The State of Natural Capital:

Towards a framework for measurement and valuation

A report from the

Natural **C**apital **C**ommittee

April 2013

Background information on the Natural Capital Committee

The Natural Capital Committee (NCC) was one of the headline commitments in the Government's 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 of the Cabinet Office.

The NCC's role is to:

- help the Government better understand how the state of the natural environment affects the performance of the economy and individual wellbeing in England; and
- 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 ecology and environmental science, economics 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 full time secretariat, based in Defra, consisting of Nick Barter, Julian Harlow, Scott Turnbull and Owain Johnstone.

In addition to this first State of Natural Capital Report, the NCC has been active in the following areas:

- Accounting for natural capital: working with the Office for National Statistics to develop and implement the 'roadmap' to embed natural capital in the UK's Environmental Accounts; and working with business, accounting bodies and major land-owners to catalyse public and corporate natural capital accounting;
- Developing approaches to the valuation of forestry assets in response to the Independent Panel on Forestry;
- Developing guidance on how an 'ecosystems approach' might inform implementation of the Habitats and Wild Birds Directive;
- Developing a research agenda on Natural Capital to inform future collaboration with Research Councils and other partners.

Further information on the Committee, its full terms of reference, its annual report and its future work programme can be accessed at http://www.defra.gov.uk/naturalcapitalcommittee/.

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Chairman's Message

The Government's Natural Environment White Paper [The Natural Choice: securing the value of nature] set out an ambition to put a stop to decades of environmental degradation and start rebuilding our natural capital. It is about time. The state of our natural capital assets varies greatly, and there have been some noticeable improvements. But these particular bright spots are the exceptions, showing what can be done. Too often natural capital is an afterthought, left out of the core of economic considerations. Without an economic price, it has too often been assumed to be of zero value. The consequence is, on the one hand, that economic opportunities to enhance sustainable growth are missed and, on the other hand, excessive damage is caused.

The Natural Capital Committee was one of the commitments in the White paper, established to give independent advice to Government on the state of England's natural capital. It is the first of its kind in the world. Our remit is to help the Government better understand how the state of the natural environment affects the performance of the economy and wellbeing and to provide advice on how to manage our 'natural wealth' in an efficient and sustainable way. Despite the newness of the Committee (the final two members were not appointed until September 2012) and the limited time and resources at our disposal, we have made a good start.

Our first State of Natural Capital report sets out a framework that will help natural capital to be hard wired into economic decision making in this country and highlights the work we will be undertaking over the coming year so that we can better understand which of our natural assets are critical to our wellbeing. We are tasked with advising the Government as and when natural assets are being used unsustainably and with helping to incorporate natural capital into the fabric of national and corporate accounting. Our job is to shine a torch on what has been going on and what needs to be done. To do so, we need a new framework for defining and measuring changes in natural capital assets. We have begun, and will continue, to engage with the Office of National Statistics on the national accounts; with businesses, land owners and land managers on corporate natural capital accounting; and with the Research Councils on the evidence gaps that will need tackling if we are to see this agenda brought to fruition.

We have an ambitious work programme that will make a genuine contribution to the better protection and enhancement of our valuable natural assets. Our economic prosperity and the wise use of our natural resources are not mutually exclusive. In fact, the latter is a precondition of the former, in both the short, medium and long-term. Economic growth must be sustainable – otherwise it will not be sustained.

The members of the NCC have all massively exceeded their time commitments and worked extremely hard to produce this first State Of Natural Capital Report. I would like to extend my sincere thanks to them and to the Secretariat's patient and professional work in bringing this to fruition. It is particularly gratifying to chair a committee of such dedicated and expert individuals all of whom are deeply committed to the NCC's mission.

Dieter Helm, March 2013

Summary and Recommendations

The Government's Natural Environment White Paper[1], the first in twenty years, sets out an ambitious vision for nature. It boldly states that the "*Government wants this to be the first generation to leave the natural environment of England in a better state than it inherited*". It aims to mainstream the value of nature across our society, create a green economy, strengthen the connections between people and nature and for Government to show international leadership to protect and enhance natural assets globally.

Box A: The 'Ambition' of the Natural Environment White Paper (NEWP)

"*We want to improve the quality of our natural environment across England, moving to a net gain in the value of nature. We aim to arrest the decline in habitats and species and the degradation of landscapes. We will protect priority habitats and safeguard vulnerable non-renewable resources for future generations. We will support natural systems to function more effectively in town, in the country and at sea. We will achieve this through joined-up action at local and national levels to create an ecological network which is resilient to changing pressures*."

NEWP (2011), p14

These are laudable goals and the Natural Capital Committee (NCC) strongly supports them. As the White Paper makes clear, natural capital (see definition on p.11) is integral to our economy. We rely on it for food, energy, clean air and clean water as well as countless other inputs into the production process and our wellbeing. It supports to varying degrees our way of life and the places in which we live and work; offering the potential for future discoveries that may prove to be critical in the development of our economies and societies. In combination with other types of capital (manufactured, human and social), natural capital forms part of our 'wealth'; that is, our ability to produce goods and services into the future from which we gain wellbeing.

If we are to achieve the goals set out in the Natural Environment White Paper, much more attention needs to be paid to tracking the state of natural capital in England, the UK and internationally. As things stand, we do not directly measure changes in its extent or quality, or account for it in national accounts. Neither do we adequately reflect its value in day to day decisions about what and how much to produce and consume. Most of the time, because it is not being properly valued, natural capital is effectively ascribed a value of 'zero' which is far from the truth.

The evidence that exists indicates we are failing to conserve our natural capital assets and invest in them adequately. In many cases we are increasingly demanding more from them while at the same time eroding their capacity to deliver. The risk is that rather than underpinning future growth and prosperity, degraded natural capital assets will act as a break on progress and development. Furthermore, by failing to invest adequately in maintenance and enhancement, we risk missing opportunities that better management and stewardship of natural capital can offer.

[1] See HM Government (2011)

It is not currently possible to identify systematically which natural capital assets are being used unsustainably, especially given the available data and knowledge about limits and thresholds[2]. Nevertheless, there are initiatives that can be taken to reduce information gaps as well as a set of actions that can be taken now to help prevent assets being over-used.

In undertaking this first and preliminary review, the NCC reports a number of key messages and recommendations which are summarised below. These can be distilled into the need for a new framework to:

1) better measure and account for changes in natural capital assets;

2) improve valuation of those changes to feed into decision-making processes.

Such a framework is essential in order for a comprehensive assessment of the state of natural capital to be carried out as well as for action to manage natural capital assets to be better prioritised and deliver greater value for money now and in the future.

Key Messages and Recommendations

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

- Most environmental trends, both globally and nationally, paint a picture of overall decline, particularly over the last 50 years. There have been some successes and improvements that illustrate what can be achieved but these are the exceptions. The ongoing loss of biodiversity, the degradation of ecosystems and the likely future impacts of demographic and climate change pressures are of particular concern.

- The evidence that exists indicates that the rate at which we are consuming our natural capital assets is unprecedented. New metrics and monitoring systems are needed to document more accurately changes in natural capital and the ecosystem services that flow from it.

- It is not possible, given available data and knowledge about limits and thresholds, to identify with certainty the natural capital assets that are being used (un)sustainably. An assessment of the risks of unsustainable use would provide management information and help prioritise action to mitigate against it.

The NCC recommends:

1. The development of a framework within which to define and measure natural capital. Once designed, the use of the framework for regular reports and advice would need to draw on

[2] A threshold is a point or level at which new properties emerge in an ecological, economic, or other system, beyond which the system then behaves differently. For example. species diversity in a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold is reached. Human behaviour, especially at group levels, can exhibit threshold effects too. Limits (or environmental limits) on the other hand tend to be socially determined and can be defined as the point or range of conditions beyond which the benefits derived from a natural resource system are judged unacceptable or insufficient. See Defra (2007) and glossary for further information.

data and monitoring systems from across government departments, non-governmental and research organisations; and

2. The development of a 'risk register' for natural capital assets to identify the implications of further depletion or lack of restoration.

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

- The amount and quality of our natural capital in part determines future prospects for growth and wellbeing yet it is almost wholly omitted from key statistics such as national income. It is critical that changes in it are properly accounted for in our national accounts so that this information can feed quickly into policy making.

- In a corporate context, the development of natural capital accounts can help secure business operations and reduce future risks to supply chains. Land owners and managers in the private as well as public sectors, have a particularly important role to play in pioneering corporate natural capital accounting.

- The valuation of natural capital in both these types of accounts would enable a more comprehensive assessment of the total wealth of the nation, its composition, and the value of corporate assets; so identifying where action is needed to improve natural capital assets.

The NCC recommends that:

3. The work led by the Office for National Statistics (ONS) to include natural capital fully in the UK's Environmental Accounts should be given the greatest possible support by Government. The development of the accounts should be informed by short and long-term policy needs as well as international work to maximise their usefulness. The UK has the opportunity to demonstrate leadership in this field;

4. Business groups, leading companies, accounting bodies, land owners and managers, as well as Government should collaborate to develop and test guidance on best practice in corporate natural capital accounting; and

5. A cross government group of senior analysts, led by the ONS, should review and develop approaches to 'Inclusive Wealth' accounting in the UK (that is, measures of our total capital stock), including a comprehensive assessment of the wealth represented by natural capital.

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

- Natural capital is enormously important to the economy and yet it is largely omitted from national economic indicators as well as from most corporate and government policy decisions. The consequence is that resources are not being allocated efficiently within the economy and opportunities for significant gains in wellbeing and future growth are being lost.

- Policy makers urgently need robust assessments of the economic value of changes in natural capital for use within appraisals. These valuations must be based on firm natural and social science evidence and be applicable to local conditions.

- More generally, policy makers require better decision support tools to help them incorporate natural capital valuations into policy analysis. Improved use of existing data and analytic approaches would significantly enhance appraisal processes and increase the value for money provided by investments.

- A major challenge is to provide the valuations and decision tools required to implement existing guidance such as HM Treasury's 'Green Book' to an appropriate standard. Extensions to this guidance may also be required to address particular natural capital issues, such as situations where robust valuations are not likely to be available, or where irreversible losses to assets, such as wild species or habitats arise.

The NCC recommends that:

6. Government undertakes a critical look at how cost-benefit analysis is being implemented with respect to natural capital to identify priority areas for improvements. While H.M. Treasury's 'Green Book' provides an good starting point for cost-benefit analysis, options to improve the treatment of natural capital within this guidance should be explored. This should include consideration of the appropriateness of physical (in-kind) compensation for certain forms of natural capital loss;

7. An urgent programme is initiated to provide high quality evidence on the economic value of changes in natural capital to feed into cost-benefit analyses. The NCC will bring forward detailed proposals on this shortly; and

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

Stewardship of natural capital is good for growth

- There is no inherent incompatibility between preserving and enhancing natural capital and economic growth, as long as growth is properly measured.

- The proper integration of natural capital into decision making at all levels is crucial to supporting and promoting future growth. This requires that natural capital is incorporated into national and corporate accounts as well as into project appraisal.

- In order to promote sustainable growth, all forms of capital (natural, human, social and manufactured) need to be properly maintained and where appropriate, enhanced. Only in this way will future generations be able to enjoy the opportunities that we do now.

The NCC recommends:

9. In addition to conventional indicators, the Government develops measures of economic growth, net of the depreciation of natural and other forms of capital as well as more comprehensive metrics of saving and inclusive wealth.

10. Offsetting and other forms of compensation are explored after a clear set of principles and a policy framework have been developed.

11. Opportunities are explored to increase the direct contribution natural capital can make to growth, such as the recommendations identified by the Ecosystem Markets Task Force (EMTF) report (published on 5th March 2013) and the Independent Panel on Forestry.

12. The Government reviews the extent to which natural capital is being effectively priced, in particular examining the scope for reducing perverse subsidies. Where practical, the costs of polluting activities that impact on natural capital should be internalised.

13. The NCC recommends that the Government's efforts to reform the Common Agricultural Policy be intensified, with a long-term view to phasing out Pillar one support and moving subsides towards Pillar two and the provision of public goods. In the short-term, securing as much flexibility as possible in how funding can be allocated for the period 2014-2020 and taking full advantage of this when shaping domestic schemes, is essential.

Conclusion

14. The Government's Natural Environment White Paper sets out an ambitious vision for nature and our natural capital assets. Genuinely embedding the value of natural capital into the fabric of economic decision-making is crucial to achieving that vision. The degradation of natural capital is not inevitable and by reversing recent declines, we can position the economy to seize future growth opportunities that will arise from it. Investing in natural capital will support growth and wellbeing in the medium and long-term. However, such changes will not happen automatically and concerted action is still needed to turn the Government's ambition into reality. The NCC is just one player in implementing the White Paper and creating a sustainable economy; others have key roles to play.

15. In subsequent State of Natural Capital reports, the NCC will develop these ideas and evidence further, reporting on progress against the suggested recommendations. In doing so, the Committee will work in partnership with Government, businesses and research organisations. In the interim, we are keen to receive feedback on the key messages, recommendations and indeed any aspect of the report at naturalcapitalcommittee@defra.gsi.gov.uk.

Section 1: Introduction

- The Government's 2011 Natural Environment White Paper sets out an ambitious agenda which, if delivered, can ensure natural capital contributes much more to economic prosperity and wellbeing.
- Natural capital refers to the elements of nature that produce value or benefits to people (directly and indirectly), such as the stock of forests, rivers, land, minerals and oceans, as well as the natural processes and functions that underpin their operation.
- It is important to recognise that the quality (that is, configuration, distribution and accessibility) of natural capital is just as important as the quantity.
- Our use and exploitation of natural capital has supported the development of economies over time. It underpins everything we collectively produce and consume.

1. Our society, economy and individual wellbeing depends upon a healthy natural environment. It underpins everything we collectively produce and consume. We rely on it for food, energy, minerals, clean air and clean water as well as countless other inputs into the production process.

2. The natural environment also provides us with a range of services that we use to a greater or lesser extent to support our way of life. For example, it is instrumental in disease and pest control, flood mitigation, pollution control and climate regulation. It heavily shapes the places in which we live and work. Furthermore, it has huge untapped potential and presents opportunities for future discoveries that may prove to be critical in the development of our economies and societies (for example medicines, genetic resources and biotechnologies)[3].

3. Many of the benefits we receive from the environment are enjoyed *directly* – for example, outdoor recreation; but more often than not we benefit *indirectly* – for example, the role a distant woodland high up in the hills might play in regulating water quality and water flow further down the catchment. Whatever the context, in almost all cases other capital inputs are required to ensure these benefits are realised, both for individuals and the economy as a whole. These other capital inputs include:

    - Manufactured or produced capital (for example, buildings, roads or machinery);
    - Human capital (for example, knowledge and skills); and
    - Social capital (trust, behavioural norms and institutions).

4. These different stocks of capital, taken together, constitute our wealth – that is our ability to produce goods and services into the future from which we gain wellbeing. Clearly, the different categories of capital are substitutable to a degree. Over recent centuries we have converted and manipulated many natural assets into other forms of capital which has generated significant economic growth and improvements in wellbeing. The concern is that this cannot go on indefinitely, especially as demands on already overstretched natural systems continue to grow alongside increasing demographic pressures and environmental change.

[3] See Harlow *et* al (2010)

5. The contribution made by the natural environment to our wellbeing which complements the other forms of capital, has been termed **natural capital**. Natural capital refers to the elements of nature that produce value to people (see Box 1.1).

Box 1.1: Defining natural capital

'Natural capital' refers to those elements of nature which either directly provide benefits or underpin human wellbeing. In this way, natural capital generates value for people. However, the ubiquitous nature of the relationship between the natural environment and human wellbeing means that the definition of natural capital is necessarily wide and includes many different types of assets. The term natural capital therefore embraces the more immediately obvious assets associated with land (such as woodlands, fields, urban parks and subsoil assets), the water environment (for example, rivers, lakes, groundwater and seas) and the atmosphere (for example, clean air, and an equable climate). However, natural capital also includes the myriad processes which underpin and generate the services which the natural environment provides (for example, the water cycle, soil fertility processes and atmospheric gas exchange). Therefore, natural capital comprises, quite literally, a wealth of component parts; parts whose sum underpins not only all economic activity but life on earth itself.

If properly measured and managed, the living aspects of natural capital, at least, can continue to provide these (ecosystem) services[4] and benefits indefinitely. The problem is that whilst some of the benefits can be measured and are clear to see (for example, timber has a market price), most are difficult to quantify and are often invisible in our day to day lives. This results in natural capital not being properly accounted for in decisions about what to produce and consume; the risk being that we fail to manage it sustainably.

In many cases, we are only just beginning to gain the level of understanding necessary to measure the enormous economic value of our natural capital. Coastal habitats provide a good example. The readily observable value might be its livestock grazing potential. However, what is often not properly valued is its role in coastal sea defence, recreational use and as a 'sink' for atmospheric carbon. The flood defence benefits alone have an estimated value of approximately £3,700 per hectare per year in the UK[5]. In addition, habitats like saltmarsh provide breeding grounds for important commercial fish species such as sea bass (*Dicentrarchus labrax*). Measuring and valuing the full range of benefits will help improve decisions about how much of these habitats should be conserved and how much might be converted to other uses.

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6. In some cases, the benefits of natural capital can be replaced with man-made alternatives. For example, the response to coastal flooding has been to build sea walls (rather than relying on coastal wetlands to buffer sea levels), water treatment works are constructed to purify water (to supplement natural purification processes), and pesticides are widely used to control insect pests of crop plants (rather than relying on natural populations of predators and parasitoids). These technologies are necessary because the scale of human activities often overwhelm natural processes. However, often they come with associated economic and environmental costs.

7. Take agriculture, for example, where levels of output have managed to stay ahead of rapid increases in population over the last 50 years. This is undoubtedly a significant achievement (albeit driven by high producer subsidies in developed countries) but there have been negative impacts too such as soil erosion, nutrient run-off, declines in wildlife and habitats and significant

[4] Ecosystem services are defined as the outcomes from ecosystems that directly lead to good(s) that are valued by people. The conceptual framework, therefore, is as follows: natural capital provides services which, in combination with other sorts of capital are turned into goods. These goods deliver benefits when consumed and those benefits in turn are valued by people. See UKNEA (2011) *Synthesis Report*.
[5] UKNEA (2011) *Technical Report.*

increases in greenhouse gas emissions to the extent that the natural processes in the environment are being adversely impacted.

8. As section 2 of this report illustrates, the evidence strongly suggests we are not effectively conserving many aspects of the environment and in turn, the ability of our natural capital assets to sustain the benefits they provide is being undermined. This is a concern for a number of reasons.

9. Firstly, there is well documented evidence demonstrating the potential for gains to the economy and wellbeing through better management of natural capital assets. For example, interventions that attempt to manage water quality upstream in a catchment can deliver significant benefits in terms of avoided water treatment costs as Box 1.2 illustrates.

10. Secondly, by not managing our natural capital assets well, we are essentially eroding their performance capabilities and this could mean we fail to seize future opportunities for growth and increases in wellbeing. This is in part a consequence of moving close to or beyond natural thresholds and tipping points, both at global scales (for example, climate change, ocean acidification) and at more local scales (for example, eutrophication of lakes – see Box 1.3).

Box 1.2: Natural capital delivering multiple services in the uplands[6]

Yorkshire Water and Natural England assessed how different land management scenarios in the Keighley and Watersheddles catchment in the South Pennines would affect the provision of a range of services. Where possible, changes in services were quantified and valued.

The study found that restoring and re-wetting upland blanket bog over a relatively small area could deliver estimated net benefits of £6.27m over a 25 year period. Overall, the benefits from increased carbon sequestration, improvements in biodiversity and reductions in water treament costs exceeded habitat restoration costs by a ratio of 3:1.

The study also looked at the costs and benefits of further deterioraton in the quality and extent of the blanket bog. Under this scenario, the estimates showed that the benefits of maintaining the habitat exceeded costs by over 5:1.

Box 1.3: Natural thresholds and environmental limits

Often natural capital is not well managed and **natural thresholds** are crossed that can have sudden and serious consequences for the benefits we receive. Such effects may be reversible, but this can take many years.

Natural thresholds are often crossed by shallow, lowland lakes. An example of this is Loch Leven, a lake in Scotland[7]. Loch Leven is the home of a world famous trout fishery, of high conservation value, and an important source of water for downstream industries. It is surrounded by farmland and small settlements, and so receives agricultural run-off and effluent from local waste water treatment works. In the past it also received industrial effluent that was rich in phosphorus. During the 1970s and 1980s, water quality deteriorated so much that it periodically suffered from algal blooms. These occur when increases in plant nutrients (typically nitrogen and phosphorus) cause one or several species of algae to increase rapidly in numbers. As algal

[6] See Harlow *et al* (2012)
[7] Personal communication: Dr. Linda May, Centre for Ecology and Hydrology

blooms can be toxic, this reduces the amenity value of the lake and the quality of the water supplied to downstream users.

In 1992, there was a particularly high profile algal bloom in Loch Leven, known locally as 'Scum Saturday'. This fuelled demands for the problem to be solved. This one incident was estimated to cost the local economy nearly £1m in lost revenue to the trout fishery and local tourism businesses and increased water treatment costs downstream. As a result, nutrient management plans were put in place and the lake has now recovered.

The concept of **environmental limits** are relevant to all natural systems, whether they exhibit a threshold response or not. They can be defined as "the point or range of conditions beyond which the benefits derived from a system are judged unacceptable or insufficient". Such 'limits' may be based on the biophysical properties of a natural system, but it is also important to take into account the way that people value ecosystem services[8].

11. It is important to recognise that it is not just our standing stock of natural capital that is significant for economic growth and wellbeing; its quality is also vital and assessments should cover its proximity to thresholds. Natural processes and functions are essential to the operation of much of our natural capital, for example, many of the functions of soils and freshwater depend on both physical context and the combination of living organisms present, including many microorganisms.

12. Wild species are a part of natural capital that require special consideration. Like great works of art they are part of our heritage, and in just the same way, once lost they are effectively irreplaceable. But unlike works of art, wild species and habitats are living, evolving and adapting as part of a history shared with people. Each species carries a unique suite of adaptations, evolved over many generations, and many species are interdependent. With the extinction of each species or loss of each local population, one particular set of adaptations is gone forever. Interdependent species are also potentially undermined. While recent, human-modified environments such as reservoirs and cultivated land can generally be re-created, many natural habitats such as ancient woodlands and chalk streams cannot be restored within reasonable timescales. **When thinking about natural capital, wild species and habitats require special treatment that reflects their irreplaceability.**

13. Section 2 develops these concepts further and presents an initial typology of natural capital assets for discussion and further development. It considers the need for the development of new metrics to monitor and measure changes in natural capital better because as things stand, we have incomplete knowledge on what assets we have, what state they are in or how close we might be to thresholds. It also considers the development of new tools to help assist in making these judgements, such as a natural capital risk register.

14. Sections 3, 4 and 5 set out the Committee's emerging thinking and recommendations on:

    - How we can significantly improve the management of our natural capital assets through the development of a comprehensive set of accounts, both at a national and corporate level;

[8] Defra (2007)

- The enormous gains to be made through valuing changes in natural capital and including them more comprehensively in decision support tools and processes like cost-benefit analysis; and
- How investing in natural capital can help tackle some of the critical challenges (such as how it can support growth and increases in future wellbeing) over the coming years and decades.

14. Finally, section 6 concludes with suggested next steps on how we can collectively start to take forward this agenda and how the Committee can contribute. We are keen to receive feedback on these suggestions and any aspect of the report at naturalcapitalcommittee@defra.gsi.gov.uk.

Section 2: Recent Trends and Assessment of the Risks of Degrading Natural Capital

- Most environmental trends, both globally and nationally, paint a picture of overall decline, particularly over the last 50 years. There have been some successes and improvements that illustrate what can be achieved but these are exceptions.
- As stated in the Government's Natural Environment White Paper, the fragmentation of natural environments is driving continuing threats to biodiversity. The previous global target to reduce significantly the rate of loss of biodiversity by 2010 was not met. In England, species and habitats are still declining. The ongoing loss of biodiversity, the degradation of ecosystems and the future impacts of demographic and climate change pressures are of particular concern.
- The evidence that exists indicates that the rate at which we are consuming our natural capital assets is unprecedented. New metrics and monitoring systems are needed to document more accurately changes in natural capital and the ecosystem services that flow from it.
- It is not possible, given available data and knowledge about limits and thresholds, to identify with certainty the natural capital assets that are being used (un)sustainably. An assessment of the risks of unsustainable use would provide management information and help prioritise action to mitigate against it.

The NCC recommends:

1. **The development of a framework within which to define and measure natural capital. Once designed, the use of the framework for regular reports and advice would need to draw on data and monitoring systems from across government departments, non-governmental and research organisations. The NCC is well placed to play a key role in shaping this framework through its technical and strategic advice; and**
2. **The development of a 'risk register' for natural capital assets to identify the implications of further depletion or lack of restoration. Again, the NCC is well placed to take a strategic lead, consulting with key stakeholders.**

1. During the 20th century, humanity's interaction with and impacts on global ecosystems was unprecedented:

- "World population grew by a factor of 4 to more than 6 billion; industrial output increased by a multiple of 40 and the use of energy by 16; methane producing cattle populations grew in pace with the human population; fish catch increased by a multiple of 35; and carbon and sulphur dioxide emissions by a factor of 10".[9]
- "Nearly two thirds of the services provided by nature to humankind were found to be in decline worldwide. In effect, the benefits reaped from our engineering of the planet have been achieved by running down natural capital assets".[10]

[9] Dasgupta (2007).
[10] Millennium Ecosystem Assessment (2005).

- "The trends from available indicators suggest that globally the state of biodiversity is declining, the pressures upon it are increasing, and the benefits derived by humans from biodiversity are diminishing, but that the responses to address its loss are increasing (See Figure 2.1). The overall message from these indicators is that despite the many efforts taken around the world to conserve biodiversity and use it sustainably, responses so far have not been adequate to address the scale of biodiversity loss or reduce the pressure"[11].

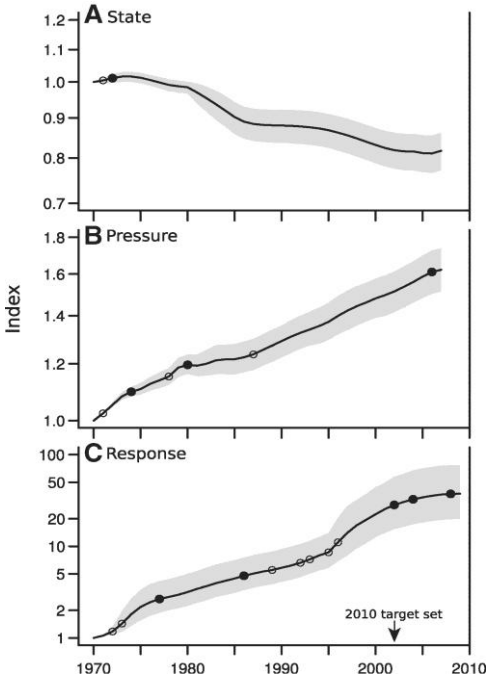
Figure 2.1[12]: Aggregated indices of biodiversity trends

Key

A. **The state of biodiversity** - based on nine indicators of species' population trends, habitat extent and condition, and community composition;

B. **Pressures on biodiversity** - based on five indicators of ecological footprint, nitrogen deposition, numbers of alien species, overexploitation, and climatic impacts; and

C. **Policy responses** - based on six indicators of protected area extent and biodiversity coverage, policy responses to invasive alien species, sustainable forest management, and biodiversity-related aid.



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2. The UK, like other countries, impacts and is affected by changes in natural capital internationally in a number of important ways. A topical example of the latter is ash die-back (*Chalara fraxinea*). Alien invasive species and diseases are a serious threat to the UK's natural environment; a situation which is likely to intensify with climate change.[13]

3. The UK's impact on natural capital overseas takes many different forms. Embedded carbon and water (sometimes referred to as 'virtual' carbon or water) are two important examples. Considering the extent to which we use or consume these resources can sometimes radically alter an assessment of environmental trends. For example, although UK territorial greenhouse gas emissions fell by around 5 per cent between 1992-2004, 'consumption' related emissions (that is, including embedded carbon in imports) actually increased by 18 per cent.[14] The figure is even more stark for water where an estimated 70 per cent of all the water consumed in the UK is 'virtual' and embedded in imports.[15]

[11] UNEP (2010).
[12] Butchart *et al.* (2010).
[13] UK NEA (2011) Synthesis Report.
[14] Wiedmann T *et al* (2008).
[15] Royal Academy of Engineering *et al* (2010).

4. In the case of carbon, one clear issue is the net effectiveness of domestic policy in contributing to global goals for climate change mitigation. There is also a need to consider the "virtual sustainability" of the national economy for strategic and humanitarian reasons. Our economic security might be reliant on the sustainable use of natural capital elsewhere and there is also concern for the wellbeing of others who might suffer adverse consequences arising from the loss of natural capital that is attributable in part to our own domestic consumption.

5. Environmental trends within the UK generally reflect global patterns. The UK National Ecosystem Assessment (UK NEA) provides the first comprehensive snapshot of the status and trends in many of our ecosystem services across the UK, providing valuable groundwork for assessing the state of natural capital assets. Examining only the living components of ecosystems (livestock, crops, fisheries, timber, fibres and biomass-based fuels), it concluded that "*The UK's ecosystems are currently delivering some services well but others are in long term decline*".[16]

6. If the UK's ecosystems were well managed, the benefits which flow from them (the ecosystem services, products and goods) would be renewable and sustainable for future generations. The UK NEA provides some important examples of how we have managed ecosystems to increase the delivery of specific services, but sometimes this has been at the expense of others (Box 2.1). Understanding these trade-offs is crucial in designing better land management strategies. There are examples of poor management where the delivery of services continues to be in decline, for example some fisheries. But for every such case, effective management can reverse the trend and there have been some notable successes (see Box 2.2).

7. The same trends in biodiversity and the pressures upon it are evident in England: the natural environment is considerably less 'rich' than 50 years ago and declines are continuing. However, there is also evidence of improvements as a result of targeted policy interventions and measures. England has globally important populations of some species. Examples of both declines and improvements include:[17]

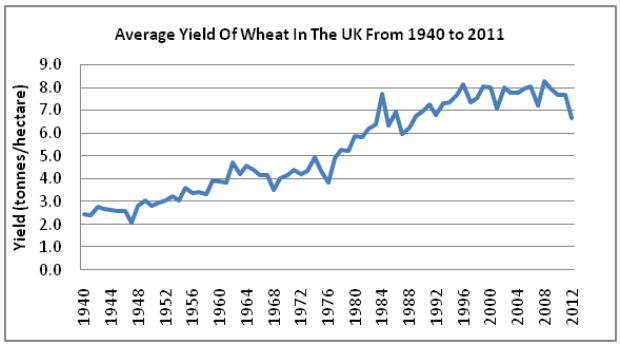
    - Major declines in populations of breeding wading birds on unprotected lowland wetland grasslands, notably the snipe (*Gallinago gallinago*) which is down by 90% in some regions;
    - Continued declines in the flora, birds and butterflies most associated with our woodland;
    - Particular declines in specialist species – those species that have very specific habitat requirements, including amphibians;
    - A levelling off in the long-term decline of a number of indicators including farmland birds and butterflies over the past decade;
    - In contrast, some of the trends over the last ten years show some improvement. There have been major increases in heathland bird populations, for example, nightjar (*Caprimulgus europaeus*), woodlark (*Lullula arborea*) and dartford warbler (*Sylvia undata*) – and the last of these has increased its range by over 100 per cent due to milder winters. Nevertheless, due to their low population sizes, these species remain vulnerable. Some wetland birds have shown massive increases (for example, gadwall (*Anas strepera*), whooper swan (*Cygnus cygnus*)), the recovery of the otter (*Lutra lutra*) has continued, there have been significant

[16] See UKNEA (2011) Synthesis Report.
[17] Natural England (2008).

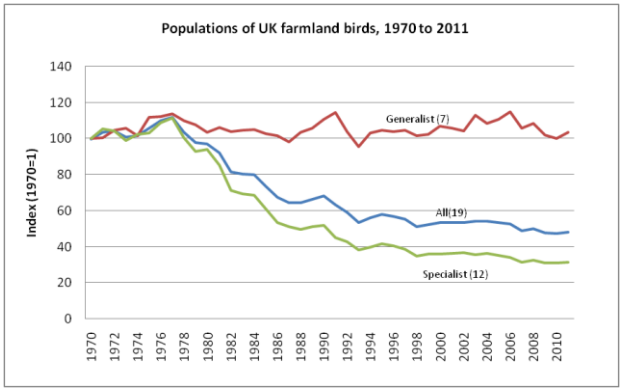
increases in wintering waterbirds and four bat species. Often these improvements are a result of targeted measures.

Box 2.1: Intensification of enclosed farmland and declining bird species[18]

Twentieth century farming practices have increased agricultural yields.
Agricultural productivity per unit area has grown four-fold after World War II driven by the introduction of high-yielding varieties of crops and an ability to control pests and diseases effectively. Other contributing factors include the introduction of selective herbicides and fungicides and more effective use of nitrogen. The following chart shows increased yields of wheat, for which historical data is most readily available.



With regard to species trends, populations of farmland generalists such as corvids and pigeons, have remained around or above the 1970s level. However, those specialist species that rely on plants and invertebrates of Enclosed Farmland, such as the grey partridge (*Perdix perdix*) and corn bunting (*Emberiza calandra*) have continued to decline and numbers are now a third of what they were in 1970. The chart below shows trends in UK farm bird populations from 1970-2011.



A causal link has been established between the decline of bird species and changing practices in enclosed farmland.

Changes in agricultural practices have always resulted in population ebbs and flows according to which species were best suited to the prevailing land management regimes. However, changes in Enclosed Farmland during the Twentieth Century changed the balance between provisioning of food and biodiversity. The use of fertilisers, selective herbicides and the switch from spring-sown to autumn-sown cereals has impacted on the arable flora. The flora of field boundaries has also changed, with decreases in plants that are important food resources for pollinators and farmland birds. Changes in the plant composition of Enclosed Farmland have inevitably impacted species higher up the ecological food chain. Reductions in safe nest sites, invertebrates during the breeding season and in seed resources in the autumn and winter have resulted in major reductions in numbers of farmland birds. In grasslands, birds have been directly affected by the reduction in botanic species richness and subsequent declines in weed seeds and key invertebrate prey.

[18] UKNEA (2011) Synthesis Report

Box 2.2: Trends in UK Fisheries[19]

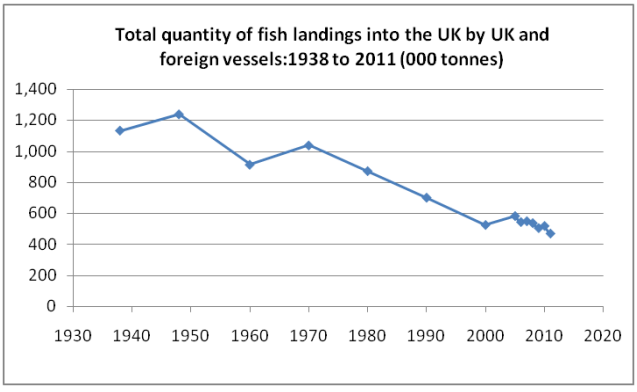
The limited evidence that exists suggests that stocks of fish in UK waters have been falling for many decades; however, we do not have good time series data on a range of fish stocks to definitively demonstrate this. This illustrates the importance of having good data on the stocks of our natural capital and how they are changing if they are to be managed in a way to maximise our wellbeing.

Perhaps the main source of long term evidence on the decline in fish stocks is data on the landings of fish over the last 75 years, as outlined in the chart below. Landings of fish into the UK are now lower than at any time in the last hundred years (bar the two world wars). Evidence on the effort that has gone into catching these fish is also not definitive (although it is more certain over the last forty years thanks to the introduction of analytical stock assessments), but the large improvements in technology over the last one hundred years, such as in sonar, suggests the fall in landings is at least in part due to smaller fish stocks which in turn has to an extent been driven by overfishing. However, political, economic and technological drivers have also had a role in affecting trends in commercial landings (for example, the gradual expulsion of British trawlers from Icelandic waters between 1958 and 1976).

While landings of fish are continuing to fall, there are some encouraging indications that some stocks are being managed more sustainably. It is estimated that out of 16 indicator fish stocks in UK waters, the proportion of stocks at full reproductive capacity that are being harvested sustainably has risen from around 10% in the 1990s as much as to 50% in 2010.[20] This is clearly a positive trend; however, a number of scientifically assessed UK stocks continue to be fished at levels considered to be unsustainable and the trends in many (commercial) species are either data-limited, not scientifically assessed or not managed by setting Total Allowable Catches (for example, gurnards and brown crab [*Cancer pagurus*]).

Thus, whilst the overall picture remains an unsatisfactory one, there are some recent signs that where fish stocks have been better managed stocks can rebound. For those stocks that are assessed, the number of overfished stocks in the Atlantic and surrounding seas fell from 32 out of 34 in 2007 to 18 out of 38 in 2011 (that is, from 94% to 47%)[21]. This is a powerful lesson in the benefits to be had from the better management of our natural capital. This is further backed up by the findings of a recent, extensive study into the health of our seas, the Charting Progress 2 Report[19]. This states that overall the large majority of scientifically assessed stocks continue to be fished at rates well above the levels expected to provide the highest long-term yield. This means that the long term economic value of fishing to us is still not being maximised due to sub-optimal management of our seas. At a global level, this is costing around $50 billion per year in lost economic rent from fisheries, which equates to over half of the value of global landings.[22]

The European Commission is developing multi-annual management plans to recover stocks and a reform of the EU Common Fisheries Policy is currently underway. This is looking to embed international commitments (World Summit on Sustainable Development – Johannesburg 2002) to restrict fishing mortality rates to the Maximum Sustainable Yield by 2015. But these actions are just the start; where improved management is put in place to reduce fishing mortality there may still be time lags in the recovery of biomass of some stocks due to the biology of certain species or environmental factors (for example, climate) affecting recruitment and recovery.



[19] Charting Progress 2 (2010) and MMO data.
[20] Data available at: http://www.defra.gov.uk/statistics/environment/coastal-waters/cwfg28-cwfishsust/.
[21] European Commission, 2012. Communication from the Commission to the Council concerning a consultation on fishing opportunities for 2013. Available at: http://ec.europa.eu/fisheries/cfp/fishing_rules/tacs/info/com_2012_278_en.pdf
[19] Charting Progress 2 (2010).
[22] See World Bank (2009).

8. A recent review of England's wildlife and ecological networks[23] appraised the current status and laid out an agenda for a step change in our approach to wildlife conservation. It concluded:

   - England's wildlife habitats have become "increasingly fragmented and isolated". This makes it harder for species to move between them and this will become more important as they cope with continuing change in climate and habitat;
   - Many of England's wildlife sites are too small. Losses of certain habitats have been so great that the area remaining is no longer enough to halt additional biodiversity losses without concerted efforts;
   - With the exception of Natura 2000 sites and SSSIs, most of England's semi-natural habitats important for wildlife are generally insufficiently protected and under-managed. Many of the natural connections in our countryside have been degraded or lost, leading to isolation of sites and too few people have easy access to wildlife;
   - Many species are now largely restricted to wildlife sites simply because they have mostly been lost from everywhere else. More specialist species tend to be in decline, while generalists (those that can adapt more easily to different and changing environments) are faring better; and
   - There have been some improvements. Decline in some habitats and species has slowed and in some cases, reversed (often through specific efforts of Non-Governmental Organisations (NGOs) and landowners). Examples include an increase in habitats such as woodlands and ponds, as well as some types of amphibians, lizards and butterflies, such as the large blue (*Phengaris arion*).

9. The report concluded that a renewed effort is required to improve the quality of existing sites, but also to enhance their size, increase their number and make them more interconnected (*bigger, better, more and more connected*). This is an important agenda for nature conservation in England and the UK, making it more adaptive and resilient in the face of growing pressures and demographic change. **The NCC strongly supports the Lawton recommendations but it needs to be recognised that while these are necessary conditions for the stewardship of particular elements of our natural capital, they are not sufficient for all the benefits of natural capital to be secured.** This is discussed in more detail below.

Developing metrics to measure changes in natural capital

10. Reversing declines in the benefits that flow from the environment will require not only the adoption of 'more resilient ways of managing ecosystems',[24] but also an evidence-based approach for the stewardship of natural capital more broadly.

11. The first step in this process is to develop an agreed framework within which to define and measure natural capital. As the examples above (and in the UK NEA) have illustrated, the range of metrics currently used are a mix of stocks, flows, quality and benefits – they are not necessarily the appropriate metrics for accounting for natural capital. For example, there tends to be data on:

[23] Lawton *et al* (2010).
[24] UKNEA (2011) Synthesis Report.

- areas of broad habitat (which may be defined as a natural asset, as detailed in the UKNEA);
- production of goods (material and non-material benefits which are produced from assets, and which may be captured through standard economic accounts);
- indicator species (which may be used to indicate the quality of a habitat, for example, see Box 2.1 as well as official biodiversity statistics);
- diversity indices (for example, Water Framework Directive (WFD) indicators of 'Good Status'); and
- visitor numbers (for example, Monitoring Engagement with the Natural Environment - MENE).

Note however that these only include biotic elements of natural capital and a broader range of metrics will need to be developed to include abiotic elements.

12. As techniques have developed, methods for monitoring certain elements of natural capital have changed. In many cases these metrics are proxies for natural capital or for the flow of ecosystem services, rather than direct measures of them. To monitor changes over time, a consistent approach is needed, in order that investment decisions about different natural capital assets are made in an equitable and evidence-based manner. At present the services that have market values and universally adopted metrics (for example, agricultural output) dominate land use decisions, whereas equally critical natural capital assets (for example, soil quality, which can be measured in many different ways and does not always directly translate to a market value) do not feature.

13. Many of our existing monitoring networks were established before the concept of natural capital and the ecosystem services framework became established. Consequently, in some cases, new indices need to be developed with particular elements of natural capital or services in mind. This is illustrated by the different metrics for water quality used to meet the goals of the WFD, as discussed in Box 2.3.

14. Furthermore, responsibility for environmental datasets is dispersed across the research community: agricultural and environmental datasets are collated, synthesised and analysed under different frameworks and for different purposes. This inhibits the systematic collation of the necessary evidence to inform the management and enhancement of natural capital assets which includes both the biotic and abiotic components of nature and cuts across habitats.

15. **The NCC recommends that a new system for measuring and monitoring changes in natural capital is developed**. A thorough assessment of existing data and metrics is necessary to help define natural capital assets of greatest importance and to highlight trends and recent changes. However, significant gaps in data and understanding will remain, some of which can only be filled through long-term research. Examples of these gaps are detailed in the UKNEA. It is important that a strategy is developed to fill them, in the context of those natural capital assets needing priority treatment.

Box 2.3: The Water Framework Directive and the Sustainability of Ecosystem Services[25]

European legislation aimed at restoring the ecological quality of waters (Water Framework Directive - WFD) or achieving favourable conservation status (Habitats Directive) will undoubtedly improve the provision of ecosystem services. That said, current "structural indicators" used in WFD assessment schemes, such as species composition and abundance, diversity indices or habitat area cannot provide a direct or complete representation of ecosystem service provision. The relationship between existing policies and ecosystem services is currently unknown, although new European strategy targets (for example, Europe 2020 Strategy and its flagship initiative for a "Resource-Efficient Europe" and the associated 2020 EU Biodiversity Strategy) place greater emphasis on maintaining and restoring ecosystem services. There is, therefore, increasing need to understand how biodiversity within freshwater ecosystems provides the ecosystem services that we depend upon and more specifically how current legislative targets (focused on biodiversity) are compatible with ecosystem service delivery.

The WFD has, as its measure of success, the concept of "good status". 'Status' is measured by a range of biological indices and defined in the legislation as the extent to which the water body "*deviates from undisturbed*". This definition is not explicitly related to sustainable water use (the ultimate aim of the WFD) or the ecosystem services provided by water bodies. The proposed revision of the WFD in 2019 could examine refining the definition of "status", to take on board some of these issues. This could, therefore, orientate the Directive much more towards the provision of ecosystem services and conserving the benefits water bodies deliver.

Future revision of the WFD could examine new ways of combining existing monitoring data to provide a more direct measure of functional quality and, therefore, a clearer indication of the quality of the freshwater 'natural capital' in relation to its capacity to deliver ecosystem services (rather than only its quality as part of an ecosystem). Functional quality can be better measured by using ratios of structural and environmental measures or biodiversity metrics (for example, age structure). The development of functional classifications for biodiversity can be used in a similar way. For example, the relative abundance of different size classes of fish can effectively indicate fish population health and the sustainability of fisheries or recreational angling.

Assessing the risks of natural capital depletion

16. Natural Capital may be classified in many different ways. The NCC is still working on a list of key assets that meets our needs, but a set of example assets is provided in Box 2.4. This indicates the breadth of items to be included: minerals and natural resources; ecosystems which provide supporting, regulating and provisioning services; and wild species, habitats and landscapes across the UK from which many people derive cultural values and benefits. Bringing these diverse items into a coherent accounting framework is a priority for the NCC, a task complicated by the fact that these different elements are managed by different agencies, overseen by different government departments, and require different amounts of other capital inputs to produce realisable benefits and values.

17. Given our current state of knowledge about environmental trends and specific aspects of natural capital (such as thresholds), the NCC recommends that **a risk register be developed to assess the implications of depletion or lack of restoration of key natural capital**

[25] Centre for Ecology and Hydrology.

assets. This might also cover the opportunities of further investment and restoration, recognising the current level and state of assets is unlikely to be optimal. Precisely what we mean by 'a risk register' and the insights it might offer is explained below.

Box 2.4: Developing a framework for classifying natural capital assets

Before we can examine trends in natural capital, clear definitions of the assets themselves are needed. This is not a straight forward exercise.

Natural capital stocks of minerals, such as iron, copper and phosphorus are non-living (abiotic) and non-renewable constituents of the Earth. To different degrees they are used, altered or recycled. Coal, oil and natural gas are crucial natural resources for energy. These are formed from activities of living organisms (biotic) interacting with the physical environment (abiotic), but over very long time scales, so that they are effectively non-renewable. Renewable resources, such as livestock, crops, fisheries, timber, fibres and biomass-based fuel are mostly provided by living (biotic) systems.

Defining natural capital, therefore, goes beyond the individual assets. The ecological systems (that is, the processes, functions and interactions between the different components of the system and how they are arranged spatially within it) not only underpin these individual assets, but need to be considered as part of asset definition. These processes include things like nutrient cycling and bioremediation, that regulate pollutants, decompose harmful compounds, and provide ecological communities with natural resistance to disease. They are governed by a great diversity of organisms, mostly micro-organisms in soil and water that we hardly ever manage, or even recognise. However, in recognising ecosystems as capital, we need to be acutely aware of what these assets comprise.

Below is list of some key natural capital assets. The NCC will develop a classification system to inform:

a. a system for monitoring changes;

b. the development of a risk register and the prioritisation of assets that might be included; and

c. the framework for natural capital accounts.

1. **Soil**: its role in primary production, decomposition, nutrient cycling, bioremediation and other processes.
2. **Water**: surface and groundwater quantity and quality.
3. **Carbon**: stocks both below (that is, soil carbon) and above ground.
4. **Energy**: including coal, oil, natural gas, as well as peat, biotic renewables such as energy crops, and possibly abiotic renewables such as wind-power and hydro-electric dams.
5. **Minerals**: stocks of metallic & non-metallic (for example, iron, copper, phosphorus, quarried stone and other aggregates).
6. **Air quality**: with a view to assessing human health impacts as well as the impacts on habitats and wild species.
7. **Wild foods & fisheries**: for example, fish stocks and other edible species (both terrestrial and marine).
8. **Agriculture, aquaculture & forestry**: including agricultural output, timber, fuel, fibre, farmed fish, seaweed and kelp.
9. **Wild species and habitats**: including land asset classes such as semi-natural grassland, habitats for rare species; coastal margins; and protected areas and their contribution to a resilient ecological network (see paragraph 10). Metrics for this group of assets would also ideally include information on red list[26] species, invasive species and native species.

Many assets may have an important international dimension that needs to be considered too (see paragraphs 2-4).

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[26] The International Union for the Conservation of Nature (IUCN) publishes a widely recognised 'Red List' of threatened animal and plant species. More information is available here: http://www.iucnredlist.org/about/red-list-overview.

18. Risk registers are a widely used tool within government, utilities, infrastructure and project management processes. Their valued added is in helping to inform decisions or strategies where there is a considerable level of uncertainty regarding particular outcomes. Recognising that there are significant data gaps for many natural capital assets and imperfect knowledge about the uses to which those assets might be put in future, the purpose of a risk register for natural capital assets would be to assess the implications of excessive depletion (or a lack of restoration) systematically against a set of specific criteria. Initial suggestions for such criteria are outlined in Box 2.5 and draw on recent scoping work funded by Defra[27]. They cover things such as an asset's key properties, condition, performance, criticalities and values of future services, or costs of maintenance.

Box 2.5: Developing a risk register for natural capital assets

Possible criteria for assessing the risks associated with changes in natural capital include:

1. **Definition of natural capital asset:** Define the component of natural capital under consideration, the temporal and spatial scales being considered and the relationship between the natural capital asset and the services it provides, directly or in conjunction with other assets;

2. **Condition:** Quantify the amount and condition of the asset, considering both trends in the recent past, expected future trends, and proximity to thresholds (if known);

3. **Drivers:** Identify drivers of change in extent and condition of the natural capital asset;

4. **Performance:** Quantify delivery of services, goods and benefits provided by the natural capital asset and how the delivery of these compares to putative 'targets';

5. **Criticalities:** Taking account of cumulative effects and predicted trends, identify which services and benefits are at risk. Include a consideration of the extent to which changes are reversible and the extent to which there are substitutes that could fulfil the same or a similar role;

6. **Values:** What are the values of services lost in the future given expected trends? What is the replacement cost of the asset if restored to previous levels?;

7. **Conclusions**: From this analysis assign a level of risk to the class of natural capital, combining probability of outcome with severity of impact. Initially this would be a simple designation such as high, medium or low risk, but this would become more graduated and quantified as data and methodologies improve over time. Describe existing and proposed actions to mitigate risks commensurate with the level of that risk.

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19. Drawing on the best knowledge and data currently available to assess the risk and implications of the continuation of current trends or further depletion, a risk register would help inform policy development, prioritise research effort and potentially promote more sustainable use.

20. A risk register constructed along these lines has the advantage that it can report information at several levels of aggregation. It could provide key high-level performance indicators for

[27] See Dickie, I. *et al* (forthcoming).

Ministers, parliament and other interested parties to review. It could also contain more detailed information which agencies, NGOs and other interested parties might find useful.

21. An important component of a risk register will be an estimation of the value of services lost, or the cost of replacing/restoring a natural capital asset to specified levels; the appropriate choice depending upon context. The case for valuing our natural capital is developed in sections 3 and 4.

22. **The NCC will work with partners to develop a 'risk register' for natural capital assets to identify the implications of further depletion or lack of restoration, consulting with key stakeholders over priorities.**

Conclusions

23. The goals set out in the Natural Environment White Paper (2011) to conserve and enhance natural capital are both laudable and ambitious. The evidence suggests that there is still a considerable amount that needs to be done to prevent further declines; even more action is required to ensure assets are improved and enhanced. The evidence that exists indicates that most trends are still declining and that the rate of decline is not slowing significantly in many cases.

24. In order to undertake a comprehensive assessment of the state of natural capital, clear definitions of the assets themselves are needed along with new metrics to measure and monitor changes. This is not a straightforward exercise and needs to link to the development of accounting frameworks.

25. It is not, therefore, currently possible to identify with certainty the natural capital assets that are being used unsustainably, especially given available data and knowledge about limits and thresholds. However, the NCC thinks that an assessment of the risks of unsustainable use would provide management information to help prioritise action.

In summary, the NCC recommends:

- **The development of a framework within which to define and measure natural capital. Once designed, the use of the framework for regular reports and advice would need to draw on data and monitoring systems from across government departments, non-governmental and research organisations. The NCC is well placed to play a key role in shaping this framework through its technical and strategic advice; and**

- **The development of a 'risk register' for natural capital assets to identify the implications of further depletion or lack of restoration. Again, the NCC is well placed to take a strategic lead, consulting with key stakeholders.**

Section 3: Accounting for Natural Capital

The Government's Natural Environment White Paper aims to "*capture nature's value in how we measure economic progress*" (NEWP,p35).

Natural capital is a crucial component of our nation's overall portfolio of wealth and needs to be measured consistently over time. This consistency could be achieved by extending the accounting frameworks currently used to record economic activity. This includes not only the national accounts but also the way in which business records its use of natural capital.

- The amount and quality of our natural capital in part determines future prospects for growth and wellbeing. It is critical that changes in it are properly accounted for in our national accounts so that this information can feed quickly into policy making.
- In a corporate context, the development of natural capital accounts can help secure business operations and reduce future risks to supply chains. Land owners and managers in the private as well as public sectors, have a particularly important role to play in pioneering corporate natural capital accounting.
- The valuation of natural capital in both these types of accounts would enable a more comprehensive assessment of the total wealth of the nation, its composition, and the value of corporate assets. This would help identify where action is needed to improve natural capital.

The NCC recommends that:

1. **The work led by the Office for National Statistics (ONS) to include natural capital fully in the UK's Environmental Accounts should be given the greatest possible support by Government. The development of the accounts should be informed by short and long-term policy needs as well as international work to maximise their usefulness. The UK has the opportunity to demonstrate leadership in this field. The NCC will play a key role developing the accounts through its technical and strategic advice;**
2. **Business groups, leading companies, accounting bodies, land owners and managers, as well as Government should collaborate to develop and test guidance on best practice in corporate natural capital accounting. The NCC will lead such collaboration; and**
3. **A cross government group of senior analysts, led by the ONS, should review and develop approaches to 'Inclusive Wealth' accounting in the UK (that is, measures of our total capital stock), including a comprehensive assessment of the wealth represented by natural capital. The NCC stands ready to contribute technical and strategic advice.**

1. Natural capital is a fundamental component of our nation's overall portfolio of wealth (see Box 3.1). It contributes in important ways to supporting our economy and wellbeing both now and into the future. It is, therefore, crucial that proper account is taken of how much of this capital we have. More critically still, tracking how this natural capital is changing over time is of considerable importance. In this way, vital clues might be provided as to how future prospects, which depend on this wealth, are also likely to change. As Section 2 discussed, one of the key

challenges is to clearly define natural capital assets and develop new metrics to measure changes over time that are consistent with accounting methods.

Box 3.1: Wealth Accounting

Any nation's wealth comprises a great number of assets. These include manufactured, human and social capital. Natural capital can be seen as a further component of this wealth although it is a component that is more often than not poorly accounted for in practical measures of national wealth. Pioneering studies such as those by Kenneth Arrow and others[28], UNU/IHDP/UNEP[29] and the World Bank[30] have sought to correct this imbalance. All of these studies provide comprehensive descriptions of the wealth of countries and the world. Sir Partha Dasgupta[31] has described this as "inclusive wealth". The concept of inclusive wealth is important as having a present day estimate of this wealth signals our future prospects for wellbeing and prosperity. In turn, the way in which this wealth is changing over time indicates how these future prospects are altering.

As an illustration of this, the *Inclusive Wealth Report* by UNU/IHDP/UNEP (2012) recently concluded that for the UK, while overall wealth was increasing, by 2008, natural capital had decreased by more than 35 per cent (relative to its 1990 level). Natural assets considered within that study were restricted largely to commercial natural resources and, as such, represented a relatively small proportion of the entirety of natural capital. Thus, while this work represents an important step forwards, there is an urgent need to extend such investigations to other strategically important natural assets.

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2. As things stand, the information needed to make this assessment is either absent or exists in disparate forms that are hard to collate, compare and analyse. Better accounting for natural capital is a key component of the emerging evidence base to support sensible management of natural capital. Box 3.2 provides an illustration of this for the case of corporate accounting for the use of natural capital.

3. Natural capital accounts are needed to correct an imbalance within the standard framework that is currently used to track the national economy. It has long been recognised that national accounting aggregates (such as GDP) are incomplete metrics of broader national wellbeing (indeed, they were never intended as such) and tell us little about whether economies are developing or growing sustainably over time. Section 5 explores some of these issues in more detail. A critical issue is that our national accounts currently provide a poor signal as to how much we can consume sustainably into the future. Improving this situation will entail substantial effort to construct comprehensive accounts which reflect the way natural capital affects measures of national income, savings and wealth.

4. Measuring what is happening to natural capital could offer genuinely new insights about economic progress. For example, a study by the World Bank[32] for China estimated that, in 2008, the costs of natural capital loss could have been as high as 9 per cent of the country's national income. This is a magnitude similar to the depreciation of manufactured capital (for example, the wear and tear of machines and other manufactured assets), which is currently recorded in

[28] Arrow *et al*. (2012).
[29] UNU/IHDP/UNEP (2012).
[30] World Bank (2006).
[31] UNU/IHDP/UNEP (2012).
[32] World Bank (2010).

national accounts. The rationale for that existing entry is clear. Future economic income depends, in part, on maintaining the manufactured capital base. It is hugely important then that the extent of its depreciation is measured. However, in the case of natural capital there is no such corresponding entry in national accounts recording its loss.

5. The same World Bank report indicates that for India and Brazil the value of these natural capital losses could be more than 8 and 5 per cent of national income respectively. In the USA and UK, however, these magnitudes are estimated at just over 2 per cent of each country's national income[33]. Yet, it is important not to take too much comfort from comparatively smaller magnitudes (in national terms); it is partly an artefact of what is being measured and what is not and, for the UK, this number is seriously incomplete. This is what makes natural capital accounting so urgent. As things stand, there is simply no overall assessment that can be made, in this way, about the depreciation of natural capital. **Until this is addressed, our national accounts will continue to provide erroneous signals about future economic prospects**.

6. This information could provide important lessons for policy development. In the case of sub-soil assets, reinvesting some of the proceeds of depleting these resources in alternative types of capital offers one means of transforming a finite (non-renewable) income stream into a stream of income that is longer lasting. One study estimates that the adoption of a relatively conservative rule of thumb for reinvesting the proceeds of UK oil and natural gas depletion since the 1970s could have resulted in a *potential* manufactured capital stock that was more than 25 per cent larger than the *actual* stock in the year 2000[34]. Put simply, had the UK invested more (and consumed less) of the proceeds of this resource depletion, its stocks of other assets would now be higher. In the absence of natural capital accounts, such insights will be lost to the detriment of planning for longer-term growth and development.

7. If these accounts are to be useful for evolving concerns about natural capital, it is critical that what is measured extends to a more comprehensive range of natural assets. To the extent that this is practically possible, they must also include metrics for the processes which underpin the operation of natural systems. So when a system (or a particular resource within it) is degraded, the impact on the flow of future benefits is recorded. The recent outbreak of Ash Die-back (*Chalara fraxinea*) in native populations of common ash trees in Britain is a case in point and the ensuing possibly catastrophic loss of this particular natural capital asset could be associated with the loss of a number of categories of future benefit (see Box 3.2).

8. How to do this accounting, in practical terms, is the major issue that the NCC is addressing. It clearly is dependent on evolving knowledge of the importance of natural capital from other disciplines. One way of prioritising might be to focus accounting efforts on those assets identified within a natural capital risk register as discussed in Section 2 (see Box 2.4).

9. The depreciation of these natural assets occurs when the underlying stock declines in terms of either its quantity or its quality. Accounting for these changes (and the various sources of these changes) in physical terms is a fundamental building block in this regard. But to fulfil the genuine potential of natural capital accounts, valuing this depreciation will also be required. How this

[33] See World Bank (2010) and (2011).
[34] Hamilton *et al*. (2005).

valuation should be done, in turn, depends on establishing the questions that we would like natural capital accounts to answer.

10. One natural question to ask concerns the value of the benefits derived from natural capital. What is needed for this is a forward looking evaluation of the value of services derived from different forms of this capital. If natural capital is in decline (that is, depreciating) then this changing value could be understood in terms of the *future* benefits that are lost as a consequence. This could be addressed through using market and other estimates of the value of future benefits and is essentially the focus of the type of wealth accounting discussed in Box 3.1 above.

11. A different question might ask instead about the costs incurred to achieve (natural) capital maintenance. So, for example, there are many elements of natural capital which, if left intact, provide a stream of services that people enjoy into the (indefinite) future. Depreciation broadly refers to a decline in this (otherwise potentially) indefinite stream of services. Taking the view that natural capital should be sustained then this depreciation could be measured by the costs of restoring these lost services. In this respect, valuation in natural capital accounts refers to a retrospective evaluation of the consumption of existing stocks, expressed in terms of the costs of maintenance[35].

12. Box 3.2 on the ash dieback provides an illustration of how these different principles might inform future accounting. It is important not to regard these two approaches to valuation as being alternatives – they provide complementary information and both are required to give a comprehensive picture of the changing nature of our natural capital. Where natural capital is being lost, accounting for both the value of changing (future) benefits and what it would cost to restore or maintain this capital is needed.

Box 3.2: National Accounting for Ash Dieback (*Chalara fraxinea)*

Having been identified initially in imports of cultivated ash trees, the first cases of the fungal infection (*Chalara fraxinea)* in common ash trees in the wider natural environment in Britain were confirmed in Autumn 2012. This outbreak adds to the growing threats from pathogens and pests faced by indigenous tree and plant species across Britain. The experience from continental Europe indicates the devastating impact that *Chalara* could have on the common ash.

The impact of *Chalara* is a possibly huge depreciation of that part of our natural capital that is embodied in ash trees. This use of accounting terminology is more than just semantics. Proper accounting for this natural capital could make a substantial contribution to understanding what the nation stands to lose. More positively, this application of natural capital accounting could also contribute to the evidence base needed to construct suitable responses to the problem. While the adverse effect on cultivated ash trees traded, for example, through commercial nurseries will be reflected in the national accounts, the impact on ash trees more broadly in Britain's woodlands will not (or, at best, will be reflected highly imperfectly). The indications are, however, that this wider impact could be hugely significant and it is important that national accounts reflect this fully.

Correcting this measurement imbalance is the province of fledging attempts to construct natural capital accounts focusing on woodland and forest. Of course, *Chalara* is a threat to a very specific species (common ash) and the accounting challenge in this context would be to understand not only the current stock of ash trees across Britain but also its distribution, age profile (given that susceptibility is greater in younger trees)

[35] Edwards, Kay and Mayer (1987).

and incidence of *Chalara* outbreaks. Knowing these physical and spatial changes, in the first instance, is crucial. So too are insights about the value of this depreciation.

One perspective on this valuation problem is a forward looking approach that accounts for the wealth represented by ash trees. More specifically, there is a (negative) value to account for given the loss of trees. This is the value of the (future) benefits now lost because of ash dieback that occurs over some period. These benefits will be manifold but could include (lost) flows of timber, opportunities for recreation, carbon storage and the regulation of surrounding ecosystems and biodiversity. In addition, as an indigenous and focal tree species, it is likely that people may attach value to the existence of ash trees.
A different perspective accounts for what it would take to sustain this natural capital. On this view, the dieback of ash trees can be evaluated by looking at the costs of restoration. This might involve, for example, accounting for the costs of replacing diseased trees with similar but more resilient specimens. This focuses the accounting problem on capital maintenance in terms of current costs of retaining the current stock of a resource.

How far off might we be from a comprehensive accounting for these changes in natural capital represented by the nation's ash trees? In the case of evaluating (future) benefits given advances in valuing ecosystem services (such as in the UK NEA) there are encouraging signs. However, significant challenges remain for some of these benefits. The cost-based approach, however, does not require future assessments, to the same extent, and is arguably more readily susceptible to measurement.

However, a complete picture of ash-tree dieback requires that the accounts offer both perspectives. That is, the questions that the accounts should address here are two-fold. First, given a declining stock of ash-trees, what is the value of the wealth that is lost? Second, what would it cost to restore this ash tree capital?

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13. Combining these pieces of information on accounting costs and benefits is also instructive in other ways. For example, for many types of natural capital, it is likely that the value of what is lost when it depreciates is greater than what it would cost to sustain the asset. While the accounting clock cannot be turned back, this provides a useful signal about policy towards preserving natural capital, namely that it would be more sensible to restore the asset than make do without it (or with less of it).

14. A set of accounts may go further in suggesting that we have too little natural capital, namely that the costs of restoration to some more ambitious target, might be a more appropriate objective. There is an important line to draw here between accounts as a source of information and decisions taken on the basis of that information. How to guide investment decisions is the focus of cost-benefit analyses and Section 4 of this report.

15. In accounting for natural capital, consideration will need to be given to the potential breach of critical thresholds or limits. If these 'red flags' are known (or can be established) then this adds significantly to what natural capital accounts can reveal. If, for example, current stocks are close to or have passed a threshold or limit, then this places greater urgency on understanding the costs of restoring that stock to some acceptable level. Even where natural capital assets are not close to such thresholds, this does not mean there is no need for concern. If this capital is being depleted or degraded then there remains a depreciation item to record in the accounts reflecting this loss. Moreover, this loss takes us further towards the threshold or limit, which ultimately is something to be avoided.

16. Establishing these thresholds or limits, for particular categories of natural capital assets will be a challenge. However, it is an important task. In fact, keeping a safe distance from such thresholds may itself have a distinct asset value. This can be viewed in terms of there being

greater resilience in the face of potential shocks and stresses and so less chance of abrupt and excessive losses of natural capital. For example, a study in South-East Australia[36] accounted for the value of this resilience in maintaining saline-free agricultural land. Here agricultural expansion, mainly through farmers cutting down trees and causing the saline water table to rise, represented a driver depleting the stock of non-salinated soils (measured as the depth of soils for which saline intrusion is not a problem). As this depletion driver increases so the stock of ecological resilience falls. Of course, this process of depleting resilience does generate benefits; here in terms of agricultural produce. But losses of resilience may lead to irreversible and large losses in agricultural productivity later on and this potential loss must be accounted for. The example of eutrophication discussed in Section 1 represents another illustration of a driver, namely nutrient loading in water bodies, increasing the chances of an ecosystem being subject to an abrupt change. In accounting for water quality, therefore, it is important to combine the accounting with the best knowledge possible about the prospects for threshold effects.

Box 3.3: Natural Capital Accounting for Watersheds – an example from Seattle, US[37]

In 1889, Seattle Public Utilities (SPU) was set-up to provide water to the city following shortages and several outbreaks of cholera and typhoid. One of its first acts was to purchase the forested Cedar River watershed to provide and filter the city's water. Within 10 years, abundant, clean water was flowing and cholera and typhoid had been eradicated. Today, it is estimated that SPU would have to pay an upfront cost of $200 million to build a filtration plant and incur annual operating expenditure of $3.6 million if the forest was lost.

Clearly the forest and watershed has immense value – at least as much as its replacement cost. More than that, it is the greatest asset the company has and yet the accounting standards it has to follow (guidance set by the Government Accounting Standards Board (GASB)) does not allow the watershed to be registered as an economic asset in the utility's financial books. This is a critical issue because it effectively stops the utility from investing in the watershed. It is difficult to justify, for example, a capital improvement project to accomplish needed maintenance or restoration. If the watershed becomes polluted, clean-up costs are recorded as a liability on the utility's financial statement. Equally perversely, if an old logging road in the watershed needs to be decommissioned due to sediment run-off, the utility's assets will be written down because the road counts as an asset (an improvement) when in fact it is a liability in this case.

In summary, the current GASB accounting rules, with their sole focus on historical cost accounting and man-made assets, do not provide an accurate or meaningful picture of SPU assets. Changing these rules and accounting practices may seem like a relatively trivial thing, but it could clearly have an enormous impact both economically and environmentally.

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17. Natural capital accounting should not just be viewed in terms of its implications for national accounts (see Box 3.3). In fact, leading businesses, both domestically and internationally, are attempting to develop accounts that accurately document the impacts of different business activities on the natural environment and help in understanding the risks that deterioration of natural capital assets can have on supply chains and future growth opportunities. Box 3.4 provides an illustration of some of these initiatives.

[36] Walker et al. (2010)
[37] Cosman *et al* (2011)

Box 3.4: Corporate natural capital accounting and the NCC

Business relies on natural capital. Some companies, for instance extractive companies, water companies and farmers, rely directly on natural capital for their activities. The dependence on natural capital of other sectors, such as retail, manufacturing and financial services, is often less direct and linked to the security of supply chains and reputation management.

The use by companies of the geological assets of natural capital is well known, and accounting for it relatively straightforward. Extractive industries, for example, have many years of experience of reporting on the extent and value of their concessions, licenses and proven and probable reserves. By contrast, companies' impacts and dependence on other natural capital assets – particularly those associated with biodiversity and ecosystem services – are less well understood. A surge of work in the last few years has helped to improve business' understanding of the nature and economic implications of companies' impacts and dependence on biodiversity and ecosystem services. This has been driven by companies' and investors' growing understanding of the risks and opportunities at stake, as well as increasing pressure from the policy, research and conservation communities which point out that the loss of natural capital could have a negative effect on the economy as well as on the environment.

Evidence has been mounting that business risks and opportunities associated with the loss or unsustainable use of natural capital can be financially material. For example, according to The 'Principles for Responsible Investment', fifty per cent of company earnings could be at risk from environmental externalities; this is equivalent to 11 per cent of global GDP[38]. Nevertheless, there has been limited adoption of natural capital valuation and accounting across the corporate sector to date. The reason is that it is often felt not to be directly relevant to or the responsibility of business, it is not perceived to be sufficiently material to their activities or its measurement is perceived to be too difficult, costly or subjective.

The NCC believes that the development of good quality, open-source guidance for companies on the preparation of corporate natural capital accounts is of the highest importance and would like to work with business in trying to identify how the concerns and problems with its adoption can be best addressed. There is a clear need for companies, business groups and accountancy organisations to work together in developing corporate natural capital accounting and integrated reporting, exchange experiences, draw together existing initiatives, encourage consistency in the use of terminology and methods, and foster as broad an uptake as possible of corporate stewardship of natural capital.

Taking forward the development of natural capital accounts

17. The NCC will perform two key roles in the development of natural capital accounts in the future.

18. The first is with respect to the development of national natural capital accounts which is a commitment set out in the Natural Environment White Paper. The Government, in conjunction with the Office for National Statistics (ONS), will include natural capital in the UK's Environmental Accounts. The ONS has recently released a 'roadmap' setting out which accounts will be prioritised and a timetable for their development[39].

19. The NCC sees this as a vitally important initiative. Without a comprehensive set of national accounts for natural capital, we have an incomplete picture of the capital base of the economy

[38] the Natural Capital Declaration is co-convened by the UNEP Finance Initiative, the Oxford-based tropical-forest group Global Canopy Programme, and the São Paolo-based Centre for Sustainability Studies (GVces) of the Business. http://www.unepfi.org/fileadmin/events/2012/Rio20/Press_release_Launch_of_Natural_Capital_Declaration.pdf

[39] http://www.ons.gov.uk/ons/guide-method/user-guidance/wellbeing/publications/index.html.

and cannot be confident that we are exploring all the opportunities for growth and future wellbeing. **The NCC will, therefore, work closely with the ONS and Government in developing the accounts, in particular providing technical input both on measurement issues and metrics as well as on the key valuation challenges**.

20. The second area where the NCC will play a key role is with respect to the development of *corporate* natural capital accounting. **The NCC will seek to encourage the development of principles, guidance and agreed metrics for inclusion of natural capital in corporate accounting**. This will need to entail engagement of financial institutions and investors as well as companies and major landowners in the promotion of corporate natural capital accounting.

Section 4: Valuing Changes in Natural Capital and Improving Decision Making[40]

The Natural Environment White Paper (2011) clearly recognises the importance of valuing changes in natural capital as part of the policy development process, for example, "*As part of [its] approach to mainstream sustainable development, the Government will fully consider the value of nature in all relevant impact assessments*" (NEWP p43).

- Natural capital is enormously important to the economy and yet it is largely omitted from national economic indicators as well as from most corporate and government policy decisions. The consequence is that resources are not being allocated efficiently within the economy and opportunities for significant gains in wellbeing and future growth are being lost.

- Policy makers urgently need robust assessments of the economic value of changes in natural capital for use within appraisals. These valuations must be based on firm natural and social science evidence and be applicable to local conditions.

- More generally, policy makers require better decision support tools to help them incorporate natural capital valuations into policy analysis. Improved use of existing data and analytic approaches would significantly enhance appraisal processes and increase the value for money provided by investments.

- A major challenge is to provide the valuations and decision tools required to implement existing guidance such as HM Treasury's 'Green Book' to an appropriate standard. Extensions to this guidance may also be required to address particular natural capital issues, such as situations where robust valuations are not likely to be available, or where irreversible losses to assets, such as wild species or habitats arise.

The NCC recommends that:

1. **Government undertakes a critical look at how cost-benefit analysis is being implemented with respect to natural capital to identify priority areas for improvements. While H.M. Treasury's 'Green Book' provides an good starting point for cost-benefit analysis, options to improve the treatment of natural capital within this guidance should be explored. This should include consideration of the appropriateness of physical (in-kind) compensation for certain forms of natural capital loss;**

2. **An urgent programme is initiated to provide high quality evidence on the economic value of changes in natural capital to feed into cost-benefit analyses. The NCC will bring forward detailed proposals on this shortly; and**

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

The vital role of cost benefit analysis in decision-making

1. The accounting approaches and techniques described in section 3 are important for understanding, at a national level, how our natural capital assets are changing over time. If designed appropriately, they can assist the policy process by helping to identify where

[40] We are grateful to Brett Day and Robert Sugden for comments on an earlier draft of this section.

interventions may be needed to ensure more sustainable use of those assets. Environmental accounts can help, therefore, to set the agenda regarding overall objectives, such as the restoration of depleted natural capital.

2. What a set of natural capital accounts *cannot* do though is to determine the best way to address those objectives. For that, a different approach is needed; one which can identify the best use of available resources to address a given objective. Furthermore, as those resources could be put to many alternative uses, including ones which are little if anything to do with natural capital, an approach is needed which can be used across the many decisions government has to take. Within the UK and many similar countries, such decisions are informed using cost-benefit analysis (CBA). In essence, CBA seeks to estimate the value of the benefits and costs of a given investment and identify that option which delivers the best value for money for society.

3. The reason that such approaches are so helpful is down to two unavoidable facts that characterise decision-making in the real world. First, society's desires (including those for social and environmental enhancement) will always exceed the resources available to meet them. In other words, we are continually faced with the problem of 'scarcity' and choices need to be made about what to produce and consume. Second, because resources are scarce, every time we decide to do one thing, we are effectively making a decision not to do another. We are, therefore, implicitly saying that one option is of greater value than another. In this sense, valuation is unavoidable; it is the essence of decision making.

4. An obvious requirement of any CBA is, therefore, that all of the benefits and costs of a potential investment or policy are considered. Because these may be many and varied, CBA seeks to express them all in comparable, common units. Furthermore, because the resources involved might justifiably be used for a variety of alternative purposes (for example, investments in the health service, education, employment), that common unit needs to be the same across all investment appraisals. CBA addresses this problem by attempting to express all costs and benefits in common, money terms. Valuing changes in natural capital in monetary terms is sometimes objected to. However, failing to do so often results in natural capital being treated as if it has zero value, resulting in over-use or under-provision. While the monetary valuation of natural capital does require careful analysis, and challenges need to be acknowledged and addressed, it can ensure that the natural environment is more effectively incorporated within decision making and no longer treated as a free and unending resource to be exploited at will.

5. For example, take the issue of land use change, which may involve alterations in the level of agricultural outputs (which have market prices) but also lead to changes in goods and services that do not (for example, outdoor recreation, carbon storage and water quality). The best way to be able to compare changes in such vastly different goods and services is to try to value them in common, monetary terms. To this end a number of methods have been specifically designed for valuing changes in natural capital[41].

6. Using valuation methods appropriately and as thoroughly as possible to take account of these so-called 'non-market costs and benefits' can be transformative in a decision-making context. For example, the UKNEA (2011) applied CBA principles to illustrate that the services and benefits we derive from our natural capital assets are critically important to both the UK

[41] see introductory review in Defra (2007)

economy and our wider wellbeing. It found that changes in land use could generate natural capital gains (or, with poorly directed change, losses) amounting to billions of pounds per annum. Furthermore, focussing solely upon the market priced consequences of land use change could be misleading, resulting in decisions that delivered relatively minor gains in say agricultural output, at the cost of major losses of natural capital value. Importantly, the analysis in the UKNEA enabled win-win solutions to be identified where net gains in market and natural capital goods could be achieved.

7. Box 4.1 provides a further example of CBA in practice and illustrates the potential for valuation studies to incorporate the natural variability of the environment within analyses. The example considers the costs and benefits of changing land use from conventional agriculture to multi-purpose woodland in Wales. It illustrates how both market and non-market values vary across different areas and shows that some areas are more suitable for one use than the other. It also shows that if we carry on ignoring the wider values that can be provided by the natural environment then we will perpetuate problems. In this case, historic agricultural subsidies have confined woodlands to upland areas, away from populations who could otherwise enjoy their recreational benefits. This has also led to some afforestation on environmentally important peatland areas. Valuing both the market and non-market environmental consequences of land use change shows us that policies such as changing farm subsidies to favour the establishment of woodlands on non-peatland areas, near to population centres, would generate benefits well in excess of costs.

8. **The NCC will work with Government to improve the valuation and incorporation of natural capital within CBA and decision making.** We will start this process through the publication of a discussion document setting out the challenges to be addressed; the general direction of which is outlined in the remainder of this section.

Box 4.1: Using valuation to inform more efficient land-use in Wales

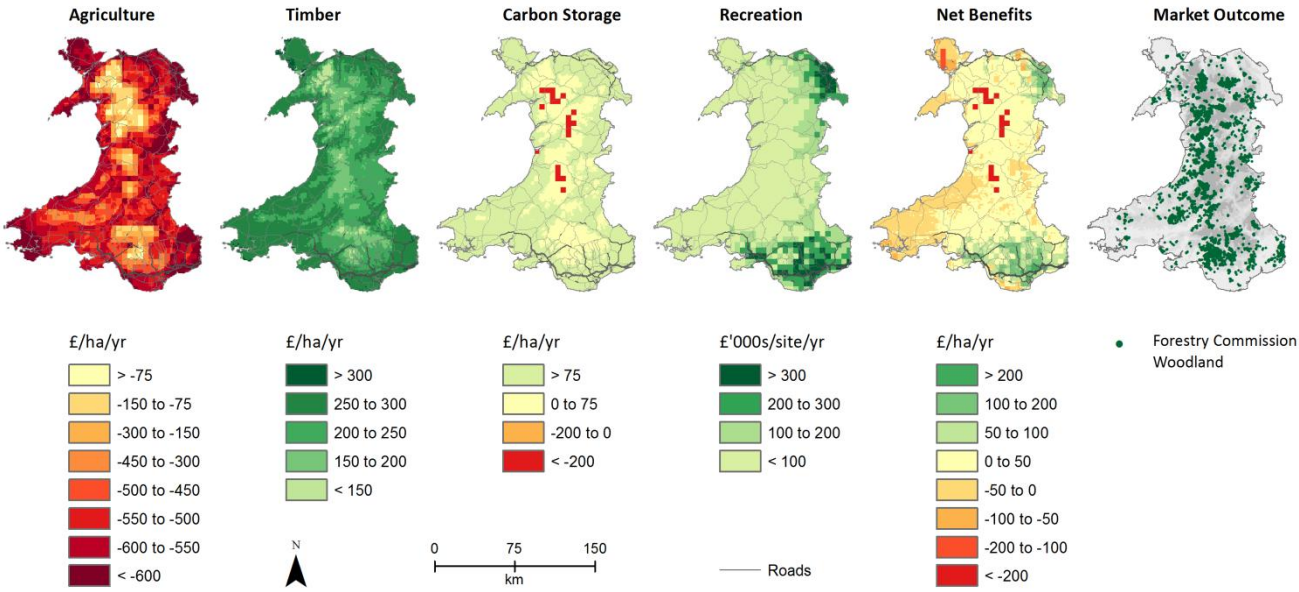
The importance of including both market and non-market (including environmental) values into decision-making can be illustrated by the case of rural land use in Wales. The series of maps below summarises the main values that would arise from a possible change of land use from conventional agriculture to multi-purpose woodland. The analysis includes both the market and non-market costs (shown in red) and benefits generated (coloured in green), and how they vary across locations.

Working from left to right along the maps:

- The first illustrates the market value of agricultural output (which is negative as the value is lost when farmland is converted to woodland). As can be seen this varies very markedly across the country, being low along its mountainous central spine and higher in lowland areas.
- The second shows the only market value generated by woodland; timber. This is coloured in green to signify the gains of timber value arising from conversion from agriculture to forestry. Its variability echoes that of agriculture, but timber market values are almost always at a lower level, even in those lowland areas where timber values are highest (and, of course, agricultural production values are also highest). Hence, left to the market we observe the current situation, with agriculture dominating almost all of rural Wales and woodland confined to mountainous areas where land prices are low.
- The third brings in the first non-market value; the change in carbon storage arising from a switch towards woodland. This is almost always positive (woodlands generally store more carbon than farmed land) except for some upland areas where tree planting dries out peatlands and releases large quantities of carbon.

- The fourth shows the change in recreation values, which are again almost always positive and now show the influence of population distribution, being highest around cities and in areas with good road infrastructure.
- The penultimate map sums together all preceding values, both market and non-market and removes all subsidies (which are effectively transfer payments within society) to obtain the net benefits to society of a move from farming to woodland in each area. Here areas coloured in green show locations where a shift to multi-purpose woodland would generate substantial net benefits. As can be seen these are predominantly located in areas near to population centres in the south east and north west.
- This pattern stands in very stark contrast with that illustrated in the last map which shows where market forces (that is, the current situation driven in part by agricultural subsidies) have consigned forests to be located; away from lowland areas (and hence cities) and onto remote upland and mountain areas where land values are low. Perversely this includes some peatland areas where forests actually contribute to global warming through the drying of peat and emissions of carbon. Note that such changes need not undermine farm incomes if subsidies were to move towards supporting all of the values (including natural capital) which can be generated by different land uses.

Figure: The market and non-market costs and benefits of land use change in Wales



Source (and further details): Adapted from Bateman et al., (2011).

This case study illustrates key principles of decision making involving natural capital. As the maps clearly show, the values generated by land use (both market and non-market) vary substantially by location, reflecting variation in the natural environment. Unfortunately, many key subsidy payments, including EU Single Farm Payments and even major environmental payments, such as Environment Stewardship schemes now covering a majority of farmland in the combined area of England and Wales, are poorly targeted and hence fail to reflect this variation in the natural environment. These subsidies are worth many hundreds of millions of pounds annually and would generate much greater value for money if they were directed by the various environmental and other values they can generate.

The case study clearly shows that incorporating non-market natural capital values into policy assessments can lead to significantly different decisions being taken. While markets are superbly efficient at allocating priced goods, they are blind to non-market natural capital goods. Only by directly addressing this failure will decisions make the best use of the scarce resources available to society.

Improving the implementation of cost benefit analysis in government

9. The discussion in box 4.1 illustrates just how important consideration of 'non-market' costs and benefits can be in a decision-making context. This is well recognised in HM Treasury's Green

Book guidelines (and supplements[42]) which provide an good underpinning to decision analysis in central government.

10. While the NCC looks to work with government on potential extensions to appraisal guidelines, one of the major challenges relates to raising the standard of appraisals to a level commensurate with existing guidance. **There is an urgent need for robust natural capital valuations suitable for decision making purposes.** The valuation literature has significant gaps and a substantial number of the studies that are available have not been designed for decision making purposes and are not easily transferable to the specifics of different appraisals. This is a substantial challenge to the incorporation of natural capital in appraisals and the NCC sees an urgent need for the Government and research funders to invest in this area. There is significant scope for progress, with a number of initial 'low hanging fruit' improvements being possible through better integration of natural science with economics and social science expertise. Equally, better use of existing data and contemporary spatial analysis tools should yield significant analytical improvements at costs which are very considerably less than the benefits on offer. **The NCC is well placed to contribute to the development of such analytical tools.**

11. The development of robust natural capital valuations will require improvements in both natural and social science evidence. Key issues include:

    a. **Improving the underpinning natural science evidence on which valuation estimates are made:** One of the most fundamental challenges to improving CBA of changes in natural capital is ensuring a sound natural science understanding of the consequences of any proposed project. This is often challenging for scientists to deliver from the existing data and monitoring evidence: reinforcing the need for new metrics for natural capital as outlined in section 2.

    Appraisals need to take account of the complex characteristics of some of the natural capital assets being assessed. This is particularly challenging for those resources which have 'threshold' levels below which they can quickly collapse (for example, population thresholds below which a species tends towards extinction). Unfortunately, some of these thresholds are difficult to detect prior to them being breached. A related challenge concerns the degree to which a change in an asset is reversible. While many assets have the capacity to renew themselves, the rate of renewal often depends upon the stock (and its condition). Depleted resources can prove very difficult (and expensive) to renew and of course excessive depletion of even the most renewable resource can induce irreversible change and hence total losses. Furthermore, long term sustainability requires that natural capital assets are maintained at levels which ensure resilience to uncertainties, fluctuations in the natural environment and other external pressures. The optimal management of non-renewable resources also raises a range of distinct issues. All these represent significant scientific challenges but are nevertheless essential to more robust valuation and appraisal.

    b. **Improving the integration of social science issues into valuation and CBA:** There are a number of social science challenges to be addressed. For example, appraisals need to quantify and incorporate how values for objectively similar natural capital resources can vary across locations. For example, as Box 4.1 illustrated, the recreational values generated by a woodland can vary massively according to the location of that woodland; planting next to a city may lead

[42] See Dunn (2012)

to very large numbers of visits while in a more remote location recreational values may be negligible. Values also vary tremendously according to the availability of substitute resources (for example, planting a woodland in an area with many other amenities is clearly of lesser recreational value than in a location with no other attractions). While understood in theory, these issues are poorly quantified in practice. Other challenges include assessment of how individuals may modify their behaviour in response to new situations. For example, individuals who invest in energy efficiency devices may increase their use of energy: the so-called 'rebound effect'. Similarly attempts to enhance the environments of disadvantaged communities, say by the provision of urban greenspace, may be undermined if this merely results in local landlords raising rental values. Understanding of such dynamic issues needs to be improved and that information incorporated with decision making.

12. Alongside these various challenges is the need to integrate such information within economic appraisals. This is particularly pertinent in the case of cross-cutting issues. For example, the multifaceted nature of biodiversity raises both natural science challenges in terms of understanding its role in both supporting the processes which deliver natural capital services and being a direct source of value. Some economists question the robustness of monetary values derived from social surveys concerning goods such as biodiversity for which respondents have little prior experience[43]. **One possible response to such problems might be to require that proposals which threaten to deplete such resources provide physical compensation for any losses** (for example, maintaining or increasing the habitat necessary to maintain or enhance biodiversity). The NCC recognises that this would require some modification to existing appraisal guidelines and will seek to work with the Government to provide strategies for dealing with such challenges and for integrating the various types of information needed to ensure robust incorporation of natural capital within economic appraisals and decision making.

13. While there are obvious challenges to be addressed, advances in analytical capabilities such as the use of geographical information systems and the increasing availability of high quality data provide new opportunities to enhance decision support. Such opportunities will be of even greater value in periods of particularly tight resource constraints and provide the potential for excellent value for money derived from investments in better evidence and decision making.

Conclusions

14. There is great potential to improve the incorporation of natural capital within economic appraisals and decision making. This will require substantial improvements in the implementation of existing guidelines for cost-benefit analysis. In particular decision makers need access to improved valuations for changes in natural capital. This in turn requires improvements in both natural and social science evidence. There is also scope to enhance the existing guidance. The NCC will provide advice on the research necessary to address these challenges and through this will work with Government to improve the valuation and incorporation of natural capital within CBA and decision making.

[43] Bateman *et al* (2011).

Section 5: Natural Capital and Economic Growth

- The Government's ambition in its Natural Environment White Paper (NEWP) is for a "*green and growing economy which not only uses natural capital in a responsible and fair way but contributes to improving it"* (NEWP p34).
- There is no inherent incompatibility between preserving and enhancing natural capital and economic growth, as long as growth is properly measured.
- The proper integration of natural capital into decision making at all levels is crucial to supporting and promoting future growth. This requires that natural capital is incorporated into national and corporate accounts as well as into project appraisal.
- In order to promote sustainable growth, all forms of capital (natural, human, social and manufactured) need to be properly maintained and where appropriate, enhanced. Only in this way will future generations be able to enjoy the opportunities that we do now.

The NCC recommends:

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

The limitations of current measures of growth

1. Our natural assets form part of the capital base which enables the production of the goods and services that drive our economy and increase our wellbeing. However, economic growth as currently measured by increases in GDP does not take account of changes in natural assets, or indeed changes in other types of capital (such as manufactured, human or social capital). Rather, it focuses on flows, not stocks. As a result an economy can run down its assets yet, at the same time, record high levels of GDP growth, until a point is reached where the depleted assets act as a check on future growth.

2. There are a number of obvious mainstream examples of such perverse outcomes. These range from the treatment of the depletion of North Sea oil and gas (as discussed in Section 3), thorough to the impact of reducing capital expenditure to maintain current spending. For example:

    - North Sea oil and gas has been treated as an income flow, with no compensating allowance made for the fact that the use by the current generation (and hence running down of the capital base) is at the expense of future generations. The sustainability rule that the value of the non-renewables asset depletion should be reinvested for the future has been broken. Economic growth in GDP terms has, as a result, been artificially inflated in this country for the last 35 years. This situation is clearly not unique to this country, although there is at least one notable international exception. In Norway, some oil profits (from taxes on oil companies and license fees) have, since 1990, been placed in a fund called The Government Pension Fund - Global. This has now become one of the largest pension funds in the world[44].

    - In GDP accounting, capital and current expenditure are in important respects treated similarly. In difficult economic times, it is often easier to cut back on capital investment than current spending. Thus the maintenance and enhancement of infrastructure including natural capital is too often sacrificed at the expense of the future services these would have produced.

3. Thus, despite GDP being a useful measure of economic activity over a period and being strongly correlated with employment, a narrow focus on it alone is not enough. It not only fails to properly reflect what is happening to wellbeing, it also does not provide information on the long term sustainability of economic growth and so, just as GDP was a poor indicator of the sustainability of the economic boom up to the 2007 crash, GDP today does not tell us whether the growth path of the economy can be sustained (see Box 5.1).

4. Taking these considerations into account, it is apparent that the recorded GDP growth rate overstates the sustainable growth rate. Broader measures of wellbeing and wealth are needed for this and there is a danger that short-term decisions based solely on what is currently measured by national accounts may prove to be costly in the long-term. Incorporating natural capital into decision making and allowing for depreciation and capital maintenance, as described in Section 3, is needed to help ensure we take advantage of all possible growth enhancing opportunities and avoid significant future costs.

Box 5.1: GDP as a measure of wellbeing

GDP (Gross Domestic Product) is the main measure of national income. The GDP of a country is defined as the total market value of all the final goods and services produced over a given period of time.

However, while GDP is an extremely valuable and commonly used metric across the world, having been in widespread use since the Second World War, it has its shortcomings. It is not a robust measure of the current growth path of the economy and its ability to sustain it. Consequently, GDP does not reflect how wealthy we really are or whether our wellbeing (the quality of life of the population) is growing in a sustainable way.

[44] http://www.nbim.no/en/About-us/Government-Pension-Fund-Global/

For example, GDP:

- only measures market-based activity and does not account for non-market wellbeing enhancing activities. For instance, a measure could increase wellbeing but not be reflected in increases in GDP, or increases in GDP may not actually reflect enhanced wellbeing. Consequently, the pursuit of activities that maximise GDP may not maximise wellbeing;

- measures flows, not stocks. GDP measures flows through the economy (via consumption and production activities) and does not take account of the capital stock of an economy. For example, the consumption of non-renewable natural resources such as fossil fuels counts as an addition to GDP, while the depleting stock is not valued or included in the GDP measure. Failure to account for stocks also means GDP has limited use in terms of anticipating critical thresholds, limits, or irreversibilities.

Many economists have, therefore, looked at the issue of how well GDP reflects a nation's wellbeing, with perhaps the most well-known recent study being undertaken by a team led by Stiglitz[45] in 2008 for the French President of the time. Stiglitz argues that measuring production is essential for monitoring economic activity. Amongst other things output determines the level of employment. Despite deficiencies in our measures of production, we know much more about them than about wellbeing. However, he then went on to argue that the time has come for a shift in emphasis from measuring economic production to measuring people's wellbeing.

Metrics such as GDP do not reflect wealth stocks. Income and consumption are crucial for assessing living standards, but in the end they can only be gauged in conjunction with information on wealth. A household that spends its wealth on consumption goods increases its current wellbeing but at the expense of its future wellbeing. The consequences of such behaviour would be captured in a household's balance sheet and the same holds for other sectors of the economy and for the economy as a whole. To construct balance sheets, we need comprehensive accounts of assets and liabilities. What is carried over into the future necessarily has to be expressed as stocks; of manufactured, natural, human and social capital.

It is clear, therefore, that whilst GDP is one measure of economic activity, it does not allow us to obtain a clear picture of what is happening to wellbeing and hence economic growth when properly measured. Making decisions based purely on GDP which, therefore, ignore the non-market aspects of the economy like natural capital, will likely prove to be more expensive in the long term. A holistic view of the impact decisions have on our wider wellbeing is needed if our prosperity is to be sustained. This means natural capital needs to be fully reflected in the accounts and decision making tools as previous sections of this report highlight.

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5. While Table 5.1, below, suggests that at face value, the contribution made by natural capital to overall economic activity may seem small and dominated by the energy sector, this is misleading. Such a narrow focus seriously underestimates the contribution natural capital makes to the whole economy and hence to our prosperity. To a greater or lesser extent, all activity is dependent on natural capital 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, will not only reduce our wellbeing and hence growth when properly measured, but also seriously undermine the contribution that all sectors can make to the economy. For sectors like tourism (which is one of the biggest sectors in the economy), that dependence is hugely significant. There are likely to be many other cases where the better management of, investment in, and opening up of natural capital to further possibilities, such as recreation, can lead to additional growth opportunities, as discussed later in this chapter.

[45] Stiglitz, Sen, Fitoussi (2008).

Table 5.1: Sectors of the economy most directly dependent on natural capital (2010), percent Gross Value Added (GVA)

Forestry & logging	Fishing & Aquaculture	Crops, animal production & hunting	Mining coal & lignite	Crude oil & natural gas	Other mining & quarrying	Water collection, treatment & supply	**Total (%GVA)**
0.04%	0.06%	0.08%	0.1%	2.41%	0.1%	0.8%	**3.58%**

Source: ONS Annual Business Survey 2011.

Sustainable growth

6. Many argue that we should reduce our consumption of natural assets to a sustainable level and accept the consequences of this, even if it affects economic growth. The argument goes that all resources are to some extent finite and that we should live within the limits that enable our natural systems to function. No thresholds should be crossed. Others argue that substitutions between natural capital and other forms of capital can be made in some circumstances, provided the total consumption possibilities of future generations are at least as good as our own. This can happen, for example, when a road is built through farmland where the loss of that farmland (natural capital) is offset by the addition of manufactured capital in the form of the road.

7. In practice, systems of international environmental governance, EU and domestic laws, embrace principles of sustainable development. However, the inevitable, if not always desirable, position lies between full and no substitutability of natural capital. For substitution to occur in an economically efficient manner and while sensibly protecting our natural world, we must be in a position to understand the implications of losing natural capital when decisions are being made, so as to avoid eroding our wellbeing. This means we need to know when and where substitution of natural capital is likely to breach thresholds so that to the extent possible these can be factored into decision making. It needs to be borne strongly in mind that just because some substitution is possible, it does not follow that it is desirable in any particular case.

8. As identified in Section 2 above, knowing when and where substitution may lead to thresholds being crossed and hence our wellbeing being negatively impacted, necessitates significant improvements in the metrics and the proper identification of risks. Current tools do not adequately capture the feedback loops between the environment and the economy and so they need improving if future wellbeing is to be maximised. The NCC intends to carry out work over the coming year to help inform this picture.

Seizing opportunities for growth

9. Notwithstanding the measurement issues described above, there are a number of ways in which the better management of natural capital can drive growth and boost wellbeing. This section highlights two such ways and the Committee will explore additional opportunities over the coming year. They are:

    I. identifying new growth opportunities; and
    II. getting prices right by, for example, eliminating perverse incentives and subsidies.

I: Identifying new growth opportunities

10. The natural environment is the source of many goods and services that are not currently being fully utilised. Recognising the value of these could unlock opportunities for growth. While there is undoubtedly a wide range of such opportunities, a flavour of them is set out below.

The Ecosystems Market Task Force

11. Opportunities of where investment in natural capital can enhance growth are being explored by the Ecosystems Markets Task Force (EMTF)[46]. The EMTF was one of the commitments in the Natural Environment White Paper and was set up to review the opportunities for UK business from expanding green goods, services, products, investment vehicles and markets which value and protect nature's services. It brought together industry leaders and experts from a wide range of sectors to look for ways in which companies can improve both the environment and their own bottom line.

12. The Task Force reported in March 2013, making a series of recommendations to Government and business, which should be considered seriously. These revolve around four key areas of opportunity:

- the Water cycle;
- the Food cycle;
- markets for carbon and nature; and
- natural resources – risk and resilience.

Payments for Ecosystem Services

13. Payments for Ecosystem Services (PES) are one of the principal ways in which a market for ecosystem services can be established. There are many different forms which can involve Government to varying degrees. Agri-environment payments, for example, are a form of PES whereby land managers are paid by Government to undertake certain actions that increase the quantity and quality of desired ecosystem services, which benefit specific or general users. Other examples include schemes operated by water companies that pay land managers to undertake certain conservation activities in order to reduce water pollution at source. This in turn can lower water treatment costs (see Box 5.5). Defra is currently leading various initiatives in this area and the NCC is very supportive of them since they have significant potential[47]. In essence, PES schemes seek to address market failures and increase the provision of ecosystem services that would otherwise not be provided through normal market incentives.

Forestry

14. The Independent Panel on Forestry considered the options for contributing towards more sustainable energy (including through biomass) and providing greater leisure opportunities. The report has a series of recommendations to improve the integration of wood and timber products into the supply chain. This includes the Green Investment Bank and the creation of woodland

[46] More information can be found at: http://www.defra.gov.uk/ecosystem-markets/
[47] For example recent PES pilots and forthcoming guidance on best practice for setting up schemes.

enterprise zones. It suggested opportunities that range from small cafes, visitor centres and mountain bike hire, through to woodland campsites and sustainable holiday destinations. It also recommended the development of a comprehensive set of accounts for the public forest estate.

15. A 2003 study[48] found expenditure on forest-related day trips in England to be around £2 billion although the contribution to local and especially more rural economies may be more significant than the national statistics suggest, simply because a majority of the businesses that benefit are most likely to be located there.

Tourism

16. One important natural capital asset is natural beauty, landscapes and wildlife, the value of which can be considerable, even though its contribution to the economy and wellbeing is not always obvious. For example, the way in which recreational benefits from visiting natural places can contribute to a local economy is outlined in Box 5.2 below.

17. Despite the British population becoming ever more urban (more than 80 per cent of the British population now lives in urban areas), the demand for outdoor recreation in rural areas is still hugely significant. It is estimated that nearly three billion outdoor recreation trips are made per year in England, of which over half were to the countryside and coast, with an annual expenditure of some £20 billion[49]. This provides numerous tourism opportunities for rural communities who, as surveys show, are much more likely to be involved in entrepreneurial activities than those living in urban areas and hence are ideally placed to take advantage of this market[50].

18. There may be significant benefits for rural communities from investigating additional tourism opportunities and in applying best practice in developing and marketing such opportunities. The best practice could be gleaned from places where eco-tourism is already making a significant contribution to the local economy, such as in the Isle of Mull, as set out in Box 5.2.

Box 5.2: Year of Natural Scotland, 2013[51]

Tourism is one of the largest Scottish business sectors, generating visitor spending of more than £4bn per year. The Scottish natural environment is clearly a key attraction to tourists, as identified in a study by Scottish Natural Heritage (SNH) and hence a key factor driving this sector.

The SNH study estimated the value to Scotland's economy (the direct economic impact) of nature based tourism at £1.4 billion per year, supporting nearly 40,000 jobs. Given this estimate is based on direct impacts and excludes day trips, it is likely an underestimate of the value nature tourism contributes to the Scottish economy.

These benefits frequently accrue to rural areas where large industry and other businesses are often absent and so can be a very significant contributor to local economies. For example, according to a recent study, White-tailed Sea Eagles (Haliaeetus albicilla) are estimated to contribute £5 million per year to the economy of the Isle of Mull, supporting over 100 jobs. That figure has grown significantly in the last few years as many wildlife spotting businesses have become established. Given the population of the island is less than 3000,

[48] Hill, G, et al (2003).
[49] Natural England *et al* (2010-2011).
[50] Levie, J. and Hart, M. (2009).
[51] Scottish Natural heritage, http://www.snh.gov.uk/docs/B720765.pdf

this is very significant. Opportunities for viewing numerous other wildlife, such as whales, sharks, otters and other birds of prey means eco-tourism is now vital to its economy.

19. Many projects in which investment is made in natural capital lead to multiple benefits. For example, when intertidal habitats are created as good value for money natural flood defences, they also act as havens for wildlife and sequester pollutants. Alkborough Flats is one such example, outlined in more detail in Box 5.3 below. Similar multiple benefits are anticipated from projects such as the setting back of river banks in Norfolk as part of the Broads Flood Alleviation strategy[52].

Box 5.3 Alkborough Flats[53]

In 2006 a 20m wide breach was cut into the flood defence bank and 170 ha of land was converted to inter-tidal mudflat, salt marsh and reedbed. The Alkborough Flats project has a number of additional biodiversity benefits. The area has become a haven for wildlife with 150 bird species recorded, including thousands of migratory birds such as lapwing and golden plover in winter. The remaining land serves as storage capacity during extreme storm surges. The annual flood protection benefit has been calculated at being in the region of £400,000. The restored intertidal area also plays a role in: climate regulation (over 500 tonnes per year of carbon are trapped in sediments worth an estimated £14,000 per year); air quality improvement; nutrient and pollutant sequestration; and recreation and tourism. Using economic valuation techniques, wildlife and wildlife habitat on the site has been valued at £535,000 a year.

20. Maximising wider sources of funding is important to the delivery of comprehensive improvements to the natural capital of this country. Innovative private sector solutions have already been put in place in a number of areas. For example, South West Water is undertaking projects to tackle pollution at the catchment scale which in turn will reduce water supply and treatment costs. More detail is given on this project in Box 5.4 below.

Box 5.4: Upstream Thinking: an example of natural capital delivering multiple services[54]

Upstream Thinking is a project by South West Water in Exmoor and other water-catchment sites in the region. Farmers are paid to manage their land in such a way that peat, soils and natural fertilisers are kept on their land and do not run off into surrounding water courses, so the water company does not have to invest as much to filter the water downstream. South West Water, therefore, by funding improvements in water and slurry management at source, can potentially cut the costs of their operations.

Such interventions are proving to be good value for money with returns of around £65 for every £1 invested over a thirty year period for specific parts of the project. Furthermore, improving the quality of water catchments is not just good for water quality but has other benefits too. For instance, re-wetted peat bogs also capture and store the greenhouse gas carbon dioxide, create habitat for plants and animals, reduce pests for the livestock that graze nearby and increase recreations values for local people to enjoy.

[52] See http://www.halcrow.com/Our-projects/Project-details/Broadland-flood-alleviation-scheme-England/
[53] See Harlow *et al* (2010)
[54] http://upstreamthinking.org/index.cfm?articleid=8692

Trade-offs, offsetting and compensation

21. It is important that apparent growth opportunities do not come at the expense of the environment and thereby undermine our future growth potential. Given that some development will happen anyway and pass cost-benefit analysis tests even where natural capital is fully included, we should look at the use of all methods for minimising its impact and contributing to wider restoration objectives.

22. In fact, this is exactly the position mandated by the National Planning Policy Framework (NPPF), which says that the planning system should contribute to conserving and enhancing the natural environment. It says this should be done by 'minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures.'[55]

23. Taking natural capital into account and developing the appropriate metrics and accounting frameworks as recommended in this report will not abolish the need to evaluate the trade-offs which inevitably arise between different development options. Almost all development projects will have costs insofar as they impact the natural environment in some way. Building new houses and new rail networks are obvious examples.

24. The standard economic test to determine whether any development should proceed is that the economic benefits must exceed the costs. This approach is enshrined in HM Treasury's Green Book and impact assessment processes. These costs must, however, include and incorporate the impacts on natural capital, as described in section 4 above.

25. A further condition is the sustainability constraint: the benefits must not only exceed the costs, but in such a way as to make sure that this net gain is carried forward to future generations (for example, by assessing potential threshold effects).

26. If indeed the benefits do exceed the costs, the question then arises as to whether the gainers should in fact compensate the losers. For example, if a new housing development destroys an area of high value biodiversity and amenity land, the question may arise as to whether the developer should compensate for this damage.

27. One approach to such compensation might involve offsetting losses (as part of a mitigation hierarchy[56] and recognising the irreplaceability of some components of natural capital, particularly some wild species and habitats). This could, for example, focus on what improvements could be made elsewhere to biodiversity and natural capital. The attractive feature of such an approach is that it has the potential to offer both the advantages of the development and those of the protection and potential enhancement of the environment simultaneously.

[55] Department for Communities and Local Government, 2012. National Planning Policy Framework, p. 25, s.109.

[56] The mitigation hierarchy views the role of offsets as a "last resort", after all reasonable measures have been taken first to avoid and minimize the impact of a development project and then to restore biodiversity on-site. Conformance to the mitigation hierarchy is the first of the ten best practice Principles established by the Business and Biodiversity Offsets Programme (BBOP), and a fundamental part of the standard on offsets. See http://bbop.forest-trends.org/pages/mitigation_hierarchy

28. An offsetting system could be a useful tool in ensuring that development does not lead to the erosion of natural capital assets. If designed in the right way, it may even contribute to improvement of certain aspects. For example, the Lawton Report[57], makes clear the benefits to be had from linking up our natural areas into a robust and diverse ecological network. Nature areas that are linked together (corridors) have a greater ecological value than do similar areas of natural environment that are broken up and separated from one another. That is, the whole is greater than the sum of its parts. Offsetting is one tool that could be used to help bring this vision about.

29. In addition to these environmental benefits, a system of offsets might also be advantageous to developers if it could speed up the process of obtaining planning consent. Clearer guidance on offsets and 'no net loss' would reduce the delays and costs developers face in the light of the current uncertainty about the outcome they need to demonstrate for natural capital.

II: Getting prices right

30. Much of this report focuses on the fact that natural capital is omitted from so many decisions that impact on our wellbeing, not least because it is frequently not priced at all. Decisions are, therefore, frequently distorted from what would occur in an economically efficient world. Thus, not only does natural capital need to be incorporated into accounts but it is important that it is properly priced to reflect its true costs. This in turn will allow sensible, economically efficient, decisions to be made, which will improve the allocation of resources within the economy. A more optimal allocation of resources will, in turn, increase the long term growth potential of the economy by boosting productivity.

31. Some of the lowest hanging fruit in terms of sustainable economic growth lie in stopping doing things that are currently reducing economic growth. Stopping distortionary subsidies that incentivise overproduction in certain sectors, such as direct income support to farmers through the Common Agricultural Policy is one obvious example. Improving the allocation of resources by redirecting this expenditure towards incentivising farmers to produce the things that the market will not provide on its own – the public and environmental goods – could increase wellbeing and potentially have knock-on impacts for the wider economy. For example, through enhancing tourism, improving public health, reducing carbon emissions and reducing water treatment costs.

32. There are many other perverse subsidies in the area of natural capital. Polluters are often not confronted with the costs of that pollution, hence they are in effect subsidised by everyone else. Market prices should reflect the full environmental costs. Just as prices incorporate the costs of labour and physical capital, so too should natural capital be included in prices. That is the point of integrating natural capital into the heart of economic activity. The result of failing to do so is a waste of resources, reducing potential sustainable economic output.

33. Aside from opportunities to reduce water treatment costs discussed above, an example of where effective pricing of external costs could yield significant benefits and avoid wasting resources concerns carbon pricing. The failure to comprehensively price carbon allows

[57] Lawton et al (2010).

damaging activities like peat extraction to be expanded beyond an efficient level. Again, this was recognised in the Natural Environment White Paper. Box 5.5 below highlights the damaging activity that still continues in this area due to the externalities of peat extraction being ignored.

Box 5.5: Protecting Peatlands

The Government's Natural Environment White Paper clearly recognises the enormous value of peatlands in England. They are huge stores of carbon, help regulate water in catchments and are important for biodiversity. At present, approximately 2.4 million tonnes of peat are consumed each year by horticultural activities, an amount no doubt exacerbated by the fact that its price does not reflect the externalities mentioned above.

The Government has encouragingly stated that it wants to reduce peat use to zero by 2030 and has set the following milestones:

- a progressive phase-out target of 2015 for government and the public sector on direct procurement of peat in new contracts for plants;
- a voluntary phase-out target of 2020 for amateur gardeners;
- a final voluntary phase-out target of 2030 for professional growers of fruit, vegetables and plants;
- establishing a Task Force bringing together representatives from across the supply chain with a clear remit to advise on how best to overcome the barriers to reducing peat use, exploring all the available measures to achieve this goal; and
- building on the advice of the Task Force, review progress towards these targets before the end of 2015 and consider the potential for alternative policy measures if necessary.

These milestones need to be met, with a progress report carried out before 2020 and non-voluntary options explored if the voluntary approach looks like it may prove unsuccessful.

Towards a sustainable growth agenda – key messages and recommendations

34. The sections above have outlined some of the ways in which natural capital assets support the economy and highlight where investment in them can lead to new opportunities for sustainable growth. However, there is still much that we do not properly understand about this relationship. In order to sustain economic growth into the future, it will be vitally important to understand better the role of natural capital in supporting the economy. In particular:

    - Which aspects of natural capital are particularly important to future economic activity and growth (as properly measured);
    - The degree of substitutability and trade-offs between different types of natural capital assets and between natural and other types of capital (some natural capital is not substitutable in this way and if stocks of it fall, output and wellbeing will suffer too); and
    - How to incorporate the existence of thresholds, limits and irreversibility into existing economic models and frameworks.

The Committee will report further on these issues over the coming year in time to inform its second State of Natural Capital report in early 2014. This work will help the Committee provide advice on how to make best use of our natural capital in order to increase the productivity of the economy and thereby boost output.

35. Furthermore, the NCC recommends that:

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

Section 6: Developing a framework for measuring and valuing natural capital: next steps

1. To achieve the ambition set out in the Government's Natural Environment White Paper, concerted action is needed to embed the value of natural capital into the fabric of the economy and decision-making. The evidence that exists indicates we are failing to conserve our natural capital assets and invest in them adequately. This is an urgent problem with significant gains in wellbeing and prosperity at stake.

2. In this State of Natural Capital Report, the NCC has emphasised a number of key messages as well as a series of recommendations which will form the basis of the Committee's future work programme. These can be distilled as follows:

   - **Measuring** natural capital: the development of a new framework to define and measure changes in assets to complement emerging national and corporate accounts;
   - **Valuing** natural capital: both in accounts and in appraisal and decision-making processes, in order to;
   - **Managing** natural capital better, including being able to effectively prioritise action to ensure value for money from investments in assets.

3. Specifically over the next year, the steps which the NCC will be pursuing, in partnership with others, include:

   1. Assist in the development of comprehensive metrics to measure natural capital, and in particular to identify critical thresholds;
   2. Develop a risk register so that the NCC can advise on any natural assets that are being used unsustainably;
   3. Work alongside the ONS in the implementation of the 'Roadmap', on the path to achieving the 2020 target of full green national income accounts;
   4. Develop natural capital accounts with landowners and specifically help the new forestry body to do this, in accordance with the recommendations of the Independent Panel on Forestry and the Government's response to it;
   5. Work with the main accounting bodies, as well as companies and financial institutions to develop principles and examples of natural capital accounting for the corporate sector;
   6. Develop valuation and decision tools as well as developing proposals to amend HM Treasury's Green Book where appropriate;
   7. Assist Defra and others with the development of policy on offsetting where appropriate;
   8. Develop, in partnership with the Research Councils, an overarching research programme which will meet the policy agenda as set out in the Natural Environment White Paper; and

9. Identify which aspects of natural capital are particularly important to future economic activity and growth (as properly measured), the extent to which different types of natural capital can substitute for one another (or for other types of capital) and how to incorporate the existence of thresholds, limits and irreversibility into existing economic models and frameworks.

In subsequent State of Natural Capital reports, the NCC will develop these ideas and evidence further, reporting on progress against the recommendations outlined in the report. In doing so, the Committee will work in partnership with Government, businesses and research organisations. In the interim, we are keen to receive feedback on the key messages, recommendations and indeed any aspect of the report at naturalcapitalcommittee@defra.gsi.gov.uk.

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Glossary[58]

Accounts: Company accounts are a systematic summary in money terms of the activities of a business over a specified period, usually a year. National income and expenditure accounts are surveys of the economic activities of a nation. This include analysis of the production of goods and services, the distribution of incomes and the expenditures of investors, consumers and the government.

Afforestation: Planting of forests on land that has historically not contained forests.

Asset: A store of value, representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another.

Biodiversity (a contraction of biological diversity)**:** The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.

Bioremediation: The use of micro-organism metabolism to remove pollutants.

Capital: A material resource used or available for use in production. Natural capital (see below) underpins the three other main types of capital that is, manufactured capital (for example, machinery and buildings), human capital (for example, knowledge and skills) and social capital (for example, levels of trust and connections amongst people).

Carbon sequestration: The process of increasing the carbon content of a reservoir other than the atmosphere.

Catchment: The land area that drains into a particular watercourse or body of water.

Condition of an ecosystem: The capacity of an ecosystem to yield services, relative to its potential capacity.

Cost-benefit analysis: A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.

Degradation of an ecosystem service: For *provisioning services*, decreased production of the service through changes in area over which the services is provided, or decreased production per unit area. For *regulating* and *supporting services*, a reduction in the benefits obtained from the service, either through a change in the service or through human pressures on the service exceeding its limits. For *cultural services*, a change in the ecosystem features that decreases the cultural benefits provided by the ecosystem.

Degradation of ecosystems: A persistent reduction in the capacity to provide ecosystem services.

[58] Adapted from UKNEA (2011) *Technical Report*

Ecosystem: A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit.

Ecosystem services: Are the outcomes from ecosystems that directly lead to good(s) that are valued by people.

Ecological community: An assemblage or association of populations of two or more different species occupying the same geographical area.

Eutrophication: The increase in additions of nutrients to freshwater or marine systems, which leads to increases in plant growth and often to undesirable changes in ecosystem structure and function.

Fishery: A particular kind of fishing activity, for example, a trawl fishery, or a particular species targeted, for example, a cod fishery or salmon fishery.

Habitat: Is an ecological or environmental area that is inhabited by a particular animal or plant species. 'Broad Habitats' are used to classify different ecosystems for reporting.

Landscape: An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems. The term cultural landscape is often used when referring to landscapes containing significant human populations or in which there has been significant human influence on the land.

Market failure: The inability of a market to capture the correct values of ecosystem services.

Natural capital: Those elements of nature which either directly provide or underpin human wellbeing. As such natural capital generates value for people.

Nutrient cycling: The processes by which elements are extracted from their mineral, aquatic, or atmospheric sources or recycled from their organic forms, converting them to the ionic form in which biotic uptake occurs and ultimately returning them to the atmosphere, water, or soil.

Nutrients: The approximately 20 chemical elements known to be essential for the growth of living organisms, including nitrogen, sulphur, phosphorus, and carbon.

Policy-maker: A person with power to influence or determine policies and practices at an international, national, regional, or local level.

Pollination: A process in the sexual phase of reproduction in some plants caused by the transportation of pollen. In the context of ecosystem services, pollination generally refers to animalassisted pollination, such as that done by bees, rather than wind pollination.

Provisioning services: The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and fresh water.

Public good: A good or service in which the benefit received by any one party does not diminish the availability of the benefits to others, and where access to the good cannot be restricted.

Renewable: Natural or man-made resources that are replenishable at least as fast as they are consumed or used up. Natural resources such as fresh water or timber may become non-renewable if used up at a faster rate than they are replenished by natural processes.

Risk-register: Used to identify, quantify and value the risks and uncertainties relating to a proposal or activity, a risk register is a tool commonly used in project planning and organisational risk assessments.

Species: An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term *species* is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity, that once described and accepted is associated with a unique scientific name.

Species diversity: Biodiversity at the species level, often combining aspects of species richness, their relative abundance, and their dissimilarity.

Stock (in fisheries): The population or biomass of a fishery resource. Such stocks are usually identified by their location. They can be, but are not always, genetically discrete from other stocks.

Sustainable use (of a natural capital): Human use of a natural capital so that it may yield a continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.

Threshold: A point or level at which new properties emerge in an ecological, economic, or other system, invalidating predictions based on mathematical relationships that apply at lower levels. For example, species diversity of a landscape may decline steadily with increasing habitat degradation to a certain point, then fall sharply after a critical threshold of degradation is reached. Human behaviour, especially at group levels, sometimes exhibits threshold effects. Thresholds at which irreversible changes occur are especially of concern to decision-makers.

Trade-off: Management choices that intentionally or otherwise change the type, magnitude, and relative mix of services provided by ecosystems.

Valuation: The process of expressing a value for a particular good or service in a certain context (for example, of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (sociology, ecology, and so on). See also *Value.*

Value: The contribution of an action or object to user specified goals, objectives, or conditions. (Compare *Valuation*).

Wellbeing: The degree of happiness, health and prosperity of an individual or society.