The State of Natural Capital:

Restoring our Natural Assets

Second report to the Economic Affairs Committee

Natural Capital Committee

March 2014

The Natural Capital Committee

The Natural Capital Committee was one of the headline commitments in the UK Government's 2011 Natural Environment White Paper. It was established in May 2012 as an independent advisory body to Government. It formally reports to the Economic Affairs Committee, chaired by the Chancellor of the Exchequer.

The Committee is defined by its Terms of Reference, but broadly its 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, Stewart Clarke and Charlotte Gorman.

The Committee appreciates the input and helpful comments on its work from a number of people, who are listed in the Acknowledgements section of the report.

Further information on the Committee, its full Terms of Reference, its annual reports and its future work programme can be accessed at: www.naturalcapitalcommittee.org.

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Chairman's Message

The Natural Capital Committee was set up as a result of the Government's 2011 Natural Environment White Paper *The Natural Choice*, with a clear remit to identify which natural assets may be being used unsustainably, to ensure the development of national and corporate natural capital accounting, and to advise on research priorities. We are making excellent progress on all three counts. This second State of Natural Capital report sets out what we have achieved so far, makes recommendations to Government as to what now needs to be done, and sets the work programme for the next year.

Over the coming decades, there will be a major programme to develop the UK's infrastructure. The National Infrastructure Plan 2013 sets out ambitious plans - for new railways, roads, airport expansions, energy systems, water resources, sewerage investments, flood defences and a major increase in house building - to modernise the economy and accommodate a sharp rise in population. In taking forward this major investment, it is important not to lose sight of natural infrastructure and the integral part that natural capital plays in delivering sustainable economic growth. As the White Paper rightly emphasised, the environment is part of the economy and needs to be properly integrated into it so that growth opportunities will not be missed.

Integrating the environment into the economy is hampered by the almost complete absence of proper accounting for natural assets. What is not measured is usually ignored. National and corporate accounts are essential building blocks. The torch needs to be shone on what is going on, in order to work out how to seize the numerous opportunities. The Committee is leading the way in developing the metrics and risk registers, identifying the necessary capital maintenance, and ensuring that project and investment appraisals in both the public and private sectors properly take natural capital into account. Our recommendations in this report spell out what further needs to be done.

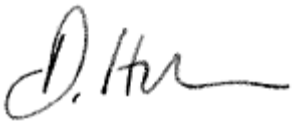
The White Paper did not just set the objectives of identifying missed opportunities and preventing further declines in natural capital. It stated that the Government's aim was to be the first generation to improve our natural environment. The Committee has begun to work out what might be necessary to deliver this. Investment in natural capital - like much of the manufactured infrastructure - is necessarily long-term. Just as it takes many years to build a new high speed railway, it will take time to recover natural assets, such as planting new woodlands and restoring river systems.

In this second report, we recommend that the Government endorses our proposal to develop a 25 year, landscape-scale plan to deliver its generational objective. We are mindful of the enormous efforts, skills and capability on the ground of the plethora of environmental groups and trusts which this country is blessed with and the millions of people they represent. We are also mindful of existing sources of knowledge that can help inform the strategic shape of the plan, such as the *Making Space for Nature* report (Lawton 2010), which provides a rationale as to why landscape-scale projects are an appropriate way forward.

The Committee will devote much of its time over the coming year to drawing on the many particular ideas already being advanced, with a view to providing more flesh on the bones of the 25 Year Plan. In doing so, we will be particularly focussed on two things: finding the projects which deliver the maximum benefits; and, identifying ways in which the various funding and spending streams could be better managed to deliver more environmental benefits for any given cost. Opportunities

should not be missed for lack of information or poor appraisal techniques. Both of these need to be improved if public and private money is to be spent more efficiently.

This report and the many other activities the Committee is working on would not be possible without the dedicated and highly professional secretariat which supports the Committee. I would like to pay particular tribute to the team led by Nick Barter, notably Julian Harlow, Alastair Paton, Charlotte Gorman and Stewart Clarke.



Dieter Helm, March 2014

The Natural Capital Committee's Work Programme

The Natural Capital Committee's purpose is to help society take better account of the value of nature and ensure this value fully informs decision-making. This will contribute to the delivery of the Government's commendable 2011 Natural Environment White Paper ambition to be "*the first generation to leave the natural environment of England in a better state than it inherited*". In its Terms of Reference, the Committee has been asked to:

- Provide advice on when, where and how natural assets are being used unsustainably;
- 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; and,
- Advise the Government on research priorities to improve future advice and decisions on protecting and enhancing natural capital.

The Committee's annual State of Natural Capital reports are one of the principal means through which the Committee addresses its Terms of Reference.

The Committee's first State of Natural Capital report was published in April 2013. It presented evidence that significant economic and wellbeing benefits can be secured through better valuation and management of natural capital. The report set out a framework for what needs to be done to ensure that this happens.

This second State of Natural Capital report builds on the first report and provides an update on the Committee's progress with several aspects of its work. The Committee's third State of Natural Capital report, due to be published in early 2015, will bring the whole work programme together and thereby fulfil the Committee's Terms of Reference for this Parliament.

The Committee has initiated several work-streams to fulfil its Terms of Reference. These are:

1. Developing metrics and a risk register for natural assets and benefits;
2. Contributing to the development of national natural capital accounts, working with the Office for National Statistics and the Department for Environment, Food and Rural Affairs;
3. Piloting corporate natural capital accounts, working with a range of organisations;
4. Undertaking research on how natural capital issues can be fully incorporated into public decision-making and appraisal processes;
5. Advising the Government on future research priorities relating to natural capital;
6. Developing a long-term plan for the maintenance and restoration of natural capital; and,
7. Providing advice to ministers on issues as requested.

In 2013, the Committee provided two substantial pieces of advice to ministers on particular aspects of Government policies in response to requests from the Secretary of State for Environment, Food and Rural Affairs.

The Committee responded to the Government's *Biodiversity Offsetting in England* Green Paper. The Committee strongly supports the importance of being the first generation to leave the natural environment in a better state than it inherited it and noted the potential role that a well-designed

biodiversity offsetting system could have in helping achieve this. The Committee is of the view that an offsetting system would be best implemented and have most impact under the strategic direction of a national long-term plan for maintaining and improving our natural capital.

The Committee also responded to the Government's *Common Agricultural Policy reform: implementation in England* consultation, recommending that the Government should allocate the maximum amount of resource possible to environmental programmes, as these offer the best value for money.

To see the Committee's full responses to the Biodiversity Offsetting and Common Agricultural Policy reform consultations, please see the Committee's website: www.naturalcapitalcommittee.org.

Executive Summary

Nature underpins our economy and is central to our wellbeing.

Natural capital refers to the elements of nature that produce value to people, such as the stock of forests, water, land, minerals and oceans. These benefit us in many ways, by providing us with food, clean air, wildlife, energy, wood, recreation and protection from hazards.

Despite its importance, the value of natural capital is routinely taken for granted. Although there have been some notable policy successes, such as improvements in air and water quality, natural assets continue to be degraded in aggregate and their capacity to deliver essential benefits to current and future generations is being reduced. This has an adverse impact on the economy.

Pressures on natural capital - such as from population growth and the consequent increasing demand for food, housing and transport - look set to persist and intensify. Although the measures set out in the Government's National Infrastructure Plan will accommodate this expansion through the construction of new transport links and homes, it is critical that we act now to manage our natural capital better, compensating for losses where appropriate, to ensure future pressures do not adversely impact on it.

If our natural capital is to continue to support development now and in the future, it is essential that it is properly taken into account in all decision-making and is invested in appropriately, such as through the Government's national infrastructure plan.

The Natural Capital Committee's second State of Natural Capital report has three key messages for Government and other interested parties. These are:

1. **Some assets are currently not being used sustainably. The benefits we derive from them are at risk, which has significant economic implications;**
2. **There are substantial economic benefits to be gained from maintaining and improving natural assets. The benefits will be maximised if their full value is incorporated into decision-making; and,**
3. **A long-term plan is necessary to maintain and improve natural capital, thereby delivering wellbeing and economic growth.**

This report presents the rationale for these key messages, providing evidence and explanation to support the Committee's conclusions.

Key Message 1: Some assets are not being used sustainably. The benefits we derive from them are at risk, which has significant economic implications.

The Natural Capital Committee has undertaken a preliminary analysis of the current state of natural capital in England. The Committee has focused mainly on renewable natural assets; it has already established that long-standing patterns of use mean some assets are not being used sustainably. As a result, the benefits we derive from them are at risk. Despite recent progress in some areas, we are not on a trajectory to meet the Government's long-term vision, as set out in the

Natural Environment White Paper, of being "*the first generation to leave the natural environment of England in a better state than it inherited*".

The Committee highlights crucial evidence gaps relating to the condition of individual natural assets, such as soils, the atmosphere, wild species and oceans. Information is generally lacking about England's natural assets and what is happening to them. It is imperative that these information gaps are addressed as a matter of urgency. In the few cases where we do have relevant information on our natural assets (freshwaters, coasts, rare species and priority habitats), we find that their current status is some way from policy objectives.

Further research is needed to record the status of our natural assets on a continuing basis. This will ensure that Government and others can make informed decisions about how to manage natural capital better. The data will also inform the development of efforts to include natural capital into the national accounts, which is being led by the Office for National Statistics and the Department for Environment, Food and Rural Affairs.

To complement this longer-term project to measure our natural assets, in this report the Committee provides insights into unsustainable use by focussing on the benefits that flow from natural assets. This part of the Committee's analysis sets out the 'level' of benefits presently supplied by natural capital, and shows how these benefits are changing as a result of human activities. In several cases, the level of benefit is currently far from ideal and more effort and investment is necessary to meet stated policy objectives.

Figure A: Benefits from natural capital at high or very high risk

Clean Water	Much of our drinking water is sourced from upland areas and their declining quality is a source of concern. In addition, the projected growth of urban areas is likely to lead to deterioration in freshwaters and soils, affecting the natural water purification process in these systems.
Wildlife	Wildlife is declining in many places in England but is a particular concern in semi-natural grassland, farmland and freshwater environments owing to poor quality habitats and fragmentation.
Carbon storage	Carbon storage is important for England's contribution to an 'equable climate'. There is the potential for greater carbon storage through improving the condition of mountains, moors and heaths.
Hazard protection	Hazard protection can be significantly improved by changing the way in which land is managed. Better management would reduce soil erosion and make the most of natural processes to manage flood risk through actions such as tree planting and the reinstatement of wetlands.
Recreation	Recreation is of enormous value and benefits that we receive from it can be increased by orders of magnitude by improving the quality of freshwater areas, increasing the amount of woodlands and other recreation areas around towns and cities and increasing urban green-space.
Clean Air	Air quality has improved over recent decades but there are still very high costs associated with it. Negative health impacts related to poor urban air quality are estimated at £9-20bn per annum, so this remains a priority for action.
Marine Fisheries	Wild fisheries are an important resource and are not being managed effectively with long-term sustainability in mind. The gains from improving wild populations could be worth as much as £1.4bn per annum to the economy.

The benefits from natural capital that society should be most concerned about, given existing data, are outlined in Figure A above. From the preliminary analysis undertaken by the Committee, there is evidence that these benefits are at high or very high risk. Improvements in urban air quality and better management of marine fisheries stand out as being of particularly high value. Better data are required to properly assess the risks to some assets and the benefits they provide. For example, improved data on the status of and risks to soils would enable a better assessment of the risks to food production.

Similarly, the recent floods in England have reinforced the need for the Government to take a holistic view of the causes of and solutions to flooding, which means looking seriously at what role natural capital can play in mitigating future events. The 2008 Pitt Review pointed out the importance of working with natural processes to defend against floods and the lessons of this report need to be taken on board in future plans stemming from the 2014 flooding.

Given that some assets are not being used sustainably and the benefits we derive from them are at risk, the Committee recommends that:

Key Recommendation 1:

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.

a) The Government prioritises work to develop measures to monitor the state of natural assets directly, paying particular heed to potential thresholds.

b) 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.

c) 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.

d) Research priorities identified by the Natural Capital Committee are addressed by the Government and the Research Councils.

Key Message 2: There are substantial economic benefits to be gained from maintaining and improving natural assets. The benefits will be maximised if their full value is incorporated into decision-making.

As indicated by the Committee's assessment of the benefits provided by natural assets, there are significant economic opportunities from managing natural capital more effectively.

This can only be done if natural capital is incorporated into public decision-making. There is evidence that this can greatly improve the net benefits of public spending, improve wellbeing and economic growth, and deliver substantially enhanced value for money to the taxpayer.

By way of illustration, the Committee[1], working with the forthcoming National Ecosystem Assessment Follow-On Programme, has produced a case study. In line with the Government's policy of expanding woodland, the study shows where new woodlands might be planted to deliver the greatest overall value for society. It demonstrates just how significant the gains from including natural capital benefits in decision-making can be. The details of the case study and the large potential benefits for society are set out in Section 4.

As a result of its findings on the benefits of incorporating natural capital into decision-making, the Committee recommends that:

Key Recommendation 2:

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

a) 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.

b) 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.

c) Where there are clear net benefits for society, the Government incentivises private investment in natural capital.

d) The Government endorses the Natural Capital Committee's efforts to encourage organisations to incorporate natural capital into their accounts.

[1] In partnership with the UK National Ecosystem Assessment Follow-On programme and the Economic and Social Research Council (ESRC) Social and Environmental Economic Research project, Funder Ref: RES-060-25-0063).

Key Message 3: A long-term plan is necessary to maintain and improve natural capital, thereby delivering wellbeing and economic growth.

The Committee's work to date indicates that the manner in which England's natural capital is managed is likely to have significant consequences for the economy and future wellbeing.

A new approach is needed if the decline of England's natural capital is to be stopped and reversed, as set out in the Government's Natural Environment White Paper. We should acknowledge that the current, not joined-up, approach to policy on the natural environment to date has not worked effectively and is not cost-efficient. Ambitious action is needed to put the economy on a sustainable footing within a generation. Most of our natural assets will need sustained action to restore and improve them.

The Committee, therefore, recommends that the Government endorses the development of a long-term, generational plan to maintain and improve natural capital. The plan should deliver on this vision in a joined-up way, working with all interested parties to maximise synergies and eliminate waste. This will allow the best overall outcome for society to be delivered for the least cost.

The key to the plan's success is to establish the right framework for its development and the Committee presents an initial proposal in this report. The plan should incorporate four basic principles. It needs to:

- Be a **collaborative effort**, recognising the distinct roles for Government, businesses and wider society, with all working together to achieve common objectives and goals. The real value added of a 25 year plan will be to take full advantage of possible synergies between policies and sectors that are currently not being sufficiently exploited. This will help deliver the Government's vision in a least-cost way;

- Recognise **the importance of location** for the provision of benefits from natural capital, which is illustrated clearly in the Committee's analysis of where to plant new woodlands to maximise net benefits. Building on the landscape-scale approach advocated in the Lawton report (2010) and the recently established Nature Improvement Areas, the development of the plan must be underpinned by a coherent spatial framework. This will enable synergies to be fully realised and resources to be utilised more effectively;

- Recognise how fundamental **natural capital infrastructure** is for a sustainable economy. Given the benefits we derive from natural capital, it is necessary to maintain and invest in these assets through a systematic programme of capital investment in order to reverse the capital decline and thereby put our economy on a sustainable footing; and,

- **Make a long-term commitment**, recognising that action now to improve natural assets will deliver benefits over the long-term. A long-term policy commitment will create the right environment for companies, communities, landowners and conservation organisations to undertake the necessary investment of time and money. Commitment over a generation, with policy certainty, is necessary.

The Committee will develop these ideas over the coming year. This project will be the centrepiece of the Committee's work programme up to 2015. The Committee recommends that:

Key Recommendation 3:

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.

a) The Government works with the Natural Capital Committee and interested parties over the next year to shape the plan.

b) The Government should incorporate natural capital into future iterations of its National Infrastructure Plan.

Next Steps

This report lays the foundation for the Committee's third State of Natural Capital report, which will be published in early 2015.

The Committee's main advice to Government on how to prioritise action to maintain and improve natural capital in order to maximise wellbeing will take the form of a 25 year plan. To produce this enabling framework for action, the Committee will engage with Government and undertake informal discussions with interested parties regarding the content and delivery of the proposed plan.

Alongside this major project, the Committee will support the Government to develop metrics and a risk register for natural capital. It will continue to engage with Research Councils and the Government to encourage the research necessary to inform and improve future advice.

It will also continue to support the Office for National Statistics and the Department for Environment, Food and Rural Affairs in their project to incorporate natural capital into the national accounts. The Committee will provide advice to Her Majesty's Treasury and the Department for Environment, Food and Rural Affairs on possible improvements to Government appraisal practice and guidance.

The Committee will collaborate with businesses and major landowners to pilot corporate natural capital accounting.

Section 1: Introduction – Taking Stock

Evidence suggests that the pressures on natural capital from human induced drivers of change, such as population growth and demand for food, housing and transport, have reached unprecedented levels and that these will continue to intensify over the coming decades.

More people were added to England's population in the decade leading up to 2011 than in any previous decade in recorded history and this rapid population growth is projected to continue, with more than eight million people set to be added over the next 25 years.

These drivers at a national and global level have led to the increased exploitation of natural resources such as the increased and more intensive use of land and oceans. This in turn has caused: widespread deforestation; reduction in supplies of clean water; increased emissions of greenhouse gases; seas that no longer have sustainable populations of many fish; reductions in wildlife abundance; and species extinctions.

It is not surprising, therefore, that most environmental trends, both globally and nationally, paint a picture of overall decline, particularly over the last 50 years.

It is imperative that we find a way to accommodate human drivers of change and reverse the degradation of natural capital. Unless natural capital is properly valued and incorporated into decision-making, the world will be far less pleasant than the one we grew up in and the foundations of the economy will be put at risk.

The Natural Capital Committee recommends that:

- **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.**

Introduction

1.1. In March 2013, the Natural Capital Committee submitted its first State of Natural Capital report to the Economic Affairs Committee. The report set out the Committee's initial thinking about what needs to be done to start properly incorporating natural capital into decision-making, in line with its Terms of Reference.

1.2. The Government has set out an ambitious, long-term goal in the 2011 Natural Environment White Paper: [*for*] *"this to be the first generation to leave the natural environment of England in a better state than it inherited"*. One of the overarching messages of the Committee's 2013 *State of Natural Capital* report was that we are currently not on a trajectory to meet this long-term goal. There have been some successes as a result of targeted policy interventions and measures[2], but most environmental trends, both globally and nationally, paint a picture of overall decline, particularly over the last 50 years.

[2] Notable examples include improvements in urban air quality, river water quality, and the conservation status of Sites of Special Scientific Interest (SSSIs).

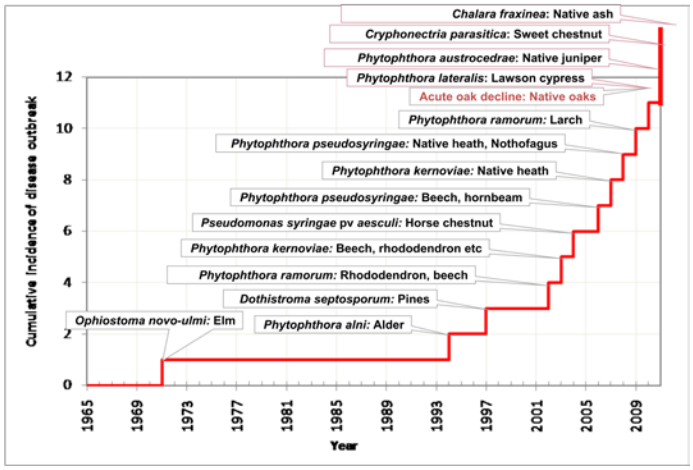
Drivers of Change

1.3. During the 20th Century, world population increased by a factor of four to more than six billion; industrial output increased by a multiple of 40 and the use of energy by 16; methane-producing cattle populations grew in pace with human populations; fish catches increased by a multiple of 35; and carbon and sulphur dioxide emissions by a factor of ten[3]. Box 1 provides an illustration of these accelerating pressures focussing on the examples of tree disease, carbon dioxide emissions[4], water consumption and species abundance.

Box 1 Examples of Accelerating Pressures on Natural Capital

Human activity is affecting the planet like never before with a range of pressures increasing exponentially since the 1950s[5]. These pressures are affecting natural capital and the ways in which it provides benefits to us.

The Incidence of Tree Disease in Great Britain

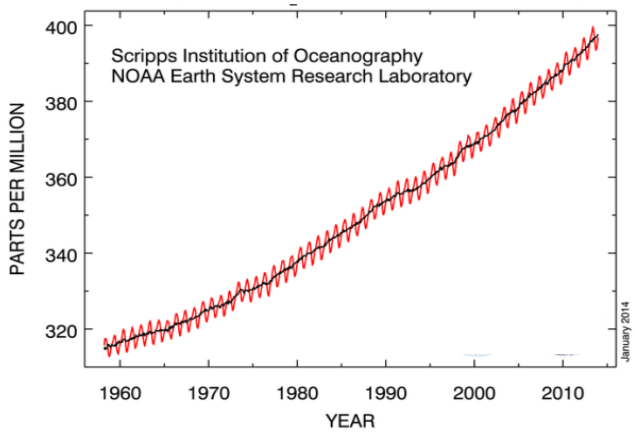


The chart to the left shows the growing incidence of tree disease in Great Britain. The trend suggests that, over the last 50 years, the incidence of disease is accelerating, taking the cumulative total to seventeen cases. The latest, *Chalara fraxinea* or Native Ash Die-Back is expected to destroy all but a very small percentage of the total population of Ash trees in Great Britain once it has run its course.

It is not known why the incidence of tree disease is accelerating but experts believe it is due to multiple factors including increasing cross-border trade, human spread of invasive species (like rhododendron) and climate change.

Source: *Forest Research and Reid, C. Personal Communication*

Atmospheric CO_2 at Mauna Loa Observatory, Hawaii



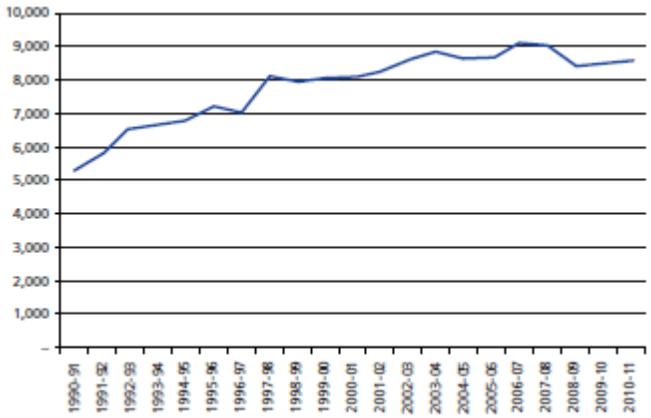
The chart to the left shows the growing concentration of carbon dioxide (CO_2) in the atmosphere which has increased from below 320 ppm in 1960 to almost 400ppm at present.

International efforts to combat climate change are attempting to get agreement to stabilise concentrations at 450 ppm which is thought to roughly equate to a global average temperature increase of around 2°C, but the evidence increasingly suggests that we are not on track to meet this target.

Source: http://www.esrl.noaa.gov/gmd/ccgg/trends/

[3] Dasgupta (2007)
[4] Rising CO_2 levels are not just a concern from a climate change perspective but are also causing ocean acidification.
[5] http://www.anthropocene.info/en/home

Water Delivered to Households, Mega-Litres/day

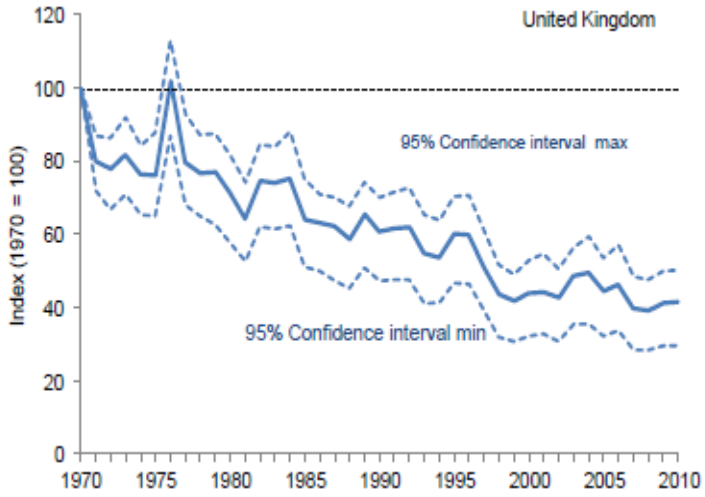


The chart to the left shows how the amount of water delivered to households in England has increased over the last 25 years, from just over 5,000 M/L per day in 1990 to around 8,500 M/L each day in 2010-11.

Water demand has generally been increasing since the 1950s. Although consumption by industry has fallen, household use has increased. While personal consumption is expected to fall between now and 2030, the expected growth in population will offset this and total demand is therefore expected to rise significantly.

Source: HM Government (2011)

Change in the relative abundance of priority species in the UK, 1970 to 2010



The chart to the left shows the decline in abundance (relative to 1970) of 210 species. These 210 are a subset of the wider priority list of 2890 species which are considered threatened. The time-series is data dependent and hence only some species are included: birds (99 species), butterflies (21), mammals (11) and moths (79). It is not indicative of the wider countryside but does show how a group of well-studied species is faring.

Other indicators suggest increasing pressures and a simplification of habitats with generalist species doing better than those with more specialist needs.

Source: HM Government, 2013

1.4. In England, the situation is similar to this global picture, though transformation and exploitation of natural capital goes back much further. Changes over the last 60 years have been well documented in the UK National Ecosystem Assessment[6]. Looking to the future, it is likely that current patterns of economic growth and population will continue to place significant pressures on natural assets.

1.5. The Office for National Statistics projects that, in the coming decade, there will be 20% more people added to England's population than in the preceding ten years, and the last decade itself showed a record expansion of nearly four million people[7]. This, together with other cultural factors, such as the move towards smaller households, will increase the demand for housing, built developments, infrastructure, food and transport – all of which will

[6] UK NEA (2011)

[7] http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html

increase pressures on natural capital, as well as the demand for the services and goods supplied by natural assets.

1.6. One of the most pressing challenges currently facing policy and decision makers in England (and globally) is, therefore, how to ensure that economic development delivers sustainable increases in wellbeing into the future. Notwithstanding the short-term difficulties facing the economy, there are legitimate concerns that a failure to manage the development process properly over coming years and decades risks eroding the natural capital base upon which future economic growth and prosperity ultimately depend.

1.7. The challenge of managing natural assets effectively and efficiently, for the benefit of future generations as well as our own, cannot be ignored. Reliance on market forces alone will not get the job done. Neither will advances in science and technology provide a technical 'quick-fix', important though they are[8]. There are well established economic reasons (namely, market failures) why society and individuals systematically fail to take proper account of natural assets in decisions about what and how much to produce, consume and conserve for the future.

1.8. In short, changes in natural assets are too often assigned a value of zero even though we know this is not the case. Without the right incentives and mechanisms to value those changes properly, the picture of overall decline will simply continue, to the detriment of future prosperity and wellbeing.

1.9. The Committee, recognising the scale and urgency of the need to improve the decisions we make, argued in its first State of Natural Capital report that it is essential to make rapid progress on the measurement and valuation of changes in natural assets. This was in order to improve management of them and thereby increase the benefits that society derives from them.

Box 2 England's International Footprint

England has played a significant contributory role in the changes to natural capital seen at the global level. This is because in an increasingly open world with a globalised economy, the impact on natural assets in other nations has grown as a result of demand for foreign goods and services in England. Indirectly, England continues to contribute to the global loss of natural capital, such as the destruction of rainforests, the reduction in supplies of clean water, and the depletion of marine resources.

England has been gradually transferring the degradation of its own natural assets to those abroad. Taking account of the extent to which we deplete the natural capital of other countries can radically alter assessments of sustainable use. For example, although UK territorial greenhouse gas emissions fell by around 5% between 1992-2004, 'consumption' related emissions (that is, emissions that include embedded carbon in imports) actually increased by 18% (Wiedmann T. *et al*, 2008). The figure is even starker for water where an estimated 70% of all the water consumed in the UK is 'virtual' and embedded in imports (Royal Academy of Engineering *et al*, 2010). Care needs to be taken if these imports are sourced from regions of high water stress.

[8] Sulston *et al* 2013, Fitter 2013.

The Natural Capital Committee cannot take a view of the sustainable use of natural capital in this country without at least acknowledging the fact that England is also impacting natural capital globally. While this largely falls outside of the Committee's current remit, the Committee recommends that Government takes this seriously and explores ways to rank and mitigate England's impacts on natural capital globally.

After all, in a global economy, British companies' supply chains are at risk from impacts on natural capital overseas and England's potential future wellbeing is eroded with the loss of global natural capital. For example, we rely on a global atmosphere that is in good condition (from both an air quality and a climate change perspective) and some of the wildlife we enjoy in this country spend part of their lives abroad.

Report Outline

1.10. This report, the Committee's second State of Natural Capital report, builds on the first and presents developments in the Committee's thinking and progress to date. It also looks ahead to early 2015 when the Committee will present its third report to the Economic Affairs Committee and sets out the likely work programme between now and then.

1.11. This report focuses in particular on three key pieces of work:

- How changes in natural assets might be measured, identifying those about which concern should be highest given the benefits that could potentially be enjoyed through better management;
- Presentation of further evidence on the value of investing in natural capital and the importance of robust appraisal approaches; and,
- The need for a comprehensive, long-term 'natural capital maintenance and improvement plan' to realise the ambition of being the first generation to improve the natural environment.

1.12. Although the Committee's work programme is broad and diverse, this report begins to bring the component parts together into a single, coherent approach. In other words, it starts to build the critical links between measuring and valuing changes in natural assets and how, in turn, this should inform a long-term approach to the maintenance and improvement of natural capital. The Committee's third report will add more detail to the long-term plan for maintenance and improvement by both the public and private sectors.

1.13. **Section 2** presents the Committee's thinking and new analysis of what is happening to individual natural assets. It looks at whether it is possible to measure changes directly (though indicators for example) and explores what conclusions can be drawn about unsustainable use.

1.14. **Section 3** looks at the issue of unsustainable use through a different but complementary lens by examining the goods and benefits we derive from natural assets. This analysis focuses on identifying goods and benefits at risk or in decline relative to levels that have been identified as desirable (for example, using existing policy targets). The difference between the current condition and stated goals has been estimated in monetary terms.

1.15. **Section 4** looks at the importance of embedding the value of changes in natural assets into decision-making and appraisal processes. It presents new analysis[9] looking at how potential changes in woodland cover in England could lead to significant benefits, highlighting the importance of location in determining the overall level of benefits that can be obtained.

1.16. **Section 5** presents the Committee's proposals for developing a long-term maintenance and improvement plan for natural assets. The Committee considers this a vital undertaking in order to realise the ambition set out in the 2011 Natural Environment White Paper of improving our natural environment. The details of any such plan need to be determined collectively. The focus of this report is on setting out why a long-term plan around which the Government, private and the third sectors can align actions and investments is so important.

1.17. **Section 6** addresses the third part of the Committee's Terms of Reference by identifying future research priorities. Over the past twelve months, the Committee has been working with a number of Research Councils to review existing research initiatives and identify evidence gaps that, if filled, could inform future policy development. A summary of the main conclusions is presented.

1.18. Finally, **Section 7** concludes with a forward look to the third State of Natural Capital report, due in early 2015, and outlines the Committee's priorities for the next year. As always, the Committee is keen to received feedback on its work and in particular on the idea of a long-term plan to maintain and improve natural capital, how this should be developed and what it might include. Please contact us at naturalcapitalcommittee@defra.gsi.gov.uk.

[9] This work has been undertaken in partnership with the UK National Ecosystem Assessment Follow-On (UK-NEAFO) programme and the ESRC SEER project, Funder Ref: RES-060-25-0063.

Section 2: The State of England's Natural Capital

Understanding the state of natural capital is important because it underpins many of the benefits we derive from nature. The value of these benefits will change over time and aspects of natural capital may therefore become more or less important in the future. For this reason it is important to consider natural capital in its own right as well as in relation to the benefits it currently provides.

There are many data on aspects of natural capital in England but these are still incomplete and hence it is difficult to assess overall status and trends for natural assets. More work is needed to fill these gaps.

In the few cases where there are measures with some relevance to natural assets (freshwaters, coasts, rare species and priority habitats) current status is some way from current targets.

The Natural Capital Committee recommends that:

- **The Government prioritises work to develop measures to monitor the state of natural assets directly, paying particular heed to potential thresholds;**
- **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; and,**
- **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.**

Introduction

2.1 To ensure that England looks after and makes the most of its natural capital, the Committee has been asked to advise Government on when, where and how natural assets are being used unsustainably. This advice must be underpinned by an understanding of the status of both natural capital itself and the status of the benefits society receives from natural capital. It is important to address both of these aspects because the production of natural capital accounts, which the Committee's first report discussed in detail, relies on the former, whereas decisions about where to invest with maximum effect requires an understanding of costs and benefits too.

2.2 This section and Section 3 set out the first results of the Committee's project to deliver this advice. This section presents an initial view on the status and trends of natural capital in England. Section 3 is a preliminary risk assessment that highlights which benefits are most at risk and therefore where restoration or recovery of natural capital is most urgent or beneficial.

How has the Committee defined natural capital?

2.3 Determining the status of natural assets is an important first step in assessing whether benefits from natural capital are at risk. The Committee has defined 'natural capital' as:

> "The elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions" [10].

2.4 Natural capital is a broad term that includes many different components of the living and non-living natural environment as well as the processes and functions that link these components and sustain life. To undertake any kind of useful assessment, natural capital needs to be broken down into meaningful components for measurement.

2.5 The Committee has defined a set of 'natural assets' for this purpose which are characterised by their distinctive components and functions, and are linked to particular kinds of benefits for people. These natural assets are: species; ecological communities; soils; land; freshwater; coasts; oceans; atmosphere; minerals; and, sub-soil assets.[11] These assets are the basis for reporting on the state of natural capital, its condition and its trends.

2.6 While this definition and the following analysis include renewable and non-renewable assets, when considering benefits at risk (Section 3) the focus is upon renewable assets. There are clear differences in the management challenges and options for these two categories of assets and economic principles exist for sustainable use of non-renewable assets (even if these are currently not being applied)[12].

What are the challenges in measuring the status of natural capital?

2.7 Natural assets are dispersed, interconnected and change over time and place. They are difficult to circumscribe and therefore to count or measure. For example, soils in different locations vary in terms of their structure and composition. Important aspects of natural capital relate to its *quantity* and *quality*. In the case of soils the quality as well location, substantially affects their function as well as the goods provided and benefits generated.

2.8 Much of the value of natural capital comes from the fact that many assets are not static but have their own processes and functions that allow for growth, recovery and adaptation; they may fulfil different functions or behave differently under changed circumstances.

2.9 The links between natural capital and the benefits it provides are complex and often not well understood. The uses for, and values people place on, natural assets may be different in the future compared to those held today. For example, insights from the genetic diversity of wild species are already helping to develop cures for human diseases. Hence there are good reasons for avoiding degradation of natural capital even if the values people hold for it today appear to be low. Indeed the future costs associated with unsustainable use may be much higher than the current value generated by that use. It is, therefore, important to

[10] Natural Capital Committee (2014)
[11] Definitions for natural assets and benefits are given in Annex 2.
[12] Natural Capital Committee (2013) 'the value of the non-renewables asset depletion should be reinvested for the future'

understand the state of natural assets themselves without direct reference to the benefits they provide.

2.10 Furthermore, a good understanding of the status of natural capital is central to producing accounts for natural capital. The work being led by the Office for National Statistics and the Department for Environment, Food and Rural Affairs to develop national natural capital accounts is of the utmost importance if we are to successfully measure changes through time in natural assets in a way that is commensurate with other economic indicators.

How is natural capital affected by human activity?

2.11 Natural capital is both used directly (for example, timber) and affected indirectly by human activities such as pollution. Non-renewable assets, such as minerals, building stone and fossil fuels can obviously be depleted to the point at which they are no longer economic to exploit. By contrast renewable assets, such as wild species, forests, and soils, can be sustainable or unsustainable depending on the intensity of use.

2.12 What constitutes 'unsustainable use' and how to measure it has been the subject of extensive debate and analysis even before the Brundtland Commission published *Our Common Future* in 1987[13]. To provide an initial view on risks that could help inform future analysis and policy development, the Committee has adopted a pragmatic approach and unsustainable use has been interpreted as occurring when[14]:

- Natural assets are continuously declining; and / or,
- Thresholds or safe limits in aspects of natural assets or benefits are approached.

2.13 In its first report, the Committee concluded that it is not possible, given available data and knowledge about safe limits and thresholds, to identify with certainty, natural assets that are being used unsustainably. However, it recognised that an assessment of the risks of degradation would provide useful management information and help prioritise mitigation actions. In other words, what is currently at stake from poor management of our natural assets and what could we stand to gain from better management?

2.14 At this stage the Committee has not addressed the question of whether and when it is sustainable to substitute other forms of capital for natural capital to maintain benefits or secure different benefits. This is an area for future research and is relevant to the development of a long-term plan for restoring natural capital.

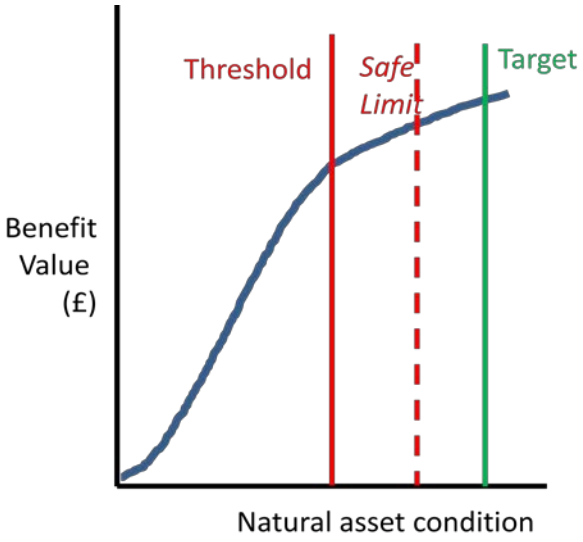
[13] United Nations (1987)
[14] NCC (2014)

Box 2.1 Thresholds, safe limits and targets

A 'threshold' is a discontinuity in a relationship whereby a small change in a pressure or driver can lead to a large change in the state of natural capital (in terms of the diagram below – a small change in asset condition (x axis) results in a large change in benefit value (y axis)). Such changes can result in a sudden change in the benefits provided and may be difficult to reverse. Empirical evidence for such thresholds is limited to a few examples such as the changes that occur in shallow lakes with increasing nutrient pollution. In such cases a lake can lose all submerged plants, becoming turbid and dominated by algae with negative consequences for biodiversity and recreation.

A 'safe limit' is a point above a threshold. In theory this point can be identified based on scientific criteria. Beyond the safe limit, the risks of crossing a threshold are greatly increased. In the shallow lakes example this limit might be a precautionary nutrient concentration used for management.

In addition, society may set 'targets' to ensure that particular levels of benefits are delivered. For shallow lakes this might relate to maintaining a high level of biodiversity.



In managing natural capital and making judgements about sustainability it would be prudent to refer to these thresholds but evidence is sparse. For this analysis the Committee has focused on assessing status against current policy targets.

What evidence is there about the state of natural assets?

2.15 The Committee has reviewed existing information and data from natural environment monitoring schemes to assess whether there are suitable metrics for the natural assets identified above. A relatively long history of nature conservation and environmental protection has given the UK an enviable collection of data which tells us something about the status of some assets. In addition, there are a suite of official indicators which already attempt to track the status of biodiversity and some other aspects of natural capital (the England Biodiversity Indicators[15]).

2.16 In particular, this review has focused on data about the quantity and quality of natural assets. Composite indicators[16] have been identified as these provide a simple overview of the status of the particular natural asset. A composite indicator should quickly and simply convey relevant information on the state of many different components of a natural asset.

[15] Defra (2013)

2.17 Table 2.1 overleaf summarises the results of this data review and shows that some assets are already well covered by existing monitoring schemes. For example, there is a good picture of the status of assets such as freshwater and at least part of coasts. Other assets (soils, atmosphere) are relatively well monitored for specific purposes but lack composite measures against which their overall status and trends can be assessed. There are also assets for which only certain components are well monitored and hence there is just a partial picture of their overall status and trends (species, ecological communities) (see Box 2.2 for details regarding species).

[16] A single measure which combines a range of condition measures to provide an overall summary of state of condition, for example 'ecological status class' for freshwaters. Note that such indicators, while helpful, can hide problems in specific components and therefore component measures should also be reviewed.

Table 2.1 Natural Asset Status and Trends Data (full table in Annex 1)

Results of data review on natural assets, with judgements about data quality. Current England Biodiversity Indicators which may provide some information on the state of the asset are listed.

Asset	Composite Indicator	Data Quality	England Biodiversity Indicators –Trend[17] (Indicator Reference No. in brackets)
Species	✘	A	↘ BAP Species (4a) ↗ EU Protected Species(4b) (↘↘↘) (↗) (←→) Farmland (5) (↘) (↗) (←→) Woodland (5) (↘) (←→) Wetlands (5) (↘) (↗) Marine (5) (↘↘↘) Invasives (20)
Ecological communities	(✓)	A	←→ Protected Areas (1) ↘ EU Protected Habitats(2b) (↘↘↘) Invasives (20)
Soils	✘	A	n/a
Land	(✓)	A	n/a
Minerals and sub-soil assets	(✓)	A	n/a
Freshwater	✓	A/G	←→ Water quality (21)
Coasts	(✓)	A	n/a
Oceans[18]	✘	A/R	↗ Fisheries (23) ↘ Invasives (20) ↗ Pollution (19)
Atmosphere[19]	✘	A	↗ Sulphur deposition (19) ←→ Nitrogen deposition (19)

Key

Composite Indicator: ✓ good data and composite indicator appropriate for purpose; **(✓)** some data appropriate for purpose and potential indicator available; ✘ no composite indicator and data insufficient to determine status and trends across all components

Data quality: Indicative assessment of state of knowledge for natural asset: Red = limited suitable data, Amber = some data, inconsistently collected across components, time or space, Green = good data at appropriate spatial or temporal scales

England Biodiversity Indicators: ↗ upward trend (improving); ↘ downward trend (deteriorating); ←→ no real change; multiple arrows indicate multiple indicators for the asset/pressure. Indicator reference number in brackets.

[17] Indicates current trend in state of natural capital asset as defined by each indicator, for example, all three invasive species indicators suggest increasing impacts upon the species asset.

[18] Note that due to the challenges of data collection in the marine environment our understanding, whilst improving all the time, is some way behind that for terrestrial assets. Whilst some components are well monitored others are not. *Charting Progress 2* is a comprehensive report on the state of the UK seas based on available data and gives a current overview of status http://chartingprogress.defra.gov.uk/

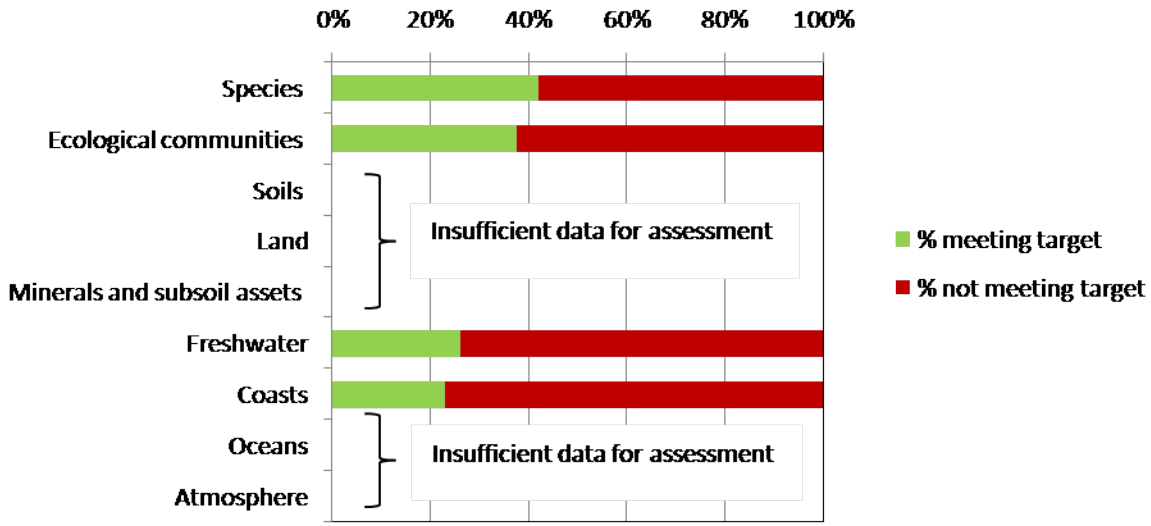
[19] There are good data for some aspects of air quality (for example, in urban environments) and long records for gas composition of the atmosphere (CO_2).

What does the data tell us about the status and trends of natural assets?

2.18 The Committee's review shows that, in particular, data sets and indicators exist where there is specific legislation. For example, the EU Water Framework Directive[20] has led to continuing records of freshwater status and of some components of coastal assets. Work led by the Government is also underway to develop and implement similar indicators for the oceans in response to the EU Marine Strategy Framework Directive[21].

2.19 For other assets (soils, species, atmosphere, minerals and sub-soil assets) there are some good data but no means of assessing these through a single composite indicator, and usually information is lacking on key aspects (for example, soil depth in the case of soil). Designing effective metrics is one of the research priorities identified by the Committee (see Section 6). Where possible, existing metrics have been used to draw conclusions on the status and current trends in condition of each natural asset. For assets with reasonable data, status has been assessed against a relevant target where this is defined. The results are displayed in Figure 2.1.

Figure 2.1 Current status of natural assets where data and relevant targets exist



Note: Targets may be for future compliance and therefore status indicates progress towards these. Targets used: Coasts – EU Water Framework Directive status for coastal and transitional waters; Freshwater – EU Water Framework Directive surface water-body status; Ecological communities – SSSI condition data; Species – priority species at index value: 1970.

2.20 Given the lack of composite indicators and the limited coverage of many datasets, the status information displayed in Figure 2.1 is indicative and incomplete. It shows that all four of the assets for which any meaningful data or targets are available (coasts, freshwater, ecological communities and species), are substantially below target status. However, it is important to note that the date for achieving these targets may still be some way off. Better data, covering a wider range of components of natural capital would enable a more informed assessment of current status across all assets.

[20] Directive 2000/60/EC
[21] Directive 2008/56/EC

2.21 The Committee has not yet been able to undertake a systematic assessment of trends, but Table 2.1 and Annex 1 give information on existing indicators relevant to the biodiversity components of natural capital, as well as indicating where relevant trend information may be found for future assessments.

2.22 The England Biodiversity Indicators offer an official view on the current trends in some aspects of natural capital and are included in Table 2.1 for reference. Together the biodiversity indicators show a complex picture with some assets still in decline and some pressures continuing to increase but in other cases recent improvements can be seen. It is, therefore, difficult to reach generic conclusions from these indicators.

2.23 Where assets have deteriorated or have been degraded there are often grounds for reversing these negative trends and in some cases there are significant gains to be realised from doing so (see Section 3). The Committee has initiated some work on the feasibility, costs and timescales associated with natural capital restoration. Some early outputs are presented in Box 2.3 and Figure 2.2.

Box 2.2 Species Data

Species are an important and well studied part of natural capital. The UK has a long tradition of recording species, largely through specialist partnerships between volunteers and professionals, and arguably has the best studied wildlife in the world. However, it is clear that this effort has largely been targeted at a few charismatic, readily identified groups (birds, higher plants, butterflies) with the result that despite our extensive data we have an incomplete picture of the overall status of species in England.

Current knowledge and data availability – UK Species

Species Group		Abundance	Distribution	Trend
Terrestrial & Freshwater	Microorganisms			
	Fungi			
	Algae			
	Lichens			
	Bryophytes			
	Higher plants			
	Invertebrates (freshwater)			
	Invertebrates (terrestrial)[22]			
	Fish (freshwater)			
	Amphibians			
	Reptiles			
	Birds			
	Mammals			
Marine	Plankton (phyto- and zoo-)[23]			
	Algae			
	Invertebrates			
	Fish[24]			
	Seabirds			
	Mammals			

Key: Red – limited suitable data; Amber – data inconsistently collected across components, time or space; Green – good data at appropriate spatial or temporal scales

There is limited understanding and information on the state of ecological communities – the way in which the component species interact with one another and the other natural assets. The information we do have on ecological communities is generally habitat data which does not cover the full scope of this asset.

Most information on species and ecological communities is focused on those already known to be of concern, with the result that declines in widespread and common species often take us by surprise (for example, eels and starlings) and rare or significant ecological communities (for example, bogs and ancient woodlands) could deteriorate without our being aware.

[22] Some terrestrial invertebrate groups are well monitored e.g. butterflies and moths
[23] The Continuous Plankton Recorder data has been regularly collected since the 1930s hence some aspects are very well monitored
[24] Commercial fish species are well understood, non-commercial species less so

Box 2.3 Restoring Natural Capital

Natural systems can exhibit a high degree of resilience in the face of natural and human induced impacts. For example, though severe winter storms can lead to the loss of many individual trees in a wood, these gaps are re-colonised by other plants and over a period of time the woodland recovers (though not necessarily to the exact same state). Such disturbance events can be very important in creating suitable conditions for certain species.

Restoration

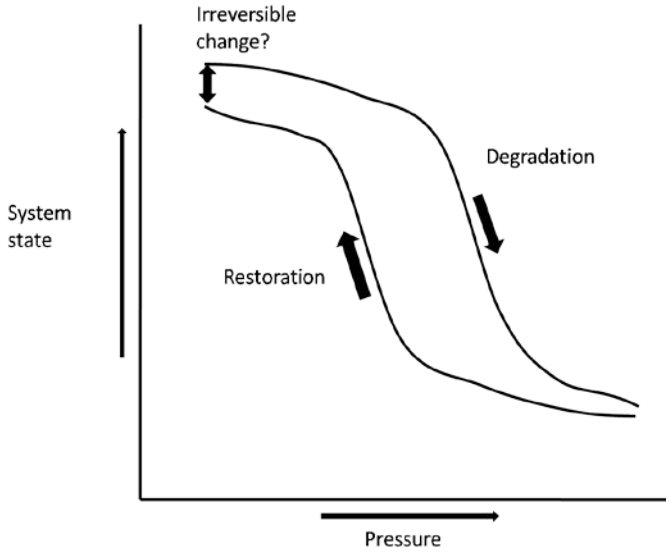
Nevertheless, there are many situations in which natural systems take many years, decades or longer to recover, or are pushed beyond a point of no return or into another less desirable state. In these situations restoration is an option, both for natural assets (for example, woodland or wetland) in their own right and as a means of returning a flow of benefits. While conserving and managing natural capital to avoid degradation to a less desirable state may be the most cost-effective approach, restoration is an option when natural assets have been lost or severely impacted.

Recovery

Restoration implies a return to a (near) natural state as if there were no human impacts. This may be difficult to achieve and may not be the state that ensures the most desirable flow of benefits. In recognition of this, action may be taken to restore particular benefits (for example, river water quality improvements to secure angling related benefits), avoid disbenefits or prevent thresholds being crossed. The Committee has applied the term recovery to such restoration of benefits**.**

Replacement

Replacement of the asset with another asset, either natural or manmade, is a different option. In the past, natural functions have frequently been replaced or augmented to provide benefits (for example, natural water purification is seldom adequate given the scale of demand and hence water treatment works are also required). The extent to which benefits from natural systems can be replaced through built capital depends on scale and complexity[25].

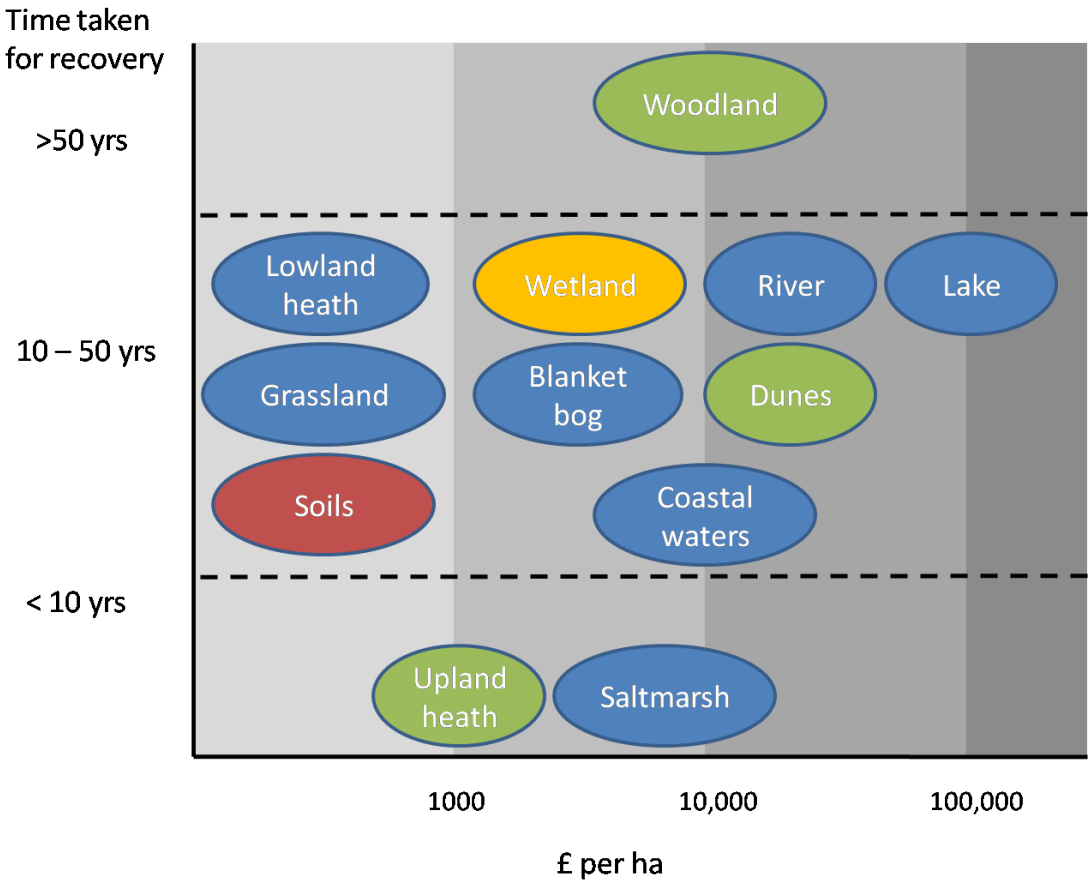


Shown here is a hypothetical restoration-degradation relationship. Restoration may take a different path to the changes that occurred as a result of degradation (hysteresis) and each 'step' may require more effort. It may not be possible to restore a system to its original state. Restoration is almost never complete; even after 100 years restored habitats can still be distinguished from their natural un-impacted counterparts[26] . However, there may be significant gains in terms of the benefits provided (when compared to the degraded state).

The costs and feasibility of restoration can vary according to the degree of intervention, the starting point, physical and ecological characteristics, location and aim. Figure 2.2 summarises some current evidence on restoration cost and timescales to recovery.

[25] See Fitter (2013)
[26] Woodcock et al., 2011

Figure 2.2 Summary of restoration costs and timescales to recovery for different aspects of natural capital



Note: restoration is highly location and context specific so these are indicative only. Colours denote confidence in the evidence: Red= low agreement, limited evidence; Amber = low agreement much evidence; Green = high agreement limited evidence; Blue=high agreement, much evidence.

How could this assessment of natural capital be improved?

2.24 Given data limitations and the lack of appropriate indicators and targets for some assets, it is not possible to state with confidence and for all asset classes, which natural assets are presently being used unsustainably or at high risk of unsustainable use. However, it is clear that there are a range of data sources upon which metrics for natural assets could be developed and the Committee's preliminary analysis highlights those assets for which further work is required. These include the development of relevant metrics for soils, species, atmosphere, minerals and sub-soil assets, as well as data gathering on both status and trends for these assets.

2.25 This summary of the status and trends of natural assets provides a baseline for future work to document and manage better changes in England's natural capital. However, the implications of these changes require a second set of analyses that examine the way in which benefits to society depend on different natural assets and how changes to them may put certain kinds of benefit at risk.

How does this analysis link to the development of national natural capital accounts?

2.26 The approach discussed in this section must not be seen as a substitute for the development of national natural capital accounts. Indeed, developing the type of physical metrics described here can be seen as a crucial input to account construction. The framework set out above is not dissimilar from the evolving structure of the United Nation's proposed ecosystem accounts[27].

2.27 Assessing status and trends offers a first important insight into the state of our natural capital. While much of the remainder of this report shows ways in which this assessment can be taken further (and where it might lead in terms of actions that are needed), it is important to see national natural capital accounts as playing a complementary role.

2.28 National natural capital accounts have two substantial functions. The first is through providing a better understanding of the wealth of the nation and, in particular, the contribution of natural capital to this wealth. In this way, important questions about the sustainability of growth and development can be further explored. The second is through the development of individual natural asset accounts which will provide greater insights into changing status and trends.

2.29 Placing status and trends data within an accounting framework is a useful way of understanding stocks and flows. Perhaps more importantly, this also creates a link to national economic accounts and opens up a whole range of potential policy uses for national natural capital accounts. This emphasis on 'potential' here is significant. Just as account development requires considerable time and effort combined with careful thought, so too does the process of developing policy uses for accounts. These two elements must evolve side-by-side.

2.30 The Committee therefore sees real benefit in the Government's continued support for the important work being led by the Office for National Statistics. Opportunities to speed it up should be found where possible. They need to be developed with clear policy uses in mind so that the information presented in the accounts can make a material difference to decision-making.

[27] See EU, OECD, UN & World Bank (2013)

Section 3: Risks to the Benefits from Natural Capital

Based on a new analysis of the available evidence, there are a range of benefits from natural capital that are at high or very high risk.

Introduction

3.1 The value of natural capital to human wellbeing lies in the benefits it can provide. This section of the report builds on Section 2 and considers how changes to natural capital can lead to risks to the benefits we derive from it.

3.2 The Committee's approach to assessing natural capital begins to highlight where the use and management of assets could be considered unsustainable. The Committee now has a clearer understanding of which natural assets provide us with the greatest benefits, which

ones are at risk, and hence which ones need to be conserved and improved in order to increase wellbeing. This knowledge can inform better decisions about management of natural capital and help the Government to set priorities for action.

3.3 This section aims to answer key questions about the Committee's methods and results. The summary presented here is supported by a more detailed report of the preliminary analysis and review of available evidence, which is available online: www.naturalcapitalcommittee.org.

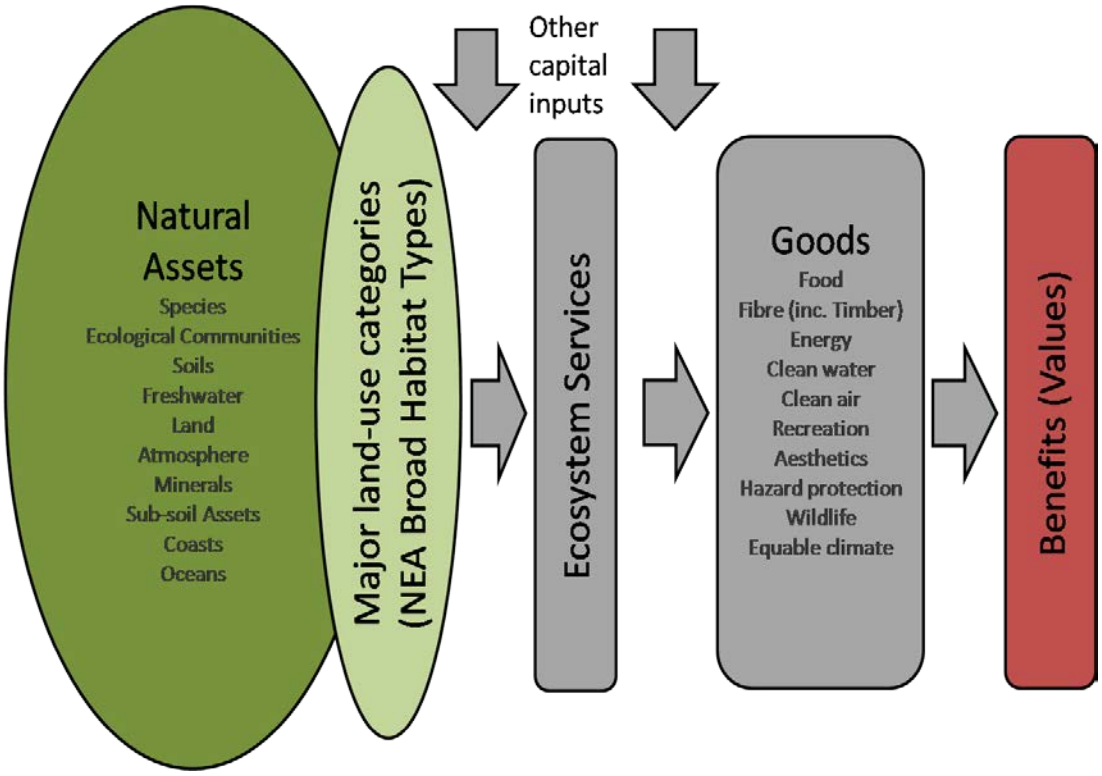
How does natural capital deliver benefits to people?

3.4 The Committee has adopted a conceptual framework consistent with that used in the UK National Ecosystem Assessment (Figure 3.1). Natural assets come together in a variety of ways to provide services. These services are in turn combined with other types of capital to produce goods. These goods are used or consumed and thus provide benefits to people. For example, freshwaters (an asset) provide a flow of clean water (a service), which can be treated to provide drinking water (a good) to support human wellbeing (a benefit).

3.5 Natural capital underpins a wide range of benefits. To consider the risks associated with unsustainable use, the Committee has focused on the most important goods from which benefits are derived. These goods[28] are: food; fibre; energy; clean water; clean air; recreation; aesthetics; hazard protection; wildlife; and, an equable climate.

[28] These goods are defined in more detail in Annex 2.Some goods have not been included in this current assessment but may be important in some circumstances. For example, the impact of noise has not been considered explicitly (the good here would be tranquillity or absence of noise).

Figure 3.1 Natural capital and benefits to people – a framework



Note: The conceptual framework shows how benefits are derived from natural capital. Major land use categories are a simplification of the complex way in which different assets can come together to provide benefits (based on the UK National Ecosystem Assessment).

How can natural capital be linked to benefits?

3.6 The way in which natural assets come together to support the provision of benefits can be complex. For example, food is the product of soils, land, water, species and ecological communities (for example, through processes and interactions such as nutrient cycling, pollination and pest control) as well as other types of capital inputs. Natural capital provides multiple values that are interdependent and interacting in ways that are complicated to describe simply. In addition, as shown in Section 2, data on natural assets themselves are often lacking.

3.7 The Committee has, therefore, adopted major land use categories as a 'lens' through which to investigate the relationships between natural capital and the benefits derived from it. The major land use categories are those used in the UK National Ecosystem Assessment[29] and form the basis of many monitoring schemes in England. Another advantage is that the major land use categories cover the whole country, are mutually exclusive, and encompass areas of land and sea with broadly similar features and use. These features make the major land use categories a convenient classification for analysing the goods and benefits from natural assets and the impact of management. Figure 3.1 illustrates how major land use categories fit within the conceptual framework.

[29] UK NEA (2011)

How do changes in different major land use categories affect the benefits we enjoy from natural capital?

3.8 Different characteristics of each major land use category determine the benefits that are generated. These characteristics can be summarised as: the extent or amount of the land use category (quantity); its condition (quality); and, where it is (spatial configuration).

3.9 For example, the more woodland there is, the more timber and wood is likely to be available for harvest (quantity). However, the timber yield of woodlands is very dependent upon the way they are managed and the resulting structure and species composition, so the condition of woodlands matters too (quality). Finally, if the recreation benefits associated with woodlands are considered, it matters where the woodlands are in relation to where people live (spatial configuration).

3.10 The Committee's approach has considered the relationship between these three characteristics (quantity, quality, spatial configuration) of the eight major land use categories and each of the ten main goods from which benefits are derived. In total 240 relationships (3x8x10) have been reviewed (Figure 3.2).

3.11 For each relationship, the Committee's analysis determined the form of the relationship between the characteristic of the land use category and the level of good provided. Following this initial analysis, 73 out of the 240 potential relationships were highlighted as being of greatest importance. These are priority relationships where society can, or does, have influence (for example, we can realistically control conditions to influence the level of benefits) and where the level of benefits derived is likely to be high[30]. For example, water quality (clean water) is strongly affected by management of enclosed farmland (pollution by nutrients, pesticides and sediment; water abstraction). As over 70% of England is farmland, it has an important influence over the overall amount of clean water available.

Box 3.1 Determining the Status of Natural Capital and Identifying Risk

Which targets have been employed in this analysis?

In the case of natural capital the most relevant policy target has been adopted for this analysis, in many cases this relates directly to any indicators of status, for example EU Water Framework Directive ecological status classes. For the major land use categories, the target used varies according to the type of the benefit provided. So for example, in assessing the level of benefits derived from changes in woodland quantity, status has been assessed against the Government's woodland cover target (12% by 2060).

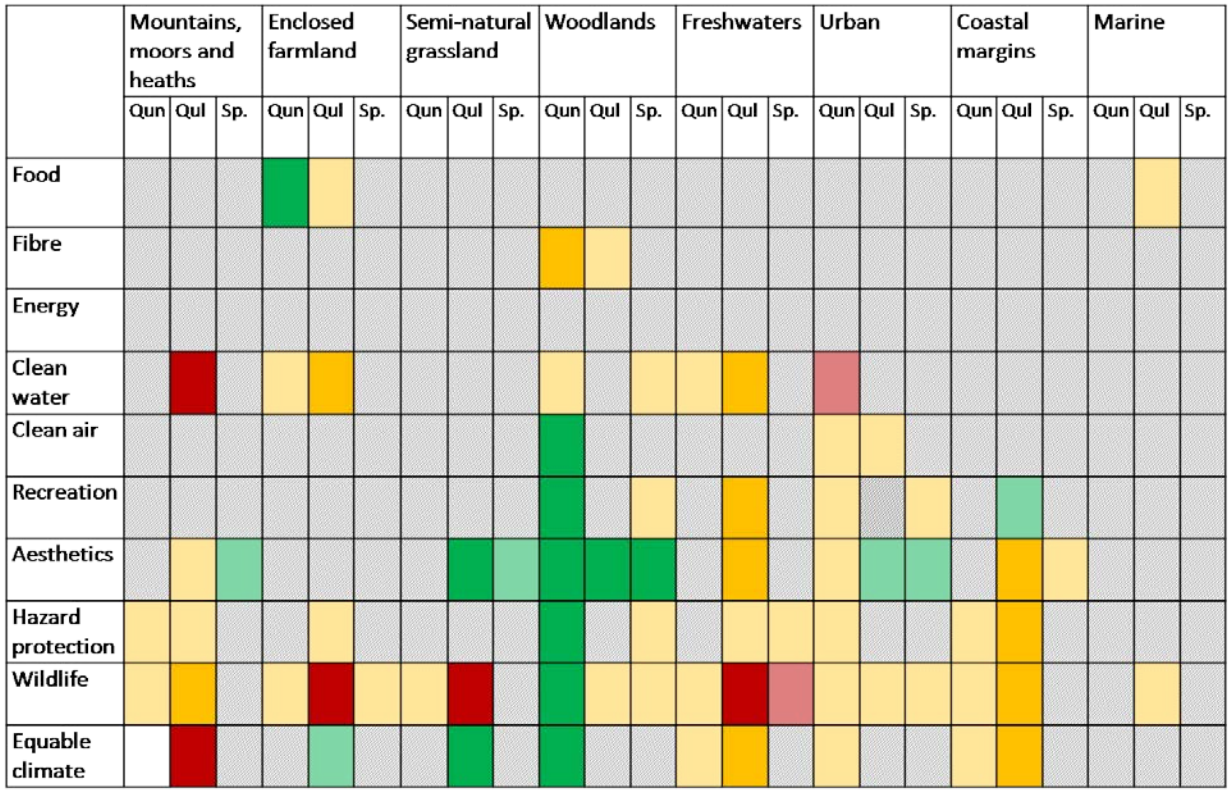
Similarly, for recreation in coastal areas, compliance with the EU Bathing Waters Directive[31] has been used and for marine fisheries (in the absence of specific targets for different stocks) the target used was an average of fish stock levels between 1938 and 1970. For some land use categories no similar, universal, target for quality exists. In these cases, the condition of Sites of Special Scientific Interest (SSSI) has been used as a proxy across all land in a particular broad habitat category. This assumption is justified on the basis that, although targets for SSSIs are

[30] See online supporting information
[31] Directive 2006/7/EC

likely to be more stringent, equally their protected status should mean that there is greater emphasis on securing the right management. Overall we would expect SSSI land to be in a better state than non-SSSI land in a similar habitat category and hence our assumption is likely to be conservative. A full list of targets is included in the supporting report.

Figure 3.2 Risk assessment results

Risk rating for 73 priority relationships between major land use categories (quantity, quality and spatial configuration) and goods



Key

Qun = quantity; Qul = quality; Sp = spatial configuration

	High confidence	Low confidence
Low risk	*A*	*A*
High risk (or risk unknown)	*B*	*B*
Very high risk	*C*	*C*

		Status		
		Above, at or just below target	Below target	Substantially below target (>50%)
Trend	Positive or not discernible	*A*	*B*	*B*
	Negative	*B*	*B*	*C*
	Strongly negative	*C*	*C*	*C*

This figure shows the results of the prioritisation and risk categorisation exercise. The 73 relationships (white cells) identified from the initial prioritisation exercise have been allocated to a risk category A-C based on current status and trend. Levels of confidence are indicated.

Which goods and benefits are most at risk?

3.12 Any significant changes in the quantity, quality or spatial configuration of natural assets within the land use categories prioritised in Figure 3.2 will have a potentially significant impact on the level of goods. In accordance with standard risk assessment procedures the next step in the Committee's analysis was to determine the likelihood of this impact occurring[32].

3.13 To assess the likelihood of the particular risk materialising, the Committee looked at the status and current trends of natural assets within land use categories associated with the goods and benefits that would be lost (see Box 3.1). These were assigned to one of three risk categories (A-C) according to their current status and trends. The results of this assessment including an indication of uncertainty are displayed in Figure 3.2.

a) High and very high risk

3.14 Seven relationships have been allocated to the highest risk category (C). These are cases where there is reasonable confidence that the current status of the natural assets in the relevant major land use category is poor and the trends are strongly negative. The categories of goods, and therefore benefits, at risk include:

- Clean water from mountains, moors and heaths, due to the quality of those habitats;
- Clean water from the current extent and projected growth of urban areas leading to a deterioration in freshwater, soils and natural water purification processes in these areas;
- Wildlife is at risk in many land use categories (semi-natural grasslands, enclosed farmland and freshwaters) due to poor quality habitats and unfavourable spatial configurations; and,
- Equable climate, essentially England's contribution to carbon storage, is at risk from the degraded condition of mountains, moors and heaths which have the potential for much greater carbon storage.

3.15 The high risk category (B) includes two-thirds of the relationships assessed but for nine relationships a confident assessment was not possible. These 'unknown' relationships are included in category B as a precautionary measure subject to further analysis. Of those high risk relationships where information on status and/or trends is available, the types of goods at risk include wildlife and hazard protection; with clean water, aesthetics, equable climate and recreation also featuring prominently.

b) Land use categories at risk

3.16 Across the two high risk categories (B and C), freshwater and mountains, moors and heaths are the two major land use categories with the greatest number of goods at risk, with six and five respectively. Both provide a range of goods (and therefore benefits) and

[32] Risk = impact x likelihood.

are currently subject to a number of human induced pressures. It is the quality of these habitats that is primarily reflected in the risk assessment.

- For freshwater the goods at risk are clean water, recreation, aesthetics, hazard protection, wildlife, equable climate; and,
- For mountains, moors and heaths the goods at risk are aesthetics, hazard protection, wildlife, clean water and equable climate.

3.17 Freshwaters continue to suffer because they are affected by activities across other major land use categories. Rivers, lakes, wetlands and ground-waters are sinks for sediments and pollutants arising elsewhere (for example, from agriculture and urban runoff) as well as being intensively managed themselves in order to provide clean water, manage flooding and to deal with waste.

3.18 In the case of mountains, moors and heaths, the high level of risk is largely the result of significant loss and degradation of blanket bog over the last 60 years. Historic air pollution combined with unsuccessful attempts to convert this habitat to productive agricultural land has left a legacy of soil erosion, impoverished vegetation and associated impacts on wildlife, carbon storage and clean water provision.

c) Low risk and success stories

3.19 The analysis identified 17 relationships which are considered to be at relatively low levels of risk based on current information. These include aesthetic goods (for example, landscape character) from a range of major land use categories, particularly in relation to the spatial configuration of those land use categories. The Committee's analysis also highlights some success stories, relationships where positive action to improve natural assets has improved status or trends and hence led to low risk classifications.

3.20 Of particular note are those goods associated with the quantity of woodland, which has doubled in the post-war period, albeit from a very low base. This positive trend means that goods associated with the amount of woodland (fibre, clean air, aesthetics, equable climate, recreation, wildlife) are considered to be low risk. However, it is important to note that many of these goods are still at risk due to the quality and spatial configuration of this increased woodland area. The low risk category also includes food provision from the quantity of farmland which reflects the fact that in the past 70 years, most increases in UK food production have come from improvements in other forms of capital (fertilisers, machinery, crop varieties and cropping techniques) rather than by bringing more land into agriculture.

d) Quantity, quality or spatial configuration?

3.21 In most cases it is the quality of the major land use categories that is the cause of the high risk classification, rather than their quantity or the spatial configuration. This may be due to our level of understanding and the nature of the data that are available, but this finding is in line with other assessments which show the condition of many of our natural assets is degraded or in decline[33]. The *Making Space for Nature* report[34] similarly emphasised the importance of improving the condition of sites for wildlife as well as increasing their size and

[33] SoNE, 2008; UK NEA, 2011
[34] Lawton *et al*., 2010

improving their connectedness. Management can often more easily influence quality compared to increasing area or relocation, so this finding points to relatively straightforward means to enhance benefits.

3.22 It is important to note that the approach taken in this analysis means that any increase in the quantity of one major land use category is balanced by a loss in another. In other words, there will be trade-offs in the benefits provided which are not explored here. The more detailed analysis presented in Section 4 illustrates how the costs and benefits of alternative land use decisions should be analysed.

What do we stand to gain by taking action to address these risks?

3.23 Reversing downward trends, or taking action to reach the targets society has (or could) set for aspects of natural capital, could provide significant benefits. By transferring valuation evidence from existing studies[35] to this analysis, the Committee has been able to estimate the potential gains to society from improving the current status of major land use categories. In other words, what is the value of goods from natural assets that can be achieved by improving them from the current to the target state? The results of this valuation are displayed in Figure 3.3. It is important to note, these values are indicative and show possibilities rather than actual gains which will depend on a variety of factors and take costs into consideration which this analysis doesn't do.

3.24 The greatest gains from improving the condition of major land use categories to meet particular targets are associated with improving air quality in the urban environment. By improving urban air quality (the 'atmosphere asset'), there are potentially huge avoided health costs. These potential gains are estimated at between £9bn per annum and £20bn per annum based on avoiding health costs associated with high levels of particulate matter of a particular size ($PM_{2.5}$ pollutants)[36]. Although the measures to achieve this gain might largely be technological or regulatory, in some urban areas natural capital itself could play a role with urban green-space and street trees known to improve air quality[37]. This urban green-space can deliver a wide range of other goods too (recreation, flood protection, wildlife).

3.25 There are also significant economic benefits that could be realised through the restoration of marine fisheries to historic stock levels; £1.4bn per annum based on recovering stocks to average levels between the 1930s-1970s. This is unsurprising as it has long been recognised that fisheries have been operating at unsustainable levels. As with urban air quality, the solutions may lie not just with regulatory and technological measures but also with natural capital. There is good evidence from around the world that the establishment of marine protected areas and no-take zones can often help stocks of commercially important fish recover[38]. Recent changes to the Common Fisheries Policy are to be welcomed and are an important step along this path to more sustainable fisheries[39].

[35] See online supporting material www.naturalcapitalcommittee.org
[36] UKNEA (2011) figures
[37] McDonald *et al*., 2007
[38] Sciberras *et al*., 2013

3.26 Robust valuation evidence is sparse and the analysis could only be undertaken for around two-thirds of the 73 significant relationships identified. More valuation evidence of better quality is needed (see Section 6). In addition, some benefits are difficult to value in monetary terms but are nevertheless highly valued and at risk; wildlife is an example of this. It is also important to note that the analysis has focused only on the level of potential (gross) benefits. It has not been possible in the time available to estimate associated costs to provide estimates of potential net benefits.

Box 3.2 Air Quality and Human Health

Human activities have changed the atmosphere significantly and there are considerable costs associated with largely detrimental changes in this natural asset. Although, air quality in England has seen significant improvements as a result of tighter controls on industrial emissions and the implementation of the Clean Air Acts[40], breaches in target levels are still common in urban areas and air quality continues to affect human health.

The pollutants of greatest concern are particulate matter (PM), ground level ozone, sulphur dioxide, nitrogen dioxide and benzo(a)pyrene. Particulate matter includes soot from incomplete combustion of fuels, organic and inorganic compounds, dust and fly ash; it is measured in size classes with PM_{10} (diameter less than 10µm) being the most commonly measured metric. There are significant health effects associated with the inhalation of PM_{10} and smaller particles can penetrate deep into lung tissues. The effect of the smallest particulates ($PM_{2.5}$) on mortality in the UK in 2008 was estimated to be equivalent to 29,000 deaths[41]. Low level ozone is a particular challenge, causing respiratory problems and contributing to premature mortality, at least 39 of the 43 UK air quality zones failed the EU target for annual ozone concentrations in each year from 2008 to 2012[42].

These health impacts are unequally distributed and fall disproportionally on the poor and vulnerable right across the EU[43]. Technological innovations and controls, such as congestion charging have played a part in reducing problems but green infrastructure, appropriately located within the built environment can also play a part (and could play an even bigger part) with urban trees removing significant amounts of PM_{10} [44].

Partnership for Interdisciplinary Studies of Coastal Oceans: Science of Marine Reserves http://www.piscoweb.org/publications/outreach-materials/science-of-marine-reserves-0;

[39] Range shifts for particular fish species may mean that restoration to previous levels is not always appropriate

[40] Clean Air Act 1956 and subsequent legislation

[41] COMEAP, (2010)

[42] ENDS (2012)

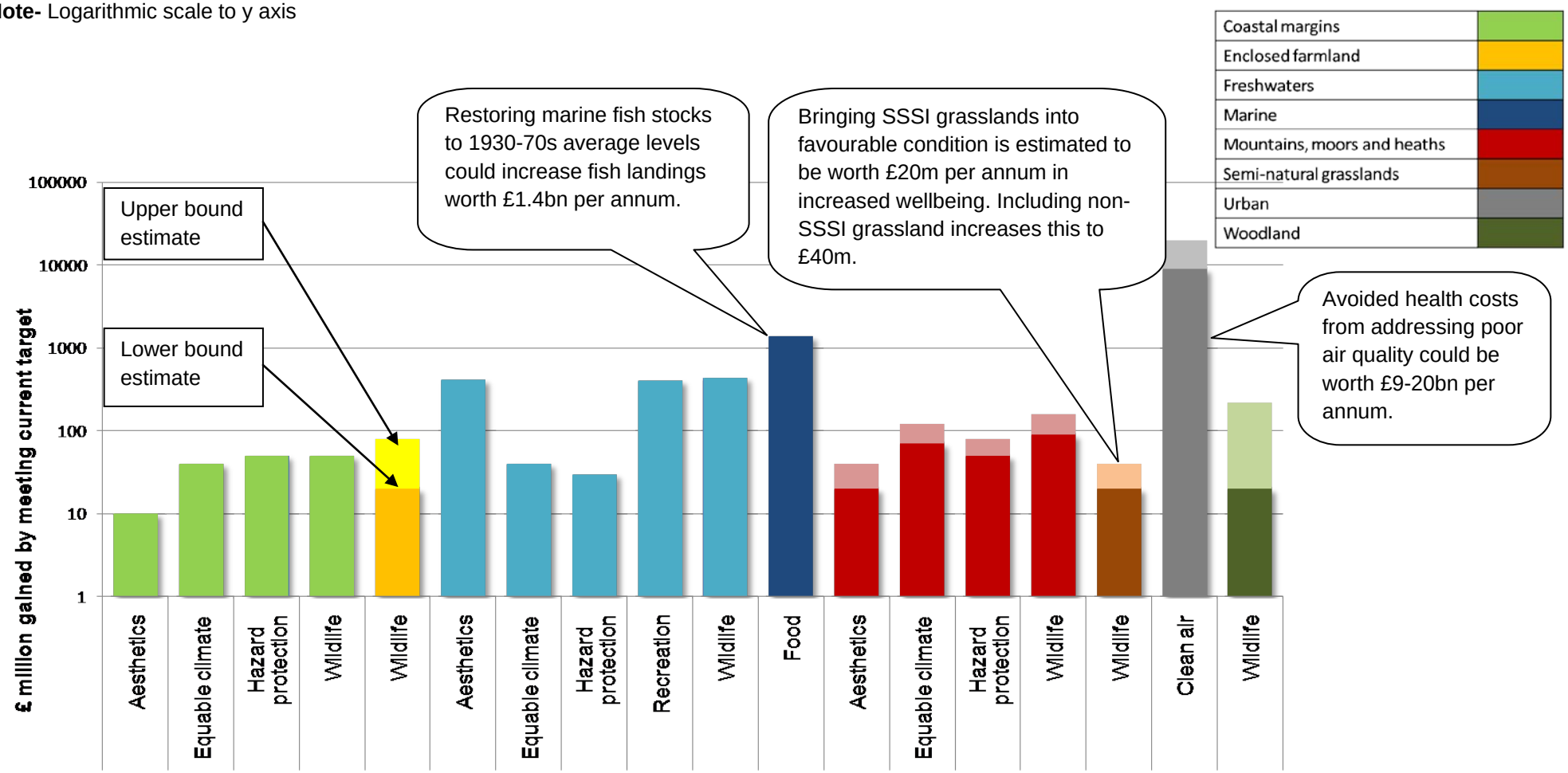
[43] European Environment Agency (2013)

[44] McDonald *et al*.,(2007)

Figure 3.3 Potential value of meeting existing targets for natural capital at high and very high risk

The potential value (£million per annum) that could be generated by improving the *quality* of major land use categories to targets levels (existing policy targets). Data shown are for high risk relationships (categories B & C in Figure 3.2) where valuation evidence is available. Increases in value are also possible through changes in quantity and spatial configuration of some land use type but these have not been presented in the chart.

Note- Logarithmic scale to y axis



How can we move towards developing a set of metrics for natural capital?

3.27 In its first State of Natural Capital report, the Committee set out the value of natural assets using a range of examples and case studies. Such conclusions are supported by a growing number of studies, including the UK National Ecosystem Assessment[45].

3.28 The new analysis presented in this section builds on these studies with a systematic, albeit initial, assessment of the different types of goods we derive from natural capital in each of the eight major land use categories in England. In doing so, it has linked changes in the key characteristics of the different land use categories (quantity, quality and spatial configuration) to potential changes in the level of benefits from natural capital, highlighting those which can be realistically influenced though management interventions.

3.29 The Committee has developed a framework for looking at the relationships between natural capital and benefits. This has allowed us to draw conclusions about risk in line with our Terms of Reference. While the Committee is confident in its identification of the greatest risks there are significant gaps in data and knowledge concerning the current status and trends in natural capital, and a general lack of valuation evidence.

3.30 The Committee considers it important that this work is developed with a more extensive review of existing data and evidence than has been possible to date. These issues are revisited in Section 6 where research needs are outlined. The analysis also demonstrates some of the economic returns associated with halting declines and restoring natural capital and these are further explored in Section 4.

[45] UK NEA, 2011

Section 4: The Benefits of Integrating Natural Capital into Decision-Making[46]

The Natural Environment White Paper (H.M. Government, 2011) firmly acknowledges that natural capital underpins the UK economy, is a major contributor to human wellbeing and that this "*requires us all to put the value of nature at the heart of our decision-making – in Government, local communities, and businesses*" (p.3).

A growing evidence base demonstrates that the benefits of reversing (or the costs of ignoring) the decline in natural capital are substantial.

Incorporating natural capital into public decision-making can greatly improve the net benefits of public spending, improve wellbeing and economic growth, and deliver substantially enhanced value for money to the taxpayer.

A substantial proportion of the UK's impact and dependence on natural capital stems from the private sector and considering natural capital in private sector decision-making can deliver significant bottom line benefits for businesses. These are driven by cost reductions, risk reductions and efficiency gains, and should be encouraged through robust guidance and clear incentives for businesses to invest in natural capital.

The Natural Capital Committee recommends that Government integrates the value of natural capital into decision-making to enhance taxpayers' value for money and to generate net benefits for society.

Specifically, the Committee recommends that:

- **The Government fully incorporates natural capital 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;**
- **Where there are clear net benefits for society, the Government incentivises private investment in natural capital; and,**
- **The Government endorses the Natural Capital Committee's efforts to encourage organisations to incorporate natural capital into their accounts.**

[46] Much of the analysis in this section is concerned with UK as opposed to England level changes. This is because the Committee has been working with the UK National Ecosystems Assessment follow-on programme, the ESRC SEER project, Funder Ref: RES-060-25-0063 and the Operational Potential of Ecosystem Research Applications (OPERAS) programme, looking at the effects and value of land use changes in a UK context. Thanks also to other contributors: Matthew Agarwala (LSE) and Tomas Badura (UEA).

Introduction

4.1. The Committee's first State of Natural Capital report[47] demonstrated that the economic value of natural capital is frequently omitted from accounting procedures and decision-making at both the national and corporate level.

4.2. This section highlights the public and private sector benefits of incorporating natural capital into decision-making. These include improved provision of public goods[48], enhanced value for money in public spending and reduced risks and costs to both society and businesses.

Improving Taxpayers'[49] Value for Money from Public Spending on the Natural Environment

4.3. Public sector decision-making is inherently complex because policy makers are interested in the overall value to society of the decisions they take. This means that they need to evaluate the impacts of policy changes both upon those goods which have market prices and upon those which do not. As indicated in Section 3, this is particularly challenging for decisions involving natural capital because many of the services it provides lack market prices, and these environmental non-market goods are measured using a variety of disparate units which are not directly comparable.

4.4. For example, water quality might be measured in micrograms of pollution per litre, while greenhouse gases are assessed in tonnes of carbon, wildlife in species richness and outdoor recreation in numbers of visitors. This diversity of measures means that appropriate trade-offs between these different units are not immediately obvious and decision-makers face a difficult task in ensuring that the allocation of limited public funds delivers the greatest possible value for money to the taxpayer. How much should be spent to reduce water pollution or greenhouse gas emissions? What is the value of generating new recreational opportunities?

4.5. Given that maintaining those benefits provided by natural capital often costs money (and of course may preclude the opportunity of funding other things with that money), then arguing that environmental goods should not be valued in economic terms ignores the fact that every decision implicitly puts a value on such goods. So the relevant question becomes whether or not those values reflect the benefits those goods provide.

4.6. If UK taxpayers are to obtain value for money from public spending on natural capital, then those funds must be guided by the benefits people obtain from changes to (or conservation of) natural assets. Economic valuation methods seek to estimate the benefits which people obtain from any good, irrespective of whether it has a market price or not.

4.7. The UK National Ecosystem Assessment[50] generated much of the evidence underpinning the 2011 Natural Environment White Paper and has been developed to examine the state of the natural environment and the economic value of many of the goods it provides to

[47] Natural Capital Committee, 2013, www.naturalcapitalcommittee.org
[48] Those 'goods' not provided by markets in sufficient quantities due to their characteristics.
[49] We use the term taxpayers' in a broad sense in this section and it is often used interchangeably with 'society'.
[50] UK NEA (2011)

people, illustrating this through an in-depth analysis of options regarding rural land use in the UK.

Case Study 1: Improving Value for Money from Public Spending on Agriculture – The UK-NEA

4.8. Roughly three quarters of the land area of the UK is used by agriculture and this land yields a wide array of important benefits. Most obviously agricultural land provides food, a valuable output given that Britain is not self-sufficient but imports 40% of the total food consumed, a proportion which is rising over time[51].

4.9. However, relative to its size, UK agriculture is a major recipient of public spending in the form of various subsidies, most prominently through the EU Common Agricultural Policy (CAP). Currently, CAP payments to UK farmers are in excess of £3bn per annum[52] compared to a total income from farming of £5bn per annum[53]. At present, the vast majority of those payments (roughly 70%) are made without consideration of the environmental consequences of land use.

4.10. This is a potential problem as land use decisions not only affect the output of food but also affect other important non-market (and hence unpriced) goods including water quality and availability, the storage and emission of greenhouse gases, the provision of outdoor recreation opportunities, habitats for wildlife, and so on. We therefore have a situation of public spending which may well fail to maximise value for money to taxpayers if valuable non-market, environmental impacts are incorrectly assessed.

4.11. This does not imply that current Government support of farms is excessive; it might be too high or too low. However, what we can say is that it is unlikely that the net social benefits obtained from present spending are as high as they could be. Value for money is very likely to be improved by including the wider effects of that spending upon non-market as well as market goods.

4.12. The UK-NEA analysis of land use is based upon nearly 50 years of data covering all areas of Britain. This allows us to examine the responsiveness of farms to a variety of factors including changes in policy, market forces and the natural environment; the latter varies both between locations and across time due to changes in climate. Indeed an initial analysis accounts for the impacts of likely changes in the pattern of temperatures and rainfall over the next 50 years as a result of forecast climate change. This suggests that, while climate change is expected to have mixed consequences for agriculture at a global scale[54], if we consider only the narrowly defined private returns to farmers, then UK agriculture is likely to benefit from warmer temperatures, although this will in places be offset by more extreme weather events ranging from drought to flood.

4.13. These effects are accounted for in all subsequent analyses which focus upon various scenarios for land use, determined by policy makers to embrace a range of futures for the

[51] Cabinet Office (2008)
[52] Defra (2013a)
[53] Defra (2013)
[54] Schmidhuber and Tubiello (2007); Lobell *et al*., (2011)

UK. The consequences of a move from current land use to that of each scenario were, as far as possible, assessed using economic values. Thus, changes in agricultural production were valued using market prices while consequences for the emission of greenhouse gases were assessed using official UK values[55].

4.14. Analyses of multiple previous studies were used to provide values for changes to open-access rural recreation (for example, studies looking at the relationship between visit costs and the number of trips taken) and urban green-space (for example, analyses of the effect on property prices of proximity to city parks). However, a lack of robust economic values meant that effects on wildlife (in this case bird species richness) were quantified but not monetised.

4.15. The extremes of the findings from the scenario analyses are illustrated in Figure 4.1. The upper row of this figure examines a scenario in which land use is changed to boost production of food, the generally positive change in the value of which is shown in the left hand map (value gains being coloured in green). However, the remainder of the maps in the upper row show the consequence of such a policy for the other environmental non-market goods considered. Here we see greenhouse gas emissions increasing substantially (resulting in losses of value, coloured in red), while rural recreation values are reduced as land is moved into more intensive production.

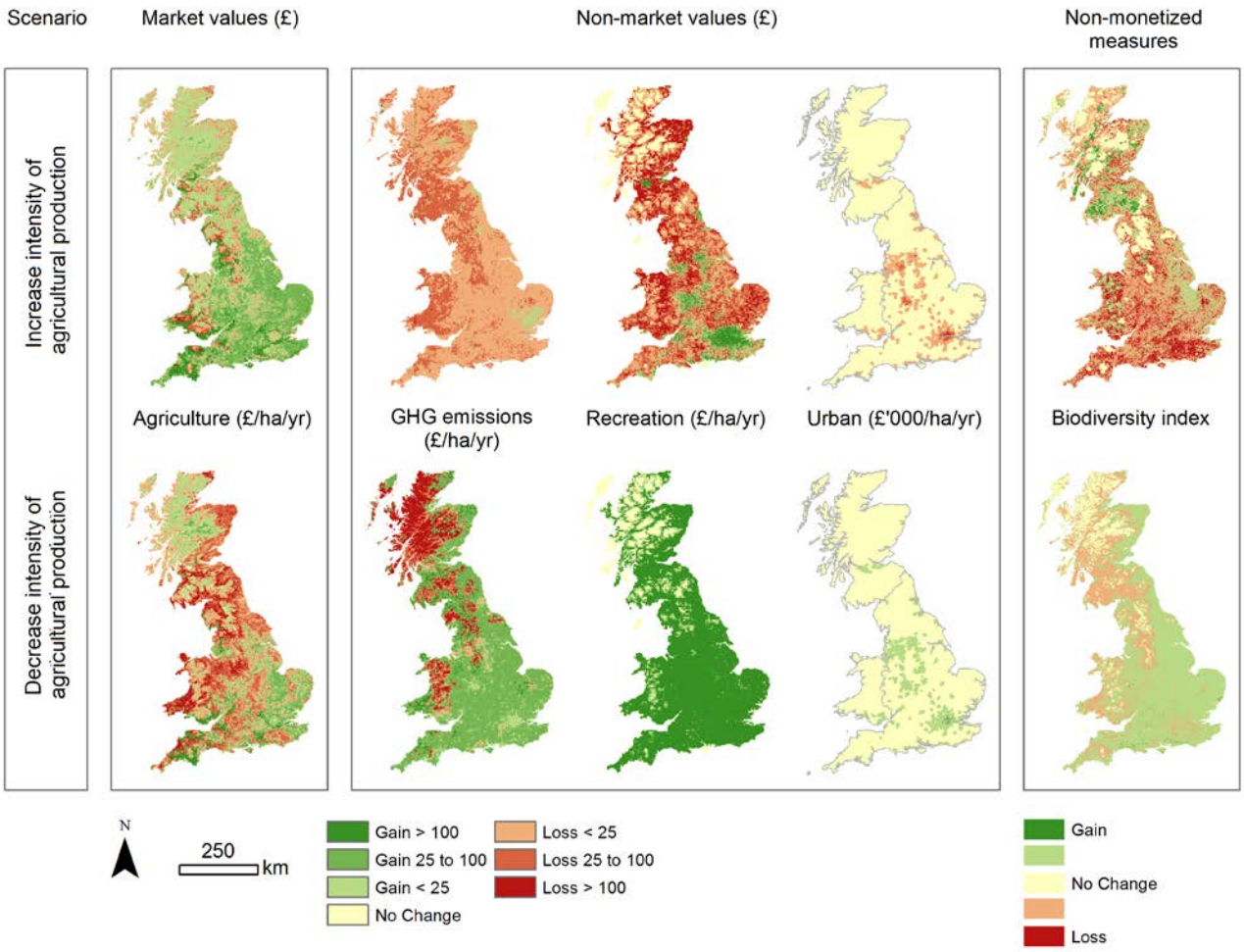
4.16. Reductions in urban green-space also generate value losses. A summation of these value losses shows that they very substantially outweigh increases in the value of agricultural production, meaning that such a move represents a retrograde step for society and, if funded by public spending, would provide a net loss to the taxpayer. Inspection of impacts on our non-monetised wildlife measure gives no support for this scenario as we observe losses across most of the country.

4.17. The lower row of Figure 4.1 considers a contrasting scenario. Here, measures such as stronger protection for the environment reduce the intensity of agricultural production in many areas (left hand map). However, this fall in agricultural values is more than offset by increases in other values. These include a general reduction in greenhouse gases as warmer drier weather allows lowland farmers to switch into higher value arable crops and out of livestock, thus reducing emissions from the latter (although this is to some extent offset by increases in the number of cattle that can now be kept in upland areas). The environmental conservation aspects of this scenario also deliver major increases in both recreation values and urban green-space benefits. Summing these values we find that a modest reduction in agricultural values yields a very substantial gain in all other values.

4.18. If this scenario was implemented through public funding (to compensate for agricultural income losses) then this policy would generate highly positive social values representing excellent value for money to the taxpayer. Furthermore, inspection of our non-monetary wildlife assessment shows that, in most areas, such a policy change would enhance wildlife.

[55] DECC (2009)

Figure 4.1 Spatial distribution of the market and non-market effects of land use change under two scenarios.



Note: Full details given in Bateman et al., (2013).

4.19. The analyses presented in the National Ecosystem Assessment provide a number of useful guides regarding the incorporation of natural capital within public sector decision-making. They reveal that land use changes which are motivated solely by a desire to boost market priced goods can deliver very poor value for money to society as a whole and taxpayers in particular. While this will not always be the case, nevertheless ignoring non-market natural capital goods can lead to errors in decision-making.

4.20. Furthermore, the maps presented in Figure 4.1 show that, across an area as diverse as Great Britain, the effects of any given change can vary very substantially; ranging from strongly positive in one area to highly negative in another. This provides a further useful insight that, if we are interested in delivering value for money from limited tax funds, then these need to be targeted at those areas where they will have the most beneficial effects.

4.21. However, while the comparison of scenarios allows analysts to see that one land use future is better than another, there is no guarantee that either will deliver the best value for money. Another important issue is that the scenarios approach gives no insight as to how a given land use is to be attained. Decision-makers cannot use such analyses to determine the best

policies for obtaining a desired outcome. These problems are addressed through the second case study.

Case Study 2: Improving Value for Money from Public Spending - Britain's New Woodlands

4.22. An alternative to comparing different scenarios is provided through the NEA Follow-On (NEAFO)/SEER research programmes[56]. Instead of examining scenarios of alternative futures as defined by focus groups, this analysis examines how land users (particularly farmers and foresters) are likely to react to changes in policies such as Common Agricultural Policy payments. The analysis again assesses agricultural output and a somewhat wider array of non-market natural capital goods.

4.23. The important advantage to the decision maker is that they can observe the impacts of any policy change in terms of which land users in which areas respond to that change. By estimating the costs of that policy to the taxpayer and the variety of market and non-market goods (and their values) that are generated, the analysis reveals the value for money generated by different policies.

4.24. To illustrate the flexibility of this decision tool, the analysis was applied to the policy relevant issue of expanding Britain's woodlands. Within England this policy goal stems, in considerable part, from the work of the Independent Panel on Forestry[57] which has been endorsed by The Department for Environment, Food and Rural Affairs[58] and the Natural Capital Committee[59]. Separate initiatives to promote afforestation have also been adopted by both the Scottish and Welsh devolved parliaments[60]. All three legislatures seek to deliver a substantial level of new woodland planting sustained over a considerable time horizon.

4.25. Following discussions with various bodies, the analysis considered a case study in which each of the three countries plants a total of 250,000ha of new woodland over a 50 year period (equating to 5,000ha per annum in each country), roughly 3% of land area. Rather than using scenarios to hypothesise where this planting occurs, the analysis examines the costs and benefits of planting in each and every location in Britain and chooses those which maximise net values. However, results depend crucially upon whether or not effects on non-market, natural capital, goods are included.

4.26. Figure 4.2 illustrates how either excluding or including non-market values affects decisions regarding the location of Britain's new woodlands, and the very different overall social values which arise under these two approaches. The left hand side map shows where woodlands would be located if we consider only their market priced effects, these being the foregone values of displaced agricultural output and the net value of timber production after accounting for planting costs. Because the latter timber values are lower than the value of displaced agriculture this yields a negative sum of about £134m per annum which taxpayers have to pay in compensation to farmers in order to induce them to allow the afforestation to go ahead.

[56] Bateman, Day et al., (2014)
[57] IPF (2012)
[58] Defra (2013b)
[59] NCC (2012)
[60] Scottish Government (2012a); Welsh Assembly (2012)

4.27. This afforestation does yield some positive non-market values, including some net sequestration of greenhouse gases (although this is small because some of this planting occurs on peat soils which consequently releases stored carbon) and recreation (but at very low levels due to the remote upland location of these woodlands as shown on the map). However, these values are insufficient to offset the market costs of the scheme which means that, overall, the taxpayer incurs a net loss of roughly £66m per annum (see details in Table 4.1). In short, locating new woodlands without considering wider non-market benefits results in very poor decisions being made and negative value for money to the taxpayer.

4.28. The right hand side map of Figure 4.2 shows where new woodlands would be located if decisions took into account both the market priced and non-market goods that would be generated. This approach locates woodlands so as to maximise the combined value of afforestation for agricultural and timber outputs, greenhouse gas fluxes and recreational opportunities. Relative to the previous map, this results in a dramatic shift in the location of Britain's new woodlands, bringing them off remote upland peatland areas, reducing methane emissions from livestock and adding a 'green fringe' of woodland around Britain's major population centres.

4.29. As Table 4.1 shows, this does increase the initial financial outlay, more than doubling this to £287m per annum. However, the value of avoided and stored greenhouse gases increases substantially while the recreation values, which previously were trivial, now increase massively due to the much greater accessibility of these new woodlands. Overall, non-market values increase more than ten-fold compared to previous results while value for money changes from negative to a very strong positive balance of over half a billion pounds per annum.

4.30. Non-monetary comparisons of the impact of these alternative planting strategies upon water quality show that including monetised non-market benefits in the planting decision resulted in significantly greater improvements in water quality than when the value of non-market goods played no part in the location of new woodlands. Not surprisingly, all strategies result in substantial improvements in woodland wildlife.

4.31. Compared to the overall size of agricultural land take, the relatively small areas dedicated to afforestation generate massively higher value for money, easily outstripping the foregone value of agricultural production. Of course this in no way suggests that much larger conversions are justified; a basic principle of economics is that, as the supply of a good increases so the unit value of further additions diminishes. This is most definitely the case with goods such as recreation and this effect is built into the analysis.

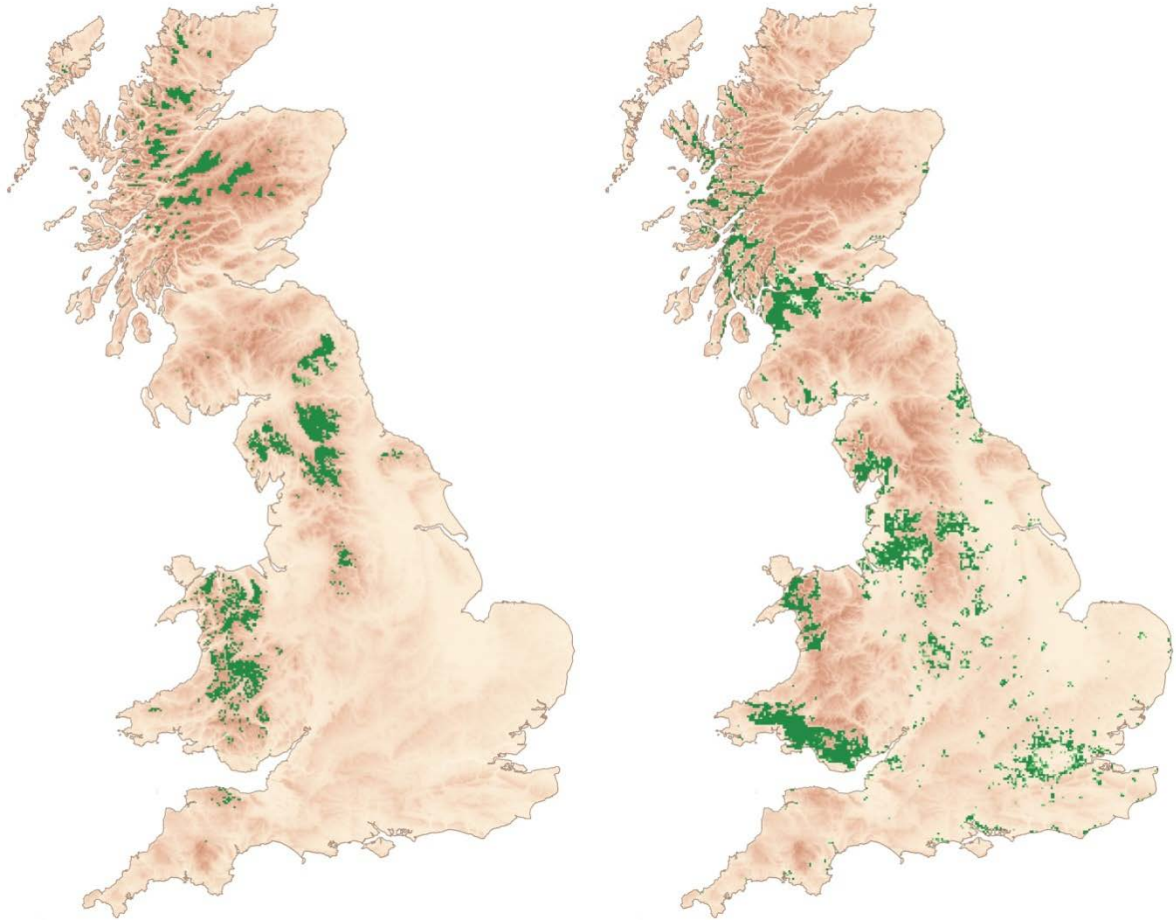
4.32. Furthermore, as land is progressively taken out of agricultural production, so concerns about food security would gradually begin to rise and the case for increased conversions of land weakens. However, the analysis shows that, at least up to this extent, such land conversion is very well justified and would generate excellent value for money to the taxpayer.

Figure 4.2 Britain's new woodlands:

The location and total social value (£m per annum) of planting 250,000 ha of new woodland in England, Scotland and Wales (total planting = 750,00ha) over the next 50 years with planting locations guided by two alternative principles:

Left Hand Side = Planting locations determined by considering only market priced goods (costs of planting and subsidies, agricultural losses and timber production values);

Right Hand Side = Planting locations determined by considering market priced goods (as above) and the economic value of non-market goods (greenhouse gases and recreation)



Social Value **- £66 million p.a.** **+ £546 million p.a.**

Table 4.1 Market, non-market and total social values of planting Britain's new woodlands under two decision rules (£million per annum)

Decision rule →	Focus on market values only (minimising costs)	Including market and non-market (natural capital) values (maximising net benefits)
Market Value	-£134	-£287
Non-Market Value	£68	£833
Total Social Value	**-£66**	**£546**

Notes: Market values = agricultural and timber output

Non-market values = greenhouse gases and recreation (water quality impacts and impacts on wildlife (assessed as woodland bird species richness) are quantified but not monetised; although afforestation improves both of these measures);

Total social values = Market values + Non-market values

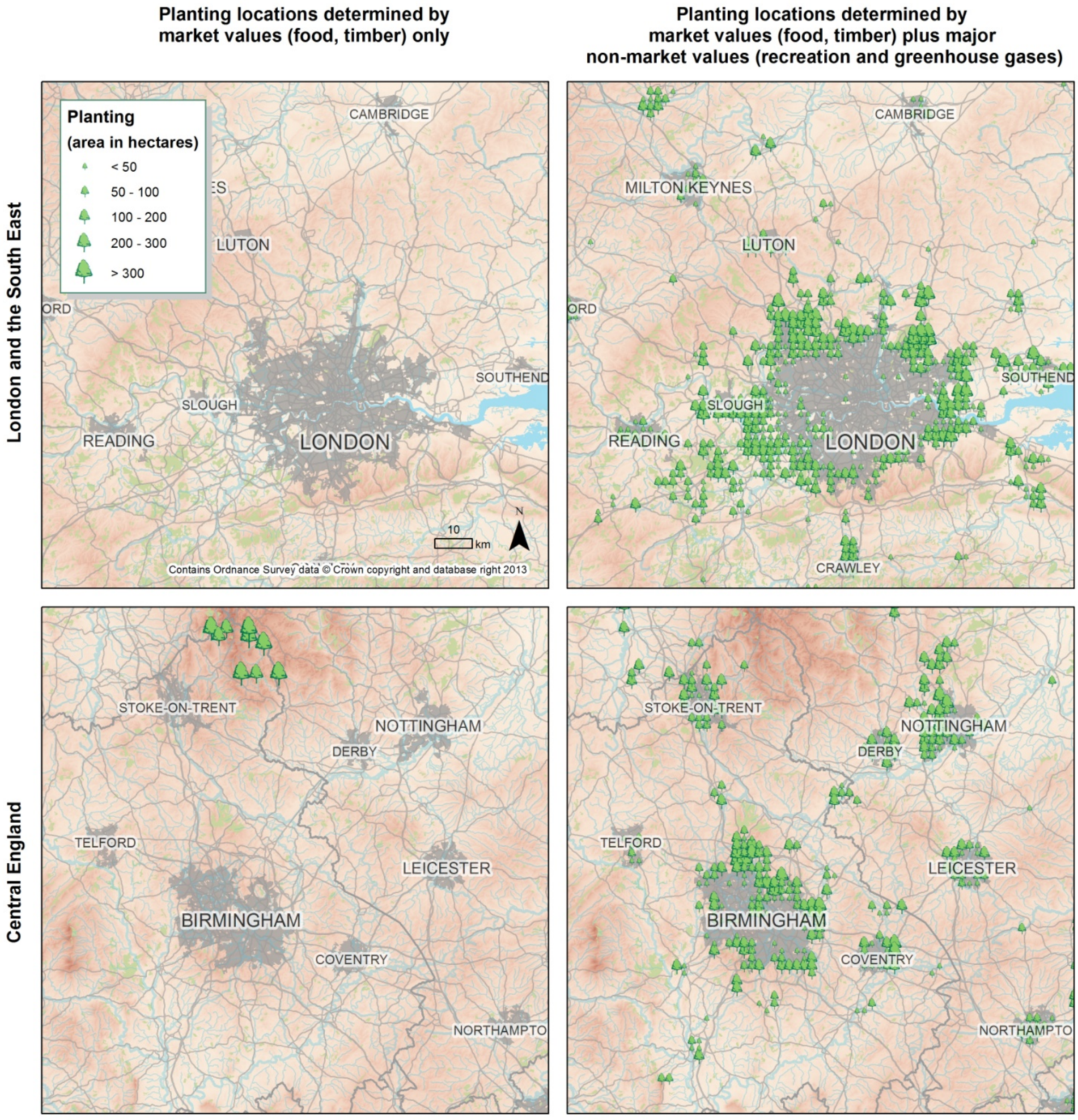
Greenhouse gas values priced using low range carbon equivalent prices (see Bateman, Day et al., 2014). Higher prices would increase non-market and hence total social values.

4.33. The impact of these different approaches to decision-making is perhaps made most visible through Figure 4.3 which illustrates the location of new woodlands relative to the two largest urban centres of the England: London and South East; and the West Midlands. In both cases the use of market prices alone to determine planting locations results in a complete absence of woodlands around these urban centres. This is because the recreational values of woodland are ignored and the minimisation of net financial costs becomes the sole priority, banishing trees to relatively remote upland areas (where the value of displaced agriculture is the lowest).

4.34. However, bringing more benefits from natural capital into the decision-making process radically changes optimal locations for planting, resulting in woodland fringes being generated around each city and town in the region. This would create a legacy of multipurpose, high value woodlands lasting for generations to come.

Figure 4.3 New woodlands for Britain's urban centres:

The location of new woodland around London and the South East (upper row) and Central England (lower row) if planting locations are determined by food and timber alone (left hand column) and food and timber, plus recreation and greenhouse gases (right hand column).



Using Natural Capital to Avoid Costs and Risks and Improve Wellbeing: UK and International Examples

4.35. Maintaining natural capital can also reduce costs related to risk. Recent events (see Box 4.1) have demonstrated the UK's exposure to environmental extremes: while floods occurred one in every five days in 2012, one in four days saw drought (Environment Agency, 2013a). Resilience to such events can be enhanced by preserving natural flood defences, considering potential shocks in land use planning and combining natural and man-made infrastructure to mitigate damages.

Box 4.1 The Benefits of Trees

Trees provide a wide range of benefits, many of which are outlined in this section. However, there are some additional benefits that have not been incorporated into the analysis, ranging from reducing flood risk through to cleaning the air we breathe. This means the estimates of value outlined in this section can be considered conservative. While some benefits from trees do not vary according to where they are sited (CO_2 absorption, for example), a lot of the benefits are particularly large for trees in or near urban areas.

Increasingly, evidence is showing that there are significant costs associated with disconnection from the natural world, for example, a lack of green space is being increasingly linked to poor health outcomes[61]. Woodlands sited in or near urban areas can be important, therefore, in encouraging people to get out and enjoy nature and thereby ensure these considerable health benefits are realised.

Reducing Flood Risk

2010-2012 saw one of the most severe droughts of the past century. It was immediately followed by the wettest Spring in England and Wales for almost 250 years[62]. The Environment Agency[63] estimates that the 2012 floods imposed direct costs to businesses of £200m, with total overall costs reaching up to £600m.

Global and UK-specific evidence suggests that changing land use can reduce flood risk. For example, planting woodlands can trap and store water in canopies and permeable soils, returning water to the atmosphere through evapotranspiration, and producing debris that slows flood waters (hydraulic roughness) and increases storage[64]. Soil infiltration rates (ability of the soil to absorb water) are 67 times greater on land planted with trees compared to grazed pasture[65].

Improving Air Quality and Cutting Carbon in the Atmosphere

Vegetation reduces air pollution (by absorbing and filtering pollutants), absorbs carbon dioxide, and releases oxygen thereby improving air quality and reducing climate change. A recent North American study[66] found that 100 medium size trees reduced small particulate matter by 12kgs each year. As long as they were well located, the planting of trees within

[61] White *et al* 2013
[62] Kendon *et al*., 2013.
[63] EA 2013.
[64] Thomas and Nisbet, 2006 and Bradshaw *et al.,* 2007.
[65] Marshall *et al* 2013.
[66] CNT 2010.

large urban areas could, therefore, improve air quality in these locations. As Section 3 of this report points out, there are very large costs associated with poor air quality in urban areas and so the benefits of such a policy would be considerable.

Reducing Urban Heat

Trees have various cooling functions, including providing shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings. In warm weather, this can reduce the energy needed to cool buildings. Trees also reduce wind speeds, which can reduce the energy needed for heating as well as releasing water into the atmosphere, resulting in cooler air temperatures and reduced building energy consumption. Together, these affects can be very important in built up areas where the so called urban heat island effect can be significant, The value of trees in helping to reduce the extremes in temperature will become even more important in a warming world.

Improving Wildlife Habitat

Depending on what the land was originally used for, the planting of trees can play an important role in improving the habitat for wildlife, especially when species native to the region are used and wildlife corridors are created in the landscape.

4.36. While the UK is a global leader in assessing the value of natural capital, it can benefit from lessons learned abroad illustrating how competitiveness can be improved by using natural capital more efficiently. A range of international examples demonstrate how other countries use natural capital to increase net benefits (see Box 4.2).

Box 4.2 Considering Natural Capital in Decision-Making: International Examples

Careful use of natural capital can avoid significant costs. For example, the Seattle Public Utilities Board (SPU) has maintained forests to regulate and purify the city's water supply since 1889. If the forest was lost, SPU would require a filtration plant with estimated initial costs of £120m, and annual operating costs of £2.2m. Similarly, protected forests in Switzerland are managed to ensure soil stability and provide flood protection, with estimated avoided costs of between £1.2bn to £2.2bn/yr[67].

Enlightened management of natural capital can also generate substantial benefits. In Denmark, following decades of drainage and agricultural expansion in the Skjern River Valley, Parliament reversed the decline in natural capital by restoring 10,000ha of wetlands between 1989-2004, with a public cost of about £30m. Total benefits from improved water quality, increased fish and bird stocks and enhanced recreational opportunities exceed £50m[68], and the area was nominated for consideration as a national park in 2008[69].

Evidence also suggests that improved access to high quality natural capital directly enhances

[67] Dudley *et al* 2009.
[68] Dubgaard *et al.,* 2002
[69] GLOBE 2010.

life satisfaction, health and wellbeing. Interacting with the environment reduces stress and can increase physical activity[70]. Such benefits can reduce sick days and increase life expectancy leading to a larger and more productive workforce, two of the critical components determining economic growth[71].

Understanding Natural Capital Use has Private Sector Benefits

4.37. Between agriculture, energy and water, a sizeable share of the UK's impact and dependence on natural capital takes place in the private sector. Unfortunately, because changes in natural capital related public goods are not typically reflected in market prices, the private sector has no overt financial incentive to deliver or conserve them. Of course this can be altered in a number of ways. For example, governments can impose regulations or other requirements (for example, permits) to force companies to pay for the 'negative externalities', such as pollution, they generate.

4.38. Alternatively payments can be offered to induce private firms to provide the 'positive externalities', such as outdoor recreation, that we want. In addition to this, leading organisations are increasingly identifying ways in which careful management of natural capital can enhance their financial bottom line, while also generating public goods. These strategies include direct cost reductions (for example, energy savings), reductions in environmental risk (for example, from drought or floods), and enhanced reputation and market share. Examples of such innovations are given in Box 4.3. However, it is important to recognise that private interests alone will not reverse the decline in natural capital and government regulation and incentives are necessary.

Box 4.3 Efficient Natural Capital Use Can Reduce Business Costs

Private sector dependence on natural capital creates risks and opportunities for UK businesses. Examples can been seen across a wide array of business sectors including agricultural production and the food supply chain, energy production, construction, tourism, manufacturing, services and finance and insurance[72]. Illustrative examples include the following:

- Walkers Crisps identified a risk; two of their UK factories operate in areas categorised by the Environment Agency as "seriously water stressed". However, in addressing this problem Walkers save themselves more than £630,000/yr in water related costs by introducing more water-efficient manufacturing processes[73];
- Pricewaterhouse Cooper UK installed low cost energy saving fixtures, reduced out of hours heating, lighting and cooling, and invested in on-site low carbon energy generation. This reduced energy intensity by 33%, saving over £7.25m from 2007-13[74]; and,

[70] Mitchell and Popham, 2008; Berman *et al*., 2008; Health Council of the Netherlands, 2004
[71] see UK-NEA, 2011; Section 22.3.16.
[72] Hanson *et al.,* 2012.
[73] http://www.theguardian.com/sustainable-business/pepsico-water-usage-potatoes-maung .
[74] http://www.pwc.co.uk/corporate-sustainability/energy.jhtml

- Recycling and waste reduction programmes can also provide real cost savings. In 2013 Unilever achieved zero net waste to landfill in 130 factories (including all of its UK and Ireland sites), with an estimated global cost savings of almost £60m[75].

4.39. An increasingly common approach to generating public goods is to use payments for ecosystem services (PES), in which service beneficiaries pay service providers to maintain environmental quality[76]. However, if carefully designed, these schemes can also save private firms money. For example, because treatment costs often outweigh the costs of avoiding pollution in the first place, South West Water (SWW) recently funded a PES scheme to assist on-farm investments to reduce pollution in Cornwall's River Fowey catchment[77]. Both the providers (farmers) and purchaser (SWW) of ecosystem services were private sector entities.

4.40. Both parties gain from this arrangement and of course an increase in river water quality also generates a number of public good benefits such as enhanced wildlife and recreational opportunities. There is, therefore, a case for complementing private schemes with publically funded PES initiatives. For example, Pillar 2 of the EU CAP is in effect a very substantial PES scheme in which the Government pays farmers in part to enhance natural capital and provide ecosystem services. The Committee has strongly endorsed the transferral of a larger proportion of Common Agricultural Policy funds into this scheme[78].

4.41. The benefits of considering natural capital in private sector decision-making extend beyond direct cost reductions. Accounting for natural capital (including throughout the supply chain) can uncover opportunities to both reduce costs and identify risks and impacts upon public goods. A number of companies, including PUMA (2011), PepsiCo UK (2012) and SAB-Miller[79] cite increased production and stronger partnerships with suppliers as a result. Moreover, investing in natural capital can increase revenues through product differentiation, increased market share among 'eco-consumers', improved corporate image and the sale of pollution-control technology[80].

4.42. However, evidence on the relationship between corporate financial and environmental performance is mixed[81]. This is in part because private companies cannot capture the full benefits of providing public goods, which creates a tension between financial and environmental performance. The magnitude of private sector impacts upon natural capital means the Government must intervene to align private sector incentives with the provision of public goods if it wishes to achieve its commitment of reversing the decline in natural capital.

4.43. The Committee will report on its work with organisations in the area of corporate natural capital accounting in its next State of Natural Capital report, to be published in early 2015.

[75] http://www.unilever.co.uk/media-centre/pressreleases/2013pressreleases/zerowaste.aspx
[76] Engel *et al* (2008)
[77] Day & Couldrick (2013)
[78] See NCC advice to Government on CAP reform at www.naturalcapitalcommittee.org
[79] Cambridge Programme for Sustainability leadership, 2013, http://www.cpsl.cam.ac.uk/Resources/Publications-and-Downloads.aspx
[80] Molina-Azorın *et al.,* (2009); Ambec and Lanoie, (2008)
[81] Horváthová, (2010); Lioui and Sharma, (2012)

Conclusions

4.44. This section has reviewed the effects of incorporating natural capital within both public and private sector decision-making, discussing a variety of examples which cover a wide range of contexts both within the UK and internationally. The consistent message is that including natural capital within decision-making results in better decisions. In the next State of Natural Capital report, the Committee will make specific recommendations about how existing Government appraisal guidance and implementation, such as the Green Book, might be developed to take better account of issues relating to the sustainable use of natural capital. Officials from the HM Treasury and the Department for Food and Rural Affairs will be involved in the work as it progresses.

4.45. Many businesses are reaping the benefits of maintaining natural capital and generating wider benefits for society in the process. Indeed in many circumstances considering natural capital within business decision-making can result in lower costs, more resilient supply lines and enhanced revenues.

4.46. The UK Government has encouraged the dissemination of such thinking through initiatives such as the Ecosystem Markets Task Force[82]. Such strategies need to be expanded upon if natural capital is to be more routinely incorporated in private sector thinking. Indeed, there is much to do and the Natural Capital Committee holds the view that sustainable and resilient natural capital will only be delivered when the Government creates conditions which robustly incentivise the private sector to maintain it.

4.47. The Government cannot undertake this task alone and needs to work with the private sector to achieve this aim. However, as the discussions and examples presented in this section demonstrate, there is a tremendous potential for improvements if decision-making places the values derived for natural capital on an equal footing with those provided by market priced goods. That gain is in terms of improved health and wellbeing for individuals, sustained economic growth and greatly enhanced value for money to the taxpayer.

[82] Ecosystems Markets Task Force (2013) http://www.defra.gov.uk/ecosystem-markets/

Section 5: A Framework for a 25 Year Plan to Maintain and Improve Natural Capital

The approach to natural environment policy to date has not worked effectively despite good intentions. This, combined with the fact that the value of natural capital is frequently ignored in wider decision-making, is why many of our assets continue to decline and opportunities for increasing our wellbeing are being missed.

A new approach is needed if we are to reverse this and meet the goal of improving the natural environment in a generation (25 years).

A long-term plan is needed that:

- takes a more overarching, joined-up approach to natural environment policy in order to ensure efficiency gains and avoid conflicting action;
- accounts for the full value of nature in all decision-making; and,
- takes a considered, long-term approach to investing in natural capital infrastructure.

Such a plan will enable the Government to meet its frequently stated policy, of being *"the first generation to leave the natural environment of England in a better state than that in which it was inherited",* first contained in the 2011 Natural Environment White Paper.

Over the coming year the Committee will work with Government, conservation groups, major landowners and other interested parties to define the necessary components of such a plan. It will identify the gaps in current policies; the action needed; and the key actors necessary to deliver on the important 2011 White Paper goal. Action can then be prioritised in order to maximise wellbeing benefits.

The Committee recommends that 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. Specifically, the Committee recommends that:

- **The Government works with the Natural Capital Committee and interested parties over the next year to shape the plan; and,**
- **The Government should incorporate natural capital into future iterations of its National Infrastructure Plan.**

Introduction

5.1. This section sets out the framework for developing a long-term plan, explains why such a plan is needed and makes some initial suggestions as to the elements that need to be considered for it to be successful.

5.2. Previous sections of this report have described intensifying human pressures and the impacts these are having on natural capital, both domestically and globally. Despite signs of encouraging improvements in some environmental indicators, the overall picture remains one of decline. This is in large part due to the decisions we make individually and collectively as a society, where the full value of natural capital is ignored.

5.3. The Government has recognised the need to reverse the decline and has set out an ambitious, long-term vision in the 2011 Natural Environment White Paper: [*for*] *"this to be the first generation to leave the natural environment of England in a better state than it inherited"*.

5.4. The Committee's initial analysis suggests that reversing the decline in the quality of natural assets can benefit the economy and wellbeing. From the work carried out to date, it is clear that priorities include ensuring good water quality, improving air quality, creating opportunities for outdoor recreation, reducing declines in wildlife and enhancing protection from natural hazards such as flooding through working with the natural environment. The contribution that certain natural assets can make to mitigating and adapting to climate change should be taken into account and marine fisheries should be better managed.

5.5. To date, policies to address these priorities have been developed mostly in isolation with the consequence that there is a broad spectrum of different actions, many of which may be pulling in different directions. It is necessary to take a look at our natural capital as a whole in order to make informed decisions.

5.6. While some declines can quickly be reversed, certain sorts of deterioration in natural assets may need long-term commitments and investment. Planning and evaluating these actions in a joined-up way would make it easier to determine real costs and benefits over different timescales and identify potential win-win situations or areas of conflict.

5.7. To make meaningful progress towards the Natural Environment White Paper goal and to ensure natural capital continues to underpin economic growth and wellbeing, we need an overarching, systematic and strategic approach. The true value of natural capital needs to be properly accounted for in order to put the economy on a sustainable footing within a generation.

Box 5.1 A National Scale Natural Capital Restoration Plan

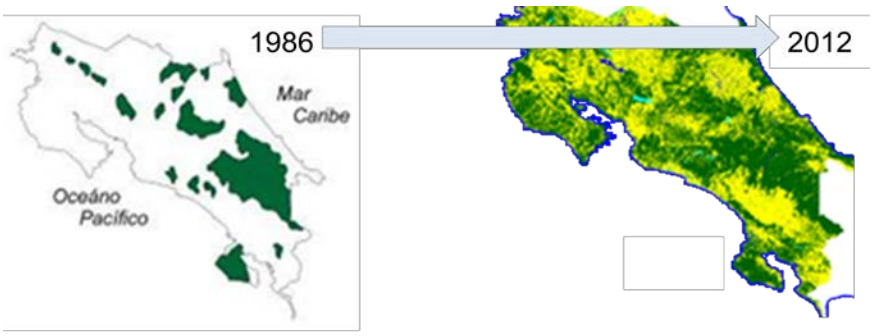
There are numerous examples of good natural capital restoration projects at the local and regional level in this country and abroad. There are also some national level policies aimed at improving natural assets, but these are collectively too narrow in the range of assets that they cover. Action needs to be taken on a national scale if the natural environment is to be improved. The following is an example of what can be achieved when there is collective political will.

Costa Rica pursued policies that ignored the value of the natural environment for much of the 20th century. Forested areas were considered an unproductive use of the land and international food markets created an incentive to destroy the rainforest in favour of creating space for cattle grazing and coffee plantations. The amount of the country given over to rainforest fell rapidly, reaching a low in the 1980s of 21% coverage.

Starting in the 1980s, the country gradually woke up to the damage that was being done to its natural environment and set about restoring it, putting in place policies to incentivise this. These were broadly based around three key themes: addressing perverse incentives; developing the proper institutional framework; and putting in place positive incentives compensating landowners for carbon storage, water services, biodiversity and scenic views. Collectively, this has led to better management and reforestation.

Progress has not been an unqualified success in every area of the country at all times, however, real success has been achieved at the aggregate level. Today over half of the country is covered in rainforest. This has brought with it a whole series of benefits, ranging from increased carbon storage, cleaner air and water, through to better flood protection. It has also meant that ecotourism has become big business in Costa Rica, providing economic benefits to many.

Summary of environmental, economic and population changes in Costa Rica, 1986-2012



GDP per capita: $3574 → GDP per capita: $9219
Forest Cover: 21% → Forest Cover: 52%
Population: 2.7m → Population: 5m

The Importance of a Long-Term Commitment

5.8. A long-term commitment is essential in order to fulfil the Government's goal of improving the natural environment in a generation. It also makes sense from an economic and fairness perspective for the current and future generations. A generational timeframe (25 years) is adequate to capture most existing policy commitments and to identify and implement any further action needed to put the country well on the path to natural capital restoration. The policy certainty that would flow from a long-term commitment is also critical if the private sector is to have the confidence to play its role.

5.9. Over the last year, the Committee has undertaken some preliminary analysis into the feasibility, cost, and timescales for restoring different natural assets and land use categories. While restoration and recovery are often possible, the process and final outcomes can be imprecise, unpredictable and require significant time. Restoration efforts, therefore, need to be sustained and underpinned by long-term commitments.

5.10. In addition, inherent natural variability coupled with evolving human pressures, in particular climate change, will increase the uncertainty of restoration outcomes. A

successful plan to maintain and improve natural capital will, therefore, need to take a long-term perspective of (at least) 25 years and be adaptive to changing circumstances.

5.11. Twenty five years may not be enough time to fully restore everything, especially given the long restoration times of some assets, but it should be sufficient to make meaningful progress.

Box 5.2 Investing in Natural Capital Infrastructure

Natural capital forms part of the capital base which enables the production of the goods and services that drive our economy and increase our wellbeing. To a greater or lesser extent, all activity is dependent on natural assets, such as on reliable supplies of clean water, clean air and good quality soils.

The erosion of the size and quality of our natural capital stock, therefore, risks not only reducing our wellbeing and growth when properly measured, but also undermining the contribution that all sectors can make to the economy. As with the other capitals (manufactured and human), we need to ensure we are not running down our natural capital, and ideally should expand it, if we want the benefits we receive from it to be sustained.

As the UK Government pointed out in its 2013 National Infrastructure Plan, *"The quality of a nation's infrastructure is one of the foundations of its rate of growth and the living standards of its people".*

The Government, therefore, needs to look at the whole capital base, including natural capital, when considering what infrastructure to invest in. In order to do this, the Government needs to take account of those aspects of natural capital which are being used unsustainably as well as taking a view on which matter most for our wellbeing. Given the benefits they provide us, it is necessary to maintain and invest in these assets through a systematic programme of capital investment in order to reverse the capital decline and thereby put our economy on a sustainable footing.

Some places, such as Birmingham through its Green Living Spaces Plan and London through its London 2050 Infrastructure Plan, have started to recognise the significance of natural capital in boosting wellbeing, such as through the provision of green spaces,. The important role of natural capital needs to be recognised in planning elsewhere.

Efficiency Gains from an Integrated, Joined-Up Approach

5.12. Although the existing plethora of efforts and policies aimed at maintaining and improving aspects of natural capital should be applauded, data on status and trends suggests that, collectively, they are not as successful as they need to be to achieve the goal of improving the natural environment.

5.13. Despite the best intentions, current policies and approaches are often piecemeal and focused narrowly on individual issues. This is largely the result of policy development and investment being carried out in isolation. At its worst this can result in different initiatives pulling in different directions or competing for scarce resources, with one policy undermining another leading to perverse results.

Box 5.3 Resourcing a Long-Term Plan

When investigating how a long-term maintenance and improvement plan for natural capital could be resourced, a wide range of options need to be considered and the opportunities for more join-up between funding sources exploited. Environmental payments through the Common Agricultural Policy are currently one of the major sources of investment in natural capital but this is not enough. Offsets or some form of compensation for damage caused could be an important part of the picture in the long-term given our objective to stop and then reverse the decline in natural assets.

Non-Renewable Assets

While many natural assets are renewable in the sense that, given time and within reason, they regenerate or replenish, non-renewable (sub-soil) resources are by definition fixed in quantity (noting of course that new discoveries can be made). It follows that depleting an asset that is non-renewable eats unavoidably into a finite stock.

Extracting sub-soil resources is often associated with the creation of liabilities (or external costs such as CO_2 emissions from the combustion of fossil fuels), some of which may impact on other forms of natural capital and these need to be properly taken into account in decision-making about resource use and pricing.

Whether the use of non-renewable assets can be considered as sustainable depends on whether there are economic processes at work that can replace or substitute for them once they are depleted. In addition, there is also an important and complementary question about what should happen to the revenues generated from their extraction and use, especially for that portion received, for example, in the form of resource taxes.

In terms of how the use of non-renewable assets features in considerations about the sustainability of development and growth of the economy, there are a number of options to consider but common to all is the need for a strategy to build up some other asset (or combination of assets) as non-renewable assets are depleted. For example, this might involve investing in physical infrastructure (manufactured capital) or health and education (human capital). Or it could involve investing in a wealth fund which will generate returns that could contribute to future public revenues such as happens in Norway. A further possibility is to invest in other elements of natural capital which are renewable but, because of the drivers identified elsewhere in this report, are currently in decline and at risk of further deterioration.

5.14. The Committee has started work to map existing goals and strategies in this sphere, and will continue with this over the course of the year in order to ensure that the plan follows a systematic approach. The aim is to ensure that as much activity as possible is mapped out in order to identify gaps as well as areas where coordinated action would be possible under the umbrella of the plan.

5.15. A clearer sense of the bigger picture and overall direction could allow for synergies between projects and programmes to be exploited that would otherwise not be possible if pursued independently. It is even more important in a time of constrained resources to fully exploit any opportunities for greater efficiencies and improvements in the allocation of resources.

5.16. Related to this is the issue of perverse incentives and subsidies. The Committee discussed this briefly in its first State of Natural Capital report, arguing that the effectiveness of current environmental spending could be greatly enhanced if perverse subsidies were eliminated.

5.17. There are numerous examples where taking an integrated approach to enhancing natural assets can have numerous positive outcomes. Efforts to improve a natural asset in a particular site can have supplementary (sometimes unintentional) positive consequences for other natural assets.

5.18. Many of the risks highlighted in Section 3 may have cost-effective integrated solutions, for example, blanket bog restoration can deliver carbon, water and biodiversity gains. Understanding where these opportunities for delivering multiple outcomes are, and focusing efforts accordingly, is critical. The Great Fen project, described in Box 5.4, is a notable example.

Box 5.4 The Great Fen Project

The Great Fen Project is an ambitious initiative aiming to restore a number of natural assets and in doing so secure a number of important benefits for a growing local population.

The Great Fen Project was set up largely in response to concerns about the increasing isolation of fenland species in two close but unconnected nature reserves (Woodwalton and Holme Fens) and the risks associated with storing nutrient rich floodwater in sensitive habitats of Woodwalton Fen. However, the vision that has emerged is one which aims to deal with these issues and also maximise the range of benefits for a local population predicted to increase by over 20% by 2021.

The project is restoring land around the two reserves to more extensive uses, creating an area of 3700 hectares in which natural environment and historic environment features will be conserved and enhanced. It is the epitome of the approach called for in *Making Space for Nature*[83]. Ten years since the start of the project, 1500 hectares are in nature conservation management and key natural assets are already being restored.

The Positive Outcomes

The land taken out of agriculture will be available to store water during times of flood and hence provide resilience to the surrounding land. By re-wetting the peat and preventing further degradation, the project could prevent the release of over 300,000 tonnes of CO_2 to the atmosphere each year. Furthermore, restoring the soil will allow future generations to use the land for food production should this be necessary. The project will also create an important breathing space for a growing local population and it is hoped it will generate new tourism and leisure opportunities, diversifying the local economy.

The Importance of Location

5.19. As well as coordinating across programmes and projects there is much to be gained from better targeting of investment and activity in terms of location. Section 4 demonstrates that investment in natural capital can have a different impact depending on where it is focused.

[83] Lawton et al. 2010

5.20. Many goods from natural capital require actions over relatively large scales (for example, wildlife, flood risk reduction and landscape quality) and even where the benefit can be delivered by small areas of intervention, it is often best to place these in a wider context. The importance of working at a landscape-scale was clearly expressed in the 'Making Space for Nature' report[84] as part of its vision for conserving biodiversity.

5.21. Responding to the recommendations from the 'Making Space for Nature' report, the Government established a competition for landscape-scale projects, this has led to the establishment of twelve Nature Improvement Areas (which complement a large number of other landscape-scale projects). These projects are often wildlife focused but are increasingly considering other goods from natural capital (carbon, clean water, recreation and tourism) with the result that a much broader community of interested parties is getting involved. Other initiatives such as the water focused Catchment Based Approach are similarly broadening out to a wider range of outcomes.

5.22. Targeting effort in the right places requires a good understanding of where natural capital and those who benefit from it are located and needs some form of spatial framework. Such a framework would help ensure maximum benefit from investments such as agri-environment schemes, water company catchment restoration projects and proposed biodiversity offsetting.

Possible Framework for the 25 Year Plan

5.23. To succeed, a long-term plan will need to do the following three things which will be the focus of the Committee's work over the coming year:

a. Identify where natural assets are not being used sustainably and/or are at risk. Section 3 of this report has presented the findings of the Committee's initial analysis. More work is needed but this initial analysis provides a starting point;

b. Undertake gap analysis, that is, review existing policies and strategies to assess what is currently being delivered against what is necessary to achieve the objective of improving the natural environment within a generation. Through this process, gaps can be identified and areas of new activity proposed; and,

c. Assess where and how existing and future activity could best be focused to have the greatest impact to restore natural capital and thus improve wellbeing.

5.24. Following a period of open discussion, the Committee will map out the existing goals and strategies and review them, identify synergies, and identify areas where additional action is needed. Actions and milestones will need to be reviewed at regular periods over the course of the plan in order to ensure that actions are concerted and remain relevant. One tool for monitoring these improvements will be the National Accounts which are currently being augmented to include natural capital.

5.25. The Committee will seek to answer questions such as the following, and would welcome contributions from interested parties:

[84] Lawton et al., 2010

- Which are the priority natural assets not covered by existing targets and plans?;
- In a world of increasingly constrained resources, what would be the most appropriate way to ensure that sources of funding are allocated in a way which maximises impact and effectiveness?;
- Given the clear need to deliver natural capital improvements at a landscape-scale, how can we build upon the recommendations and learn the lessons from 'Making Space for Nature' report and the current suite of Nature Improvement Areas to deliver *more*, *bigger*, *better* and *joined* spaces for nature and more benefits for people?; and,
- What further actions are required in order to deliver the goal of improving the environment within a generation, and how should these be defined?

5.26. Figure 5.1 details an illustrative conceptual representation of how the 25 year plan could be developed. Over the coming months, the Committee would like to start a process of engagement with the Government and other interested parties to help ensure this framework is as inclusive and coherent as possible.

Figure 5.1 Possible conceptual structure of the 25 year plan. The five goals identified are those which capture the main benefit categories which we derive from our natural capital.

Next Steps

5.27. The Committee will develop these ideas and the underlying evidence further over the coming year in order to feed in to the Committee's third State of Natural Capital report, which will be published in early 2015.

5.28. In doing so, the Committee will work in partnership with Government, businesses, landowners, conservation groups and research organisations. In the interim, we are keen to start a process of engagement with the wider community and to receive feedback on the proposed content of what might be included in a 25 year plan at: naturalcapitalcommittee@defra.gsi.gov.uk.

Section 6: Research Needs

To truly '*put the value of nature at the heart of our decision-making*' (Her Majesty's Government 2011), new research is needed on how to measure and value changes in natural capital.

The principle research gaps identified by the Committee include:

1. A consistent approach to meaningfully measure changes in the status of natural assets that enables early detection of potential thresholds;
2. A sufficient understanding of the relationship between changes in natural capital and economic growth, employment and related measures;
3. The lack of (and acute need for) more robust valuation estimates of changes in natural capital; and,
4. How new evidence and knowledge can be integrated into and improve current decision-making frameworks.

Current research initiatives will make a useful contribution to filling these evidence gaps. NERC have aligned their forthcoming Valuing Nature programme to the research priorities identified by the Natural Capital Committee which is an excellent start, though more work will be needed in the long-term to have the required impact.

The Natural Capital Committee recommends that:

- **Research priorities identified by the Natural Capital Committee are addressed by the Government and the Research Councils.**

Introduction

6.1. The third area of the Committee's Terms of Reference is to provide advice to Government on research priorities to improve future advice and decisions on conserving and enhancing natural capital. Over the past year, the Committee has worked with relevant Research Councils and the academic community to identify what those priorities ought to be.

6.2. This section of the report presents a summary of those discussions and conclusions. It highlights some of the key research questions and gaps in knowledge, noting the likely contributions from existing initiatives and research programmes. A copy of the full research priorities paper will be published alongside this report[85].

Major Research Themes

6.3. Answers to some of the most pressing questions about how to measure and value changes in natural assets require a genuinely interdisciplinary approach, combining new research in natural science, economics and wider social science. Even a short-list of potential priorities is extensive given current levels of understanding in some areas. For example, fundamental science questions remain relating to the identification of ecological thresholds and we currently lack methods to value characteristics of natural systems such as resilience.

6.4. The Committee has structured its recommended research priorities around two main themes:

1. Sustaining natural capital; and,
2. Decision-making for efficiency and sustainability.

Each is discussed below with more detailed research questions presented in Annex 3.

Sustaining Natural Capital

6.5. This theme is centred around measuring the extent to which natural assets are being used sustainably at a national level and in a manner which complements existing measures of economic progress, most notably national income. A further two sub-themes have been identified. The first relates to definitional and measurement challenges. To measure natural capital in a meaningful way, its various component parts need to be categorised and units of measurement determined to ensure comparability between them. The Committee has laid some foundations in Sections 2 and 3 but further work is needed.

6.6. Key research challenges include gaps in the natural science knowledge base, prior detection of thresholds and information on depletion/restoration relationships. Addressing these is a prerequisite for meaningful progress on subsequent economic valuation because measurement of natural capital needs to focus not only on absolute (total) amounts, but also on rates of change, and potential threshold effects and irreversibility.

6.7. The second sub-theme concerns improving understanding of how changes in natural capital affect the economy and growth. The impact of increases and decreases in the amount and condition of natural assets upon conventional measures of UK economic performance remains an open empirical question.

6.8. The view still persists that efforts to improve natural capital have a negative effect on measures such as national income, growth and jobs. While short term impacts on the level of economic activity may be relatively minor, longer term effects might be significantly positive and almost certainly increase prosperity and wellbeing. Given the fundamental services which natural capital provides to the economy[86], a clearer understanding of the relationship between changes in natural capital and economic growth, employment and related measures would make a significant contribution to strategic policy making.

[85] See www.naturalcapitalcommittee.org
[86] See UK-NEA, 2011 and Bateman et al., (2013)

Decision-Making for Efficiency and Sustainability

6.9. This theme concerns the development and use of robust economic values for changes in the goods derived from natural assets. Two sub-themes have again been identified.

6.10. The first concerns the need for more solid and reliable estimates of the value of changes in natural assets. This remains one of the most fundamental barriers to improving decision-making along the lines outlined in Section 4. Although there have been many valuation studies undertaken over the last thirty years, very few adequately:

a. Reflect the characteristics of the natural assets they refer to (that is, the way they behave and operate in different circumstances);

b. Deal with the interactions between natural capital, human and other forms of capital, which are often needed in different combinations to produce the goods from which we derive value;

c. Investigate which goods and benefits are actually being valued;

d. Account for physical location in relation to beneficiaries, the importance of which is set out in Section 4;

e. Take account of the stock characteristics of natural assets and whether they are being used sustainably (which can significantly alter valuation estimates);

f. Consider how resilient natural assets are to external shocks; or,

g. Consider whether changes to assets (that is, as a result of degradation) are reversible.

6.11. The second sub-theme builds on the first and concerns the incorporation of valuation evidence in decision-making. Her Majesty's Treasury's (2003) Green Book appraisal guidelines provide an internationally acclaimed basis for cost-benefit analysis and is an excellent starting point for the incorporation of natural capital into conventional decision-making frameworks. Nevertheless, there is scope for improvement and there remains an urgent need to develop better decision support tools which are capable of incorporating the type of valuation evidence referred to in 6.10 above. The Committee will set out its views in this area in its next report.

6.12. Finally, it is also important for researchers in the field of valuation to work with decision makers and policy leads in both the public and private sector to ensure the values developed are compatible with and can help improve existing decision-making systems.

Existing Research Initiatives

6.13. Discussions with the Research Councils have identified a number of relevant research initiatives currently in progress which could make a contribution to filling some of the gaps identified. These are outlined in more detail in the Committee's research advice paper which has been published alongside this report (see www.naturalcapitalcommittee.org). Possibilities for greater synergies and join-up to address the gaps identified by the Committee are discussed.

6.14. Finally, the Committee is pleased to acknowledge the efforts of the Natural Environment Research Council (NERC) and other funders of the Valuing Nature Programme, a six year, £7m-plus inter-disciplinary programme aligned to the research priorities identified by the Natural Capital Committee[87].

Conclusion

6.15. In summary, the Committee has identified a number of research priorities based on the two themes of 'sustaining natural capital' and 'decision-making for efficiency and sustainability'. Filling these gaps is essential to improve future advice on conserving and enhancing natural capital in England and indeed elsewhere. Although these gaps may seem significant and will be challenging to fill, they are not insurmountable. With the right levels of commitment and funding they can be addressed. There are several current research projects that have the potential to make meaningful contributions.

[87] http://www.nerc.ac.uk/research/themes/tap/tap-phase4.asp

Section 7: Next Steps

7.1. Drawing on the conclusions and recommendations of this second State of Natural Capital report, this section sets out the actions that the Committee will undertake to deliver on its Terms of Reference over the coming year. These next steps will form the basis of our third State of Natural Capital report, due to be published in early 2015.

7.2. Term of Reference 1: To provide advice on when, where and how natural assets are being used unsustainably, the Committee will:

- Work with Government, should it accept the Committee's recommendation, to progress and apply the experimental metrics and risk register for natural capital developed by the Committee over the last year.

7.3. Term of Reference 2: To advise the Government on how it should prioritise action to protect and improve natural capital, so that public and private activity is focussed where it will have greatest impact on improving wellbeing in our society, the Committee will:

- Develop the concept of a 25 year plan to maintain and improve natural capital, to be published in more detail in the third State of Natural Capital report. Starting in 2015, such a plan could provide an enabling framework to coordinate the delivery of the ambition to be the first generation to leave the natural environment in a better state than it inherited;

- Undertake informal discussion with the Government and other interested parties regarding the content and delivery of the proposed 25 year plan. This feedback will shape the substance of the plan so that it brings together existing policies and strategies in a way that will maximise impact and cost-effectiveness;

- Run a pilot project for corporate natural capital accounting with several major UK businesses and landowners. Natural capital accounts aim to document an organisation's ownership, liability and assets related to natural capital. In the same way that recording more conventional assets on their balance sheet informs and improves an organisation's management decisions, natural capital accounts will enable organisations to make better decisions about their natural assets.

  The Committee's pilot project will involve working closely with the pilot organisations to trial and refine an experimental natural capital accounting methodology. The lessons learned from this process will be distilled into high-level guidance and the Committee will publish a generic accounting framework that can be adapted for use by a wide group of organisations. The Committee will seek opportunities to work with the private sector to encourage adoption of this model for corporate natural capital accounting;

- Continue to support the Office for National Statistics and The Department for Environment, Food and Rural Affairs in their development of national natural capital accounts;

- The Committee has and will continue to undertake work[88] to help shape the debate around approaches to, and relevance of, accounting for natural capital at both national and corporate levels; and,

- The Committee will bring forward recommendations in its next report about how Government appraisal guidance and implementation could be improved to take better account of natural capital issues. The Committee will involve officials from HM Treasury and Defra in this work.

7.4. Term of Reference 3: To advise the Government on research priorities to improve future advice and decisions on protecting and enhancing natural capital, the Committee will:

- Maintain engagement with Research Councils and the Government in order to communicate the significant remaining research challenges associated with natural capital. Where appropriate, we will offer guidance and support to research projects that seek to address current evidence gaps.

[88] Mayer.C, 2014, Unnatural Capital Accounting, NCC Member's Discussion Paper, Number 1. www.naturalcapitalcommittee.org

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Annex 1: Natural Assets Status and Trends Data

Results of data review on natural assets, with judgements about data quality. Current England Biodiversity Indicators which may provide some information on the state of the asset are listed.

Key
Composite Indicator: ✓ good data and composite indicator appropriate for purpose; **(✓)** some data appropriate for purpose and potential indicator available; ✗ no composite indicator and data insufficient to determine status and trends across all components
Data quality: Indicative assessment of state of knowledge for natural asset: Red = limited suitable data, Amber = some data, inconsistently collected across components, time or space, Green = good data at appropriate spatial or temporal scales
England Biodiversity Indicators: ↗ upward trend (improving); ↘ downward trend (deteriorating); ←→ no real change; multiple arrows indicate multiple indicators for the asset/pressure. Indicator reference number in brackets.

Asset	Composite Indicator	Quantity Data	Condition/Quality Data	Components Measured	Data Quality	England Biodiversity Indicators – Trend[89] (Indicator Reference No. in brackets)
Species	✗ BAP Priority Species Indicator (rare species only) State of Nature (3148 species) Biodiversity Indicators (combined)	✗ Mostly based on presence-absence distribution data Very little abundance data (bird counts, butterfly counts, some moth data)	✗ Very little data	Rare species Vertebrates Some invertebrates Higher plants (See Box 2.2)	**A**	↘ BAP Species (4a) ↗ EU Protected Species(4b) (↘↘↘) (↗) (←→) Farmland (5) (↘) (↗) (←→) Woodland (5) (↘) (←→) Wetlands (5) (↘) (↗) Marine (5) (↘↘↘) Invasives (20)
Ecological communities	**(✓)** BAP Priority Habitat Indicator & Countryside Survey	✓ Countryside Survey & BAP Priority Habitat Inventory	✓ Countryside Survey & SSSI Condition Data	Vegetation community Structural components	**A**	←→ Protected Areas (1) ↘ EU Protected Habitats(2b) (↘↘↘) Invasives (20)
Soils	✗	✗ No data on soil depth	✓ Countryside Survey (CS) and National Soil Inventory (NSI) provide partial picture for components measured	pH Loss on ignition Metals Soil invertebrates (CS) Nutrients (NSI, CS)	**A**	n/a
Land	**(✓)**	✓	✓	Topography	**A**	n/a

[89] Indicates current trend in state of natural capital asset as defined by each indicator e.g. all three invasive species indicators suggest increasing impacts upon the species asset

Key
Composite Indicator: ✓ good data and composite indicator appropriate for purpose; **(✓)** some data appropriate for purpose and potential indicator available; ✖ no composite indicator and data insufficient to determine status and trends across all components
Data quality: Indicative assessment of state of knowledge for natural asset: Red = limited suitable data, Amber = some data, inconsistently collected across components, time or space, Green = good data at appropriate spatial or temporal scales
England Biodiversity Indicators: ↗ upward trend (improving); ↘ downward trend (deteriorating); ←→ no real change; multiple arrows indicate multiple indicators for the asset/pressure. Indicator reference number in brackets.

Asset	Composite Indicator	Quantity Data	Condition/Quality Data	Components Measured	Data Quality	England Biodiversity Indicators – Trend[89] (Indicator Reference No. in brackets)
	Countryside Quality Counts (measured landscape change)		Countryside Quality Counts and Geological SSSI Condition Data	Height Landscape character		
Minerals and sub-soil assets	**(✓)**	**(✓)** British Geological Survey Production Data	✖	Distribution of onshore minerals Production data	**A**	
Freshwater	✓ Water body status	**(✓)** UK River and Lake inventories Countryside Survey for wetlands Some flow and water level data	✓ Water body status (EU Water Framework Directive)	Water chemistry Macroinvertebrates Fish Algae Hydromorphology	**A/G**	←→ Water quality (21)
Coasts	**(✓)** Transitional and coastal water body status (EU WFD) Does not cover terrestrialised coastal habitats e.g sand dunes	✓ BAP Habitat inventory	**(✓)** Transitional and coastal water body status (EU Water Framework Directive)	Phytoplankton Sea weeds and grasses Invertebrates Hydromorphology Water chemistry	**A**	n/a
Oceans	✖ EU Marine Strategy Framework Directive will introduce composite measure	**(✓)**	**(✓)** EU Marine Strategy Framework Directive preliminary assessment	Species diversity Fish populations Water quality Pressures (non-natives, pollution,	**A/R**	↗ Fisheries (23) ↘ Invasives (20) ↗ Pollution (19)

Key
Composite Indicator: ✓ good data and composite indicator appropriate for purpose; **(✓)** some data appropriate for purpose and potential indicator available; ✖ no composite indicator and data insufficient to determine status and trends across all components
Data quality: Indicative assessment of state of knowledge for natural asset: Red = limited suitable data, Amber = some data, inconsistently collected across components, time or space, Green = good data at appropriate spatial or temporal scales
England Biodiversity Indicators: ↗ upward trend (improving); ↘ downward trend (deteriorating); ←→ no real change; multiple arrows indicate multiple indicators for the asset/pressure. Indicator reference number in brackets.

Asset	Composite Indicator	Quantity Data	Condition/Quality Data	Components Measured	Data Quality	England Biodiversity Indicators – Trend[89] (Indicator Reference No. in brackets)
			Charting Progress 2	noise, litter)		
Atmosphere	✖	n/a	**(✓)**	CO_2 concentration Specific pollutants Areas affected by deposition – sulphur, nitrogen	**A**	↗ Sulphur deposition (19) ←→ Nitrogen deposition (19)

Annex 2: Definitions of Natural Assets and 'Goods' (from which benefits are derived)

The Committee has used the following classification and definitions of natural assets and the goods they provide in the report. More information can be found in the accompanying Natural Capital Committee (2014) working paper[90].

Natural Assets

Note: these assets are not mutually exclusive and there is overlap between categories (for example, soils include species, minerals, water), illustrating the complexity of natural capital.

Species: All living organisms including plants, animals, fungi and micro-organisms; the product of ongoing evolutionary processes.

Ecological Communities: A group of actually or potentially interacting species living in the same place. Groups of interacting species form distinctive assemblages interacting with their physical environment.

Soils: The combination of weathered minerals, organic materials, and living organisms and the interactions between these.

Freshwaters: Freshwater bodies (rivers, lakes, ponds and ground-waters) and wetlands. This includes water, sediments, living organisms and the interactions between these.

Land: The physical surface of the Earth and space for human activity. This includes the various landforms and processes which shape these (weathering and erosion).

Atmosphere: The layer of gases surrounding the Earth including oxygen, carbon dioxide and nitrogen used by all living organisms, and the processes which give rise to climate, weather (wind, precipitation) and temperature regulation.

Minerals: Naturally occurring, non-living substances with a specific chemical composition formed by geologic processes.

Sub-soil assets: Other non-living substances in the Earth's crust including rocks and aggregates as well as non-mineral substances such as fossil fuels.

Oceans: Saline bodies of water that occupy the majority of the Earth's surface. This includes water, sediments, living organisms and the interactions between these.

Coasts: The transitional zone between land and oceans. This includes water, sediments, living organisms and the interactions between these.

[90] www.naturalcapitalcommittee.org

Goods (from which benefits are derived)

Note: All 'goods' are the product of both natural and other capital inputs which is reflected in the Committee's conceptual framework. For example, most food is prepared or processed before being consumed.

Food: Plant, animal and fungi consumed by people; both wild and cultivated sources.

Fibre: Plant and animal materials used by people for building, clothing and other objects, including timber.

Energy: All sources of energy used by people (fossil fuels, wind, tidal, wave, hydro, biomass and solar).

Clean water: Water for human use (for example, drinking, bathing, industrial processes); a combination of quality and quantity.

Clean air: Air quality that has no adverse impact upon human health or wellbeing.

Recreation: Active enjoyment of the natural environment, for example, walking, fishing, canoeing.

Aesthetics: Passive enjoyment of the natural environment, for example, landscape appreciation and views.

Wildlife: Wild species diversity and abundance which has aesthetic and recreational value and has cultural and spiritual significance. Distinct from the natural assets, species and ecological communities, in that these represent the species that are significant to England and that people care about.

Protection from hazards: Natural regulation of extreme events such as flooding, drought and landslips.

Equable climate: A comfortable climate that has no adverse impact upon human health or wellbeing. This is the result of both global scale and local scale effects (for example, urban cooling by trees).

Annex 3: Overview of Research Priorities and Key Questions Identified by the Natural Capital Committee in Collaboration with Research Councils

Theme	Sub-theme	Key questions
Sustaining Natural Capital	Definition and measurement of natural capital	o How should we define and classify natural capital for accounting purposes? o How should we physically measure natural capital? What are the best metrics/proxies? o How does this map onto existing monitoring schemes? o How do we derive information on thresholds and limits and incorporate this into measurement? o How should we incorporate attributes such as the ability of some natural capital to renew itself and hence the degree to which degradation can be reversed? o How should non-renewable natural capital be measured in the face of potential changes in known stocks or changes in extraction technologies? o How do we incorporate uncertainty in our measurements and assessments? o Should we incorporate substitute assets (including non-natural capital) into our analysis and if so then how? o How should we identify the most vulnerable natural capital stocks?
	Impact of changes in natural capital on the financial economy and growth	o How do changes in our natural capital affect measures such as national income, growth and jobs? What sort of frameworks do we need to examine, measure and model these links effectively? o How do these changes vary across the short- and long-term?
Decision-making for efficiency and sustainability	Develop robust economic values for the goods provided by and sustainability of natural capital Incorporating valuation evidence into decision making	In general: o How do we develop robust economic values for the goods provided by the natural environment which reflect the characteristics of the natural assets they derive from and the benefits they provide? More specifically: o How do we ensure that the economic value of the goods provided by natural capital reflects the spatial and temporal variation of those goods? o How should we incorporate natural capital sustainability and resilience to shocks within economic valuations? o How should values incorporate natural capital characteristics such as thresholds, non-linear degradation paths and (ir)reversibility? o How should we incorporate the complexity of social science factors underpinning preferences and values? o What data do we need to meaningfully incorporate non-use values in decision-making? o Where robust economic values are not available, what role might opportunity costs or other approaches play in decision-making? o How should non-renewable natural capital resources be valued? o How do we reflect the interaction of natural capital services with other capital and the potential for substitution?

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Glossary – Key terms

Where possible, technical terms have been defined and explained in the body of the report. Nevertheless some terms are integral to the Committee's work and are used throughout. These key terms are defined below.

Benefit – changes in human welfare (or wellbeing) that result from the use or consumption of goods, or from the knowledge that something exists (for example, from knowing that a rare or charismatic species exists even though an individual may never see it). Note that benefits can be both positive and negative (dis-benefits).

Ecosystem services – functions and products from nature that can be turned into goods with varying degrees of human input.

Goods – something used or consumed by humans, such as food, timber or clean water that delivers benefits or is of 'value'. Often goods are produced through the input of different forms of capital e.g. food may require inputs of both natural (soils, water or species to pollinate and control other pests) and manufactured capital (fertilisers, farm machinery or processing).

Major land use category – units of land that encompass areas of land and seas with broadly similar features and use.

Metrics – the means through which changes in assets, goods and benefits can be measured.

Natural Asset – a distinctive component of natural capital as determined by the functions it performs, e.g. soils, freshwater, species. Ten individual natural assets have been indentified and listed in the report, though in practice, they combine to deliver goods and benefits.

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

Natural capital accounts – ways of organising information on changes in natural capital to conform with the principles and framework set out in the national accounts.

Safe limit – a target used in management to avoid crossing a point at which the condition of a particular component of natural capital changes dramatically (see threshold).

Target – a set level of benefit or status for natural capital determined by society.

Threshold – a discontinuity in a relationship whereby a small change in a pressure or driver can lead to a large change in the state of natural capital with consequences for the benefits it provides. Some of the best known examples are from water quality changes in shallow lakes.

Value – a measure of the change in human wellbeing that results from the consumption of goods. This may be expressed in monetary terms though this is not always possible.

Wellbeing – is used instead of the economic term 'social welfare' which is what economists typically use to describe the sum of individual utility from the consumption of goods. Wellbeing comprises a mix of market and non-market goods, including those derived from natural capital.