ENGLISH NATURE

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ENGLISH NATURE

Revealing the value of nature

working today for nature tomorrow

Revealing the value of nature

Introduction

We need to protect our natural heritage, both for its own sake, and for ourselves and future generations. We depend on biodiversity more than we realise. Without healthy ecosystems we cannot exist, and yet habitat degradation and species extinction continues. A lot of work has been done to describe, in scientific terms, the importance of species, habitats and geological features, but there is also a need to identify how nature provides direct and indirect benefits for our quality of life.

Many of nature's services are fundamental to our existence, yet their importance to our lives is often unrecognised. This report illustrates how the many services provided by the natural world, specifically its wildlife and geology, sustain and improve our quality of life. We have called these services the 'social functions of nature'. In this report, the term 'social' includes economic benefits that affect human well-being, whether or not these benefits are reflected in market prices, and also other benefits relating to current social priorities.

Ecologists have developed the concept of functioning, or 'healthy', ecosystems to describe natural areas and their processes. **Biodiversity** can be an important factor in many situations: the appropriate species mix for a habitat provides an **insurance** function where some species provide key ecological roles, while others can step in and perform such roles if conditions change. Without the conservation of biodiversity, the long term functioning of many natural systems may be affected. Similarly, the term **geodiversity** describes the variety of our geological resources, which are connected to the provision of biodiversity.[1]

In recent years, we have become aware that healthy, functioning natural systems also provide direct benefits to mankind. Indeed, many of these are essential in maintaining our quality of life. Research in this area has been summarised by Rudolf de Groot (*Functions of Nature, 1992*)[2], Gretchen Daily (*Nature's Services, 1997*)[3], and Alterra Green World Research (*The forgotten values of nature and landscape,1999*)[4]. These publications provided the inspiration and starting point for this report.

We have taken these ideas and adapted them to help describe the important social functions of nature in England. Most of the examples described in this report relate to this country.

The approach we have set out describes the ways that nature contributes to our quality of life in four main groups, and 25 more detailed categories, as follows:

- **Appreciation** - nature for our enjoyment, health and spiritual enrichment, a better living environment, cultural meanings and artistic inspiration.
- **Knowledge** - a knowledge resource for our general education, scientific and historic discovery and environmental monitoring.
- **Products** - sustainably harvested products such as food, fuel, medicines, cosmetics and construction materials.
- **Ecosystem services** - natural systems provide our basic life-support structures, without which our lives would be impossible or very costly to sustain. Our air, soils and climate are maintained by natural processes. Managed wisely, natural habitats can mitigate the effects of flooding and pollution.

Figure 1 lists the 25 categories of social function that we have identified. These are a modified version of de Groot's typology, to reflect the specific character of England's nature. Figure 2 describes the links between biodiversity, healthy ecosystems and nature's social functions. It also demonstrates the links between these categories and people's more general motivations for nature conservation, which have been elaborated upon by economists[5]. So this report focuses on the ways in which nature's services provide benefits in terms of uses, potential uses, enjoyment, and processes on which we rely for our physical existence. However, as figure 2 demonstrates, this is only one part of the equation. Economic research suggests that society is motivated to conserve biodiversity for its own sake, or for other reasons over and above any particular 'use value' that can be identified and reflected in market prices[6]. These 'non-use' motivations are not discussed in detail in this report, but they represent a very important, perhaps even the most important, component of society's desire for nature conservation.

Many of these benefits are not immediately apparent but are very important. For example, how many people realise the essential cliff protection and flood defence services provided by intertidal habitats that soak up the energy of the sea's waves? If we do not recognise these benefits, and consequently fail to conserve biodiversity and geological features, we risk seriously undermining our quality of life in the future. The purpose of this report is to promote an understanding of the actual and potential benefits of nature conservation. To achieve this goal, it is necessary to unlock what has been described as the 'mentally hidden' value of nature; in other words, the background ecological processes which we hardly notice yet which are important for human well-being.[7] We probably underestimate the way that nature contributes to our quality of life, for the following reasons:

- our economic system does not readily reflect environmental benefits in market prices;
- appreciation of the value to society of ecosystem processes is made more difficult by their complexity;
- there may be as yet undiscovered benefits of natural resources.[8]

We hope this discussion report will help to improve understanding of the social functions of nature. In turn this should aid the development of genuinely sustainable options for the management of our natural resources. It will help us to deliver both environmental and economic objectives. It is also becoming clear that protecting nature can help deliver some of the Government's social priorities. By providing quality accessible natural green space and a more diverse and attractive living environment, we can start to address the environmental exclusion and degradation that is evident in some areas of our country. Working to protect our nature can also provide local employment opportunities, help personal development through volunteering, and help build both community spirit and personal well-being.

This report complements other recent research that shows how decisions to invest in nature conservation can lead to positive economic impacts for local areas, such as jobs in **economically** vulnerable locations.[9]

The examples provided here are chosen mainly because of their relevance to the value of England's wildlife and geology. However, the categories and examples are only illustrative, and there are doubtless other types of service and many other examples. This document represents the first stage in an ongoing research process.

The case studies throughout this report demonstrate how nature's services can improve our quality of life. They also demonstrate that some natural areas may have the capability to provide important social functions but, for one reason or another, this potential has not yet been fulfilled.

We must also understand that some of the benefits identified have the potential to be mis-used. For example natural resources can provide valuable opportunities for recreation, and for harvesting of natural products, but in each case it is essential that the resource is managed sustainably.

This report is intended as an initial review and discussion paper. We are aware of the need for further, more detailed, evaluation of the overall importance and potential of the social functions that have been identified. We hope this analysis provides a framework for helping to understand and evaluate the actual or potential value of nature, from a socio-economic perspective.

If you have any comments on the report, we would be pleased to receive them. Please send them to Jonathan Burney, Economic Adviser, English Nature, Northminster House, Peterborough, PE1 1UA, UK.

To illustrate the report, we have included case study examples from English Nature publications, but also from a variety of other sources. We are grateful for the permission to adapt and/or reproduce these extracts.

Summary

England's nature provides a wealth of benefits to society:

Appreciation

- Accessible natural green space improves our living environment and health.
- Nature reserves are a resource for huge numbers of visitors.
- Nature contributes to our sense of place.
- Natural areas stimulate our artistic and cultural life.
- Our nature is connected with a very rich social history.
- Nature conservation work provides opportunities for personal satisfaction and community development.

Knowledge

- The study of our natural world has led to medical and engineering invention.
- Our biodiversity is used to monitor general environmental changes.
- Our wildlife and geology is used for many school visits and for international research in the natural sciences.

Products

- England's natural habitats are used for a variety of traditional food and drink products.
- Research has documented the commercial use of many of our native plant species.

Ecosystem services

- Our intertidal and wetland habitats, amongst others, help reduce the risk of flood damage.
- Reedbeds and other habitats are being developed for their pollution filtering properties.
- Natural processes help maintain the beauty of our land and coastline.
- Our natural areas contribute to essential large-scale processes such as climate stability and nutrient cycling.

Otter *Lutra lutra*. M J Hammett / English Nature 24,710

Figure 1 - The social functions of nature: 25 categories relevant to England's wildlife and geology

Appreciation

1. Better living surroundings (eg healthy environment, well-being from local walks and views).
2. Resource for recreational visits (eg day visits and tourism).
3. Distant appreciation (eg nature in magazines, books, TV etc).
4. Cultural, spiritual and historic meanings (eg folklore, sense of place, local distinctiveness, historic settings).
5. Artistic inspiration (eg nature in poems, literature, music, visual arts, sculpture, and marketing images).
6. Social development (eg conservation volunteers, ecological surveys, skills for work, building community spirit).

Biodiversity and healthy, functioning natural systems.

Knowledge

7. Scientific discovery (eg medicine, genetics, forensic science, behavioural studies, etc).
8. Historical analysis (eg archaeological finds in peat, evolution).
9. Environmental monitoring (eg climate change, pollution monitoring).
10. Educational resource (eg for school and college visits).
11. Natural science research (eg UK resources important for ecological and geological knowledge worldwide).

The social functions of nature: 25 categories relevant to England's wildlife & geology.

Products from sustainable use

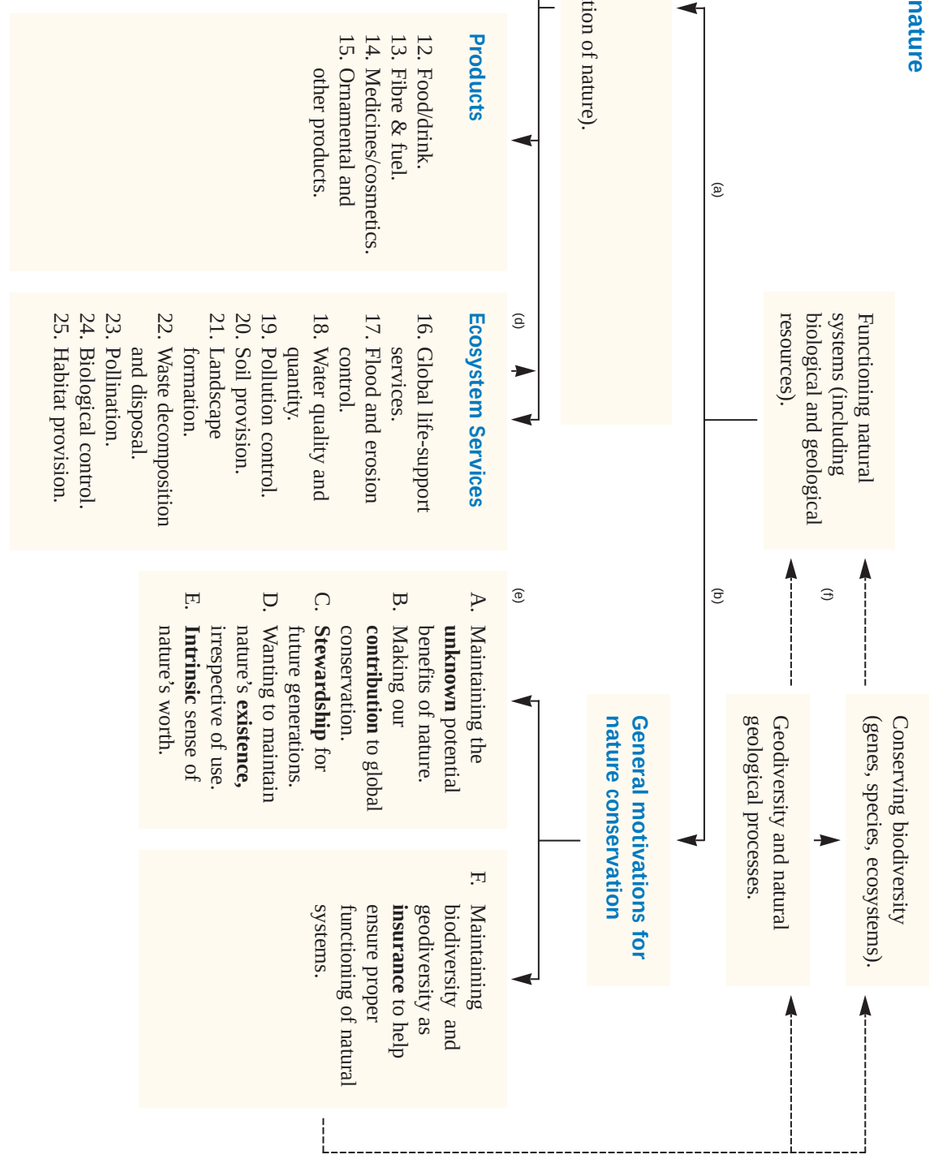
12. Food and drink (eg organic meat and vegetables, sustainable fisheries, fruit, berries, natural drinks).
13. Fuel, fibre and construction (eg thatch, coppice, charcoal, etc).
14. Medicinal and cosmetic products.
15. Ornamental and other products (eg responsibly collected fossils, flowers for floral ceremonies, seeds for ornamental meadows).

Ecosystem services

16. Global life-support services (eg atmosphere and climate regulation, carbon storage).
17. Flood and erosion control (eg river storage, wave attenuation).
18. Water quality and quantity (eg aquifer recharging).
19. Pollution control (eg land preparation, physical health from pollution capture properties, noise and wind reduction).
20. Soil provision (eg soil formation processes and soil erosion prevention).
21. Landscape formation (eg river and coastal geomorphological processes).
22. Waste decomposition and disposal (eg micro-organism processes and scavenging).
23. Pollination (eg crops and flowers).
24. Biological control (eg pest reduction through predators).
25. Habitat provision (eg spawning grounds for commercial fish).

Adapted from de Groot (1992)[2]; Daily (1997)[3]; Costanza et al (1997)[10]

Figure 2 - The ecological and social functions of nature



Notes

(a) This describes the link between functioning natural systems (in the scientific sense) and the goods and services that these can provide.
(b) This link describes people's other motivations for conserving nature, which are unrelated or only indirectly related to the goods and servi
(c) Our appreciation of the natural world is derived from our fascination with how it works, our experience of its beauty and tranquillity, the
(d) It may be argued that ecosystem services provide benefits to people and also underpin the provision of services in the appreciation, know
(e) These categories may be overlapping to an extent. Various, slightly differing typologies of 'non-use' and related value categories exist in
(f) These links describe the role of biodiversity, geological diversity and natural geological processes in the functioning of healthy natural sy

Lindisfarne NNR, Northumberland. Peter Wakely / English Nature 19,992

Appreciation

People derive benefit from their direct or indirect contact with the natural world. Nature provides a backdrop to our everyday lives and, albeit sometimes unconsciously, we regularly experience it. These experiences can be summarised as follows (they are not mutually exclusive):

- Our **fascination** with the natural world and how it works.
- Our **experience** of its beauty, tranquillity, and physical forces.
- The **meanings** that natural areas have for us in terms of culture, personal recollections, folklore, sense of place and identity, spiritual importance and history.
- The opportunity it provides for **recalling**, or **reconnecting** with, the natural world.
- The **inspiration** that nature provides for artists, writers, musicians, film-makers and designers.

These senses are manifested throughout the 'appreciation' categories, described below.

1. **Better living environment.** Access to nature enhances the areas in which we live and work by providing aesthetic, recreational and health benefits. Some evidence of these factors in influencing housing demand is emerging. There is also evidence of the psychological and physiological health benefits of having access to natural areas.

A better living environment: nature and health

Most people live in towns and cities, but even though we choose to live close to each other, making contact with nature improves our moods and outlook. Research into academic papers on the psychological effects of urban living identifies that even if people do not visit wild spaces, they may get pleasure from simply looking at one as they walk by. The report's overriding general finding is that contact with nature is good for your mind[12].

This idea is also suggested by findings at a conference on Human Health and Trees (*National Urban Forestry Unit and the Conservation Volunteers Northern Ireland, June 2000*). This reviewed evidence of the value of trees in reducing stress, skin cancer (by blocking out sunlight), air pollution and in the promotion of exercise through the 'green gym' concept. Professor Roger Ulrich, from A & M University, Texas, provided examples of the links between trees and stress reduction, and the role of parkland views in patients' recovery times[13].

2. **Visiting experiences.** Natural areas provide a major destination for day visits and longer stays. As well as specific visits to nature reserves or other natural areas, the quality of the natural environment, including its wildlife, provides a strong motivation for choice of destination for tourists. Our geological resource is also very important in this respect (the fossil-rich cliffs of the Dorset coast, for example). Nature provides the opportunity for varying levels of involvement, from hiking, walking or camping, to simply enjoying the views on a coach journey. Consequently, it is an important resource for a wide range of people. This is an important consideration given that tourism activity is one of our major economic sectors. Of course, it is essential that the resource nature provides for tourism is used sustainably.

Saltfleetby - Theddlethorpe Dunes NNR, Lincolnshire. Paul Glendell / English Nature 24,135

Day trips

Visitors to the English countryside spent about £8.4 billion in a single year, according to a new survey from the Countryside Agency. More than 1.2 billion day visits were made in 1998. These figures come from the Report of the 1998 UK Day Visits Survey. The average distance travelled to the countryside was 33km, and each visit spending more than three hours there spent £15 on average.[14]

Tourism and environmental quality

Studies by Environmental Resources Management Ltd have attempted to estimate the extent to which tourism visits in the area involved trips to environmental attractions. These studies estimated that visits to these attractions, as a proportion of total visits in a region, were about 20% in the South West region, and 25% in the West Midlands and North West regions. This amounts to a significant level of environmentally related expenditure in these regions.[15]

National Nature Reserves are for people as well as wildlife

As well as conserving the finest examples of the country's geology and wildlife, English Nature increasingly promotes National Nature Reserves as places for people. The reserves are used for walking, school outings, settings for sculptures, photography, painting classes and many other activities.

A survey from 1996 to 1998 showed that once people have discovered a National Nature Reserve they like, they keep coming back. About one quarter had been returning to the same site for more than 20 years.[16]

Examples of estimated annual visitor numbers to the most popular National Nature Reserves (1997/98):

Sutton Park (812 ha):	2,500,000
Burnham Beeches (220 ha):	750,000
Holkham (3,851 ha):	500,000
Chobham Common (517 ha):	300,000
Hatfield Forest (392 ha):	250,000
Derbyshire Dales (350 ha):	200,000
Gibraltar Point (429 ha):	190,000
Castle Eden Dene (221 ha):	150,000
Dunkery & Horner Wood (1,604 ha):	150,000
Lizard (1,662 ha):	150,000
Saltfleetby-Theddlethorpe (440 ha):	150,000
Upper Teesdale (3,509 ha):	150,000

Estimated annual local expenditure by visitors to Royal Society for the Protection of Birds (RSPB) reserves:[17]

Titchwell, Norfolk	138,000 vistors	spending	£1,800,000
Leighton Moss, Lancashire	93,000 vistors	spending	£950,000
Bempton Cliffs, East Yorkshire	44,000 vistors	spending	£407,000
The Lodge, Bedfordshire	38,000 vistors	spending	£155,000
Radipole Lake, Dorset	35,000 vistors	spending	£423,000
Total RSPB reserves (UK)	*1,080,703 vistors*	*spending*	*£11,802,000*

3. **Distant appreciation.** Our fascination with the workings of the natural world, and its beauty, power and mystery is reflected in the huge volume of print and broadcast media that is now devoted to nature. Most newspapers have at least a column devoted to wildlife, and there are a growing number of specialist magazines, such as *BBC Wildlife*. Many people also access information through membership of voluntary organisations.

Appreciation of nature through wildlife programmes

The BBC's famous natural history unit has pioneered the appreciation of nature through its television and radio programmes. Approximate average audience figures for UK-focused television broadcasts are 5-6m for series such as '*Living Britain*', 2m for short programmes such as '*Wild Britain*', and 3-4m for individual features, for example '*The Timeless Thames*' and '*The Millennium Oak*'.

4. **Cultural, historic and spiritual meanings.** Particular landscapes, habitats and species can often have huge significance for people because of cultural or personal associations.
For example:
- Natural spaces evoke a particular sense of place or local identity which is often captured in folklore and legend. It is likely that the distinctiveness of a place will become an increasingly important economic factor, and nature has an important role to play in this.
- Natural preservation of our archaeological heritage provides historic connections with the landscape. Landscapes document the way we lived and the technologies we used in past times and it is vital that we maintain the settings where important events happened.
- Place, street and pub names constantly evoke our natural connections.
- Nature has spiritual significance for many people.
- Our geological resource has strongly influenced the economic and social history of some areas, such as the Black Country.

Fossils and folklore

Many fossils have been given distinctive colloquial names, based on either a quasi-religious belief in their medicinal or magical powers or, more frequently, on the direct comparison of specimens with familiar everyday objects. Many prehistoric beliefs about fossils have passed into more recent folklore.

In England the folklore of snakestones is centred mainly around Whitby in Yorkshire and Keynsham in Somerset. Legend supposes that the ammonite fossils were once living serpents which were common in the area when the abbess St Hilda, in the 7th century, turned them into stone in order to clear a site for the building of her convent. The heads of the serpents were assumed to have been destroyed on their death, leaving the ammonite in the shape of a curled snake's body. This legend is described in Sir Walter Scott's poem *'Marmion'*.

Sussex has a particular and distinctive association with ammonites in everyday life, dating from the early 19th century regency period when designs based on these fossils were incorporated in the façades of fashionable houses.

Numerous legends and colloquialisms are associated with other fossil types in Britain: gryphaea ('Devil's toenail'), belemnites ('thunderbolts'), procardia ('bulls' hearts'), gastropods ('screwstones'), echinoids ('shepherds' crowns'), and trilobites (eg the 'Dudley locust'). The Dudley locust became so well known in the 19th century that it came to be regarded as an emblem of the town.[18]

A sense of place: the river Stour

The river Stour runs through Somerset, Wiltshire and Dorset and is rich in native plants and animals such as Loddon pondweed (found in only two other English rivers), the scarce chaser dragonfly, occasional salmon and sea trout, and a returning otter population. But the Stour, meaning the 'powerful one', and its tributaries are also full of social interest.

Our ancestors had both the need and the time to gain insights into the character of our rivers. As part of its work on Local Distinctiveness, Common Ground's 'Confluence' Project helped people to discover, share and value their own knowledge, as the basis for caring better for our rivers, for decision making which will keep brooks close to our lives rather than pushing them underground, to re-invent rivers that are safe to swim in and ensure a rich mix of wildlife particular to the place.

The project involved, amongst other things, the creation of 50 new pieces of music written by local people. Examples included spoken histories gathered from young and old in some of the Stour villages. These conversations reveal rich veins of knowledge about the decline in numbers and species, from dace, grayling and wild trout to lapwing and yellow wagtails, and a love and intimacy with the river for fishing, walking and playing. The project culminated in a concert entitled Talkative River, with local ballads sung by their writers and accompanied by the Bournemouth Orchestras.[19]

River Stour near Sturminster Marshall. Bob Gibbons / Ardea ROG 8118

Plants and social history: the Flora Britannica

Plants have had symbolic as well as utilitarian meanings since the beginning of civilisation. They have been the tokens of birth, death, harvest and celebration, and bringers of good (and bad) luck. They are powerful emblems of place and identity, true not just of nations, but of villages, neighbourhoods, even personal retreats.... In Britain, wild species have an even more central role in national and local cultures than those from gardens. We pick sprigs of heather for luck, munch blackberries in the autumn, remember Wordsworth's lines when the daffodils are in flower, and link hands around threatened trees. Our children still make daisy chains, whack conkers, and stick goosegrass stems on each other's backs. Despite being one of the most industrialised and urbanised countries on earth, we cling to plant rituals and mystical gestures whose roots stretch back into prehistory: holly decoration for the winter solstice, kisses under the mistletoe, the wearing of red poppies to remember the casualties of war.

The common names of wild plants are the fullest and most revealing register of the part they have played in our lives. Often they indicate aspects that have touched people's imaginations. Beyond there is the great lexicon of purely local names. Some species have acquired more than a hundred over the centuries, many of these vernacular names recording quirks of local geography or custom.

What we have found in the field research for *Flora Britannica* is that Britain still has a lively popular culture of plants... the ancient engagement between plants, people and places continues unabated. What is fascinating is how they are now informed by popular ecology and a sense of social history. What comes across time and time again is the overriding importance contributors attach to their neighbourhood, their local patch. For many contributors, an intimate and equal relationship with nature is not so much a path to conservation as its goal. Local plants are markers not just of their landscapes, but of their autobiographies.[20]

Nature and the cultural landscape

One of England's finest stretches of parkland became a focal point at an international cultural festival in June 2000. Moccas Park, near Bredwardine, Herefordshire, a historic landscape famed for its beauty, veteran trees, insects and fungi, was the first ancient deer park to become one of English Nature's National Nature Reserves. It was also memorably described in *Kilvert's Diary*, the diary of Reverend Francis Kilvert, which became a literary classic. Visitors to the famous Hay Festival of Literature and the Arts visited the site for a tour. This was accompanied by the publication of a new, exhaustive account of the site.

As well as its outstanding wildlife features, Moccas has very strong cultural links. The park is part of Herefordshire's Georgian parkland legacy. It has been shaped by active management over the years. Its look was influenced by such 18th century landscape figures as Capability Brown and his successor, Humphrey Repton. Moccas is a jewel in the 10-20,000 hectares of England that are classified as actively managed lowland wood-pasture and parkland, a priority habitat in the UK Biodiversity Action Plan.[21]

Ornamental pond at Moccas Park NNR, Herefordshire and Worcestershire. Peter Wakely / English Nature 17,676

5. **Artistic inspiration.** Nature provides a resource which has consistently stimulated our nation's artistic endeavours, in novels (eg Hardy); plays (eg Shakespeare); poetry (eg Clare, Wordsworth); painting (eg Turner, Constable, Nash, and, more recently, artistic communities such as those at St Ives and Norfolk); sculpture, photography, furniture design, and music (eg Elgar, Williams). A modern form of artistic inspiration is the persistent use of nature in logos and advertisements (eg Red Kite beer). Some people may feel uncomfortable with such an appropriation of nature, but it does indicate the value of people's personal connections with wildlife. It is difficult to be very precise about the components of value. For example, how much of the value of a great landscape painting is tied up in the natural features which provided the original inspiration, and how much is in the skill of the artist? All we can really say is that where wildlife and natural features provide the inspiration for artistic and cultural endeavour, or scientific discovery, they provide a contribution to the value of the whole. We need to develop a greater understanding of these links.

Landscape poetry

Kenneth Baker begins his introduction to *The Faber Book of Landscape Poetry* with a candidly financial metaphor for this desire to conserve our visions of the land. "The two greatest assets that we have in our country are its language and its landscape".... at the front of the book... (is) Wordsworth's "*The Tables Turned*", which proclaims that "Sweet is the lore which Nature brings". Much of the poetry he has chosen tries to find this "lore" sustaining, and a good deal of it preserves in verse what seems to be being lost in reality.... From around the late 18th century, the poetry of British landscape echoes with the sense of precariousness, of endangerment or desecration. We can hear it sharp in Gerard Manley Hopkins's "*Inversnaid*": "O let them be left, wildness and wet;/Long live the weeds and the wilderness yet". Gloomily we hear it in Philip Larkin's "*Going, Going*", regretting the loss of "The shadows, the meadows, the lanes".... Baker's section on "Birds and Birdsong" echoes with nightingales and thrushes, Clare's bushes full of "larks" and Edward Thomas's songs of "all the birds/Of Oxfordshire and Gloucestershire"; they now seem sounds from distant times.... The book features a map of Britain and Ireland with the names of poets instead of places scattered across it.... Some poems ask not so much to be judged as poetry as to be matched against a real place.[22]

Wild Day Out at Richmond Park NNR, London. English Nature

English Nature's Wild Day Out

Nature has inspired many people to write poetry. An example of local activity is the 59 people participating in a series of creative writing workshops on four National Nature Reserves in the North East: Lindisfarne, Moor House - Upper Teesdale, Teesmouth and Castle Eden Dene. The events were coordinated by English Nature's Community Liaison Officer, and a community playwright and poet. This has now been published as *Wild Words for Wild Places - A Celebration of Northumbrian National Nature Reserves*.[23]

6. **Social development.** The Government has now recognised the social importance of volunteering activity. Nature reserves, and other areas in towns and the wider countryside, have always provided a very important resource for voluntary work and for the personal satisfaction and social connections that this provides.

Knowledge

7. **Scientific discovery.** Habitats and species are constantly used as a source for scientific research. It is the diversity of these biological resources, as well as their abundance, that will enable scientists to continue with their research. Specific habitats or species act as a library of biological information. Countless examples exist where studying the natural world has led to discoveries that directly benefit humankind (see the example on insects and science, overleaf). Many species have provided the original source material used for an important medical advance. This material can then be produced using synthetic methods, although it is still best to harvest some products. Wildlife also provides a resource of genetic knowledge which is being used in product development. Our geology provides a crucial resource for our understanding of the origins of life and landforms, evolutionary processes, and periods of major extinction.

The British Trust for Conservation Volunteers (BTCV)

BTCV attracts volunteers from the ages of 16 to 60 who come from all walks of life and for a variety of reasons. Most like the thought of fresh air and exercise, meeting people and having fun while doing their bit for wildlife. BTCV was founded in 1959 and since the first working party set out to clear scrub from Box Hill in Surrey, countless people have bent their backs to work which has lifted the organisation to number one practical conservation charity, supporting more than 95,000 volunteers annually in activities to promote and improve their environment.[24]

Nature conservation can provide a focus for the community, either by bringing it together to fight for the protection of an important local resource, or through local improvement projects which help to develop a sense of pride and confidence in the local area.

Nature and community development: Castle Manor estate, Sheffield

The Sheffield Wildlife Trust intend to make nature conservation central to the social and environmental regeneration of the most deprived wards of the city. Using £10m of partnership funding, 22 green estate projects will be implemented in the next eight years. The initiative has involved many local residents in the area's transformation from a derelict estate into an area of natural beauty. Following ecological surveys, green audits and local consultation, the Trust gained a good picture of an environment just waiting to be harnessed. There will be parks and gardens the community will actually use, and a whole urban renaissance for people and wildlife. The key to success has been in giving local people a direct say in how the community gardens, tree nurseries and green spaces are managed.[25]

Groundwork's Changing Places programme

Groundwork has employed techniques to encourage broad participation from residents, schools and business since it was formed .... Changing Places went one step further, introducing training programmes to strengthen community groups' capacity to take over the stewardship of the sites. The most ambitious has been a programme for local volunteer groups to build confidence and teach business and management skills, again funded by the millennium commission.[26]

While educating children about the environment was a key feature of all Changing Places projects, Leeds Groundwork used the transformation of Rothwell colliery to a country park as an opportunity to develop the skills of disaffected young people.

Insects and science

Insects are a major source of knowledge for pharmaceutical product development, especially those that use defensive chemicals. Water beetles, for example, produce large quantities of hormone analogues which can be used as hormone substitutes (notably cortisone). The rove beetle *Paederus* (a UK species) produces an extremely toxic substance - Paederin - that is being used in minute quantities to cure chronic ulceration - especially on feet.

Rove beetle *Paederus littoralis*. N. A. Callow / Nature Photographers Ltd 116791

Geophilomorph centipedes produce glue as a defensive secretion, the structure of which has been used to improve the sticking power of corn plasters.

Insects with bright colours and a nasty taste or poison are thought to have a memory enhancing substance to ensure that would-be predators recognise an unpleasant mouthful in the future. This is being investigated for use as a memory enhancing/restoring pharmaceutical.

Fire Bugs *Pyrrhocoris apterus* mating. B Borrell / FLPA 409040-00001-020

Chemical defence peptides from the red and black bug *Pyrrhocoris apterus* (a UK species) have been identified as having highly specific antibacterial properties with good potential for targeting drug resistant superbugs. Scientists are looking for specific genes to transfer elsewhere.

This area of pharmaceuticals is set to grow, in the development of anti-cancer drugs, for example. The applied study of insect defence biochemicals is still in its infancy and *in situ* conservation will provide the best way to maintain the information archive.

8. **Historical analysis.** Nature can provide the raw material through which we can re-construct past events (see example right). Natural habitats such as peat bogs provide a service in maintaining material *in situ* for archaeological investigation.

Õtzi - the 'ice man'

Lower plants - mosses and liverworts - are continuing to provide some answers to the mysteries proposed by the 5,300 year old ice man, found on an alpine pass on the Italian / Austrian border in 1991. Ron Porley, English Nature's moss specialist, was first involved in 1994 when he went to examine the bryophytes found on the iceman's clothes and in sediments. Evidence produced in collaboration with Professor James Dickson of Glasgow University was critical in establishing the origin of the iceman and thus which country could lay claim to him. As a result of more recent work by the pair, we have significantly increased the known altitudinal range of many of the species. This has implications for understanding the vegetation and climate that prevailed in the mid-holocene, and the route by which the iceman made his final journey.[27]

Model of Õtzi the Tyrolean Iceman.
Ron Porley / English Nature

9. **Environmental monitoring.** As human activity places increasing burdens on our essential ecological processes, environmental monitoring is becoming a key economic activity. Biodiversity in general, and specific biological resources in particular, provide natural ways to monitor the state of the environment as a whole. While our biodiversity provides a snapshot of recent and current changes, our geological resource provides the long-term monitoring picture about species and climatic change (3,000m years of evolution!).

10. **Resource for general education.** Nature provides an important resource for general education at all age levels with nature reserves providing an ideal area for field trips and school visits. A local bio-diverse natural environment can also provide an informal educational resource for raising awareness about a variety of linked environmental issues.

11. **Resource for natural science research.** Many natural areas in the UK provide an important resource for ecological and geological education and research on an international scale.

Lichens as environmental indicators

Lichens are very important because they are dual organisms. They are a fungus and an alga living together in symbiosis. There is a very delicate balance between the two partners. This is easily disturbed which makes them excellent bio-indicators. They are very much the canaries of the plant system. If their species composition changes or they get sick, this is the time to ask why this is the case.

Many people have heard of lichens as indicators of air quality. Their leaves absorb a wide range of chemicals, but this is not the only way in which we can use lichens. They are also very sensitive indicators of farming practice. They can detect nutrient enrichment, the presence of different types of fertilizers, metal contamination and atmospheric quality.

After Chernobyl, lichens accumulated large amounts of radiation which helped determine the path of the nuclear clouds and enabled us to monitor this. There is a growing realisation that in addition to chemical measurement you can use lichens, for example, to determine what is happening more widely in the environment. Because they can survive extremely harsh and toxic conditions, they may also be able to teach us about how to adapt to our polluted environment.[28]

A resource for education

The Cramlington Organisation for Nature and the Environment (CONE) demonstrates the importance of nature for the education of our children. It brings together business, local authorities, the community, and conservation organisations. Its school nature area schemes stand out from others around the country because CONE is co-ordinating their planning and development to create a variety of habitats and is cutting duplication of effort and the wasting of resources. Woodland, hedgerow, cornfield, wildflower meadow, pond, marsh and deadwood are among habitats created at a number of schools.[29]

Many of our National Nature Reserves provide a resource for both general and specialist ecological education. An example is Slapton Ley in Devon. This is owned by the Whitley Wildlife Conservation Trust and managed by the Field Studies Council, the country's leading environmental education body. Slapton Ley's shingle bar is of national geological interest and surrounding marshes and reedbeds harbour rare wildlife, including otters and Cetti's warblers. More than 2,000 fungi and lichen species are also found there. In 34 years, the Field Studies Council has hosted 70,000 biology and geography students on the reserve, which has also been used by Exeter, Oxford, Plymouth and Sheffield Universities.[30]

Innovative schemes are also being developed to make use of the marine environment as an educational resource. A marine centre at Wembury in Devon, part-funded by English Nature and involving a wide collaboration of organisations, extends along four miles of shoreline and out to the ten metre water depth contour. It includes a model rock-pool, a walk through kelp forest, a video and various activity stations. Overall, the centre offers visitors a remarkable insight into the wonders of Wembury's marine life. Tens of thousands of people have visited it since its establishment in 1981.[31]

Moor House - Upper Teesdale NNR, Cumbria and Durham. Richard Lindsay / English Nature 5684

The harsh Pennine uplands of English Nature's Moor House - Upper Teesdale National Nature Reserve have been the focus of upland research for over 40 years. Intensively studied, more than 400 scientific papers have been produced based on this site.

Now, the reserve's scientific data, amassed over the years, has special importance as the site takes on a pivotal role in monitoring environmental change.

The effects of global warming are likely to be seen first on upland plants and animals. The detailed knowledge of Moor House - Upper Teesdale will be used as a baseline. Thanks to English Nature's purpose-built laboratory, heavily insulated to withstand Pennine winters, Moor House - Upper Teesdale is a significant contributor to this research which, in turn, shares its data with international networks.[32]

Products

Natural and semi-natural habitats provide many products for society. Unfortunately, resources can be harvested irrespective of the consequences for nature.
An alternative approach would be to manage an area in a sustainable fashion to maintain the ecological health of the habitat while at the same time providing useful products and services. It is this latter scenario that we concentrate on here: **products are included in this analysis on the basis that they can be cropped and harvested on a sustainable use basis while maintaining the overall health of the habitat.**
This is not to say that such an approach is economically feasible in all areas. However, the increasing development of 'countryside products' in this country is testament to the ability of some natural habitats to provide products on a sustainable use basis.

12. **Food and drink.** This category includes organic vegetables and livestock and other sustainable production systems on traditional farmland habitats, and sustainable fisheries. It also includes products from semi-natural habitats, including honey, nuts, berries and fruits, fish, natural mineral water, other natural drinks, etc.

13. **Fuel, fibre, fodder, fertilizer and building products.** This category includes coppicing (for charcoal), new energy crops (biomass), reed thatch, etc.

14. **Medicinal and cosmetic resources.** Our natural habitats, and their associated plant and animal species, provide a range of cosmetic and medicinal products. For example, 'wort', as part of the common name of plants, denotes a medicinal use at some time. A nature reserve in England now provides leeches for use in hospitals.

15. **Ornamental and other resources.** This category includes other woodland products (such as walking sticks, willow and other craft products), wild seeds, other garden products sustainably harvested, traditional flowers for local ceremonies, fossils, etc. In this category, the emphasis is firmly on sustainably-harvested ornamental products.

A review of countryside products

Research for the Countryside Commission (now Agency) reviewed the wide range of 'countryside products' which were defined as: those using land management practices which enhance landscape character, wildlife etc; which strengthen the sense of place in an area; and which are sustainably produced. The review identified:

- 50 agricultural food and drink products, covering arable and dairy products, fruit, vegetables, meat, drinks, jams, preserves, herbs, spices, mushrooms, and marine products.
- Four other agricultural products, including flowers and seeds, fuel, hay, crafts, building materials, compost, and textiles.
- Nine wood products, including charcoal, fencing, furniture, building, firewood, and garden products.[33]

Samphire *Salicornia sp.* Peter Wakely / English Nature 18,617A

Living from the wild

The Centre for Economic Botany at Kew Gardens are carrying out a survey to examine the commercial uses of wild and traditionally managed plants in England and Scotland today. To date, the database contains more than 55 commercially exploited plants. Species include seaweeds (*Porphyra sp.*) and marsh samphire (*Salicornia europaea*) for food, bilberries (*Vaccinium myrtillus*) and sloes (*Prunus spinosa*) for syrups and liqueurs, coppice wood (eg *Salix spp and Alnus glutinosa*) for charcoal, and bracken (*Pteridium aquilinum*) for fertilizer. These studies are revealing some interesting data on the economic value of habitats. For example, fruits harvested from a stretch of hedgerow in Suffolk produce liqueur worth £100 per km of hedge. In England and Wales, about 600ha of reedbed are commercially harvested for thatch reed and the raw material is valued at about £1200 per ha per year.[34]

Ecosystem services

We referred earlier to the 'mentally hidden' value of nature. This is especially the case with ecosystem services. These functions describe the background processes of nature. Often they are not noticed by people until they are damaged or lost. Yet they are very important. Some ecological and physical services are essential for human life; the majority would be impossible or very costly to replace by other means if the ecosystem processes were damaged on a large scale. Some human impacts, which have damaged ecosystem services, have already proved costly.

Natural scientists often evaluate species in terms of their functional characteristics: the role they play in the ecosystem. However, in our 'ecosystem services' categories, we concentrate on those processes which can be directly linked to a specific benefit for society. Consequently, these categories do not represent a full evaluation of the ecological function roles of different species, which are likely to be indirectly relevant to society's well-being. De Groot[2] has identified how a number of ecosystem 'processes' will interact to provide a 'service' to society. Below we have summarised those that are most significant from our perspective.

16. **Global life support services.** These include regulation of the chemical composition of the atmosphere and oceans, and climate regulation. **This category represents the key life-sustaining ecological processes. All natural areas play a role in the maintenance of these life-essential services.** In practice it is difficult to evaluate and demonstrate the contribution that particular habitat types or areas make. However, it is important to acknowledge this category in principle. The one area that is being recognised more explicitly is the contribution that some natural areas can make to carbon storage (eg peat bogs and woodlands).

Understanding the world's ecosystems

The United Nations has launched a four-year project, called the Millennium Ecosystem Assessment, involving 1,500 leading scientists to map the world's ecosystems and produce what it describes as "the first global report card on the environment". It will provide vital information on life-supporting ecosystems such as grasslands, forests, rivers and lakes, farmland and the oceans. Tim Wirth, of the UN Foundation, said the global economy was largely dependent on these natural systems. If the environment were "forced to file for bankruptcy, the economy would go down with it". Kofi Annan, UN Secretary General, said the new study would fill significant gaps in the knowledge required to preserve the planet's health. Eventually, it will provide decision-makers with the authoritative data about the impact of changes in ecosystems on livelihoods and environments.[35]

Peatlands as carbon sinks

Peat is organic material rich in carbons and living bogs act as valuable sinks for carbon dioxide. This is released back into the atmosphere if the peat is drained.[36]

Humberhead Peatlands NNR, Thorne Moors, South Yorks. Peter Wakely / English Nature 20,850 and 20,868

17. **Flood & erosion control.** Natural areas such as floodplain wetlands can buffer hydrological flows and dampen environmental fluctuations. They offer flood and storm protection and prevent run-off damage. Well managed soils can act as a sponge, soaking up water rather than allowing rapid surface flow into rivers which would cause flood peaks. Intertidal habitats such as saltmarsh and mudflats provide similar services on the coast, buffering it from the energy of the sea's waves. Geological processes such as shingle and beach formation are also important for coastal protection.

The importance of washlands and coastal habitats

If floodplains can be managed in a way which reduces risk to people and the built environment, and at the same time provide additional habitat and other benefits, then there will be increased benefits to society from this integrated approach.

Not only will flood risk be managed in a more natural way, but there are real opportunities across the country to enhance biodiversity, delivering Biodiversity Action Plan targets and providing an environmental resource that can be enjoyed by all. An actively managed washland can provide benefits including conservation, recreation and productive uses (such as the production of reed/sedge or biofuel). Therefore, this approach to managing flood risk, is a fully integrated, living and sustainable water system rather than a reliance on hard engineering options such as embankments or flood relief channels that require large amounts of public money to construct and manage.

Washlands provide a real opportunity to take a catchment-based approach to managing flood risk. Washlands provide flood defence benefits that are the same as any other flood risk management option i.e. the reduction in flood damages to the built environment, but they are not appropriate in all situations. However, a number of case studies show that washlands can provide an environmentally sustainable, technically feasible and economically robust method of managing flood risk.[37]

On the coast, saltmarsh habitats soak up wave energy that would otherwise be dissipated against the flood defence structures. This helps protect coastal areas from flooding and erosion. It has been estimated that an 80m depth of saltmarsh in front of the defensive structure can save roughly £4,600 per metre in additional flood wall protection.[38]

Nene Washes SSSI, Whittlesey.
Peter Wakely / English Nature 15,596

18. **Water provision.** Natural management of catchments provides important services in terms of water quantity and quality. Natural processes can provide water quality benefits, for example, by preventing sediment run-off into rivers. Water quanity benefits can be provided by preventing valuable water resources being drained too quickly and washed out to sea.

19. **Pollution filtering and reclamation.** As the impact of economic activity increases, natural resources play a very important role in pollution control and detoxification, including the removal of nutrients and pollutants from water, filtering of dust from the air and providing noise and wind attenuation. These benefits can reduce costs of land reclamation, and improve human health. Even if many of the most toxic of pollutants are eliminated or reduced from our industrial processes it is likely that ecological filtering services will play an increasingly remedial role in reversing the effects of the more diffuse pollutants (eg the use of oil-eating bacteria to clean up oil spills).

Natural areas, flood control and water quality

To treat the dispersed causes of pollution or to moderate the flow of flood waters, clearly we need some serious joined up thinking: an integrated approach to land and water management. In the urban landscape we could start to re-invent the porous city, with soakaways in housing areas; marshes, ponds and lakes in open spaces, and a much more extensive canopy of urban forest to slow down the rate at which the rainfall hits the ground. Urban flood problems begin in the countryside. 'Unproductive' wetlands - which make wonderful sponges to absorb heavy rain - have been drained. Wetter, more wooded gathering grounds and river catchments bring many benefits. Surface streams and aquifers are more consistently recharged, and this also boosts biodiversity. More extensive marshes, settlement lakes and reedbeds in less absorbent landscapes would replace missing wetland habitat. A landscape of unpolluted natural broadleaf woodland, permanent pasture and extensive wetland systems would revive wildlife. New wetlands would also provide a very effective biological filtration system. Broadleaf woodland also has a vital role to play in boosting water quality. There are many places elsewhere in the world where water companies pay for woodland management in the uplands as a cost-effective way of guaranteeing purer drinking water.[39]

Pollution filters

Algae in wetlands filter and remove nutrients, in some instances by incorporating them into plant material. Specially constructed wetlands can also treat surface water. In many developed countries constructed wetlands have proved to be effective, providing moderate to high levels of pollutant removal throughout the year.[40]

Reedbed at Benacre NNR, Suffolk. Peter Wakely / English Nature 21,444

20. **Soil provision.** This category covers the ecological processes which aid the formation and retention of soils, the storage of silt and the nutrient cycling services for commercial plant growth.

21. **Landscape formation.** Geology and geomorphological processes, such as erosion and sediment transport, maintain natural landscapes such as coastlines, uplands, rivers and other areas, which are highly valued. Another example is the combination of biological and physical processes which create sandy beaches.

22. **Waste decomposition and disposal.** This includes the breaking down of organic matter by micro-organisms, and the disposal of animal bodies and other waste by scavenging birds and mammals.

23. **Pollination.** This is mainly achieved by a wide range of wild invertebrate species and is vital for crop development.

24. **Biological control.** Food web interactions ensure natural population control mechanisms, including natural pest control.

25. **Habitat connections.** Natural areas provide space for crucial stages of species life, such as nursery and migratory habitats.

Inner Farne Islands NNR, Northumberland. Paul Glendell / English Nature 24,590

Conclusions

The categories suggested in this report reflect the social importance of England's wildlife and geology. They are a starting point; no doubt the categories can be developed.

This report demonstrates that, in addition to the scientific and moral arguments, the conservation of biodiversity can also provide significant economic and social benefits in terms of goods, services and cultural connections, which contribute to human well-being.

Increasingly, economic growth has impacts on our stock of natural resources. Our economic systems may be able to react in ways that will conserve nature; but this cannot be guaranteed. Consequently, our decision-making processes need to take specific account of impacts on ecosystem health alongside socio-economic considerations. What we do to protect biodiversity is an important measure of our commitment to sustainable development.

Recognition of the role of 'background' ecosystem services is especially important. Society's decision-making processes need to acknowledge the importance of the natural systems that underpin our environmental, social and economic well-being. Decisions about land use and management are often based on the impacts on specific sites of environmental importance. However, it is important that these decisions recognise not just the on-site benefits of conserving natural areas, but also the off-site effects. A change in conditions in one location can affect the provision of important ecological services elsewhere. It is important that land use decisions consider **ecosystem effects** that will operate at a **landscape scale**. There is increasing awareness of the need for, and value of, a network of natural areas in the countryside and in towns to ensure the long-term viability of habitats and species, and their adaptability to climate change.

In this report, we have used examples to illustrate, in general terms, the way that nature conservation improves our quality of life. For real-world decisions, however, we need to evaluate the scientific and social importance of nature in particular locations, and how these values will be affected by changes to land use or land management.

Some of the seriously threatened species and habitats that English Nature and other organisations are trying to conserve will, almost by definition, not be playing a major ecosystem role, since they have become so rare or impoverished. However, in this framework we recognise the range of **potential** benefits and the fact that much of the value of nature is not simply hidden but unimagined. In setting out the range of potential benefits, we can look at management options for our semi-natural habitats and evaluate whether we can maintain the ecological interest in ways that also deliver significant benefits to society. In this context, the idea of **sustainable use** of our wildlife resources may be appropriate in some situations. Management options that maximise the range of benefit categories may be the most **sustainable**, in an economic and environmental sense, in the long term. In evaluating the social functions of nature, we must also recognise that different stakeholders will have different perceptions. Stakeholder discussions can help elaborate the full range of potential values, both positive and negative.

Finally, it is worth reflecting that our natural resources provide a particular contribution to our well-being, which some see as being different categorically from the tangible economic benefits that can be identified, but no less important for our overall quality of life.

Can the broad set of categories described in this report be applied to specific habitats and species groups? Specialists at English Nature have undertaken a preliminary examination of this question. A summary note of these discussions, for a sample of habitats and for one species group, is set out in the attached annex; this provides some examples but is by no means intended to be comprehensive. We are at the starting point of a research process. However, discussions to date indicate that all major habitat types demonstrate a significant range of these social benefits and each habitat makes a particularly significant contribution to certain categories. English Nature plans to continue to research this area.

Annex

Illustration of the social functions of a selection of habitat and species groups in England.

This annex has been drawn from initial discussions with English Nature's specialists. It is intended to be illustrative rather than comprehensive, and should be considered as 'research in progress'.

Invertebrate species

Appreciation

- The sight of butterflies, the buzzing of bees and the singing of grasshoppers is synonymous with a summer idyll.
- Planting schemes in gardens are often designed to attract butterflies.
- *Distant appreciation*
  - People are fascinated by insects, as is demonstrated by the popularity of wildlife programmes on that subject. Examples include the *Wildlife on One* programme on British beetles introduced by David Attenborough, and the *Alien Empire* series, largely about British insects.
- *Artistic inspiration*
  - Butterflies, dragonflies and bumblebees are quite commonly depicted in jewellery.
  - Models of invertebrates are common in most toyshops - many are anatomically correct.
- *Marketing images*
  - Butterflies have been used frequently in marketing images (eg Swallowtail). TOG24 used the stag beetle as the swing tag on its clothes and sponsored the conservation project for the species.
- *Cultural, spiritual and historic information and appreciation*
  - Ladybirds have wide cultural affection "Ladybird, ladybird fly away home".
  - The singing of crickets on heathland used to be a sign of good luck in Dickensian times.
  - Weather myths - if you step on a ground beetle it will rain.

Swallowtail *Papilio machaon*.
Roger Wilmhurst / FLPA 45785-00049-169

Stag beetle *Lucanus cervus*. Derek Middleton / FLPA 40770-00034-231

  - There is a common children's cultural myth that soldier beetles are bloodsuckers.
  - There are various mythologies surrounding cockchafers and stag beetles.
  - Insects appear on pub signs. For example: The Midge, The Dragonfly, The Chequered Skipper, The Red Admiral, The Stag (illustrated with a beetle). This phenomenon has been reviewed in papers by the Royal Entomological Society.

Knowledge

- *General education*
  - Invertebrate studies are widely used in schools as part of the National Curriculum. This is because invertebrates are small, accessible and can be captured easily in the field. Examples include pond dipping at primary schools. County Wildlife Trusts WATCH projects have included a large number of invertebrate projects to illustrate conservation ideas to children, for example the Big Ladybird Survey (subsequently taken up by Cambridge University).
- *Ecological knowledge and scientific discovery*
  - Invertebrates are widely used in biological science education at universities - for teaching physiology, ecology, biomechanics etc (see also the examples in the main text of this report).
  - The whole science of forensic entomology focuses on determining the date of death of corpses by using maggot species composition and stage of development.
  - Mother of pearl is structurally stronger than would be expected, given its chemical makeup, so mollusc and crustacean shells are now being investigated to discover if they have similar properties.
  - Crushed crab, prawn, and lobster shells are being investigated for use as cleaning agents to clear pollutants out of liquids.
  - Invertebrates are widely used in physiological research as they are relatively simple - they use a few cells to do what a mammal uses a whole organ to do, thereby making for less complicated research experiments (eg giant nerve fibres of some invertebrates, optics in squids etc). British fruit flies have been used in genetic research for decades.
- *Environmental monitoring*
  - The Trent index, using freshwater invertebrates to monitor pollution, has been used for decades. Invertebrates are also uniformly tested for toxicity for any chemicals that are likely to be used in the field (eg pesticides). The butterfly monitoring scheme has been identifying climatic and management trends on nature reserves for nearly 20 years now. By monitoring moths and aphids, scientists at the Rothamsted research station have been looking at biodiversity trends in 'aerial plankton' across Britain for about 40 years. There is great potential in using invertebrates as indicators because they are so sensitive.

Products

- Medicinal products include leeches - the anti-clotting chemical Hirudin derived from leeches is used to treat thromboses and strokes.

- Maggots are being used to clean septic wounds. This practice goes back thousands of years but increasingly is being used again. Their use is more than biochemical as maggots eat necrotic tissue and destroy infection.
- Real spider silk is now being used in the manufacture of bulletproof vests and other ultra high strength/high elasticity materials.
- Invertebrates were the source of many 'historic' products which form part of our heritage: honey, silk, and byssus threads (material that mussels use to attach to rocks - which looks like spun gold) used to weave the famous 'cloth of gold'.

Ecosystem services

- Trees would decay very slowly without saproxylic beetles and flies - they work in association with fungi.
- Marine invertebrate use of $CaCO_3$ (crustaceans, molluscs) are very important as carbon sinks in the global climate.
- Many invertebrates have nitrogen fixing bacteria in their gut and contribute to N_2 fixation.
- A very significant proportion of the degradation of sewage occurs when chironomid midges and bloodworms ingest the solid material.

- *Biological control*
  - Red spider mite numbers are controlled by other mites; aphids and mealybugs are controlled by ladybirds and parasitic wasps.
  - Most biological control is carried out by predators and parasites; many would-be pests never become pests because they are naturally controlled.
  - Beetle banks and unsprayed headlands bring more hoverflies, ground beetles and rove beetles into crops.
  - Seed predators regulate the number of seeds in many plants.
- *Pollination*
  - Domestic honey bees are remarkably poor pollinators. Most pollination is done by wild bees, wasps, flies, beetles, sawflies, moths etc.
  - All fruit, rape (though partly wind-pollinated), linseed and anything with showy flowers are all insect pollinated.
  - Insects are now sold as pollinators for use in greenhouses.

- Ants are responsible for the dispersal of many seeds - especially those of the legume (eg gorse) and poppy families.
- Earthworms play a major role in soil formation.
- Nearly all carrion and dung degradation and plant litter degradation is carried out by invertebrates such as flesh flies, dung beetles and dungflies (usually symbiotically with fungi, bacteria or protozoae).

Cotswold Commons and Beechwoods NNR, Gloucestershire. Peter Wakely / English Nature 16,159

Woodlands

Important woodland habitats include broadleaved and coniferous woodlands and wood pasture and parkland.

Appreciation

- Woodland habitats
  - Provide an enhanced local living environment (eg Cotswolds, Chilterns, Sussex Weald).
  - Provide physical and mental health benefits.
  - Provide resources for recreation (eg Castle Eden Dene National Nature Reserve, Peterlee, Monks Wood NNR, Cambridgeshire, Burnham Beeches NNR, Berkshire, and wood pasture sites such as the New Forest, Hatfield and Sherwood Forests, and 'Friends of Woods' organisations).
  - Are appreciated 'distantly' in books (eg *Meetings with Remarkable Trees*, Thomas Pakenham).
  - Provide artistic inspiration (eg trees provided the focus for the Babington school of painting).
  - Provide significant cultural historic meanings (eg ancient tree names, folklore, 'wildwood' myths and fairytales). These historical and cultural associations were highlighted in English Nature's Veteran Trees Initiative.
  - Provide an opportunity for community development, through volunteering or via networks of owners (eg Anglia Woodnet, Woodland Trust).

Knowledge

- Woodland habitats provide a resource for general education and scientific research (eg Wytham Woods, Oxford and field study centres in Epping Forest and North Wales).
- Ancient trees provide important dating information for scientific and historical research.
- Woodland diversity provides a gene bank for research into development of wood products.

Products

Sustainable use of woodland habitats can provide a number of products for society's use.

- Charcoal (eg Anglia Woodnet, BioRegional).
- Taxol, the cancer therapy drug derived from yew.
- Wood-based biomass provides new opportunities for energy sources.
- Ornamental products such as willow sculptures, hurdles, baskets, wood carvings, walking sticks, yew, holly, mistletoe, wreaths, stumps etc (eg Wessex Coppice Association).

Ecosystem Services

Woodland habitats provide important ecological services.

- *Climate regulation*
  - Woodland may fix carbon, and make a positive contribution to the climate change problem. After a certain point in the forest growth cycle, it will reach an equilibrium point whereby the carbon fixing reduces. However, if the wood is harvested and goes into long-term product use, then this should provide the opportunity for further carbon fixing from the growing of new timber in its place.
- *Micro-climate regulation*
  - The use of trees in windbreaks, cooling through shade effects and evapotranspiration.
- *Flood protection*
  - Strategic tree planting in water catchments can help attenuate water flows. This benefit needs to be weighed against potential loss of water from the catchment area through increased rates of transpiration/evaporation.
- *Water quality*
  - Tree planting can provide a buffering function to prevent agricultural run-off.
- *Pollution control*
  - Woodlands, and trees in the urban environment, provide significant pollution filtering processes.
- *Soil protection*
  - Stabilises soil and minimises erosion risks.

Upton Warren Pools SSSI, Herefordshire and Worcestershire. Peter Wakely / English Nature 18,517

Wetlands

Important wetland habitats include reedbeds, bogs, fens, swamp, and grazing marsh.

Appreciation

- Numerous social research studies demonstrate the value that people place in water and wetland habitats.
- Many wetlands in the UK are visitor attractions (eg the Norfolk Broads).
- Fen habitats in East Anglia, for example, have a strong cultural significance and have inspired many books (eg *Waterland* by Graham Swift).
- Rivers and wetlands are often used as a marketing image to depict a calm atmosphere and a sense of well-being.
- These habitats provide many recreational benefits (eg fishing, boating, walking and birdwatching).

Knowledge

- Peatlands are historical archives which act as extremely sensitive indicators of environmental change since the last glaciation.
- Britain is a 'type' location for European Atlantic raised bogs. These bogs are highly valued internationally for ecological research.
- Ponds are often used as an educational tool.

Products

Wetland products include fish, waterfowl, reeds (for thatching), rush (for basket making), willow products and leeches for medicinal use.

Ecosystem services

- Multi-purpose washlands are semi-natural floodplain habitats which are deliberately designed for flood control purposes. Examples include the Nene and Ouse washes.
- Wetland habitats can aid the process of flood attenuation, by soaking up floodwaters and percolating water through the land to help re-charge aquifer levels.
- Wetlands can help retain sediment on the land. Traditional land management on the Somerset levels included 'warping' the land. Sluices would be opened to put sediments back into the land from the fine sediments in the river. This can provide benefits to agriculture and helps to maintain water quality.
- Peat bogs act as natural filters, providing valuable supplies of clean water. During dry weather they also provide rivers with a more reliable supply of water than many mineral soils do.
- Living peat bogs act as valuable sinks for carbon dioxide. This is released if the peat is drained.
- Wetlands help recycle nutrients and cope with sewage effluent (eg reedbeds and agricultural run-off).

Natural grassland habitats

This category includes hay meadows and other chalk, neutral and acid grassland habitats.

Appreciation

- Fascination and appreciation of meadows is reflected by the many books and TV series on these areas. Meadows have also been an important source of artistic inspiration. Examples include Constable's *Salisbury Cathedral*, and references in writings such as *Gerard's Herbal*, various Shakespeare plays, *Kilvert's Diary, The Country Diary of an Edwardian Lady*, etc.
- Ridge and furrow grasslands provide a record of our social history (eg Upwood Meadows National Nature Reserve).
- Chalk grasslands are probably the most pictorally depicted English landscapes. They also provide the setting for many ancient monuments, such as Bronze Age earth works, Iron Age hill forts, Roman dykes, and chalk figures.
- Large grassland areas are used for recreation including walking, hang-gliding, kite flying etc and are bases for tourism (eg Cotswolds, Downs, Breckland, Yorkshire Dales).
- Meadows provide inspiration for many garden designs.

Lewes Downs (Mount Caburn) NNR, East Sussex. Peter Wakely / English Nature 12,515

Knowledge

- Many grassland sites are used as resources for education (eg the Suffolk Unimproved Grassland Project).
- Natural grassland habitats have undisturbed soil profiles which are important for scientific research.
- They support traditional breed conservation and maintenance of genetic resources.
- Study of grassland habitats has provided wider lessons for ecological research, for example species diversity, co-existence and ecological structure.

Products from lowland grassland habitats include:

- Meat from sustainable and organic livestock.
- Seeds for ornamental wild flower areas and habitat re-creation in other locations.
- Bracken can be used for composting and in the past was used for animal bedding.
- St. John's wort is an original lowland grassland species which is now produced commercially as an anti-depressant.
- Other ornamental resources such as wild daffodils in Worcestershire, well-dressing, wild species flower displays.
- Reed canary grass for fuel.

Ecosystem services

- Grassland habitats provide flood attenuation services (eg Derwent Ings, a lowland hay meadow alongside the river Derwent in Yorkshire).

Blakey Ridge, North Yorkshire Moors. Peter Wakely / English Nature 12,801

Upland habitats

This group includes heather moorland, bracken, grassland, blanket bog, limestone grassland and pavement, montane grassland, screes and cliffs.

Appreciation

- Upland Britain provides a very significant recreational resource, especially for walking, mountaineering, fell running, hang-gliding, birdwatching, fishing, shooting, etc. This resource has a particular importance in providing a green lung for many metropolitan cities, such as Manchester. As well as the National Parks, some of our upland National Nature Reserves are amongst the most visited (eg Stiperstones, Upper Teesdale).
- The struggle for establishment of the National Parks is a key element of our recent social history.
- Natural areas in the uplands provide people with a strong sense of place. This is characterised by the holding of festivals and fairs, such as at Alston and Appleby, and the May Day tradition which sees people flock to the hills.
- Upland Britain provides a backdrop for our ancient settlement history and archaeology. These natural settings add to people's appreciation of such monuments.
- These areas provide numerous examples of artistic inspiration, producing writers like Wordsworth, Wainwright and Beatrix Potter, and artists and photographers including Turner and Baxter.
- The nature of upland areas provides characteristic sounds, such as the curlew and red grouse.

Knowledge

- Upland habitats provide an important resource for environmental monitoring studies.

Products

- Premium honey from bees raised on upland heather.
- Mineral water.
- Bracken products.
- Other ornamental products.

Ecosystem services

- Sustainable land management in the uplands can provide water resource management benefits. Proper management of the uplands will prevent peat getting into the water supply which is then expensive to remove.
- Pollution filtering - upland vegetation helped trap some of the radioactive fall-out from Chernobyl so less found its way into the water supply.

Urban habitats

This group consists of habitats which are the result of predominantly human activities, or recent ecosystems established on land that was once developed. They include: parks, cemeteries & churchyards, wasteland, secondary woodland, gardens and allotments, transport corridors (canals, railway linesides), and playing fields.

Appreciation

- House prices seem to be higher proximal to green spaces, especially parks and woods, and 'quality' open rivers. Desirable neighbourhoods are often close to areas of significant 'quality' greenspace - these are generally closely correlated with relict spaces and older town centres - (eg Richmond/Richmond Park). Many of these sites provide a unique 'sense of place'.
- Urban green spaces attract many visitors (eg Hyde Park has more visits than museums in the same area).
- 'Friends of' groups have responded to threats of development on open spaces since the 1980s. Cemeteries, for example, have been a particular focus of this activity and most have taken biodiversity as a valid feature of the modern-day resting place.
- There is evidence of correlation between social deprivation indicators and a lack of green space and natural features.
- Urban place names reflect natural origins, for example: Forest Hill (London), Oakenshaw (Bradford), Kingswood (Bristol), Fulwood (Sheffield), Hazel Grove (Stockport), Gosport (Hants), Moss Side (Manchester), Small Heath (Birmingham).
- Urban street names (London has 330 with 'oak', over 400 starting with 'wood', 67 with 'hazel'), and pub names (eg Chequers Arms wild-service tree, Royal Oak, White Swan, Magpie & Stump) reflect our desire to connect with the natural world.
- Other 'points of contact' with the natural world include feeding grey squirrels, pigeons, ducks/geese, foxes and badgers, and bird feeders in gardens.
- The popularity of gardening, and growth in the awareness of gardening for wildlife (40,000 people responded to the *Daily Telegraph* survey in 2001).
- The growth in the urban nature conservation movement from the late 1970s reflects the increasing social importance of these habitats.

River Wandle. Mathew Frith / London Wildlife Trust

Bradbrook Road Nature Reserve. Charles Snell / London Wildlife Trust

Products

- Berries can be collected on local walks.

Ecosystem services

- Pollution filtering (eg tree belts, vegetation, reedbeds).
- Noise prevention (eg tree belts).
- Reducing surface water run-off (eg Sustainable Urban Drainage Systems, green roofs, and soakaways).
- Climatic benefits such as increasing shade and moisture (which is important in inner urban environments) and reducing wind.
- Indicators of invisible pollution (eg trends in house sparrow populations).
- Waste disposal by cockroaches, rats, crows, magpies and foxes.

Geologically important areas

Appreciation

- The geological resources of Dudley in the West Midlands were fundamental to the economic development of that area, an industrial heritage which is now celebrated.
- Dorset and the Isle of Wight attract large numbers of visitors, due to their geological heritage, to enjoy the spectacular rocky coastlines and the fossils.
- The diversity of England's geology underpins the varied landscape that is so highly valued by people.
- Artistic inspiration from geological landscapes (eg the white cliffs of Dover, the Giant's Causeway, Northern Ireland), the trilobite as a symbol for the town of Dudley (on the coat of arms).
- Disused quarries provide significant recreational and educational resources.
- Fossils are associated with folklore, for example the ammonites in Whitby which were believed to be the bodies of serpents.

West Bay, Dorset. Peter Wakely / English Nature13,078

Writhlington SSSI, Somerset. Colin Prosser / English Nature

Knowledge

- Pioneering geological study in Great Britain provided the foundation for the development of the discipline and contributed to a classification system which is now used worldwide.
- Many areas of England are studied by large numbers of visitors because of their relevance to international geological learning. For example, Dudley, Dorset Coast, Ludlow, and Wenlock.
- Palaeontological study provides key insights into evolutionary biological processes. Some of these are of great public interest and economic value, for example the 'dinosaur industry'.
- Geological study also provides information on other environmental processes of interest (eg volcanic rocks in the Lake District).
- Understanding of geology provides important insights for mining, water, and other industries.

Products

- Responsible fossil collecting is now a significant 'industry' in parts of the UK.
- Sustainably harvested vernacular building materials.

Ecosystem services

- Geological and geomorphological processes are fundamental to our enjoyment of England's natural landscape (eg white cliffs of Dover).
- The variety of geology and active processes affecting the land has resulted in the mosaic of habitats in this country.
- Natural processes have produced physical barriers which help to manage floods (eg beaches and other coastal features).

Visiting teachers search for fossils at Wren's Nest NNR, West Midlands. Peter Wakely / English Nature 11,444

Coastal habitats

Appreciation

- People's appreciation of England's natural coastline is reflected in the very high desirability of many residential areas, for example Woodbridge, Maldon, Aldeborough, Totnes, Dartmouth, Brixham, the Solent, and many other areas.
- The natural coast provides people with a diverse recreational resource for walking, sailing, swimming, surfing, birdwatching, whale, seal and dolphin watching, boat trips, beach days, wild fowling, and so on.
- Natural coastal settings have provided a resource for artistic inspiration. Examples include the artistic community that has developed in North Norfolk in recent years, the St Ives painters, bird artists such as Scott and Tunnicliffe, and novelists such as Du Maurier, Stevenson and Buchan.
- Our coastal environment has huge cultural and historic significance to a country whose economic base grew up on its seafaring activities. Particular examples of the cultural links with the coast are provided at Whitby, the Grimsby heritage Centre, Plymouth, Redcar etc.
- Many advertisements use coastal settings for their images.

Knowledge

- England's coast provides a very important educational resource for worldwide study of coastal processes. Prime examples include Durlston Head, Lyme Bay, and Cleethorpes Discovery Centre. Thanet is used internationally as a resource for understanding the importance of seaweeds.

The Lizard NNR, Predannack Downs, Cornwall. Peter Wakely / English Nature 15,810

- Observations of England's estuarine bird life provides information for global monitoring.

- *Scientific discovery*
  - Skates and rays are being investigated for their anti-ageing properties.
  - The chalk in the Thanet coast was used for a luminescent compound for medicine.
  - The Dorset and Isle of Wight coasts are internationally important geological research sites.

Products

- Marine and coastal habitats provide many fish and shellfish products. Unfortunately, many fishing activities are currently unsustainable. It is possible, however, to maintain the ecosystems in ways which can also provide economic benefits. An example of such an approach is the Marine Stewardship Council pilot project on the Thames Herring Fishery in Essex, which encourages sustainable fishing activity.
- The coast also provides a resource for harvesting natural products which are no longer significant economically, but which remain very important as social products because they represent a particular way of life. These include the gathering of samphire, cockles and winkles, bait, etc. Recent conservation management agreements, such as at the Wash, have recognised these local rights.
- Ornamental resources include white weed from Maplin Sands (for aquaria), and sea urchins from the Isles of Scilly.

Ecosystem services

- Mudflats help to recycle nutrients and cope with sewage effluent and agricultural run-off. The sediment formation process helps to trap contaminants.
- Coastal systems shift sediment around the coast, re-charging beach material.
- Intertidal habitats such as saltmarsh soak up wave energy and reduce the cost of sea wall flood and coastal protection.
- Intertidal habitats provide nursery habitats for economically important species such as bass, flatfish, etc.
- The marine environment provides a crucial role in the water cycle.
- Plankton in the open sea provide an important carbon sink function, helping to maintain a healthy atmosphere and climate.

More generally, the marine environment demonstrates the potential economic costs that are incurred when ecosystems are not protected properly. Examples include the introduction of non-native species, which are then very difficult to get rid of. In the UK, skipper limpets have had a significant effect on the shellfish industry.

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