal desires* and preferences. For example, there is a network of National Parks and Areas of Outstanding Natural Beauty. These are all societal designations aimed at meeting people's wishes and expectations for recreation in semi-natural areas, both for present as well as future generations. In addition to social preferences, there are also the internationally agreed targets on biodiversity (the Aichi targets) and the EU and English responses to them⁴².

4.1.9 International law and policy provide an agreed and often negotiated set of targets to which the UK has committed. In addition, target setting based on 'societal desires' is a perfectly legitimate approach and common place, but care is needed to avoid an endless 'wish list' of

⁴¹ Bateman *et al* (2014).

⁴² <https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services>.

initiatives that are not supported by either scientific or economic evidence and are unaffordable. Economic approaches can play an important role through cost-effectiveness analysis which will help to inform how socially determined objectives can be met at lowest cost, and cost-benefit analysis which will help to inform whether an action will make society better off. Therefore, determining the objectives of a long-term investment programme in natural capital will ideally need to combine all three approaches.

- 4.1.10 Of equal, if not greater, importance is that Government leads a process of target setting so that subsequent investments are prioritised and focus on specific objectives and outcomes. Chapter 5 of this report provides examples of projects that could be prioritised in a long-term investment programme.

4.2 Which aspects of natural capital are at greatest risk from poor use or management?

- 4.2.1 The starting point for an investment programme in natural capital is to focus on those assets where actual or potential benefits are at greatest risk. This risk may result from weak practices for use or management. In our second State of Natural Capital report, we developed a preliminary risk register based on an initial assessment of the risks to the benefits provided by different natural capital assets and land-use types as defined in the National Ecosystem Assessment (NEA)⁴³.
- 4.2.2 The starting point for the risk register was to develop a comprehensive list of natural capital assets and benefits (see Figure 3), and examine the relationships between them. The purpose of this exercise was to understand which natural assets provide which benefits. Notwithstanding significant uncertainties and gaps in information, this allowed us to identify those natural assets of greatest importance in terms of the benefits they offer us, and then to establish the extent to which these are at risk.
- 4.2.3 To illustrate, using upland areas as an example, we reviewed how much uplands already and could potentially contribute to the provision of the full range of benefits derived from natural capital, concluding that while they are important for clean water, carbon storage, recreation, wildlife and protection from flooding, they are relatively less important for the provision of clean air or food. This exercise was undertaken for all major land-use types in the UK.
- 4.2.4 Following this initial prioritisation exercise, we investigated the most important linkages between the natural assets and benefits further. This enabled us to ascertain those cases where the benefits from natural capital were thought to be at risk, for example the provision of clean water from upland areas. The identification of risk comes from a review of existing targets, and an expert assessment of whether the condition of an asset or the provision of a benefit is deteriorating, and whether it is or could soon be below the target level or close to any known thresholds.

⁴³ UK NEA (2011).

4.2.5 The risk register is a pilot version of the approach we suggest that Government adopts in the longer term. As it stands, it is incomplete and based on information that was readily available to the Committee, but even so the existing exercise has revealed some important results which are summarised below:

- Outdoor recreation is of high economic value and its benefits can be increased by orders of magnitude by improving the quality of freshwater areas, increasing the amount of woodlands and other recreational areas around towns and cities, and by increasing urban greenspace provision;
- Air quality has improved over recent decades but there are still substantial benefits to be realised from improving it further;
- Wild fisheries are an important resource that are not all being managed with a view to long-term sustainability. The gains from improving commercial fish populations could be as much as £1.4bn to the economy per annum;
- Clean water from mountains, moors and heaths is at risk, due to the quality of those habitats and is being heavily affected by the growth of urban areas;
- Wildlife is at risk in many areas (for instance, semi-natural grasslands, enclosed farmland and freshwater environments) due to habitats that are fragmented and in poor condition;
- The degraded condition of mountains, moors and heaths is undermining the potential for much greater carbon storage in soils.

4.2.6 We advise that the Government continues the work started by the Committee to develop the natural capital risk register and, based on research already communicated to the Research Councils⁴⁴, establishes the appropriate evidence base, and undertakes a regular (at least every five years) annual update of the risk register.

4.2.7 In addition, the natural capital assets and benefits at greatest risk may warrant inclusion on the national risk register⁴⁵. Although, at present, this tends to focus on the risk of certain eventualities as opposed to chronic risks, broadening environmental risks to include those we have highlighted would improve coverage.

The NCC Recommends that:

Government should assign institutional responsibility for monitoring the state of natural capital. This should build on the NCC's work to develop a risk register that systematically assesses the benefits from natural capital.

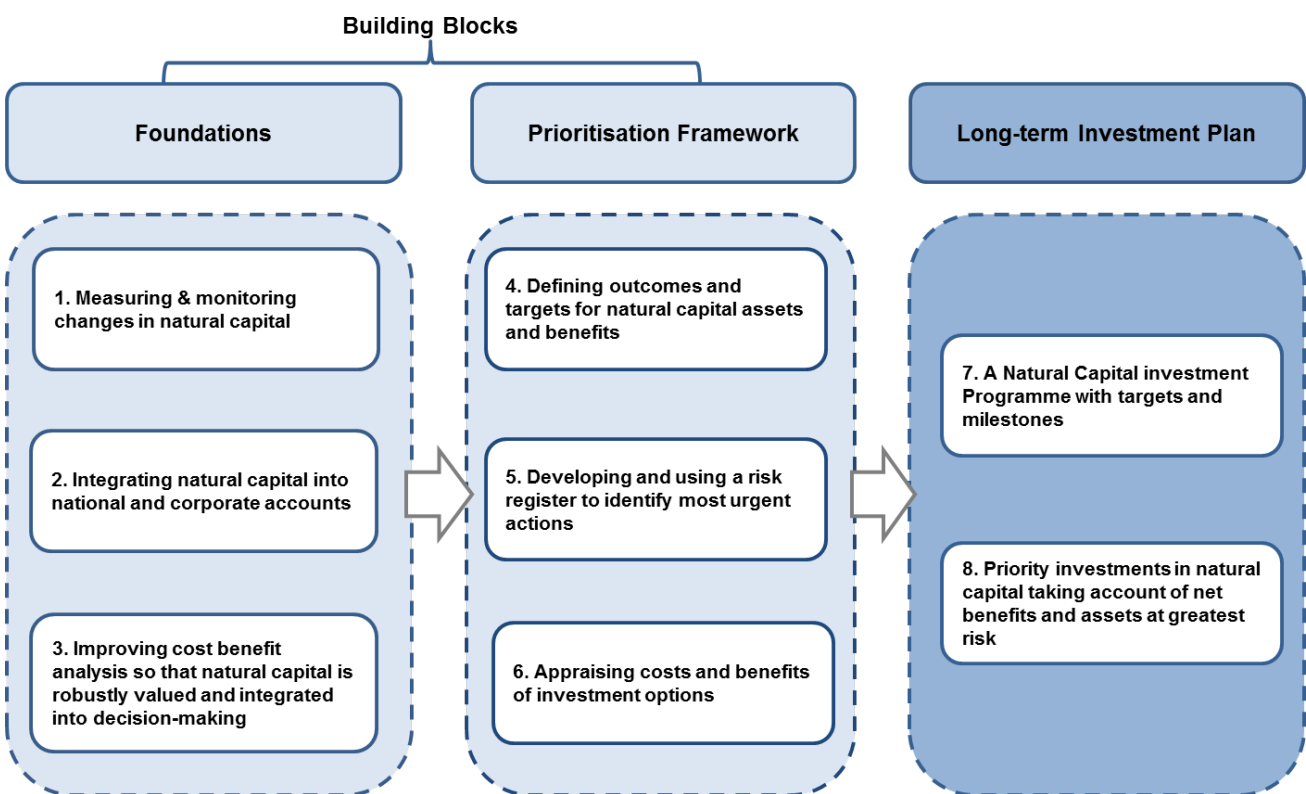
⁴⁴ See NCC advise paper at www.naturalcapitalcommittee.org.

⁴⁵ See National Risk Register for Civil Emergencies - <https://www.gov.uk/government/publications/national-risk-register-for-civil-emergencies-2013-edition>.

4.3 How do the foundations and the approach to prioritisation fit together to inform an investment programme for natural capital?

4.3.1 The preceding sections have outlined a range of steps necessary to develop a strategy and programme of investment in natural capital. How these fit together is presented in Figure 4 and explained below. Together, these should ensure that policies are effective and efficient with a strong underpinning economic and scientific justification. Although the foundations may take several years to develop fully, we emphasise again that investments in natural capital need not wait until all are in place. Enough is known now to design and execute a programme of action that will benefit the economy and people’s wellbeing.

Figure 4: Bringing together the foundations and prioritisation approach



4.3.2 New metrics are needed so that changes in natural assets and the benefits they provide can be adequately monitored over time. This is an essential first step and adjustments need to be made to existing monitoring programmes to include metrics for natural capital.

4.3.3 The next step is to organise the information generated by the metrics in accounts, both at a national level and in corporate accounts. This will add enormous value to our understanding of how natural capital is changing over time if the accounts are designed in the right way and with policy application in mind.

4.3.4 Improving cost benefit analysis so that changes in natural capital are properly appraised and robustly valued in decision making processes is the third essential foundation. Improving

Green Book guidance in the way the Committee has suggested (see Section 3.3) will be a significant step forward for Government.

- 4.3.5 Following the foundations comes the prioritisation framework in the centre of Figure 4. We've identified three steps to undertake this effectively. Firstly, clear outcomes or targets are essential to guide investment decisions. We have proposed a variety of ways in which these could be determined and recommend that Government leads and facilitates the process.
- 4.3.6 Secondly, a risk register to understand which assets and benefits are at greater risk is needed. As discussed in Section 4.2, we have piloted an approach that Government and others could develop further to establish which areas require urgent attention.
- 4.3.7 Finally, as part of the prioritisation framework, an assessment of the costs and benefits of specific interventions is needed. This is likely to be required at two levels: 1) to cover the entire investment period which will provide a high level understanding of net beneficial investments and how they compare with one another; and 2) to inform more detailed delivery options and milestones, of which there will be many.
- 4.3.8 Over the past year, we have undertaken an initial assessment of costs and benefits of sample investments in natural capital, in order to gain a better sense of what the priorities might be. These are discussed in Chapter 5 below.



Scafell Pike, Lake District

5. An initial assessment of investment priorities

5.0.1 One consequence of having ignored the true value of natural capital in decision making over many years is a legacy of over-consumption and underinvestment in natural assets. This accumulated 'debt' following successive deficits does mean that where declines in natural capital are reversible from the current baseline, a range of productive investments can be implemented which will boost growth and wellbeing.

5.0.2 Since our last report, we have undertaken an initial assessment of natural capital investment opportunities in England to illustrate the range of possibilities and so that the Government

“One consequence of having ignored the true value of natural capital in decision making over many years is a legacy of over-consumption and underinvestment in natural assets.”

and others can start a programme quickly if they choose to do so. In line with our Terms of Reference, we have developed advice on how to prioritise investments in natural capital, looking in particular at the economic valuation evidence underpinning each investment opportunity. The purpose of such investments is to tackle the overall declining trend, transforming it into a trend where natural capital is improved in aggregate, despite intensifying pressures.

5.0.3 We have reviewed a range of potential investments, mostly at a project level, and assessed the extent to which evidence supports 'scaling-up' to a much larger, national level. A number of individual cases document the significant net benefits of investment at a small scale. The factors affecting the potential for scaling-up and the uncertainty inherent in the exercise are documented in separate reports⁴⁶. The analysis is presented in Section 5.1.

5.0.4 In Section 5.2, we turn our attention to the potential synergies between investments, identifying substantial benefits to their implementation in combination. It is difficult to overstate how important this is: a key characteristic of natural capital is that it regularly delivers multiple benefits. Furthermore, at larger scales those benefits generally require fewer resources per unit of benefit. An area of intertidal habitat on the coast, for example, can act as a buffer against flooding. It can also provide areas for recreation; act as a nursery ground for commercial fish species; sequester and store carbon from the atmosphere and maintain itself. In contrast, a sea wall only protects against coastal flooding and tends to have a negative effect on the other benefits listed and will require regular, sometimes costly maintenance.

5.0.5 The synergies between investments in natural capital significantly complicate any analysis of this kind but they are of fundamental importance and cannot be ignored. To succeed, a long-term investment programme must take them into account. Indeed, the potential to add significant value by defining a coordinated programme of investment is enormous and is the

⁴⁶ Eftac in association with CEH, APBmer & Regeneris (2015) Report to the natural capital committee available at www.naturalcapitalcommittee.org.

principal reason that we are emphasising an integrated approach to the delivery of investments in natural capital.

5.1 Which investments in natural capital offer the greatest economic return?

- 5.1.1 To begin the analysis, the Committee identified an initial list of nine potential investment areas, drawing on the risk register work (as outlined in Section 4.2) and expert knowledge of the quality and coverage of economic valuation evidence. The list is by no means comprehensive, but it does offer a good starting point for developing a set of investment cases and for highlighting those that the Committee thinks Government should develop further.
- 5.1.2 The nine areas are set out in Figure 5 below. They have been grouped according to the strength of the evidence underpinning each and how far it is currently possible to develop each case. Those in the blue upper box, labelled 'good evidence', include woodland planting, wetland creation, upland peatland restoration, intertidal habitat creation and fisheries. For each of these, there is good evidence on the costs and benefits at a project level and we have found that there is significant scope for the benefits of larger scale, coordinated investments to outweigh costs. Benefit cost ratios of 4:1 are typical at a programme level and are often higher at a project level.
- 5.1.3 Those in the green lower box have been labelled 'more evidence required'. Here we have found that although there appears to be a strong case for action to protect and improve natural capital, which is supported by individual examples, there are information gaps on either the costs or the benefits. Further work is therefore needed to develop an investment case that includes both to a satisfactory degree on a larger and / or national level scale. Nevertheless, given the sheer scale of benefits that could be delivered and the number of people that would benefit from investments in urban greenspaces and better air quality in particular, it is inconceivable that appropriately targeted investments would not yield positive net economic benefits. The application of our corporate natural capital accounting framework should help fill the data gaps and provide more comprehensive evidence upon which to base investment decisions.

Figure 5: Options for investing in natural capital





J Akerman, Environment Agency – Medmerry

5.1.4 The nine areas examined are discussed in more detail below.

Woodland planting

- 5.1.5 Investment in an expansion of England's woodlands could generate very substantial benefits, particularly in terms of recreation opportunities and carbon capture and storage. Gains for wildlife and improvements in water quality would also be delivered.
- 5.1.6 Our analysis shows (also see Section 3.3) that a substantial woodland planting programme, of between 150,000 to 250,000ha over the next 50 years, would deliver considerable net benefits. However, to secure these benefits, the new woodlands would need to be located appropriately: near to cities to generate recreational values; avoiding fragile habitats such as peatlands to ensure that stores of soil carbon are not damaged; taking account of the importance of certain areas for wild species or for the abstraction of water supplies; and recognising the high value of certain areas for food production. In addition, delivered as part of a coordinated catchment management programme, there are also good project level examples where new woodlands have contributed significantly to water quality and to protection from hazards, specifically flooding. This is discussed further in Section 5.2.

Restoring upland peatlands

- 5.1.7 Peatlands that are in good condition, particularly in upland areas, generate very substantial benefits, such as considerable carbon storage. The condition of these areas varies widely

across England. Most suffer from a combination of heavy drainage and inappropriate burning practices.

- 5.1.8 Our analysis finds that there is a strong economic case to support investments in activities aimed at re-wetting certain areas of peatland which will lead to significant benefits beyond carbon storage including improved water quality and wildlife.
- 5.1.9 To illustrate, we estimate that improvements on around 140,000ha of upland peatland could deliver benefits (in net present value terms) of approximately £560m over 40 years. On the benefits side, this calculation only takes account of avoided losses of carbon, so this figure is a very low estimate of the benefits to be gained. Case study evidence demonstrates significant wildlife and water treatment cost savings too. However, these additional benefits vary significantly across catchments and require careful targeting, so it is inadvisable to generalise. Further spatially explicit work is needed to develop this aspect of the analysis further.
- 5.1.10 We note that Government is already very active on peatlands and are particularly encouraged by initiatives such as the pilot UK Peatland Code which was launched in September 2013 by Defra and the International Union for the Conservation of Nature. The Code is designed to support funding from businesses interested in restoring degraded peat bogs as part of their corporate social responsibility (CSR) commitments. A pilot phase of the Code is expected to run until July 2015 with the aim of developing it further to ensure it is ready for wider rollout⁴⁷.

Box 5.1: The benefits of restoring upland peatlands in the South Pennines⁴⁸

Yorkshire Water and Natural England assessed how land management scenarios in the Keighley and Watersheddles catchment in the South Pennines would affect the provision of a range of benefits. The study found that restoring and re-wetting upland blanket bog over a relatively small area (around 3,000ha) could deliver estimated net benefits of £6.3m over a 25 year period. Overall, the benefits from increased carbon sequestration, improvements in wildlife and reductions in water treatment costs exceeded restoration costs by a ratio of 3:1. The study also looked at the costs and benefits of further deterioration in the quality and extent of the blanket bog. Under this scenario, the analysis found that the benefits of preventing further declines exceeded costs by over 5:1.

Creating more wetlands

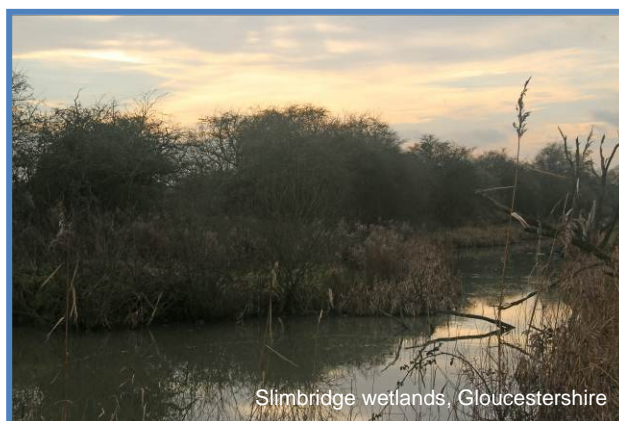
- 5.1.11 Over the past 75 years, 45% of wetland habitats have been lost in England⁴⁹. Those that remain have declined in condition due to a variety of pressures (particularly diffuse water pollution) and tend to be highly fragmented across landscapes. Freshwater wetlands can provide a wide range of benefits, in particular recreation, improved water quality, flood protection, carbon storage and wildlife habitat.

⁴⁷ <http://www.iucn-uk-peatlandprogramme.org/peatland-gateway/uk/peatland-code>.

⁴⁸ Harlow *et al* (2010).

⁴⁹ <http://www.wetlandvision.org.uk/dyndisplay.aspx?d=downloads>.

5.1.12 Our analysis demonstrates there is a good economic case for expanding the extent of wetland areas by around 100,000ha, particularly in areas of suitable hydrology, upstream of major towns and cities, and avoiding areas of high grade agricultural land. The estimated benefits range considerably in magnitude, but were found to exceed costs significantly under certain scenarios. Ratios of 9:1 are possible for some wetland sites of 100ha.



Slimbridge wetlands, Gloucestershire

5.1.13 Measures to improve the quality of existing wetland areas and other water bodies were not reviewed in our analysis but there is evidence from individual case studies demonstrating improvements can generate net benefits in economic terms. In addition, the Environment Agency has recently completed an economic assessment of measures to improve the quality of water bodies and rivers to 'good status' in England⁵⁰. Their analysis shows that these measures could generate benefits of around £21bn (present value over a 37 year period) for costs of £16bn. Altering the package of measures to include less costly interventions⁵¹ improves the overall picture, generating estimated benefits of £20bn for costs of around £12.1bn, thus deriving significant net gains for society.

Protecting and expanding intertidal habitats such as saltmarsh

5.1.14 As stated in the introduction to this chapter, intertidal habitats provide a range of benefits which are not currently valued properly. As a result, approximately 100ha of saltmarsh per annum in the UK continues to be lost. This might sound like a small area but this has been happening for decades and what is being lost can be extremely valuable. A growing number of case studies demonstrate that investments in habitats like saltmarsh offer value for money once a wider range of benefits are assessed. This is especially so given the anticipated effects of climate change and sea level rise.

5.1.15 Our analysis finds many individual examples where the benefits of managed realignment of coastal flood defences outweigh costs (see Box 5.2). It also finds that there is good evidence to support a step change in the rate of managed realignment activity as set out in the various Shoreline Management Plans (SMPs) covering our coastal areas. However, some of the economic cases only stack up if costs and benefits are assessed over a sufficiently long period of time.

⁵⁰ <https://consult.environment-agency.gov.uk/portal/ho/wfd/water/choices?pointId=2416646>

⁵¹ This involves removing some of the more ambitious but expensive measures with less ambitious but less costly measures.

Box 5.2: Medmerry realignment project in the Solent Estuary

The Environment Agency recently undertook a 450ha managed realignment project at Medmerry on the south coast. This scheme was undertaken primarily for flood protection and to provide compensatory habitats for losses of marshes elsewhere in the Solent estuary.

The project created 183ha of saltmarsh and large areas of extra transitional, newly created habitat (i.e. not compensation for losses elsewhere). The project saves on recurring coastal protection expenditure (which averaged £300,000 per annum), and is likely to have helped avoid considerable damage to the surrounding area during the 2013/4 winter storms. The project has estimated benefits of over £90m, compared with project costs of £28m.

Improving fish stocks

- 5.1.16 Actions to restore fish stocks, such as cod and shellfish, could generate substantial net benefits. Fishing effort is still high, meaning that these stocks are not able to recover to more productive levels that could be supported by the wider marine ecosystem. Recovery of stocks towards maximum sustainable yield (MSY) levels could lead to significant, sustained increases in landings. We recognise that reducing the level of fishing effort to allow these stocks to recover will have short-term impacts on the fishing industry, but the long-term gains are potentially large, securing jobs in the industry for generations to come.
- 5.1.17 An initial analysis of measures to improve stocks of lobster and brown crab suggest that the benefits of increased future landings could outweigh costs of forgone landings in the short-term by a ratio of 6:1 over a period of 50 years. Benefit cost ratios would be much higher under a baseline scenario of stock collapse. A 6:1 ratio is therefore a conservative estimate under such an eventuality.
- 5.1.18 In the case of some demersal fish species, such as cod, the recently reformed Common Fisheries Policy requires that stocks are restored and maintained above biomass levels that can produce MSY. Achieving this across all fisheries in the UK could increase resource rents by approximately £570m per annum, ten times more than their current value.

Improving and expanding urban greenspace

- 5.1.19 Green space, particularly in urban environments, can be of enormous recreation value as the evidence above on woodland planting shows. In addition, there is a growing body of evidence supporting the substantial mental and physical health benefits that can arise if people use it regularly (see Box 2.2). Natural England, for example, have estimated that if every household in England were provided with more equitable access to good quality green space, then around £2.1bn in health cost savings could be achieved by the National Health Service (NHS) per annum⁵². The vast majority of homes do not have such facilities⁵³.

⁵² Natural England (2009)

⁵³ CABI (2010)



5.1.20 Our analysis in this area has found that the benefits of providing access to greenspace are high, even when only a limited range of values are considered, and that they are growing stronger all the time. Urban greenspaces, designed in the right way, can also make contributions to wildlife (for example creating corridors for pollinators and other species), air quality albeit limited and water quality. None of these benefits are properly valued in most of the evidence we have reviewed.

5.1.21 Consideration should also be given to the development of geological attractions as a potential source of recreation for nearby urban populations, such as the proposed Black Country Global Geopark in the West Midlands.

5.1.22 Further investment in good quality greenspaces will bring with it significant net economic benefit. The main area of uncertainty lies on the cost side of the equation. To develop a robust investment case requires consideration of the quantity and quality of greenspace, and consideration of specific location. This makes the analysis particularly complicated and very difficult to do at an aggregate level, which has been our focus here.

5.1.23 In order to make progress on the delivery of greenspaces, we urge the Government to review its policy and funding framework. Much of the responsibility for funding is rightly devolved to Local Authorities but given that other areas of Government and society will also reap the benefits, it seems logical for the Department of Health, Public Health England and the National Health Service to play a significantly greater role than they do at present.

Box 5.4: Improving urban natural capital is cost effective

Box 2.2 outlined some of the benefits obtained from urban natural capital (also called green infrastructure). These include: physical and mental health benefits; improved air quality; reduced urban heat effect from the built infrastructure; enhanced carbon capture and storage; reduced flood risk; greater habitat and food provision for wildlife; and even food for humans.

Given that over 80% of England's population now lives in urban areas⁵⁴, the quantity and quality of green infrastructure (GI) in our urban areas is of critical importance. It is not just an issue of wellbeing and economic benefits, but one of equity and distribution, too. It is the poor who often suffer particularly from a lack of access to good quality local GI. The air quality is often worse in poorer neighbourhoods due to the proximity of busy roads and few trees to absorb pollutants. The quality of local parks is often poor, which discourages people from using them. The poor are less likely to have their own gardens, and they are less able to afford to visit quality rural natural recreation areas such as national parks and woodlands.

Investment in GI is often the first to be sacrificed during periods of financial pressure, but this is a false economy. Local authorities therefore need to get better at valuing their GI, for example, by using the

⁵⁴ 2011 Census - http://www.ons.gov.uk/ons/guide-method/census/2011/index.html?utm_source=twitterfeed&utm_medium=twitter.

Committee’s corporate natural capital accounting framework. This will enable them to make a stronger case for its protection to central government and their voters.

GI needs to be fully incorporated into urban planning systems, to help avoid short termism. Building GI into long-term development plans will not only ensure its benefits from the outset, but will also avoid costly retrofitting in the future.

The cost of protecting and improving GI does not need to be prohibitive. Significantly better outcomes than is common for GI can be achieved simply by using existing resources more wisely. For example:

There are some really encouraging examples in all these areas of good work to improve GI around the country, but unless these are taken up much more widely, many opportunities to improve wellbeing will be missed.

Improving air quality

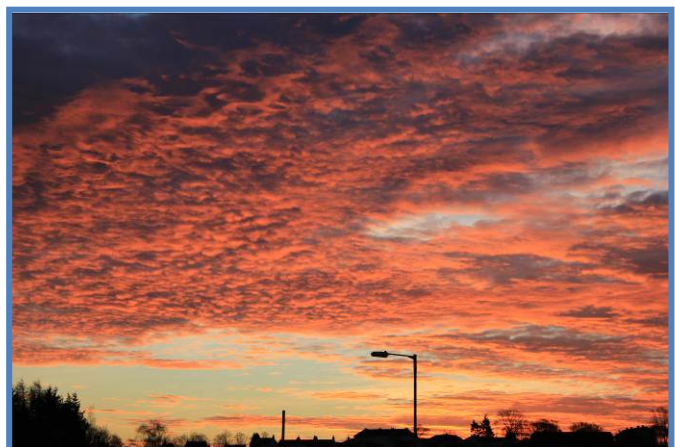
5.1.24 Although notable improvements in air quality have been achieved over recent decades, air pollution, particularly from vehicle use in urban areas, continues to have significant negative health effects. According to the European Environment Agency (EEA), “*air pollution is the top environmental risk factor for premature death in Europe; it increases the incidence of a wide range of diseases and has several environmental impacts, damaging vegetation and ecosystems*”⁵⁵.

“The effect of the smallest particulates (PM_{2.5}) on mortality in the UK in 2008 was estimated to be equivalent to 29,000 premature deaths, valued at around £16bn.”

5.1.25 The effect of the smallest particulates (PM_{2.5}) on mortality in the UK in 2008 was estimated to be equivalent to 29,000 premature deaths, and have an economic value of around £16bn⁵⁶. In 2011, that estimate was even higher at nearly 40,000 premature deaths⁵⁷. Emissions of ammonia, primarily from the agricultural sector, are also high and cause

significant damage to ecosystems and wildlife, estimated in the region of £631m per annum in the UK.

5.1.26 Efforts to tackle poor air quality in urban areas will clearly bring enormous benefits and potentially make a difference to millions of people who live in towns and cities. However, the costs



⁵⁵ EEA (2014).

⁵⁶ Note the figure of £16bn is for PM_{2.5} only.

⁵⁷ EEA (2014).

of improving air quality are also likely to be high. Traffic volumes are predicted to increase significantly and will need to be better managed, and major reductions in emissions from those vehicles (particularly diesel vehicles) will be required. Such measures will take time and more information is needed on costs in order to build a robust investment case.

- 5.1.27 As with urban greenspaces, delivering improvements in air quality is complex and we believe that greater coordination is needed across Government and between different levels of Government to address the problem effectively.

Improving the environmental performance of farming

- 5.1.28 Farming is an important sector of the economy. Despite only accounting for around 0.7% of GDP, it utilises around three quarters of total land area and therefore has a huge bearing on natural capital, both positive and negative.
- 5.1.29 On the positive side, extensive farming practices of the past have shaped much of our wildlife, habitats and landscapes. Many species and habitats rely on these practices continuing; extensive farming practices are especially important for designated areas like Sites of Special Scientific interest.
- 5.1.30 On the negative side, farming can produce large external costs to society in the form of greenhouse gas emissions, water pollution, air pollution, habitat destruction, soil erosion and flooding. These costs are not reflected in the price of food. As a result, farming is responsible for net external costs to society that have been valued at £700m per annum⁵⁸.
- 5.1.31 Improving the environmental performance of farming has the potential to deliver significant benefits to society and improve many of our natural assets. Evidence for this stems mainly from analysis looking at the costs and benefits of environmental payments to farmers. Recent work by Defra⁵⁹ found that for every £1 invested in environmental schemes under the Common Agricultural Policy, society gets over £3 in return. This analysis covers only those aspects of environmental improvements that can be valued in economic terms. Other benefits that are presently non-monetised would be additional and make the case even stronger. Also, evidence from demonstration farms shows that farming practices which improve natural capital can be incorporated into commercial farming systems without compromising profitability⁶⁰.
- 5.1.32 Finally, the location of environmental improvements in farming matters, just as it does in many other investment cases. Many of our most important wildlife sites suffer from isolation and fragmentation. The Lawton report⁶¹ made a convincing case for wildlife sites to be better connected across landscapes. The planting of hedgerows, changes in the management of

⁵⁸ Defra (2009). Taken from the Environmental Accounts for Agriculture work which was discontinued in 2010. Net external cost figures were last produced for 2008.

⁵⁹ See Defra (2013) https://consult.defra.gov.uk/agricultural-policy/cap-consultation/supporting_documents/131022%20CAP%20Evidence%20Paper%20%20Final.pdf.

⁶⁰ Eftac, CEH, APBmer & Regeneris (2015) Report to the natural capital committee available at www.naturalcapitalcommittee.org.

⁶¹ Lawton *et al* (2010).

grasslands and arable margins, and improving the connectivity of fragmented woodland on farmland could all make an important contribution to improved connectivity. This is an important element of efforts to improve natural capital.

Managing catchments to improve water quality and soils

- 5.1.33 Catchment management approaches are already widely funded in England through the Catchment Sensitive Farming Programme and other initiatives with a growing number of Water Company programmes. The underpinning logic of these initiatives is that many small land management interventions of the right sort and in the right place can make a significant contribution to improvements in freshwater systems. Indeed, catchment management interventions form a substantial part of the proposed measures required to meet objectives under the Water Framework Directive. In places, reductions in flood risk have also been documented as an additional benefit.
- 5.1.34 Our review points to many individual examples with significant positive benefit cost ratios – notable ones being in the South West (see Box 5.5 below). In other areas of the country, water companies are increasingly reporting the potential for savings in water treatment costs as a result of land management interventions, though these are highly location-specific.

Box 5.5: Upstream thinking - an example of natural capital delivering multiple services as part of a catchment approach⁶²

'Upstream Thinking' is a project undertaken by South West Water in Exmoor and other water-catchment sites in the region. Joint investments between farmers and the water company ensure that land is managed in such a way that potential water pollutants including peat, soils and natural fertilisers are kept on their land and do not run off into surrounding water courses. This brings benefits to the farmer (in terms of lowering the costs of operations), to the water company (which does not have to invest as much to treat the water downstream) and wider society (which benefits from having healthier rivers for recreation, angling and enjoying wildlife).

By funding improvements in water and slurry management at source, South West Water has cut the costs of its operations. Such interventions are proving to be good value for money. Furthermore, improving the quality of water catchments is not just good for water quality but has other benefits too. For instance, re-wetted peat bogs also capture and store carbon dioxide, create habitat for plants and animals, reduce pests for the livestock that graze nearby and increase recreation values.

- 5.1.35 The value added from catchment approaches is demonstrated by their ability to coordinate a range of different measures as part of a broader, more strategic plan of action seeking to exploit synergies, rather than by individual interventions. This is discussed further in the next section.

⁶² <http://upstreamthinking.org/index.cfm?articleid=8692>.

Box 5.6: Benefit cost ratios of natural capital investments⁶³

As this Chapter demonstrates, the benefits of natural capital investment that can be measured exceed the total costs for many restoration projects. That is, investing in natural capital frequently makes economic sense even when some of the benefits cannot be adequately valued.

A comparison of natural capital investment against other capital investment shows that returns on the former are competitive with the latter. This suggests that inadequate money is being allocated to improving our natural capital infrastructure, and also that societal wellbeing as a whole could be improved if resources were reallocated towards investing in natural capital.

The cost benefit analysis results from different types of capital investment are not comparable in every respect, since several methodologies may have been used and the scope of the costs and benefits included vary. However, they should be broadly consistent through adherence to the Government's Green Book on appraisal guidance, so comparison is meaningful.

The table below shows average benefit cost ratios (BCRs) for various categories of capital investment.

Area of investment activity	BCR Range
Road schemes	Average 4.2 (local) to 4.6 (national), but can range from 1 to 10
Light and heavy rail	2.1 (light) to 2.8 (heavy)
Active travel schemes	1 to 3 for cycling; 10 plus for other transport modes (e.g. walking)
Flood defence	Min of 8 and forecast of an average of 9 for investments made 2010 to 2014
Broadband	Potentially 20
Non-residential property	c. 6 (cautious) to 10 (central)
Residential – support for new build	1.7 (cautious) to 2.6 (central estimates)
Residential – support for demolition and new build	3.7 (cautious) to 5.5 (central estimates)

Indicative BCRs for some of the possible natural capital investment projects outlined in this chapter have been calculated. These show that:

- A widespread planting programme of woodlands has a BCR of at least 5:1 rising to considerably higher levels in the most optimal locations;
- While it is hard to generalise for catchments, the main case study investigated for this work had a BCR of 4:1;
- Saltmarsh restoration has BCRs in the region of between 2 and 3:1;
- Inland wetlands restoration projects can have BCRs of up to 9:1.

5.2 Why is a coordinated plan of action on natural capital so important?

5.2.1 To implement the strategy to protect and improve natural capital, the Committee advises that Government should develop a comprehensive and coordinated plan of action with the other main interested parties – the private sector and civil society. This might be a large task but it is essential to ensure that the many interested parties' initiatives needed for this to succeed

⁶³ See Eftec, CEH, APBmer & Regeneris (2015) Report to the natural capital committee available at www.naturalcapitalcommittee.org.

pull in a similar direction and work towards a common purpose⁶⁴. A long-term action plan is also necessary to:

- Secure the multiple benefits delivered by natural capital on individual sites;
- Exploit synergies in benefits *between* different sites; and
- Take account of location, which is of great importance.

“One of the unique properties of natural capital is that it delivers multiple benefits simultaneously.”

5.2.2 As stated in the previous section, one of the unique properties of natural capital is that it delivers multiple benefits simultaneously. In virtually every situation we have reviewed, investments in natural capital have the potential to provide a range of benefits to many different beneficiaries – locally (e.g. through recreation opportunities) and globally (e.g. through carbon storage). We can already show that many natural capital investments generate attractive benefit-cost ratios and with further research to strengthen the evidence, the investment case for individual projects at specific sites is likely to grow.

5.2.3 In addition to multiple benefits being provided on single sites, it is also important to understand the synergies between investments in natural capital on different sites, especially when developing a plan that brings together different initiatives of different interested parties. For example, take the individual cases for woodland planting, peatland restoration, and wetland and intertidal habitat creation. Individually, strong arguments can be made for undertaking each, but if investments in these activities were effectively coordinated at both a national level (to ensure resources are allocated as efficiently as possible across different areas of the country) and more locally at a catchment scale for example⁶⁵, net benefits could be significantly enhanced in aggregate. Also, the costs of achieving the targets as set out in the strategy could be minimised.



Woodwalten Fen, Cambridgeshire

⁶⁴ A good example of this [a coordinated plan of action on natural capital] is an initiative in the Upper Thames being led by Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT). In order to achieve the Water Framework Directive objectives for water bodies in the area, a catchment approach is being taken that coordinates the investment activities of different interested parties. This might involve the creation of an independent steering organisation that is able to foster trust and facilitate communication between a diverse range of groups operating in the area. The scale of necessary action and funding requirements make governance of this kind essential. Over the coming year, BBOWT will take a lead on developing these relationships.

⁶⁵ The Committee is of the view that catchments perhaps offer the best means of exploiting synergies at a local level so that individual actions can collectively become far greater than the sum of their parts.

- 5.2.4 This is true for water quality in particular. Improving the condition of upland peatlands at the top of the catchment can lead to reductions in water colour and other pollutants, for example. This in turn can lead to savings in water treatment costs depending on the particular circumstances. Further down the catchment, woodlands planted in the right places can lead to reduced sedimentation of water courses, benefiting wildlife in these habitats as well as improving water flow and quality. One study looking at the Upper Wharfedale catchment in North Yorkshire found that woodland planting on only 5% of the catchment, in very specific areas, could prevent 80% of sediment entering the river⁶⁶. This offers a good illustration of the point made in Chapter 3 that careful spatial targeting and a good understanding of the underpinning science can lead to significant benefits at relatively low cost.
- 5.2.5 Increasing wetland areas will most likely lead to further improvements in water quality as one progresses down the catchment. As discussed previously, they will also provide valuable recreational benefits as well as key habitats for wildlife. Good quality urban greenspaces and sustainable urban drainage systems (SUDS) will help clean the water even more. Finally, at the bottom of the catchment, increased areas of intertidal habitats offer benefits such as storm protection, habitats for wildlife, and can act as sinks for certain pollutants (as explained in Section 5.1). The fundamental point here is that individual actions and investments in natural capital should not be considered in isolation.
- 5.2.6 Finally, it is worth emphasising that an investment programme in natural capital would be strengthened through better integration with similar initiatives in other areas' programmes – for example the National Infrastructure Plan⁶⁷.

The NCC Recommends that:

Government, working with business, NGOs and other parts of society, should fully develop a 25 year plan. This plans needs to incorporate specific all the Committee's recommendations, detailing specific actions for all parties to deliver the strategy to protect and improve natural capital. This will need to set out who does what, when and where and how actions are to be resourced and incentivised.

The NCC Recommends that:

The National Infrastructure Plan should incorporate natural capital into each of the main infrastructure sectors, following the mitigation hierarchy for managing impacts (avoid, minimise, restore, offset). An investment programme for natural capital should also explicitly feature in the National Infrastructure Plan.

⁶⁶ Lane et al (2008).

⁶⁷ <https://www.gov.uk/government/collections/national-infrastructure-plan>.

6. Incentivising and financing improvements in natural capital

6.0.1 So far we have set out why natural capital is so important and what needs to be done in order to secure its protection and improvement. We have made it clear that basic building blocks need to be put in place (the proper and full measurement and valuation of natural capital and its incorporation into decision making), but that this on its own is not sufficient, and that we already know enough to invest effectively in natural capital now, even if the full set of building blocks are not yet in place. In order to correct the legacy of overconsumption over many years, we can say with confidence that investment in natural capital is required and we can point to priority activities, such as those outlined in the preceding section.

“There is a strong rationale for dividing responsibilities between the private and public sectors, in line with the benefits accrued.”

6.0.2 Many actions and projects to improve natural capital have the potential to boost growth and wellbeing. The case for undertaking them is strong as demonstrated in the previous section, so it is logical to ask whose responsibility is it to ensure the right incentives, frameworks and funding are in place so that required improvements in natural capital actually happen.

6.0.3 There is a tendency to assume that responsibility for this lies solely with the Government and that the cost of protecting and improving natural capital inevitably falls on the Exchequer. However, this is not necessarily the case; there is a strong rationale for dividing responsibilities between the private and public sectors, in line with the benefits accrued. Recent initiatives, including those highlighted above and the work of the Ecosystem Markets Task Force⁶⁸, the Natural Environment Research Council (NERC) Valuing Nature Network⁶⁹, the Economic and Social Research Council (ESRC) Nexus Network⁷⁰, the Cambridge Institute for Sustainability Leadership (CISL)⁷¹ and others provide a wide variety of examples of successful business sector actions and collaborations with the public sector. These initiatives need to be built upon.

6.0.4 The private sector owns and is responsible for a significant proportion of our natural assets. Decisions taken by private organisations and consumers determine the fate of natural assets to a large extent. For example, our food, water, sewage, clothes, houses and travel all affect and are affected by natural capital. An increasing proportion of our impact falls overseas. We are all responsible for these impacts. The Government controls many of the levers, be they taxes, subsidies, legislation or other, and so can be instrumental in ensuring the right incentives are in place, but the private sector and civil society also have a significant part to play.

⁶⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/316101/Ecosystem-Markets-Task-Force-Final-Report-.pdf.

⁶⁹ See <http://www.nerc.ac.uk/research/funded/programmes/valuation/vnn-final-report.pdf> and www.valuing-nature.net

⁷⁰ www.thenexusnetwork.org.

⁷¹ www.cisl.cam.ac.uk.

The NCC Recommends that:

Government should determine how the plan to protect and improve natural capital is to be funded, drawing on a combination of public and private funding as proposed by the Committee.

6.1 Options for financing

6.1.1 We have broken down financing options into a number of distinct categories, namely:

- (i) Capital maintenance payments from public, not for profit and private sector asset owners;
- (ii) Rents from non-renewable resources (e.g. oil or shale gas);
- (iii) Compensation payments from developers;
- (iv) Greater use of economic instruments (e.g. taxes and charges);
- (v) Reforming and eliminating perverse subsidies;
- (vi) Potential new and innovative sources (e.g. plastic bag charge, crowd funding schemes, Payment for Ecosystem Services);
- (vii) Taking advantage of match funding opportunities (e.g. the EU Life Programme).

(i) Capital maintenance payments from private sector asset owners

6.1.2 A potential avenue for maintaining renewable natural capital could be to place an obligation on organisations to maintain the natural capital they own or are responsible for. As outlined in Section 3.2⁷², we have developed a method for corporate natural capital accounting that can help achieve this.

6.1.3 To the extent that natural assets are owned by private organisations, they should be responsible for maintaining assets in perpetuity so there is no loss of natural capital. This would imply that we all effectively hold natural assets in trust for future generations. It suggests that an appropriate way of ensuring that privately owned natural capital is not degraded is to attribute the responsibility for its maintenance to its private owners.

6.1.4 In essence, our approach to CNCA is an extension of the polluter pays principle to a concept of owner-responsibility obligations for natural capital. For example, developers could be required either to restore or protect existing natural capital or alternatively to make compensating investments in natural capital where its protection on site is simply not possible after applying the mitigation hierarchy.

6.1.5 The Committee's natural capital accounting project has shown that the external (societal) value of natural capital on the land covered by the pilot projects is significantly greater than the private value of those assets to the organisation. Therefore there is in general a net public benefit from maintaining natural capital for present as well as future generations.

⁷² See NCC report on corporate natural capital accounting at www.naturalcapitalcommittee.org.

6.1.6 By reporting the benefits that society derives from natural assets in corporate natural capital accounts, the social benefits for which organisations are not being rewarded through the market place are made clear. Therefore some form of transfer is required from the social benefactors to the private owners to ensure that organisations are fully compensated for the benefits that they provide to others through maintenance of their natural assets. This could take the form of a subsidy or of a private payment though some form of Payment for Ecosystem Services (PES). Our accounting framework provides a robust method for calculating the appropriate level of transfer and monitoring its ongoing delivery should Government, the private sector or a charity wish to fund the provision of public goods on privately owned land.

(ii) Rents from non-renewable resources (e.g. oil or shale gas)

6.1.7 Whether the use of non-renewable assets, such as oil and shale gas, can be considered sustainable depends on the economic processes at work that can replace or substitute for them once they are depleted and the environmental management of the consequences. A related question is what should happen to the revenues generated from their extraction and use, especially that portion received in the form of resource taxes.

6.1.8 There are a number of options to consider but common to all of them is the need for a strategy to build up an asset (or combination of assets) to compensate for the depletion of the non-renewable assets. One approach would be to invest in physical infrastructure (manufactured capital) or health and education (human capital). Another would be to invest in a wealth fund which would generate returns that could contribute to future public revenues, similar to Norway's sovereign wealth fund. Norway started its fund, based on oil profits, in 1990 and this fund has already grown to be the largest in the world, approaching \$900bn (not far off twice the country's GDP).

6.1.9 A further possibility is to invest in other elements of natural capital that are renewable but, because of the drivers identified elsewhere in this report, are currently in decline and at risk of further deterioration. That is, a proportion of the revenues from the extraction of oil and shale gas could be set aside to invest in renewable natural capital, such as new forests, wildlife reserves and improvements in air quality.

The NCC Recommends that:

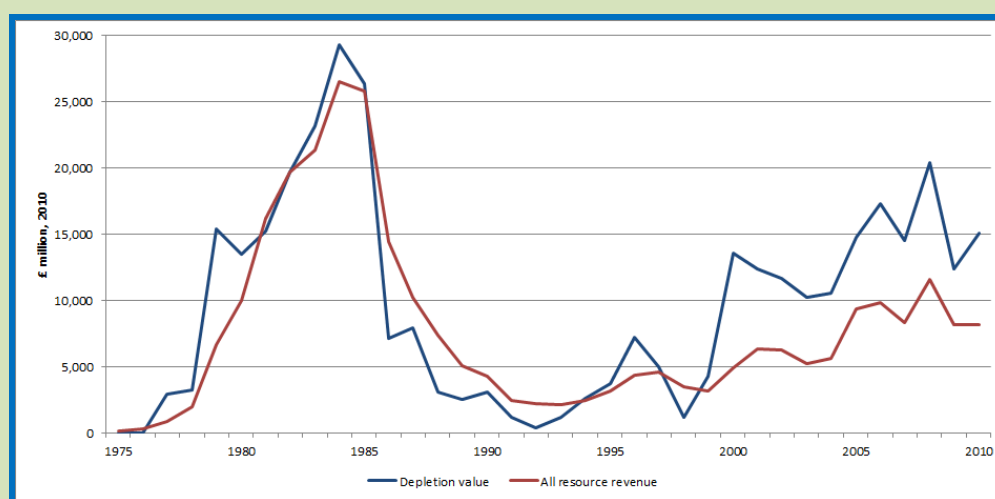
Government establishes a 'wealth fund' derived from the depletion of non-renewable natural assets, part of which should be used to support the delivery plan.

Box 6.1: Resource funds and protecting natural capital⁷³

By definition, the depletion of non-renewable resources is an unsustainable use of an asset. However, the proceeds of this depletion can be managed over the long term by careful investment of these sums in new assets that contribute to sustainable development goals. Resource funds provide one means of achieving this outcome. That is, the setting up of a designated fund where resource revenues are deposited and either (a) expended on currently identified productive investments or (b) saved for another day, in a sovereign fund. In the latter some portion of the returns of the fund is then available for future investment or spending more generally.

Ideally what is paid into such a fund should at least correspond to the “depletion value” of using a non-renewable resource. Exactly how much is a question that natural capital accounts can answer. The interpretation of the depletion value is important too. It is the portion of the proceeds of non-renewable resource depletion that should be invested if future generations are to benefit from having us – as the current generation – use up a finite resource now. Benchmarking the amount actually collected in resource revenues through fiscal policy (and tracking what happens to those revenues) against the depletion value is thus a matter of some importance.

Figure 6: Resource revenues relative to depletion values (£m, 2010)



As an example, the blue line in Figure 6 describes the value of depleting (conventional) primarily North Sea oil and gas in the UK over the period 1975 to 2010. As discussed, this can be interpreted as the monetary value of what should be re-invested to compensate for the fact that a non-renewable asset is being exhausted. The red line describes the revenue actually raised by UK taxes on the production of oil and gas over the same period. What is particularly striking is how the two series track one another (albeit with some greater divergence over the last decade). Had the resource revenues been invested in a resource fund (such as a Sovereign Wealth Fund) the size of this endowment would be in excess of £300bn today. Put another way, this would have had a substantial impact on the size of the public balance sheet. The likely return on this (hypothetical) fund would now be substantial too.

(iii) Compensation payments from developers

6.1.10 It is important that apparent growth opportunities do not come at the expense of the environment and thereby undermine our future growth potential. Given that some development will happen anyway and will pass cost-benefit analysis tests even where

⁷³ Atkinson and Hamilton (2015)

natural capital is fully included, one should look at the use of all methods for minimising the impact of development activities and contributing to wider restoration objectives.

- 6.1.11 Taking natural capital into account and developing the appropriate metrics and accounting frameworks as the NCC has recommended in its reports still leaves the issue of the trade-offs which inevitably arise between different development options. Almost all development projects will have costs in the sense that they will have an impact the natural environment in some way. Building new houses and rail networks are obvious examples.
- 6.1.12 The standard economic test to determine whether any development should proceed is that the benefits must exceed the costs; now these costs must include and incorporate the impacts on natural capital. If indeed the benefits do exceed the costs and there is damage to high value biodiversity and amenity land, the developer should compensate for this damage.
- 6.1.13 Such a system of compensation, if designed appropriately with suitable metrics for gains and losses, could be a useful tool in ensuring that development does not lead to the erosion of natural capital assets: it could even contribute to the improvement of certain aspects of the environment.

The NCC Recommends that:

Government ensures that damage to renewable natural capital is, where possible, avoided and minimised, but where it does occur, it is fully compensated by investment in renewable natural capital of equivalent or higher priority or value.

(iv) Greater use of economic instruments (e.g. taxes, charges and permits)

- 6.1.14 Market prices should fully reflect environmental costs and benefits. Just as prices incorporate the costs of labour and physical capital, natural capital should also be included. That is the essence of integrating natural capital into the heart of economic activity. The result of failing to do so is a waste of resources, reducing potential sustainable economic output.
- 6.1.15 Taxes are a key potential mechanism to internalise environmental costs and benefits as well as to raise revenue. For example, taxes on transport fuel reduce demand and thereby reduce, at the margin, the harmful effects on the environment stemming from their use. Other economic instruments, such as permits and charges can also be a useful tool in helping to minimise the degradation of natural capital, both by restricting the demand for such activities and by using the revenues raised to fund environmental improvements.
- 6.1.16 The Committee is of the view that Government needs to make more use of such tools to help ensure that the prices of goods fully reflect the marginal environmental cost and benefits of consumption and production. An example of where effective pricing of external costs could yield significant benefits and avoid wasting resources is carbon pricing. The failure to price carbon comprehensively allows damaging activities like peat extraction to be

expanded beyond an efficient level. This was recognised in the Natural Environment White Paper.

(v) *Reforming and eliminating perverse subsidies*

6.1.17 Decisions that affect natural capital are frequently distorted from what would occur in an economically efficient world because of the absence of proper valuations of natural capital. This is often made worse by perverse subsidies which incentivise the misuse of the environment, for example, tax incentives for hydrocarbon exploration. This goes beyond direct subsidisation. Indirect subsidies are a problem too. Polluters are often not confronted with the costs of their pollution and hence are effectively subsidised by everyone else.

6.1.18 The Common Agricultural Policy is a classic example in an EU and UK context. Every year a little under £3bn is spent on subsidies. These subsidies indirectly incentivise production. At the same time, farmers receive environmental payments to help prevent damage to the environment and to protect important wildlife habitats. The two instruments potentially work against one another with the former dwarfing the latter. Realignment of these incentive systems could provide the same income opportunities for farmers while reducing the depletion of natural capital.

6.1.19 These potential gains could be substantially enhanced by targeting changes on those areas which will deliver the most in terms of gains for society (see for example the discussion of the opportunities for conversion of land into multipurpose woodland shown in Box 4.1). At present the majority of environmental payments are very poorly targeted, tending to be allocated without considering the value of the benefits they might generate or how that might change if those subsidies were applied to alternative locations. Moving to this 'spatial targeting' approach would provide a virtually cost-free improvement in terms of the value for money delivered to taxpayers.⁷⁴

(vi) *Potential new and innovative sources (e.g. the plastic bag charge, crowdfunding schemes, Payment for Ecosystem Services)*

6.1.20 There are a number of new and innovative sources of funding available to support a natural capital investment programme. The 5p plastic bag charge to be introduced in England in autumn 2015 could raise as much as £100m per annum. It will be a charge levied and the revenue collected by retailers, rather than as a tax, and it will not be for the Government to decide where this money goes. Many organisations have agreed to give profits (after reasonable costs) to good causes following the models in Scotland and Wales. There is scope, therefore, to demonstrate to retailers the value of investing in the natural environment, as part of a wider investment programme with both public and private sector participation.

⁷⁴ See Bateman et al (2014).

- 6.1.21 Crowdfunding (funding projects through raising money from a large number of people, frequently online) has taken off in recent years. Many new businesses are now funded in this way. Such an approach could also be used to fund relatively small scale natural capital investment projects, especially if control of them is devolved so that the scheme managers and investors can dictate the types of schemes and where they take place. There is a role for Government in helping to facilitate such investment projects through the removal of any red tape.
- “There are a number of new and innovative sources of funding available to support a natural capital investment programme. The 5p plastic bag charge being introduced in England later this year could raise as much as £100m per annum.”**
- 6.1.22 Payments for Ecosystem Services (PES) are a potential way in which markets for ecosystem goods and services can be established. In essence, PES schemes seek to address market failures and increase the provision of benefits from natural capital that would otherwise not be provided through normal market incentives. We are aware that Government is currently funding a series of pilots and support efforts to provide seed funding for further initiatives in this area to test their efficiency and effectiveness. We also encourage OFWAT to establish the right framework to allow water companies to expand their use of PES schemes where it makes economic sense to do so.
- (vii) Taking advantage of match funding opportunities (e.g. the EU Life Programme)**
- 6.1.23 Opportunities exist to lever funding from external sources through the use of match funding. This type of funding can significantly increase the returns from investment. Such opportunities should be exploited where appropriate to bolster investment in natural capital restoration projects and Government should actively look for and pursue such opportunities, thus maximising the impact of its own investment.
- 6.1.24 One example of such funding is the EU LIFE Programme which has €3.4bn available for the period 2014 – 2020 for projects contributing to the environment and action against climate change. Utilising match funding to create investment in peatlands restoration for example, will have multiple benefits as described earlier, as well as building resilience to, and mitigating against, climate change.

7. Next steps

In order to meet the commitment to be the first generation to leave the natural environment in a better state, we have shown that the Government will need to develop an overarching strategy to protect and improve natural capital. Implementing this will secure the prize of sustainable economic growth.

This prize will only be achieved if the actions contained in this report are implemented. This requires actions by all parties, but in many cases government will need to facilitate non-government participation. The actions for government are:

- **Develop a 25 year plan** and consult on it;
 - The plan will need to put into practice the critical building blocks outlined in this report, such as improving cost benefit analysis by revising the Green Book in line with our recommendations
 - The plan should include an investment priority framework that makes use of, develops and publishes the natural capital risk register that we have developed
 - It should also identify priority investments to incorporate into the National Infrastructure Plan
- **Publish estimates of the value of the UK's natural capital** and incorporate renewable natural capital into these, broadening the scope of the Government's work to date. Renew the commitment to fulfil all of the ambitions of the ONS 2020 natural capital accounting Roadmap which Government endorsed;
 - As part of the national accounts, commit to build the capacity to construct and maintain natural capital accounts within the ONS
- **Create and embed a financing framework** commensurate with the 25 year plan. The private sector, non-governmental organisations (NGOs) and landowners need to play their part in this;
 - As part of the financing options, full consideration should be given to setting up a natural capital wealth fund
- **Decide which governance structures would be most effective** to deliver the plan. Set this in the context of the overall institutional architecture for environmental protection;
- **Consider legislation to put such a plan into effect;**
- **Take forward the development of the corporate natural capital accounting framework** with the appropriate bodies and proactively encourage organisations that own or are responsible for natural capital to adopt these accounting practices.

The actions for private and non-governmental owners of natural capital and the wider environmental bodies are:

- **Make use of the corporate natural capital accounting framework** that we have developed;

- **Coordinate natural capital protection and improvement plans.**

Further research on natural capital is needed but this is not an excuse for inaction in the short-term. Over the last three years, we have largely worked with information that was available to us in the public domain, but more research and data are required. We urge the Government to establish a substantial, long-term, interdisciplinary research programme on natural capital to inform future iterations of the strategy. This should be led by the Research Councils and build on existing initiatives. We have set out our view of four priority areas in a separate paper. These include:

- Developing a consistent approach to measuring changes in the status of natural assets that enables early detection when approaching potential thresholds;
- Improving our understanding of the relationships between changes in natural capital and economic growth, employment and related measures;
- Ensuring we have robust valuation estimates of changes in natural capital;
- Integrating evidence and knowledge into decision making frameworks.

The Natural Capital Committee's term has been extended until September 2015. Between now and then, the Committee will produce a series of working papers and other outputs which will go into more depth on many of the issues we discuss in the report. All papers will be accessible on our website at www.naturalcapitalcommittee.org. These will include a working paper on the Committee's corporate natural capital accounting pilot and accompanying guidance and detailed reports, technical and non-technical papers on improving cost benefit analysis and further information on natural capital investment projects amongst others.



References

- Atkinson, G. and Hamilton, K. (2014) "A Tale of Two Windfalls": *Asset Accounting, Fiscal Policy and the UK's Oil and Gas Resources, Past & Present*", Department of Geography and Environment, London School of Economics, mimeo.
- Alcock, I., White, M. P., Wheeler, B. W., Fleming, L. E., & Depledge, M. H. (2014). Longitudinal effects on mental health of moving to greener and less green urban areas. *Environmental science & technology*, 48(2), 1247-1255.
- Astell-Burt, T., Feng, X., & Kolt, G.S. (2014) 'Is Neighbourhood Green Space Associated With a Lower Risk of Type 2 Diabetes? Evidence From 267,072 Australians'. *Diabetes Care*, 37(1), 197-201.
- Bateman, I.J., Day, B.H., Agarwala, M., Bacon, P., Bađura, T., Binner, A., De-Gol, A.J., Ditchburn, B., Dugdale, S., Emmett, B., Ferrini, S., Fezzi, C., Harwood, A., Hillier, J., Hiscock, K., Hulme, M., Jackson, B., Lovett, A., Mackie, E., Matthews, R., Sen, A., Siriwardena, G., Smith, P., Snowdon, P., Sünnerberg, G., Vetter, S. and Vinjili, S. (2014) *Economic value of ecosystem services*, Final Report from Work Package Report 3 to the UK National Ecosystem Assessment – Follow-On programme, Defra, London.
- Ball, K., Timperio A., Salmon, J, Giles-Corti, B., Roberts R., Crawford D. (2007) Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *Journal of Epidemiology and Community Health*, 61(2), 108-14.
- Clark, D., Field, S., & Layard, R. (2012) Mental health loses out in the National Health Service. *The Lancet*, 379 (9834), 2315-2316.
- Cohen, D.A., McKenzie, T.L., Sehgal, A., Williamson, S., Golinelli, D., Lurie, N. (2007) Contribution of public parks to physical activity. *American Journal of Public Health*, 97(3), 509-14.
- Comedia, Demos. (1995) *Park life: urban parks and social renewal*. Stroud, Gloucestershire: Comedia.
- Coombes, E., Jones, A. P., & Hillsdon, M. (2010) The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social science & medicine*, 70(6), 816-822.
- Croucher, K., Myers, L., Jones, R., Ellaway, A., Beck, S. (2007) *Health and physical characteristics of urban neighbourhoods and health: a critical literature review*. Glasgow Centre for Population Health.
- Costello, C., Kinlan, B.P., Lester, S.E. & Gaines, S.D. (2012) The Economic Value of Rebuilding Fisheries, OECD Food, Agriculture and Fisheries Papers, No. 55, *OECD Publishing*.
<http://dx.doi.org/10.1787/5k9bfqnmptd2-en>.

- Cunningham, S., Neiland, A., Bjorndal, T., Gordon, D., Bezabih, M., Hatcher, A., McClurg, T. & Goodlad, J. (2010) ‘*The Potential Benefits of a Wealth-Based Approach to Fisheries Management: An Assessment of the Potential Resource Rent from UK Fisheries*’, Defra Project MF 1210, Final Report, IDDRA Ltd. Portsmouth.
http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CCMQFiAA&url=http%3A%2F%2Frandd.defra.gov.uk%2FDocument.aspx%3FDocument%3DMF1210_982_0_FRP.pdf&ei=7Zm_VKz1OYfk7AaNioCgAg&usq=AFQjCNHDjWqb09lfdgC-9Fclb85afeO6dw&bvm=bv.83829542.d.ZGU.
- Currie, J. and Neidell, M. (2005) “Air Pollution and Infant Health: What Can We Learn from California’s Recent Experience”, *Quarterly Journal of Economics*, 120(3): 1003-30.
- De Vries, S., Verheij, R.A., Groenewegen, P.P. & Spreeuwenberg, P. (2003) Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environment and Planning A*, 35 (10), 1717-1731.
- DEFRA (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*. Volume 1. London: Defra.
- Dunnett, N., Swanwick, C., Woolley, H. (2002) *Improving urban parks, play areas and green spaces*: Department for Local Government Transport and the Regions.
- EEA (2014) *Air Quality in Europe – 2014*, European Environment Agency.
<http://www.eea.europa.eu/publications/air-quality-in-europe-2014>
- Eftec in association with the Centre for Ecology and Hydrology, APBMer and Regeneris (2015) ‘*The Economic Case for Investment in Natural Capital in England*’. A report to the Natural Capital Committee. www.naturalcapitalcommittee.org.
- English Nature (2006) *The social and economic value of the UK’s geodiversity*, Research Report 709, English Nature.
- Gibbons, S., Mourato, S. & Resende, G., M. (2013) ‘The Amenity Value of English Nature: A Hedonic Price Approach’, *Environmental and Resource Economics*, Volume 57, Issue 2, pp 175-196.
- Goulding, K., Jarvis, S. & Whitmore, A. (2008) ‘Optimising nutrient management for farm systems’, *Philosophical Transactions (B) of the Royal Society*, DOI: 10.1098/rstb.2007.2177
- Graff Zivin, J. and Neidell, M. (2013) ‘Environment, Health and Human Capital’, *Journal of Economic Literature*, 51(3): 689-730.
- Graff Zivin, J. and Neidell, M. (2012) ‘The Impact of Pollution on Worker Productivity’, *American Economic Review*, 102(7): 3652-73.

- Grahn, P., & Stigsdotter, U. A. (2003) 'Landscape planning and stress'. *Urban forestry & urban greening*, 2(1), 1-18.
- Guite HF, Clark C, Ackrill G. (2006) The impact of the physical and urban environment on mental well-being. *Public Health*, 120 (12), 1117-26.
- Harlow, J., Clarke, S., Phillips, M. & Scott, A. 2012. Valuing land-use and management changes in the Keighley and Watersheddles catchment. *Natural England Research Reports*, Number 044. <http://publications.naturalengland.org.uk/file/1312018>
- Hartig, T., Mitchell, R., De Vries, S. & Frumkin, H. (2014) 'Nature and health'. *Annual Review of Public Health*. 35:21.1–21.22. <http://illinois-online.org/krassa/hdes598/Readings/Green%20Spaces%20and%20Health/Hartig%20Mitchell%20De%20Vries%20Frumkin%20ARPH%20Nature%20and%20Health%20Review%20in%20Advance%20online.pdf>.
- HMG (2011) *The natural choice: securing the value of nature*, Her Majesty's Stationary Office. <https://www.gov.uk/government/publications/the-natural-choice-securing-the-value-of-nature>
- Kahn, J., Greene, P. & Johnson, A. (2014) *UK Natural Capital – Initial and Partial Monetary Estimates*, Office for National Statistics.
- Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.A., Tew, T.E., Varley, J., & Wynne, G.R. (2010) *Making Space for Nature: a review of England's wildlife sites and ecological network*. Report to Defra.
- Lavy, V. Ebenstein, A. and Roth, S. (2014) "The Long-run Human Capital and Economic Consequences of High-Stakes Examinations", *National Bureau of Economic Research*.
- Natural England (2009) *Our Natural Health Service: The role of the natural environment in maintaining healthy lives*. Sheffield: Natural England.
- NCE (2014) 'New Climate Economy' Report, <http://newclimateeconomy.report/>.
- Obst, C. & Vardon, M. (2014) Recording environmental assets in the national accounts, *Oxford Review of Economic Policy*, Volume 30, Number 1, pp. 126–144.
- Pearce, D., Markandya, A., and Barbier, E.R. (1989) *Blueprint for a Green Economy* Earthscan Publications Ltd, London.
- Royal Committee on Environmental Pollution (2011) *Demographic change and the environment*, RCEP. <http://webarchive.nationalarchives.gov.uk/20110303145146/http://www.rcep.org.uk/reports/29-demographics/29-demographics.htm>.

- Seely, A. (2009) *Landfill tax: recent developments*, House of Commons Library, SN/BT/1963, <http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CCMQFjAA&url=http%3A%2F%2Fwww.parliament.uk%2Fbriefing-papers%2F%2FSN01963.pdf&ei=2iy9VJCILM3dapjmgpAL&usq=AFQjCNEEgkWdjux9hGNMUhhoY4bCeB87pw&bvm=bv.83829542,d.d2s>.
- Steffen, W., Persson, A., Deutsch, L., Zalasiewicz, J., Williams, M., Richardson, K., Crumley, C., Crutzen, C., Folke, C., Gordon, L., Molina, M., Ramanathan, V., Rockstrom, J., Scheffer, M., Schellnhuber, H. J., Svedin, U. (2011) 'From Global change to planetary stewardship', *AMBIO*, Royal Swedish Academy of Sciences, published online.
- UK National Ecosystem Assessment (2011) *UK National Ecosystem Assessment: Technical Report*, UNEP-WCMC, Cambridge.
- Van der Elst, K. & Davis, N. (2011) World Economic Forum's Global Risks Report 2011. <http://reports.weforum.org/global-risks-2011/>
- World Bank (2008) *The Sunken Billions: The Economic Justification for Fisheries Reform*, World Bank, Washington DC.
- Zweig, J.S. Ham, J.C. and Avol, E.L. (2009) "Air Pollution and Academic Performance: Evidence from California Schools", *mimeo*.

Annex A: Natural Capital Committee Terms of Reference

1. Background

Our understanding of the value of nature is improving thanks to major recent studies such as the UK National Ecosystem Assessment (NEA) and at the international level the Economics of Ecosystem Services and Biodiversity (TEEB). The Government wants to ensure the value of the flow of services that nature provides and of the natural capital that underpins them is properly understood and reflected in the economy and policy-making. This will help ensure we can continue to prosper and grow economically by protecting nature and using its services sustainably.

The Natural Environment White Paper, therefore, announced the creation of an independent Natural Capital Committee (“the Committee”), reporting to the Economic Affairs (EA) Committee of the Cabinet to provide expert independent advice on the state of English natural capital.

2. The Role of the Committee

The Committee will play a key role in supporting the Government to ensure that natural capital is properly and consistently valued and accounted for in policy decisions and economic planning. By performing this role the Committee will help the Government ensure that our natural wealth is managed efficiently and sustainably, unlocking opportunities for increasing prosperity and wellbeing.

Specifically, the Committee will:

- Provide advice on when, where and how natural assets are being used unsustainably. For example, in a way that takes us beyond some acceptability limits or non-linearity thresholds, or in a way that diminishes some measure of comprehensive wealth;
- Advise the Government on how it should prioritise action to protect and improve natural capital, so that public and private activity is focused where it will have greatest impact on improving wellbeing in our society. This will include advising the Government on tools and methodologies to ensure that the value of natural capital is fully taken into account in policy decisions and in economic planning;
- Advise the Government on research priorities to improve future advice and decisions on protecting and enhancing natural capital. The Committee’s advice in this area will reflect consultations with the Research Councils and the academic community.

The Committee may:

- Produce and publish annual reports to the Economic Affairs Committee; it may also choose to publish a range of additional reports as appropriate;
- Provide advice to Ministers in confidence;
- Provide responsive, ad-hoc advice if requested by the Secretary of State for the Environment (or by the EA Committee via the Secretary of State).

The Committee may not:

- Perform a watchdog or advocacy role with respect to Government's policy decisions;
- Be policy prescriptive in its advice – unless requested by the Secretary of State for the Environment (or by the EA Committee via the Secretary of State);
- Make decisions on classifications or statistical standards.

3. Committee Set-up and Structure

The Committee has been set up as an ad-hoc independent advisory body, comprising of a Chair and expert members. They come from disciplines including economics, natural and social sciences. They are widely recognised as leading experts in their respective fields and have been appointed and perform on the basis of their academic and professional background as opposed to representing interests of any interested parties. Expert Committee members are independent appointments made through open competition, in line with OCPA guidelines on best practice for making public appointments. Members are expected to act in accord with the principles of public life.

The Committee is supported in its work by a secretariat based in Defra. It may also set up expert working groups or rely on existing groups to take forward its analytical work.

Annex B: Recommendations from the Committee's first State of Natural Capital report

This annex summarises the recommendations from our first State of Natural Capital report (SoNC 1) which was published in April 2013.

They were organised around four key messages.

Natural capital assets are in decline and these trends should be measured:

1. A framework within which to define and measure natural capital is developed. Once designed, the use of the framework for regular reports and advice would need to draw on data and monitoring systems from across government departments, non-governmental and research organisations;
2. The development of a 'risk register' for natural capital assets to identify the implications of further depletion or lack of restoration.

Changes in natural capital should be properly included in national and corporate accounts:

3. The work led by the Office for National Statistics (ONS) to include natural capital fully in the UK's environmental Accounts should be given the greatest possible support by the Government. The development of the accounts should be informed by short and long-term policy needs as well as international work to maximise their usefulness. The UK has the opportunity to demonstrate leadership in this field;
4. Business groups, leading organisations, accounting bodies, landowners and managers, as well as Government, should collaborate to develop and test guidance on best practice in corporate natural capital accounting;
5. A cross government group of senior analysts, led by the ONS, should review and develop approaches to 'Inclusive Wealth' accounting in the UK (that is, measures of our total capital stock), including a comprehensive assessment of the wealth represented by natural capital.

Changes in natural capital should be properly valued and those values more effectively included in decision making processes:

6. Government undertakes a critical look at how cost-benefit analysis is being implemented with respect to natural capital to identify priority areas for improvements. While H.M Treasury's 'Green Book' provides a good starting point for cost-benefit analysis, options to improve the treatment of natural capital within this guidance should be explored. This should include consideration of the appropriateness of physical (in-kind) compensation for certain forms of natural capital loss;
7. An urgent programme is initiated to provide high quality evidence on the economic value of changes in natural capital to feed into cost-benefit analyses. The NCC will bring forward detailed proposals on this shortly;

8. Government, working with the NCC, explores the development of new 'decision-support tools' aimed at incorporating economic valuations of changes in natural capital within wider decision appraisals.

Stewardship of natural capital is good for growth:

9. In addition to conventional indicators, the Government develops measures of economic growth, net of the depreciation of natural and other forms of capital as well as more comprehensive metrics of saving and inclusive wealth;
10. Offsetting and other forms of compensation are explored after a clear set of principles and a policy framework have been developed;
11. Opportunities are explored to increase the direct contribution natural capital can make to growth, such as the recommendations identified by the Ecosystem Markets Task Force (EMTF) report (published on 5th March 2015) and the Independent Panel on Forestry;
12. The Government reviews the extent to which natural capital is being effectively priced, in particular examining the scope for reducing perverse subsidies. Where practical, the costs of polluting activities that impact on natural capital should be internalised;
13. The Government's efforts to reform the Common Agricultural Policy be intensified, with a long term view to phasing out Pillar one support and moving subsidies towards Pillar two and the provision of public goods. In the short-term, securing as much flexibility as possible in how funding can be allocated for the period 2014-2020 and taking full advantage of this when shaping domestic schemes, is essential.

Annex C: Recommendations from the Committee's second State of Natural Capital report

This annex summarises the recommendations from our second State of Natural Capital report (SoNC 2) which was published in March 2014. They were organised around three key messages.

The Government, as a matter of priority, takes steps to improve our understanding of natural assets, focussing on those that are not being used sustainably and are important for our wellbeing:

1. The Government prioritises work to develop measures to monitor the state of natural assets directly, paying particular heed to potential thresholds;
2. The Government, as a matter of urgency, develops and keeps up-to-date a risk register for natural capital, building on the work done by the Natural Capital Committee;
3. Given the Government's endorsement of the Rio+20 outcomes, the Government demonstrates global leadership by working to mitigate England's impacts on international natural assets that underpin our economy;
4. Research priorities identified by the Natural Capital Committee are addressed by the Government and the Research Councils.

The Government integrates the value of natural capital into decision making to enhance taxpayers' value for money and to generate net benefits for society:

5. The Government continues to support the important work being led by the Office for National Statistics to integrate natural capital accounting into the national accounts and looks for opportunities to speed this up where possible. The accounts need to be developed with policy application in mind;
6. The Government fully incorporates natural capital costs and benefits into its decision making tools and frameworks, in particular working with the Natural Capital Committee to improve the Government's appraisal guidance. These tools should inform all policy development;
7. Where there are clear net benefits for society, the Government incentivises private investment in natural capital;
8. The Government endorses the Natural Capital Committee's efforts to encourage organisations to incorporate natural capital into their accounts.

The Government and interested parties endorse the Natural Capital Committee's proposed 25 year plan to maintain and improve England's natural capital within this generation:

9. The Government should work with the NCC and interested parties over the next year to shape the plan/framework;

10. The Government should incorporate natural capital into future versions of its National Infrastructure Plan.

Annex D: Acknowledgements

With thanks to the consortium of eftec, RSPB and PwC on Corporate Natural Capital Accounting:

Allan Provins (eftec)
Duncan Royle (eftec)
Katharine Bolt (RSPB)
Will Evison (PwC)
Victoria Cox (PwC)
Ece Ozdemiroglu (eftec)
Shannon Anderson (eftec)
Adams Koshy (eftec)

And the pilot organisations:

United Utilities, notably Jonathan Dobson
National Trust, notably Sue Cornwell and Patrick Begg
Lafarge Tarmac, notably Dave McCabe
The Crown Estate, notably Mark Gough

We would also like to say thank you to members of the NCC's Landowners' and Managers' Group who have played a key part in shaping the corporate natural capital accounting work along with many others.

We would also like to thank the consortium of eftec, CEH, ABPmer and Regeneris for evaluating the evidence for investments in natural capital, particularly: Ian Dickie, Phil Cryle, Shannon Anderson, Allan Provins, Sarah Krisht, Adams Koshy and Angela Doku (eftec)
Lindsay Maskell, Lisa Norton (CEH)
Suzannah Walmsley, Colin Scott (ABPmer)
Tim Fanning, Stephen Nicol (Regeneris)

We would also like to thank David Maddison and Brett Day for their work on appraisal.

We would also like to thank the Wildlife Trusts, members of the Wildlife and Countryside Link, The Environment Agency, Natural England and Defra for providing examples and analysis for the investment cases.