Benefits of Sites of Special Scientific Interest

Defra

Annex 1: Literature Review

A report submitted by GHK

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Executive Summary

Introduction

GHK Consulting Ltd and partners were commissioned by Defra to examine the benefits of Sites of Special Scientific Interest (SSSIs) in England and Wales. This literature review examines available evidence about SSSIs and their ecological and economic benefits.

The structure of the review follows the Defra (2007) impact pathway framework for assessing the effects of policies on ecosystems (Figure 1.1).

Figure 1.1Impact Pathway of SSSI Policy

The review therefore provides an overview of SSSI policy and of the SSSI network in England and Wales; examines the benefits of SSSI policy in enhancing ecosystems, biodiversity and geodiversity; reviews evidence of the effects of SSSIs on the delivery of ecosystem services; and examines the effects of these services on human welfare, and the valuation of these benefits.

SSSI Policy

SSSI policy in England and Wales dates back to the 1949 National Parks and Access to the Countryside Act, and has been developed through a series of subsequent items of legislation. It designates and conserves the most valuable sites for biodiversity and geodiversity nationally. In England, there are more than 4,000 SSSIs, covering around 8% of the total area, and there are more than 1,000 SSSIs in Wales, covering around 12% of the total area. These areas have been notified for habitat features, animal and plant species, assemblages of animals or plants or geological and geomorphological features.

More than 1,000 SSSIs in England and almost 500 in Wales are also subject to higher national and international designations such as Special Protection Areas and Special Areas of Conservation (together known as Natura 2000 sites), National Nature Reserves (NNRs) and Ramsar sites. SSSIs vary greatly in size – some are very large but most are smaller than 100 hectares.

In the last 10 years there has been increased emphasis on improving and maintaining the condition of SSSIs in England and Wales. In 2000, DEFRA agreed a Public Service Agreement to ensure that 95% of the SSSI land area in England is in favourable or recovering condition by 2010, while the Environment Strategy for Wales gives a commitment that 95% of Welsh SSSIs will be in favourable condition by 2015 and that all sites will be in favourable condition by 2026. Considerable progress has been made against the achievement of these targets.

Achieving favourable condition of SSSIs is dependent on the development and implementation of appropriate management strategies. Efforts to meet targets for SSSI condition have been accompanied by significant increases in public expenditures on SSSIs in England and Wales. Current levels of public expenditure are estimated at £101 million in England and £10 million in Wales annually. Providing sufficient resources to achieve and maintain the condition of SSSIs is a key element of the policy, and assessing the benefits that will be achieved by continuing to allocate financial resources to SSSI management is the key focus of this study.

It is increasingly recognised that large areas of countryside are beyond the influence of SSSI policy. SSSIs cover a large proportion of some habitats and features but only a minority of others, and are affected by management of adjacent sites (e.g. diffuse pollution from agriculture). In addition, climate change and other pressures have brought a need to

rethink the effectiveness of the current network of protected sites and to look beyond SSSI boundaries, although it has been argued that, even if these changes affect the wildlife and geology that SSSIs support, the need for a well managed network of protected areas will remain in future.

Conservation Benefits of SSSIs

The conservation value of SSSIs is difficult to quantify. However, it is clear that the SSSI network represents our national biodiversity well and has enhanced the protection of many of our more valuable species, habitats and geological and geomorphological features, a significant but variable proportion of which are now concentrated in SSSIs. SSSIs have made a significant contribution to reducing declines and local extinctions in several species groups and have helped to improve the ecological condition of sites, to the benefit of habitats and species. They are therefore playing a major role in the delivery of the UK Biodiversity Action Plan. They have been effective in conserving and maintaining the condition of many of our most important geological and geomorphological sites.

Evidence shows that a larger proportion of habitats are in favourable condition inside SSSIs than outside them. In February 2010, 43.4% of the SSSI area in England was in favourable condition, and 47.3% in unfavourable but recovering condition, resulting in the total of 90.7% in target condition as defined in the PSA.

Examples of the benefits to species include the following:

- SSSIs protect the entire populations of some threatened species, such as the bog orchid.
- A study of 371 Red List vascular plant species found that 88% of species were represented at least once within SSSIs and that protected area coverage was the most important predictor of species richness across Britain.
- Habitat protection, mainly in the form of SSSI designation, has been effective in safeguarding the natterjack toad, with safeguarded sites increasing from 60% in 1970 to 83% in 1990. Sites with SSSI or NNR status fared better than sites without any statutory habitat protection.

SSSIs form the main statutory mechanism for protecting nationally important geological sites in Great Britain. SSSI designation provides a high degree of protection for sites although it does not guarantee their long-term conservation. However, as for biological SSSI sites, geological SSSIs have attracted resources in recent years to enhance management in order to achieve favourable condition.

Ecosystem Services Delivered by SSSIs

SSSIs provide a variety of ecosystem services; they offer important cultural and recreational opportunities; provide a resource for scientific study and education; contribute to the regulation of air, water, and soils; and provide food, fibre and genetic resources. As well as protecting the ecological processes on which society depends, SSSIs provide opportunities for people to appreciate nature and often make a direct contribution to the local economy.

Overall evidence of the ecosystem services provided by SSSIs is limited and fragmented. However, available evidence suggests that SSSIs provide a wide range of provisioning, regulating and cultural services. Quantitative evidence of service delivery is limited, but is available for certain services at some sites.

Examples of ecosystem services include:

- Genetic resources - crop wild relatives (CWR) are potentially important for future agricultural production. A paper has shown that all 17 CWR hotspots that would need to be protected to conserve two thirds of CWR species are designated SSSI.
- Climate regulation – carbon sinks in soils, vegetation and the oceans play a vital role in regulating climate. A range of habitats - peatlands, woodlands, agricultural land, coasts

and the seas - play a role in greenhouse gas regulation. One study found that SSSIs store 1.8 times as much carbon as would be expected on the basis of their area alone, especially as they protect carbon-rich soils in habitats such as heather moorland and wetlands.

- Flood defence – Freiston Shore managed coastal realignment project in Lincolnshire has been shown to yield net cost savings compared to engineered flood defences, as well as increasing annual recreational visits from 11,000 to 60,000 and supporting 6 full time equivalent jobs.
- Cultural services - Around 50% of SSSIs are open to the public and more than 39,000 hectares of SSSI land are in or close to urban areas. SSSIs attract around 380 million visits each year and support more than 40 different types of recreational and educational activities. However, there is evidence that overall recreational use of SSSIs is less than for the countryside as a whole, because on average they tend to be located in less densely populated areas.
- Multiple services through habitat restoration – Wallasea Island is the site of Britain's biggest coastal wetland restoration project, involving managed realignment to restore saltmarsh, creeks, and mudflats for the benefit of wildlife and to provide a wide range of ecosystem services (grazing, flood defence, fisheries, recreation, carbon sequestration, nutrient cycling and water quality).

Geodiversity, as well as biodiversity, contributes to the delivery of ecosystem services and underpins the delivery of provisioning, regulating, cultural and supporting services. Many of these services can be assessed within the ecosystem services framework. However, geodiversity plays a distinct role in contributing to our scientific and historical knowledge and understanding. It also provides abiotic materials for use in construction and industry.

The net effects of SSSI designation on service delivery are difficult to assess. It is likely that by improving the condition of sites, SSSI policy enhances the delivery of regulating services, though this is difficult to quantify. SSSI status is also likely to enhance cultural services, including recreational, educational and existence values, although evidence suggests that much recreational use of SSSIs is unrelated to site condition. Net direct effects on provisioning services may be negative, though SSSIs may have direct benefits to fisheries and indirect benefits through pollination and nursery functions. Evidence suggests that agricultural production is significantly under-represented in SSSIs, reflecting the under-representation of arable farming in these areas.

Valuing the Benefits of SSSIs

SSSIs provide a wide range of benefits, some of which are traded and others which are not. These benefits can be valued using a variety of market and non-market valuation techniques, whose applicability varies depending on the particular service being valued.

While there is limited evidence of the overall value of SSSIs, a variety of studies have estimated some of the benefits provided by particular sites, while others have assessed related policies or habitats and potentially provide evidence of the value of key services which could be used in SSSI valuation, by employing benefits transfer methods.

As with assessment of ecosystem services, a key challenge lies in the assessment of the net benefits of SSSI designation – the overall benefits of particular sites may be easier to assess than the effect on these benefits of designating the site as an SSSI and the effects of this designation on site management and condition.

The review suggests that there is much existing evidence relevant to the valuation of the benefits of SSSIs, but that limitations in scientific evidence highlight the challenges in quantifying service delivery, and the effect of SSSI designation on it, as a basis for valuation. In other words, it is often more difficult to quantify the change in service being valued, than to identify potential unit values.

Where evidence is available from SSSIs and other protected areas, it highlights that the benefits of designation often significantly outweigh the costs. Evidence suggests that non-use values may significantly exceed use values, while the value of regulation of climate, water flows and water quality may also be substantial in some cases.

Examples of the value of benefits of SSSIs include:

- The Sustainable Catchment Management Programme (SCaMP) in the Peak District has restored degraded moorland in a 20,000ha catchment area, more than 40% of which is SSSI. Around 13,500ha of SSSI land has been restored into favourable or recovering condition recreating habitats and enhancing biodiversity. As a consequence the moorland's capacity for sequestering carbon has recovered (the moorland previously had a net loss of carbon) and the area is sequestering an estimated 2000t CO_2 per year valued at £0.86m per year over 50 years. There have also been improvements in water quality in the catchment.
- Based on an average value of £1 to £3 per visit, one study estimated the overall value of recreational visits to SSSIs at between £372m and £1,110m per year. However, it was noted that many of these visits would have taken place whether the sites were SSSIs or not, with the author concluding that the additional benefits of SSSI designation could not be estimated.
- At Ingleborough National Nature Reserve, an improved management regime is estimated to have increased recreational benefits to the site's 100,000 annual visitors by £3m and brought improvements to the historical and cultural landscape valued at a further £3m. This increase entirely relates to increased utility per visit, as the numbers of visits are assumed to be constant.
- Early valuation studies estimated the aggregate willingness to pay of users of three SSSIs in Upper Teasdale, Skipworth Common, and Derwent Ings at £150,000, £1m, and £520,000 per year respectively at 1990 prices.
- A study of the Pevensey Levels Wildlife Enhancement Scheme (WES), which paid landowners and occupants to develop schemes which enhance SSSI wildlife habitats, found an estimated mean willingness to pay of £0.41 for non-users and £0.97 to £1.07 for users. Taking account of use values alone, the benefit cost ratio for the Pevensey Levels WES was 0.5; incorporating non-use values increased the benefit/cost ratio to 2.0.
- A study of the economic benefits of geodiversity estimated willingness to pay to access two sites - Wren's Nest National Nature Reserve (also SSSI) and the Jurassic Coast World Heritage Site (which comprises 14 SSSIs). At Wren's Nest, access to the whole site with educational material was valued at £21.26 per household per year compared to £7.83 per household per year without the provision of educational material. At the Jurassic Coast WHS, access with extensive interpretative material was valued at £62.35 per household per year compared to a value of £23.69 per household per year for access without educational material. People also expressed a positive willingness to pay to be able to collect fossils, provided that this was accompanied by sufficient protection of rare and important fossils.

Other studies assessing the value of related policies and designations (e.g. UKBAP, Natura 2000 sites and agri-environment schemes), habitats, sites and species also demonstrate the value of biodiversity and ecosystems and the services they support. Many of the values obtained are potentially transferable to SSSIs.

There is also evidence that SSSIs can provide positive economic impacts by supporting employment and incomes in local economies, both through site management and by supporting tourism. Examples include:

- North Norfolk Coast - A study of visitors to six sites on the Norfolk Coast in 1999 estimated that they spent £21 million per year in the local economy. Visitors attracted to these sites mainly by their birds and wildlife were estimated to have spent a total of £6

million in the area, supporting an estimated 135 FTE jobs. The Norfolk Wildlife Trust's Cley reserve and Titchwell RSPB reserve were estimated to bring extra visitor spending of £2.5 million and £1.8 million respectively into the Norfolk coastal economy in 1999. In addition, work by conservation organisations in managing sites in the Norfolk coast area supports 30 FTE jobs.

- Minsmere RSPB Reserve, Suffolk – the site receives almost 80,000 visitors per year, who were estimated to spend £1.1 million in the local economy in 2000, supporting 27.5 FTE tourism jobs. Direct employment on the reserve totals 20 FTE jobs.
- Symond's Yat Rock, Forest of Dean - each year, the RSPB and Forestry Commission operate a peregrine falcon nest protection and viewing scheme, which attracts 50,000 visitors. A visitor survey estimated that Symond's Yat Rock Peregrine Project attracted extra visitor spending of £551,000 to the Forest of Dean area in 1999, supporting an estimated 18 FTE jobs.
- Geodiversity has been estimated to attract annual visitor expenditures of £11 million to the Isle of Wight economy, generating between £2.6 million and £4.9 million in local income and supporting between 324 and 441 full time equivalent local jobs.

Finally, the review highlights a number of key methodological issues which need to be taken into account in valuing benefits, such as:

- The need to avoid double counting of benefits, especially when aggregating different values relating to different services
- The importance of distinguishing between the gross values of SSSI sites and the net benefits of the policy;
- The difficulties of distinguishing between the benefits of SSSIs and other designations;
- The need to separate estimates of the economic benefits and economic impacts of SSSIs;
- The site-specific nature of many services and benefits, requiring caution in transferring benefit estimates between sites;
- Caveats regarding particular valuation techniques, such as the various potential biases associated with stated preference methods.

Gaps in the evidence base provide significant challenges for the current research study, which the case studies, stakeholder workshops and focus groups have sought to address. The literature review demonstrates, however, that the benefits assessment will inevitably be based on an incomplete understanding of the services and benefits provided by SSSIs. This confirms the need to design solutions to the inevitable evidence gaps. For example, where scientific evidence does not permit the quantification of individual ecosystem services, expert judgement, through workshops, will be used to assess the relative importance of different services. Similarly, elicitation of the public's willingness to pay for the services provided by SSSIs can be based on an accurate summary of currently available evidence.

1 Introduction

1.1 This Report

GHK Consulting Ltd and partners (ADAS, IEEP, Aberystwyth University and Rick Minter) were commissioned by Defra to examine the benefits of Sites of Special Scientific Interest (SSSIs) in England and Wales. This literature review is one of outputs of the research which also includes case studies examining the benefits of individual SSSIs, workshops involving experts and stakeholders, and focus groups of the general public, which include a choice experiment valuation exercise.

This literature review examines available evidence about SSSIs and their ecological and economic benefits. It will help to inform an overall assessment of the benefits delivered by the network, its relationship with other initiatives and designations, and its likely delivery of different ecosystem services. It examines the extent to which these services can be quantified and valued based on the existing evidence available, and by drawing insights from similar valuation studies that focus on other schemes and initiatives.

1.2 Structure of the Review

The structure of the review follows the general framework set out in the inception report, based on the Defra (2007) impact pathway framework for assessing the effects of policies on ecosystems (Figure 1.1).

Figure 1.1 Impact Pathway of SSSI Policy

The review is therefore structured as follows:

- Section 2 provides an overview of SSSI policy and of the SSSI network in England and Wales;
- Section 3 examines the benefits of SSSI policy in enhancing ecosystems, biodiversity and geodiversity;
- Section 4 reviews evidence of the effects of SSSIs on the delivery of ecosystem services;
- Section 5 examines the effects of these services on human welfare, and the valuation of these benefits.
- Section 6 draws general conclusions from the review, regarding the benefits of SSSIs and their assessment and valuation.

1.3 Research Methods

The review covers a combination of published evidence, grey literature, online resources and data provided directly by the statutory nature conservation agencies (Natural England and the Countryside Council for Wales, CCW). A wide range of sources have been consulted in order to collect as much relevant evidence as possible against the above framework, and response to the key questions set by the study brief and elaborated in the inception report (GHK *et al.*, 2010).

Relevant evidence has been identified through a variety of different means, including:

- Evidence known directly to the study team and reviewed in previous assignments;

- Reviews of websites and publication lists of key organisations (Defra, Natural England, CCW, JNCC, RSPB and others);
- Requests for data and evidence from key contacts in the above organisations;
- Online searches employing combinations of keywords (SSSIs, benefits, values, ecosystem services etc);
- Suggestions made by steering group members;
- Other evidence uncovered as part of other research tasks for this assignment (case studies and expert workshops);
- Additional evidence identified from reference lists in the above sources.

While much of the evidence reviewed is specific to SSSIs, it has also been necessary to review the wider evidence base relating to other nature designations and to the benefits and values of ecosystem services, biodiversity and geodiversity more generally. Restricting the review to SSSIs only would be too limiting, overlooking much evidence that helps us to understand the benefits and values that SSSIs are capable of delivering.

A full list of references is given at the end of this review.

2 SSSI Policy and the SSSI Network

2.1 SSSI Policy

Summary of SSSI legislative documents summarises the key pieces of legislation that have impacted upon the establishment of the SSSI network, and the way in which it is managed.

Table 2.1 Summary of SSSI legislative documents[1]

Year	Act	Summary
1949	The National Parks and Access to the Countryside Act	The Act first created SSSIs. It created the Nature Conservancy (NC) and gave it the power to acquire land for establishment and maintenance of nature reserves, make byelaws on nature reserves and enter into agreements with owners of land of national interest to be managed as nature reserves. The NC was charged with the duty to notify land that is of special scientific interest and to inform local planning authorities of any SSSIs. The first SSSIs were designated in the 1950s.
1968	The Countryside Act	The Act gave the NC the power to enter into management agreements with owners, lessees or occupiers of SSSIs to maintain the special interest of the site.
1973	The Nature Conservancy Council Act	The Act established the Nature Conservancy Council (NCC).
1981	The Wildlife and Countryside Act	The changes introduced were primarily in response to changing land management practices in agricultural and forestry sectors which largely fell outside planning control, and were at odds with the conservation of semi-natural habitats and species. The Act took forward the concept of special sites, but provided greater protection through notification to all owners and occupiers of the special features of these sites (administrative arrangements helped inform a wide range of statutory bodies, utilities and other interested parties). It placed a requirement on managers of these sites to notify the NCC before carrying out any potentially damaging operations. It also introduced the facility to negotiate compensatory management agreements with owners for the profits foregone by agreeing not to carry out operations considered likely to be damaging to the SSSI. These measures helped create a direct relationship between the land manager and the conservation agency.
1990	The Environmental Protection Act	The Environmental Protection Act 1990 established English Nature, the Countryside Council for Wales and the Joint Nature Conservation Council (JNCC) and made provision for management agreements to be negotiated with owners of land adjacent to a SSSI for the purposes of protection of the site. The JNCC is given responsibility for the production and publication of the Guidelines for the selection of SSSIs.
1994	The Conservation Regulations	The Conservation (Natural habitats, &c.) Regulations 1994 transposed the requirements of the Habitats Directive into national law. This built on existing nature conservation legislation for the protection of habitats and species by introducing requirements for assessing plans and projects affecting sites designated under the European Birds and Habitats Directives (and – as a matter of UK Government policy - also those affecting Ramsar sites) and licensing certain activities affecting European Protected Species.

[1] http://www.defra.gov.uk/rural/protected/sssi/legislation.htm

Year	Act	Summary
2000	The Countryside and Rights of Way Act	The Act substantially strengthened the 1981 Act provisions and improved protection for SSSIs in England and Wales. The Act increased the statutory agencies' powers to refuse consent for damaging activities (and to withdraw consents already given) and also introduced the right of appeal against the refusals of consent. It also introduced the ability to change notifications by enlargement, addition, variation and de-notification and provided new powers to combat neglect; increased penalties for deliberate damage and a new court power to order restoration; improving powers to act against cases of third party damage; and placing a duty on public bodies to further the conservation and enhancement of SSSIs. The provisions in the Act also gave people a new statutory right of access to mountain, moor, heath, down and registered common land, and improved the rights of way system so as to be more responsive to the needs of modern recreation and land management.
2006	The Natural Environment and Rural Communities Act	The Natural Environment and Rural Communities Act 2006 merged English Nature with parts of the Countryside Agency and Rural Development Service to create Natural England. The Act also introduced a new third party offence for intentionally or recklessly destroying or damaging sites or features which make the site special, and extended the offences for public bodies and statutory undertakers to include failure to notify Natural England of its intention to permit possibly damaging operations, or failure to take into account Natural England's advice.
2009	The Marine and Coastal Access Act	The Marine and Coastal Access Act 2009 allowed the creation of marine conservation zones and introduced a call-in power, by the Secretary of State, for all new SSSIs which are proposed to extend below Mean Low Water Mark.

In 2000, DEFRA agreed a **Public Service Agreement** to ensure that 95% of the SSSI land area in England is in favourable or recovering condition by 2010, while the Environment Strategy for Wales gives a commitment that 95% of Welsh SSSIs will be in favourable condition by 2015 and that all sites will be in favourable condition by 2026.

In addition, a number of guidance documents have been provided relating to the management of SSSIs in England, including the Code of Guidance - *Sites of Special Scientific Interest: Encouraging Positive Partnerships*[2] (Defra, 2003b), Guidelines on Management Agreement Payments and other related matters (DETR, 2001) and the Government's Planning Policy Statement 9 (ODPM, 2005a).

In particular, the **Code of Guidance** prepared by the Secretary of State of Environment, Food and Rural Affairs, emphasises the significance of SSSIs and the importance of making sure they are properly protected and conserved whilst securing their restoration and enhancement. The Code endorses

- the value of constructive dialogue;
- listening carefully to a range of views;
- the importance of support both through advice and where appropriate, through financial assistance; and
- the expectation that the information about SSSIs will be freely available.

The Code also draws specific attention to the need for public bodies to be fully accountable in the actions they take, both on and in respect of SSSIs. The advice and guidance is also directed towards other public bodies, including Government Departments and public utilities that exercise functions in relation to SSSIs. Guidance in the Code constitutes advice to them on the manner in which they should exercise their legal responsibilities in relation to SSSIs. In particular:

[2] The Code of Guidance refers to the provisions contained in sections 28-32 of Part II of the Wildlife and countryside Act 1981, as amended by the Countryside and Rights of Way Act 2000, for the notification and protection of Sites of Special Scientific Interest (SSSIs). Revisions to the 1981 Act apply in England and Wales; however, the Code of Guidance applies only in England.

- Natural England must notify all of the owners and occupiers of the land, including any holders of common rights, where it considers an area to be of special interest;
- The Secretary of State expects Natural England to enter into discussions wherever necessary, with owners and occupiers, so as to produce a short and clear statement of the management requirements for the site;
- The Secretary of State places greatest emphasis on ensuring that SSSIs are appropriately and positively managed. The management scheme will provide owners and occupiers of SSSIs with a detailed statement which clearly sets out the measures required for positive management of that land.

In addition, the **Planning Policy Statement 9** sets out planning policies on protection of biodiversity and geological conservation through the planning system. The accompanying Circular provides detailed guidance on statutory obligations and their impact within the planning system. Both documents include SSSI policy and obligations (ODPM, 2005b).

There is no specific guidance relating to SSSI management in Wales.

2.2 Guidelines for designation of SSSIs

Natural England and the Countryside Council for Wales have a duty to notify SSSIs when they are of the opinion that an area of land is of special interest by reason of its flora, fauna or geological or physiographical features. This opinion is based on the exercise of specialist judgement which is informed by scientific guidelines.

There are two types of SSSIs: biological SSSIs and geological/geomorphological SSSIs (henceforth referred to as “geological SSSIs”). The procedure for selecting a SSSI is based on a rigorous definition of what constitutes "special scientific interest." The objective of the SSSI series is "*to form a national network of areas representing in total those parts of Great Britain in which the features of nature, and especially those of greatest value to wildlife conservation, are most highly concentrated or of highest quality*."..."*each site represents a significant fragment of the much-depleted resource of wild nature now remaining in this country*."

2.2.1 Selecting Geological SSSIs

The origin and history of geological SSSIs is described by Prosser (2008) and the guidelines for the selection of geological and physiographical SSSIs were published by JNCC (Ellis *et al.*, 1996) in the Geological Conservation Review (GCR). The aim of the GCR programme which began in 1977 was to identify the best, most representative, geological sites in Great Britain, with a view to their long-term conservation. The GCR also re-evaluated sites that were designated SSSIs before 1977. As a result, nearly all of the pre-1977 geological SSSIs were confirmed as retaining their interest, and additional localities also deemed to be of national importance to the study of geology and geomorphology were identified, creating the comprehensive GCR site ‘register’. The GCR sets out general principles of selecting geological SSSIs. The rationale for the GCR can be encapsulated in four definitive statements as follows:

- The objective of the geological SSSI system is to identify and conserve a GB-wide series of Sites of Special Scientific Interest for their ‘geology and physiography’.
- Each site within the series must have a special interest demonstrable at national or international level, either in its own right or by virtue of its contribution to a network of closely related sites.
- The special interest of the series is interpreted as the minimum number of sites needed to demonstrate our current understanding of the diversity and range of geological features with regard to the following criteria:
  - Representativeness
  - Exceptional features

- International importance

Sites are assessed against the above guidelines on a network basis. Each network consists of a group of sites addressing a particular geological period of time or subject area. The 97 networks are grouped into 5 sub-divisions covering the entire discipline of earth sciences. The resulting 3,010 GCR sites are condensed into 2,200 geological SSSIs by virtue of the occurrence of different geological features at the same site. Box 2.1 illustrates the selection guidelines for geological SSSIs in more detail.

Box 2.1: Understanding the selection guidelines for Geological SSSIs

- Implicit in the concept of **minimum numbers** is the concept of a minimum area for sites: that is, the least area to adequately encompass the interest. This area varies according to the type of site- for example: a large folded structure or a volcanic centre may require many sites close together, or large sites, whilst a specific fossil horizon may only require one small site.
- **Representative** sites are selected to adequately demonstrate (or represent) the diversity and range of the geological and geomorphological history of Britain. The GCR provides a framework that covers five main subject areas:
  - Precambrian, metamorphic and structural geology;
  - Igneous petrology and mineralogy;
  - Stratigraphy;
  - Palaeontology; and
  - Quaternary geology and geomorphology.
- Within each of the five subject areas, individual themes (based on 97 sub-divisions of geological time or subject areas) are recognised. Each theme provides the focus for the assessment and selection of a network of sites which best represent the features of its geology.
- The term '**exceptional features**' refers to sites that have spectacular, rare or remarkable features, which, by definition, are unrepresentative, but which form a critical part of the resource. The term also refers to geological or geomorphological features or remarkable abundant accumulation of material (e.g. fossils, mineral or cave formations) and classic landform.

Internationally-important sites tend to have a strong research value and may also have considerable historic importance.

Application of the three conceptual guidelines (representativeness, exceptional features and international importance) does not inevitably lead to straightforward options as to whether to include or exclude a site. It was therefore identified that preference should be given to sites:

- With an assemblage of several different geological interests, or representation of different sub-disciplines;
- Which show an extended, or relatively complete record of the feature of interest;
- Which have been studied in detail and that have a long history of research and re-interpretation;
- Which have potential for future study and interpretation. Such potential might be manifested by, for example, extensive in situ deposits with continuing interest or sites which otherwise lend themselves to further work;
- Which have yielded results that assist in placing them in a wider context (e.g. radiometric dates, palaeomagnetic or geochemical data, pollen dating).

2.2.2 Selecting Biological SSSIs

The guidelines for the selection of biological SSSIs were published by the Nature Conservation Council in 1989 and have been revised by JNCC since 1991.

Primary biological criteria as set out by the NCC in 1989 are size, diversity, naturalness, rarity, fragility and typicalness. Both of the geological and biological guidelines for site selection include rarity, fragility and size as criteria, albeit with different weightings of importance. The geological concept of 'representativeness' is to some extent similar to the biological concepts of diversity and typicalness. In addition, in the geomorphological field at least, the earth science preferential weightings also include the biological criteria of naturalness. Therefore, the two sets of guidelines for selecting biological and geological sites seem to partially overlap with shared concepts.

There are also secondary guidelines for selecting biological SSSIs, which include recorded history, position in an ecological/geographical unit, potential value and intrinsic appeal.

Box 2.2: Understanding the selection guidelines for biological SSSIs

- Some criteria are used in a more general way than others, for instance, **typicalness**. Selection aims to choose sites with examples of habitats and species which are not only characteristic (i.e. typical) of that ecosystem in the particular Area of Search (AOS), but are also the best example. It is also necessary, when appropriate, to select other sites which are equally good examples of typical features which also have special interest, to avoid under-representation.
- **Fragility** is a property which causes natural and semi-natural habitats and native species as a class to be more highly valued than any of the artificial substitutes which replace them through human activity. The greater their fragility, the higher their value.

The quality of non re-creatability **is probably a better integrating measure of nature conservation value than any other single factor or criterion. Many species of plant and animal are difficult to reintroduce, but a greater problem is that the full list of species formerly present is seldom known. Re-created habitats tend to be regarded as inferior substitutes for the originals, and emphasis has to be placed on the conservation of natural and semi-natural ecosystems before they are damaged.**

The application of primary and secondary guidelines is complex, and different guidelines or different combinations or emphases are needed for evaluation and selection:

- Between the use of minimum standards and of exemplary representation;
- Between habitats and species-groups;
- Between different habitats; and
- Between different species-groups.

In particular, assessment to identify **habitats** which meet **minimum standards** places emphasis on naturalness, size, rarity and diversity, whilst assessment of **species**-groups against minimum standards emphasises on diversity, population size and rarity.

Within each Area of Search (AOS), a minimum aim will be to represent within SSSIs all of the different habitats and species that are present and preferably the best examples. For many habitats and species, the minimum of one example or population within each AOS will not be enough, and the guiding principle is that, as rarity or other special value increases, so does the need to notify a larger proportion of the total remaining area or population. Assessment to identify **best examples** which represent a field of variation differs from assessment against minimum standards, in that it involves:

- The comparison of similar sites, to arrange them in order of merit- whether there be only two or a larger number;

- A decision on the number and extent of sites required to adequately represent a given field of ecological variation.

2.3 Overview of the SSSI network

SSSIs aim to represent the very best of the rich variety of wildlife and geology that makes nature in England and Wales special and distinct from any other country in the world. The SSSI network mirrors the distribution of habitats, ranging from small sites that protect populations of a single species to large expanses of upland moorland or coastal mudflats.

In England, there are more than 4,000 SSSIs, covering around 8% of the total area (Natural England, 2008) and there are more than 1,000 SSSIs in Wales, covering around 12% of the total area (CCW, 2006). These areas have been notified for habitat features, including blanket bog, lowland heath and saline lagoons; for animal and plant species; or for assemblages of animals or plants (Gaston *et al*., 2006; Rowell, 2009). In Wales, more than half of the total area of SSSIs is within the uplands, primarily in large sites (CCW, 2006).

Table 2.2 Extent of SSSI network in comparison with other designations in England

	Number of sites	
Designation(s)	**England**	**Wales**
All SSSI	4,116	1,028
SSSI only	3,041	537
SSSI + SAC	686	336
SSSI + SPA	296	59
SSSI + Ramsar	244	20
SSSI + NNR	243	76
SSSI + SAC + SPA	186	40
SSSI + SAC + Ramsar	142	14
SSSI + SAC + NNR	152	51
SSSI + SPA + Ramsar	194	6
SSSI + SPA + NNR	70	7
SSSI + Ramsar + NNR	70	-
SSSI + SAC + SPA + Ramsar	120	-
SSSI + SAC + SPA + NNR	54	-
SSSI + SPA + Ramsar + NNR	55	-

More than 1,000 SSSIs in England and nearly 500 in Wales are also subject to higher national and international designations such as Special Protection Areas and Special Areas of Conservation (together known as Natura 2000 sites), National Nature Reserves (NNRs) and Ramsar sites (Natural England, 2007; CCW, 2006). Table 2.2 provides a breakdown of the number of SSSIs in England which have joint designation with other conservation designations.

In Wales, 359 of the 1019 SSSIs were subject to international designations in 2005/06, with 72% of the overall SSSI land area subject to such designations (Table 2.3). This indicates that a high proportion of larger sites are subject to international designations.

Table 2.3 International Designations on SSSIs in Wales

International Designation	Number of International Sites in Wales	Number of SSSIs covered by international designations	Area (ha) of SSSI covered by international designations	% of total SSSI area
SAC	90	337	149,483	58%
SPA	19	77	104,675	41%
Ramsar Sites	10	34	25,770	10%
Biosphere Reserves	1	2	3,003	1.2%
Biogenetic Reserves	1	1	593	0.2%
All International Designations	n/a	359	184,068	72%

Source: CCW (2006)

In addition, about half of SSSIs in Wales are also designated as National Parks and Areas of Outstanding Natural Beauty (AONB; CCW, 2006). In England 7% of SSSIs are designated as National Park and 15% as AONB (Natural England, 2007). SSSIs in Great Britain cover a range of habitats, with some large sites in the uplands, on estuaries and the New Forest and Salisbury Plain. On the coasts and in the uplands, some semi-natural habitats such as intertidal saltmarsh and mudflats, upland heath and blanket bog survive as uninterrupted expanses. Due to the nature of these habitats, a relatively large area is designated in large sites on the coasts and in the uplands. In contrast, many lowland habitats including meadows, heaths and woodlands, are presented by small, fragmented sites.

Characteristics of SSSIs in England4 shows the proportion of habitats that are represented in the suite of SSSIs in England. In terms of actual area designated as SSSIs, heathland and mudflats are the most abundant. The highest proportions (percentages of habitat notified as SSSIs) are for coastal habitats, highlighting the importance of the coast for habitats and species. 53% of England's SSSI land area is in the uplands (Natural England, 2009c).

Table 2.4 Characteristics of SSSIs in England

	Habitat	Estimate of resource (ha)	Area (ha) of habitat within SSSI (or SAC where specified)	% of habitat notified	% of SSSI area in favourable or recovering condition
Grassland	Acid grassland *	12,202	7,305	60	73
	Calcareous grassland	66,238	51,200	77	90
	Neutral grassland	22,402	12,416	55	80
	Purple moor-grass and rush pastures	8,734	3,974	45	90
Heathland	Heathland	316,260	228,201	72	73
Woodland	Broadleaved, mixed & yew woodland	510,292	51,647 **	10	83 ***
	Coniferous woodland	301,020	24,012	8	98
Open water	Rivers and streams	136,000 km	2,500 km	6	28
	Canals	2,624 km	154 km	2	35
	Standing waters	>50,000	20,458	<41	66
Wetlands	Bogs	265,534	185,089	70	70
	Fen, marsh and swamp *	28,305	24,921	88	64
	Coastal and floodplain grazing marsh	235,046	37,288	16	69
Inland rock	Inland rock ****	>8,500	2,429	<29	73
Coastal	Maritime cliffs	14,545	8,484	58	91
	Sand dunes and shingle	17,295	15,209	88	78
	Intertidal mudflats and saltmarsh	231,880	226,156	98	90

* Lowland types only
** Based on area of Interpreted Forest Types (Forestry Commission 2001) within broadleaf woodland SSSIs
*** Condition of broadleaf woodland SSSIs (total area 82,796 ha)
****EC Habitats Directive Annex I inland rock types only

(Source: Natural England, 2008)

Table 2.5 gives a breakdown of SSSI habitats in Wales. No one habitat type is dominant, with the three largest habitat groups - grassland, wetland and heathland - together accounting for 48% of the total SSSI area.

SSSIs vary greatly in size – some are very large but most are smaller than 100 hectares. For example, in Wales, the smallest SSSI is a nursery roost of rare Lesser Horseshoe bats in a 150-year old cottage in Pembrokeshire. It is only 0.004ha in size. The largest SSSI is the Berwyn, a large moorland area supporting heath, blanket mire and upland birds, which is 24,321 ha in size. 41% of Welsh SSSIs are under 10ha in size and 83% are under 100ha in size. Upland sites are relatively large, with 179 SSSIs in the uplands (18% of the Welsh total) accounting for 59% of the SSSI land area in Wales. In contrast the network is more fragmented in the lowlands, comprising a large number of relatively small sites (CCW, 2006).

The majority of SSSIs are privately owned, with the land primarily managed for agricultural, forestry or other purposes, rather than for wildlife conservation. SSSIs are often owned by more than one individual or organisation. The land may be used and managed by the owner(s) themselves and/or tenants, as well as by third parties who may hold rights to graze, fish, shoot or exploit other resources. In Wales, there are around 12,000 different owners and occupiers of SSSIs in Wales (excluding holders of common land and other rights). In addition, 209 SSSIs include Registered Common Land, covering 30% of all SSSIs by area. At least one quarter of Welsh SSSIs by area are owned or managed by voluntary or public conservation sector organisations, including conservation bodies such as CCW, RSPB and the Wildlife Trusts and other organisations with wider responsibilities such as the Forestry Commission, Ministry of Defence and the National Trust. The National Trust alone is responsible for 10% of the Welsh SSSI land area (CCW, 2006).

Table 2.5 SSSI Habitats in Wales

Grassland	Area (ha)	Coastal habitats	Area (ha)
Acid grassland	30,932	Inter-tidal	6,530
Calcareous grassland	905	Maritime cliff & associated ledges & crevices	669
Coastal grassland	961	Salt-marsh	7,366
Marshy grassland	9895	Sand-dune	3,477
Neutral grassland	1295	Shingle/boulders above high water mark	269
Arable	22	*Subtotal*	*18,311*
Subtotal	*44,010*	Woodland	
Wetlands		Mixed plantation	9
Blanket bog	27,416	Parkland/scattered trees, broadleaved	75
Raised bog -ombrogenous-	1,668	Semi-natural woodland	9,545
Montane flush and spring	2,873	*Subtotal*	*9,629*
Swamp	833	Freshwater	
Fen	1,573	Running water	5,211
Flush & spring	4,468	Standing water	3,639
Subtotal	*38,831*	*Subtotal*	*8,850*
Heathland		Marine	36,994
Coastal heath land	749	Geology	11,640
Dry heath	38,949	Natural inland rock exposures, screes & upland ledges	4,742
Lowland lichen/bryophyte heath	38	Bracken	11,377
Montane heath	220	Scrub	2635
Wet heath	5,841	Other	
Subtotal	*45,797*	Improved grassland, hedges, supporting habitat for species and boundaries.	32,736
		TOTAL SSSI AREA (ha)	265,552

Source: Data provided by CCW

2.4 Geological SSSIs

1214 SSSIs in England are notified for their geological / geomorphological interest (hereafter referred to as “geological SSSIs”).

Geological SSSIs can be looked at in two ways: 1) by the specialist scientific interest they were selected for, and 2) by the physical type of site they are.

Geological SSSIs are classified into site types (Prosser *et al*., 2006). There are three broad categories: finite sites, integrity sites and exposure sites (Table 2.6). Within these broad categories there are more specific types such as buried interest, caves, karst, disused quarries, road and rail cuttings etc. Individual geological SSSIs are classified against one or more site types. The site types are then used to derive the conservation objectives, against which the site condition is assessed and the management regime determined. This can then be related to the some of the benefits which can accrue from a particular site.

Table 2.6 Types of Geological SSSI in England and Wales

	Type of site
Exposure or extensive	Active quarries and pits
	Disused quarries and pits
	Coastal cliffs and foreshore
	River and stream sections
	Inland outcrops
	Exposure underground mines and tunnels
	Extensive buried interest
	Road, rail and canal cuttings
Integrity	Active process geomorphological
	Static geomorphological
	Caves
	Karst
Finite	Finite mineral, fossil or other geological
	Mine dumps
	Finite underground mines and tunnels
	Finite buried interest

Source: Prosser *et al.* (2006)

Table 2.7 GCR Categories, Number of Geo-features and their Condition, England

GCR Category	Total no. of geo-features	% of total	Favourable/ recovering	Unfavourable no change/ declining	Destroyed/ part destroyed	Not assessed/ not known
Geomorphology	190	11%	76%	8%	1%	15%
Igneous Petrology	95	5%	94%	5%	1%	0%
Mineralogy	96	5%	78%	7%	13%	1%
Palaeontology	226	13%	86%	12%	<1%	1%
Quaternary geology and geomorphology	286	17%	88%	11%	<1%	<1%

Stratigraphy	791	46%	83%	15%	2%	<1%
Structural and metamorphic geology	51	3%	92%	6%	2%	0%

The GCR identifies nationally important features of geological interest. In total, there are 1,704 notified GCR features in England within the 1,214 SSSIs. Because many SSSIs have more than one GCR feature and some GCR features extend over more than one SSSI, this gives a total of 1,735 SSSI-GCR combinations, which are referred to as 'geo-features' (Natural England, 2008). The State of the Natural Environment 2008 report categorises GCR features into seven major groups (Table 2.7). The South West region contains over a third of the total number of geo-features.

Prosser *et al*. (2006) summarise the different pressures facing geological sites and issues regarding their management, and present a series of case studies based on actual experience in conserving geological sites.

In Wales, 30% of SSSIs in Wales are notified for geological and geomorphological features (CCW, 2006). The geological features protected by SSSIs are summarised in Table 2.8.

Table 2.8 Geological Features in Welsh SSSIs

Geological Feature Groups	No. of Component Geological Features in Group	Total No of Geological Features on SSSIs	No of SSSIs where these Geological Features Occur
Palaeozoic Stratigraphy - rock layers revealing intervals of time in Earth's history	14	156	143
Igneous Petrology and Mineralogy – volcanic rocks and minerals	3	68	66
Quaternary Stratigraphy and Geomorphology - rocks and landforms associated the ice ages	2	61	60
Geomorphology - geological landscapes	6	52	45
Palaeontology - site selected for fossils	6	52	45
Precambrian, Structural and Metamorphic Geology - ancient rocks and their transformation	3	40	37
Mesozoic Stratigraphy - rock layers revealing younger intervals of time in Earth's history	2	4	3

Source: CCW (2006)

2.5 Delivery and Enforcement of the Policy

Enforcement on SSSIs is carried out by Natural England and the Countryside Council for Wales. Both bodies seek to protect sites by positive measures and through cooperation with owners and occupiers. Natural England and the Countryside Council for Wales work in partnership with others by:

- Advising the Government, other agencies, local authorities, interest groups, businesses, communities and individuals on nature conservation;
- Regulating activities affecting nature conservation sites;
- Helping others to manage land for nature conservation through grants, projects, and information; and
- Enthusing and promoting nature conservation for all.

However, where damaging activities take place on a SSSI, enforcement measures can be used. These measures range from information site notices and warning letters to prosecutions and fines (CCW, 2006).

Box 2.3: Types of offence

SSSI owners and occupiers:

- Carrying out, causing or allowing operations likely to damage a SSSI without consent;
- Failing to keep to a management notice;
- Failing to inform statutory bodies (Natural England/the Countryside Council of Wales) of any change in ownership or occupation of land in a SSSI.

Public bodies

- Carrying out or authorising operations likely to damage a SSSI without meeting the requirements;
- Failing to minimise any damage to an SSSI and if there is any damage, failing to restore it to its former state so far as is reasonably practical and possible.

Any person

- Intentionally or recklessly damaging, destroying or disturbing:
  - any of the habitats or features of a SSSI;
  - a site notice put up on land within a SSSI.

Preventing officers lawfully accessing a SSSI.

Source: Natural England (2007)

2.6 Achieving SSSI Condition

In the last 10 years there has been increased emphasis on improving and maintaining the condition of SSSIs in England and Wales.

The condition of SSSIs in the UK is monitored under a Common Standards Monitoring (CSM) framework agreed between the country statutory conservation agencies and the JNCC (JNCC, 1998). The key element of CSM is that the condition of each site is assessed with respect to site-specific Conservation Objectives for the Interest Feature(s) for which the site was notified and, in the case of SPAs, cSACs and Ramsar sites, the features for which the site was designated. A common terminology is used to describe the condition of each Feature. The PSA target for England is to achieve target condition (favourable or unfavourable recovering condition, Box 2.4) on 95% of SSSIs by area by 2010, while the Environment Strategy for Wales gives a commitment that 95% of Welsh SSSIs will be in favourable condition by 2015 and that all sites will be in favourable condition by 2026.

In 2003, Natural England completed the first round of its condition assessment programme which showed that 56.89% of SSSI area was in target condition. Based on this, progress milestones have been set. The reported condition of sites has been comparable to the projected milestones with an increase from 57% of land area in target condition in 2003 to

91% by 31 March 2010. Trajectory milestones and progress made on SSSIs in England2.9 shows the trajectory milestones and results of assessments carried out annually.

Box 2.4: Definition of different types of condition

Favourable condition means that the SSSI land is being adequately conserved and is meeting its 'conservation objectives'; however, there is scope for the enhancement of these sites.

Unfavourable recovering condition is often known simply as 'recovering'. SSSI units are not yet fully conserved but all the necessary management measures are in place. Provided that the recovery work is sustained, the SSSI will reach favourable condition in time. In many cases, restoration takes time. Woodland that has been neglected for 50 years will take several years to bring back into a working coppice cycle. A drained peat bog might need 15-20 years to restore a reasonable coverage of sphagnum.

Unfavourable no change condition means the special interest of the SSSI unit is not being conserved and will not reach favourable condition unless there are changes to the site management or external pressures. The longer the SSSI unit remains in this poor condition, the more difficult it will be, in general, to achieve recovery.

Unfavourable declining condition means that the special interest of the SSSI unit is not being conserved and will not reach favourable condition unless there are changes to site management or external pressures. The site condition is becoming progressively worse.

Part destroyed means that lasting damage has occurred to part of the special conservation interest of a SSSI unit such that it has been irretrievably lost and will never recover. Conservation work may be needed on the residual interest of the land.

Destroyed means that lasting damage has occurred to all the special conservation interest of the SSSI unit such that it has been irretrievably lost. This land will never recover.

Source: Natural England (undated) Online SSSI Glossary

A database recording the reasons for SSSIs not reaching favourable condition and actions required to remedy this is used by Natural England to monitor progress and prioritise action in order to meet the PSA target (National Audit Office, 2008). In Wales, CCW used 'rapid review' monitoring rather than full CSM to assess the condition of SSSIs until recently. This approach is an indicative one, based on a sample of SSSI features and uses a combination of survey data, field visits and professional judgement.

Table 2.9 Trajectory milestones and progress made on SSSIs in England

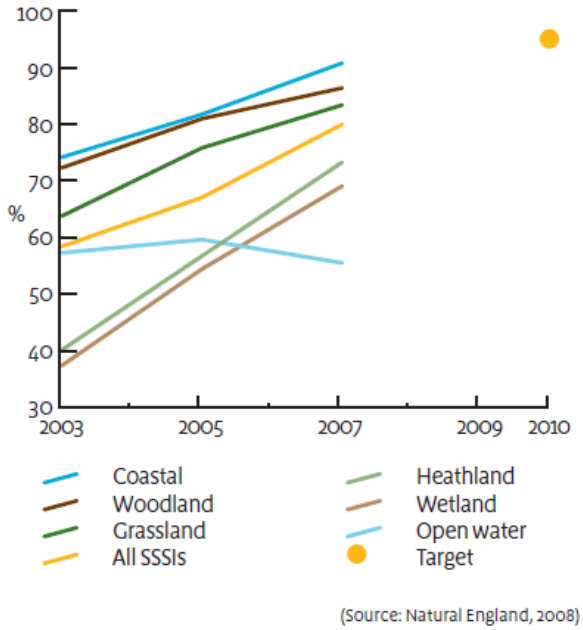
DATE	Trajectory Milestone (Percentage of SSSIs in Target Condition)	Actual end of year figure (Percentage of SSSIs in Target Condition)
31-Mar-04	62	63
31-Mar-05	67	67
31-Mar-06	72	72
31-Mar-07	78	75
31-Mar-08	83	83
31-Mar-09	89	88
31-Mar-10	93	91
31-Dec-10	95	

Source: Defra (2009)

On the whole, progress has been made in meeting the PSA target, indicating an improvement in SSSI protection and recovery. The most recent report showed that in February 2010, 43.4% of the SSSI area in England is in favourable condition, and 47.3% in unfavourable but recovering condition, resulting in the total of 90.7% in target condition as defined in the PSA (Natural England, 2010). Of the remaining area, the majority is in unfavourable and declining condition, whilst a very small proportion is destroyed or partly destroyed.

SSSI condition varies between habitats. Most habitats in England improved in condition over the period 2003 to 2007, with the exception of open waters (Figure 2.1). The only habitats with less than 50% in favourable or recovering condition at the end of 2007 were rivers and streams and canals. The habitats with the greatest area in unfavourable condition were bogs, heathlands, and intertidal mudflats and saltmarsh, though large areas of these habitats were improving in condition.

Figure 2.1 Progress towards SSSI condition target set out in the PSA, classified by main types of habitat in England (2003-2007)



(Source: Natural England, 2008)

The overall condition of geodiversity SSSIs is represented by the condition of geo-features. About 86% of geo-features in England were in favourable or unfavourable recovering condition in 2008 (Natural England, 2008). There is little difference in condition between the seven major GCR categories (see Table 2.7 above) with the exception of mineralogy (sites selected for their minerals). This has a below-average proportion of sites in favourable condition and a higher proportion of part-destroyed or destroyed sites, reflecting the sensitivity of mineral sites as a finite resource that is easily damaged by removal of material. A higher than average proportion of coastal and natural inland sites, such as river sections and outcrops in upland areas, are in favourable condition. Natural erosion helps to maintain exposures of geological features, which need to be exposed in order to study them. In contrast, inland man-made sites (such as disused quarries and cuttings) have more sites in unfavourable condition, as these geological exposures are less subject to erosion and more vulnerable to becoming obscured by vegetation and scree (Natural England, 2008).

Causes of unfavourable condition of geological sites include:

- Coastal protection schemes that obscure geological exposure and disrupt natural processes.
- Loss of geological exposures in disused quarries through vegetation encroachment, slumping of faces or landfill.

- Loss of exposure on road or railway cuttings as a result of vegetation encroachment or works to stabilise rock faces.
- Loss of mineral deposits in underground mines as a result of flooding or collapse of mine passages.
- Loss of and damage to geodiversity features as a result of development.
- Damage to fossil and mineral sites due to inappropriate collecting (Natural England, 2008).

In Wales, from a sample of SSSIs, 32% of sites were judged to be in favourable condition and 68% in unfavourable condition in 2006. Of the individual features for which SSSIs were designated:

- 47% of all features were judged to be in favourable condition
- 72% of geological features were judged to be in favourable condition
- 53% of species features (individual species and assemblages) were judged to be in favourable condition
- 29% of habitat features were judged to be in favourable condition (CCW, 2006).

The CCW report suggested that more species features were considered to be in favourable condition than habitat features, because species can be targeted more easily by conservation measures and recovery is quicker than for habitat features. Condition of habitat features could reflect long-standing issues of site management. Cliff and inter-tidal habitats for example were in more favourable condition as relatively unaffected by intensive land management, whereas grasslands, heathlands and bogs were more often in unfavourable condition. In the case of bogs, this reflects the dual pressures of overgrazing and burning in the uplands, and drainage and land claim in the lowlands. Most sand dunes were in poor condition as a result of lack of grazing, sediment starvation, and atmospheric deposition. The 2006 CCW report found that trends differed little from the results of the 2003 review, illustrating the considerable challenge faced by CCW and its partners in restoring sites and features to favourable condition.

2.7 SSSI Management – Costs and Resources

Achieving favourable condition of SSSIs is dependent on the development and implementation of appropriate management strategies. Efforts to meet targets for SSSI condition have been accompanied by significant increases in public expenditures on SSSIs in England and Wales.

A report by the National Audit Office (2008) examined Natural England's role in improving Sites of Special Scientific Interest. It estimated that £395m of public money was spent on managing SSSIs between April 2000 and March 2008, equivalent to £50 per hectare per year. Private businesses, non-government organisations, local government and individuals also contribute to the maintenance of sites, but it was noted that there is no complete overview of the costs involved. The NAO also commented that the public are not fully aware of the wider benefits of SSSIs, and called for Natural England to quantify the benefits of SSSIs and promote these to the public and businesses to encourage greater support for SSSIs

Subsequent work by Defra has provided further estimates of the costs of delivering SSSI policy, based on data provided by the main Exchequer-funded bodies with the most significant commitments to delivering SSSI condition (NE, EA, the Ministry of Defence (MoD) and the Forestry Commission (FC)). The Crown Estate also owns or manages more than 10,000ha of SSSI land, but is not strictly funded by the Exchequer, so was not included in this exercise.

Total expenditures by these four bodies on SSSIs in England are estimated at £538 million in the 11 years between 2000/01 and 2010/11. Annual expenditures have increased over

the period and are estimated at £71 million in the current financial year (2010/11). Inclusion of EU co-funding of £30 million brings the annual total to £101 million (Table 2.10). The largest elements relate to incentives paid to private land owners and costs of direct management of public land.

Table 2.10 Estimated Public expenditures on SSSIs, England, 2010/11

Cost Item	Estimated Expenditure (2010/11, £k)	Estimated Expenditure (2000/01 to 2010/11, £k)
Incentives	26,947	225,878
Advocacy/Advice	13,920	101,640
Project/Programme Management	1,260	12,315
Direct Management	25,900	170,105
Regulation	3,230	28,510
UK Exchequer Cost	***71,257***	***538,448***
EU Co-Funding	30,204	156,119
Total Public Cost	**101,461**	**694,567**

Source: Defra data (unpublished)

SSSIs have benefited greatly from agri-environment schemes (AES) and other land management/conservation schemes. **Error! Reference source not found.** 2.11 estimates the area in different schemes as documented in a 2008 report by Natural England. Further development of the Environmental Stewardship scheme since then is likely to have increased the area of SSSI under HLS and ELS agreements.

Table 2.11 Area (ha) of designated sites attracting funding from land management schemes (percentage in parentheses)

	Higher Level Stewardship scheme	Environmentally Senstive Areas scheme	Countryside Stewardship scheme	Wildlife Enhancement scheme	Woodland Grant scheme
National Park	55,920 (5)	322,780 (31)	199,230 (19)	151,910 (14)	12,580 (1)
AONB	114,100 (6)	157,740 (8)	480,610 (24)	96,060 (5)	41,450 (2)
SSSI	73,890 (7)	131,260 (12)	196,320 (18)	249,980 (23)	25,570 (2)
SAC (without marine SAC area)	46,830 (6)	100,080 (14)	127,700 (17)	207,870 (28)	10,230 (1)
SPA	43,070 (6)	60,680 (9)	111,450 (16)	158,060 (22)	3,260 (<1)
Ramsar	10,700 (3)	14,760 (4)	28,300 (8)	8,450 (2)	280 (<1)
NNR	2,110 (2)	5,190 (6)	7,820 (8)	13,300 (14)	3,990 (4)

The schemes are not exclusive, eg SSSI land may have both an ESA and a WES agreement.
HLS and CS figures are based on the area of the complete holding rather than the specific area in agreement.
(Source: Natural England, 2008)

Maintaining resourcing of SSSI management is a key element of the policy, as without sufficient resourcing of management activity the condition of SSSIs could be expected to decline over time. The funding of SSSIs is therefore the key variable used in this study to assess the benefits of SSSIs relative to the counterfactual ("policy off") scenario, as set out in the Inception Report (GHK *et al.*, 2010):

Using the current condition of Sites of Scientific Interest as a baseline, the project will estimate the benefits of designation in alternative scenarios where:

a. *Increased future funding leads to achieving favourable condition on all sites.*
b. *Future funding is maintained at levels sufficient to maintain current levels of SSSI condition*

c. *Future funding is removed, leading to a gradual decline in the proportion of sites in favourable condition.*

No breakdown is available for the amounts spent on biological and geological SSSIs; however, the latter are believed to account for only a small proportion of the total, and in general are not covered by agri-environment schemes.

In Wales, no detailed assessment of expenditure is available, though the project specification for this Benefits of SSSIs study estimated total annual expenditure on SSSIs at around £10 million. In 2005/06, around 18% of the SSSI land area was covered by Section 15 and 16 management agreements with CCW and 30% by agri-environment schemes (Table 2.12).

Table 2.12 Management Agreements on Welsh SSSIs, 2005/06

Mechanism	Total area of SSSI with agreement (ha)	Total number of SSSIs with agreement	Percentage of all SSSIs by area	Total value of CCW payments in 2005/06
Management Agreements				
Section 15	36,957	338	14.4%	£1,362,231
Section 16	9,641	29	3.7%	£332,619
Agri-Environment Schemes				
Tir Gofal	47,122	158	18%	n/a
Environmentally Sensitive Areas	22,488	182	9%	n/a
Organic Farming Scheme	7,752	85	3%	n/a
Habitat Scheme	489	57	0.2%	n/a

Source: CCW (2006)

The best estimate of current public expenditure for SSSIs in England and Wales is therefore £111 million annually (£101 million for England and £10 million for Wales).

2.8 Effectiveness and Limitations of SSSI Designations

The SSSI system was developed to meet the needs of conservation within the confines of a populated country, much of which has been modified by human activities (McCarthy, 1991). Barton & Buckley (1983) looked at the extent to which SSSI notification safeguarded conservation interest. They found that prior to the Wildlife and Countryside Act (1981), in the south east of England, SSSI status often failed to prevent damage by activities such as farming, urban development and forestry, and resulted in a constant stream of proposals to develop or improve the land. Many sites suffered loss (total or partial modification) of semi-natural vegetation, e.g. of species-rich grassland, due to ploughing and fertilising of grassland.

Loss and damage to SSSIs was also documented in more recent assessments (e.g. Rowell, 1991; Sheail, 1998), focusing attention on the achievement of condition. Lack of remedial management is most often cited as the reason for unfavourable condition in SSSIs (Williams, 2006). Over- and under-grazing, as well as presence of invasive or non-native species are often commonly associated with unfavourable condition. Almost half of sites assessed between 1997 and 2003 were considered to be in unfavourable condition (Williams, 2006). Under- or over-grazing is one reason for this, particularly in relation to Red List plant conservation. Increased visitor damage to sensitive habitats and negative impacts

on landscape and biodiversity can be an issue for protected areas including SSSIs (Selman, 2009). However, Mather (1993) found that intensive cultivation and built developments were rarely found on SSSIs, particularly in Scotland. In most cases, there was no increase or decrease in management. Management agreements and agri-environment schemes are important tools to deal with management problems. SSSIs are protected (to an extent) against over-management, under-management and potentially damaging operations (Selman, 2009).

The major focus on SSSI condition in recent years has addressed many of these concerns. However, issues remain with regard to the extent of the network and its interactions with other activities and land uses.

Most statutory protected areas in Britain area are small in size. This creates large edge effects, increased interference from outside activities and a reduced potential for maintaining local populations as well as difficulties with dispersal between local populations (Latham, 2007).

Some other difficulties associated with protected areas include the tendency to treat protected areas as 'islands', and as an alternative to (rather than an element within) a national strategy for conservation (Jackson *et al.*, 2009). There may be a failure to integrate protected areas requirements into policies which affect them (e.g. agriculture, tourism, transport) and the needs and interests of local people may not always be fully recognised.

Much important habitat lies outside of SSSIs e.g. in England: 84% of broadleaved woodlands, 45% of heathlands, 14% of semi-natural grasslands and 26% of mires, bogs and fens lie outside of SSSIs and SACs (Catchpole, 2007). Some have argued that physical changes such as those caused by climate change or marine incursion could make protected areas obsolete in the future (Bishop *et al.*, 1995). Others, however, argue that climate change will intensify the pressures on wildlife and increase the importance of protected areas, as strongholds for wildlife in a changing environment (RSPB, undated).

Indeed, the need for nature conservation policy to look beyond SSSIs was recognised by Natural England in its response to the House of Commons Innovation, Universities, Skills and Science Committee report on Sites of Special Scientific Interest in July 2009. The report focused on the scientific evidence base used for designating and monitoring SSSIs. Natural England's response noted that:

"SSSIs cannot be regarded as a scientific curiosity, and the idea that they can be maintained as isolated conservation showpieces is moribund. All too often, SSSIs are now the only enclaves left for a wide range of species and we cannot leave them isolated in the way they have been if we are to secure a stable future for our wildlife and biodiversity.

Caring for SSSIs is a conservation imperative, but allowing habitats and species to survive beyond these protected areas and to expand into the wider landscape is perhaps an even greater one. We welcome today's IUSS report and the focus it maintains on getting SSSIs right, but we should be under no illusions that SSSIs are the only part of the equation. We have to give wildlife and habitats more room to thrive and to do this we have to move urgently from relying on the conservation of small sites to the management of entire landscape areas."

Similar conclusions were drawn by the Public Accounts Committee (2009) in its report *Natural England's role in improving Sites of Special Scientific Interest*.

"The current approach of designating individual locations may not be the most appropriate as biodiversity responds to increasing climate and environmental pressures. Enabling species to move between sites may be essential if they are to adapt, for example to a changing climate."

The PAC report also noted that: *"public understanding of the role, existence and accessibility of sites is low… Through its web site and other media, Natural England should pilot approaches to encourage responsible public use of sites…"* This raises questions as to whether the public benefits of SSSIs, and the values that people attach to them, are being optimised.

The limitations of SSSIs were also recognised in the recent Making Space for Nature Review (Lawton *et al.*, 2010), which concluded that:

The evidence demonstrates that the SSSI series, as important as it is, clearly does not in itself comprise a coherent and resilient ecological network. Perhaps this should not come as a surprise since SSSIs were not designated with this aim in mind.... 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.

Further details of the review and its recommendations are given in the next section.

Little evidence could be found evaluating the effectiveness of geological SSSIs. However, the relatively high proportion of geological SSSIs in favourable condition indicates that the policy has been relatively effective in their conservation. Most geological SSSI are static features and SSSI designation has worked well in protecting them from damage and degradation. Mobile and dynamic features such as eroding coastlines or mobile river features present greater challenges, but overall the SSSI approach is understood to have worked well for geology and geomorphology, where sufficient resources have been available for site management.

2.9 Current Policy Reviews and Developments

2.9.1 Making Space for Nature - a review of England's wildlife sites and ecological network

The need to look beyond designated sites and to assess their role within the wider landscape was reflected in Defra's creation in September 2009 of an independent panel to review England's wildlife sites and ecological network. Chaired by Professor Sir John Lawton, the panel explored whether England's collection of wildlife areas represents a coherent and robust ecological network that will be capable of responding to the challenges of climate change and to other pressures. The review sought views from consultees on the characteristics of a coherent and resilient ecological approach, and the factors that such an approach can deliver. The review reported in September 2010 (Lawton *et al.*, 2010).

The Making Space for Nature Review concluded that there is a need for a step-change in nature conservation, embracing a new, restorative approach which rebuilds nature and creates a more resilient natural environment for the benefit of wildlife and society. It observed that legislation has improved first the protection, and more recently the management, of wildlife sites in particular SSSIs. However, despite the important contribution designated sites have made, England's wildlife habitats have become increasing fragmented and isolated, leading to declines in the provision of some ecosystem services, and losses to species populations.

Ecological networks have become widely recognised as an effective response to conserve wildlife in environments that have become fragmented by human activities. Establishing ecological networks in England will deliver a range of benefits for people as well as wildlife, because of the range of ecosystem services that resilient, coherent ecological networks can provide. The review recommended that this should be underpinned by three objectives:

(1) To restore species and habitats appropriate to England's physical and geographical context to levels sustainable in a changing climate, and enhanced in comparison with those in 2000;

(2) To restore and secure the long-term sustainability of the ecological and physical processes that underpin the way ecosystems work, thereby enhancing the capacity of our natural environment to provide ecosystem services such as clean water, climate regulation and crop pollination, as well as providing habitats for wildlife; and

(3) To provide accessible natural environments rich in wildlife for people to enjoy and experience.

Establishing a coherent and resilient ecological network will help wildlife to cope with climate change and other economic, demographic and environmental pressures. It will also improve the ability of the natural environment to provide a range of high quality ecosystem services today and in the future.

Lawton *et al.* argued that we need to take steps to rebuild nature by (i) improving the quality of current sites by better habitat management; (ii) increasing the size of current wildlife sites; (iii) enhancing connections between, or join up, sites, either through physical corridors, or through 'stepping stones'; (iv) creating new sites; and (v) reducing the pressures on wildlife by improving the wider environment, including through buffering wildlife sites.

The review recommended that the first priority is to enhance the quality of remaining wildlife habitat. While increasing connectivity is important, first there needs to be high quality sites with thriving wildlife populations to connect. In particular, we need to continue the recent progress in improving the management and condition of wildlife sites, particularly SSSIs. Recommendations are made for how these should be designated and managed in ways that enhance their resilience to climate change. Further recommendations are made regarding the planning and development of ecological networks to link these sites.

While precise cost estimates cannot be made, the review suggested that the total annual costs of establishing a coherent and resilient network will be in the range of £600 million to £1.1 billion, including existing expenditures.

2.9.2 The National Ecosystem Assessment (NEA)

The NEA has been commissioned by Defra and the devolved administrations of Northern Ireland, Scotland and Wales. The UNEP World Conservation Monitoring Centre in Cambridge is coordinating the different assessment activities for the NEA, with reporting due early in 2011. The NEA stems from the 2007 House of Commons Environment Audit Committee which recommended that Government conduct a full review of the state of the UK's ecosystem services, looking across the full scope of such services as set out in the Millennium Ecosystem Assessment.

The proposed outcomes of the NEA can be summarised as:

- Explaining the state and value of the UK's natural environment and ecosystem services;
- Exploring the linkages between habitats, ecosystem services and biodiversity;
- Identifying knowledge gaps for habitats and ecosystem services that will inform future research;
- Embedding ecosystem services and the ecosystems approach in decision making at all practical and administrative scales.

To date, the main interim output from the NEA is *Progress and Steps Towards Delivery*, a report published in February 2010 (UKNEA, 2010). There is no specific reference to SSSIs in the document, but it notes that: *"Biodiversity plays an important role in the natural environment and the UK NEA will consider the role biodiversity plays throughout the assessment".*

Amongst the progress reported in this document, is commencement of the monetary valuation of goods provided by the UK's ecosystem services. The document also notes that non-economic values such as "inspirational and spiritual experiences" will be assessed, and some benefits such as "health changes" will be assessed using both monetary and non-monetary measures.

2.10 Conclusions

Policy for SSSIs in England and Wales has developed over a period of 60 years, during which time it has evolved to reflect changing issues and understanding reflecting the pressures affecting sites and their needs with regard to protection and management.

There are now more than 4,000 SSSIs in England and 1,000 in Wales, covering a significant area of land and supporting many of our most valuable habitats, species and geological and geomorphological features. Since SSSIs were introduced policy has gradually developed – where previously the focus was very much on protection from development and damaging operations, there has been a sharper focus in the last decade on the condition of sites and in implementing management regimes to achieve favourable condition. This in turn has required increasing levels of financial resources to be focused on SSSIs, through agri-environment and other land management schemes. The increasing cost of SSSI policy demands greater attention to be paid to the benefits that it delivers. SSSI policy is understood to have worked well in the conservation of geological SSSIs.

While SSSI policy is increasingly effective in protecting and enhancing the condition of SSSIs themselves, it needs to be recognised that large areas of countryside are beyond the influence of the policy. SSSIs cover a large proportion of some habitats but only a minority of others, and are affected by management of adjacent sites (e.g. diffuse pollution from agriculture). In addition, climate change and other pressures have brought a need to rethink the effectiveness of the current network of protected sites and to look beyond SSSI boundaries, although it has been argued that, even if these changes affect the wildlife that SSSIs support, the need for a well managed network of protected areas will remain in future.

3 Conservation Benefits of SSSIs

3.1 Introduction

This section of the review focuses on the benefits of SSSIs in conserving species, habitats and geodiversity in England and Wales. These benefits depend on:

- The extent to which the SSSI network covers our most important species, habitats and geodiversity features;
- The degree to which SSSI status furthers the conservation of these biological and geological features, by protecting them from development or other pressures and by facilitating positive management of the sites which support them.

3.2 Measuring the Benefits of Biological SSSIs

Measurement of the effectiveness of protected areas is useful to improve the efficiency of conservation action and facilitate appropriate management action at local and national levels, as well as providing more evidence for funding agencies, policymakers and landowners. To address the lack of information on effectiveness of protected areas, the UK Population Biology Network (UKPopNet) workshop looked at the current state of knowledge and carried out a gap analysis (Gaston *et al.*, 2006). There are two ways to measure the ecological effectiveness – measures of inventory (the amount of biodiversity present) and measures of condition or persistence (the status of biodiversity features within protected areas). Over time, measures of inventory can indirectly give indications of condition or persistence.

Ecological effectiveness can be addressed at three spatial extents – individual protected areas, series of protected areas, and functional networks of protected areas, though less is currently known at the network scale. The main issue for ecological effectiveness at the series scale is how well it represents the full range and examples of biodiversity features across a region (or nationally). Studies looking at the effectiveness of protected sites at this scale (e.g. Oldfield *et al.*, 2004; Jackson *et al.*, 2004) have generally concluded that the series does represent the biodiversity features well, but that it could also be improved upon. Overall, availability of accurate information on the distribution of biodiversity features at the regional level is limited (Gaston *et al.*, 2006). At larger scales, a key issue is whether individual species can move between sites, so their location and connecting habitat is important. However, apart from some work by CCW and Forestry Commission Wales (Latham *et al.*, 2004) which provided an indirect measure of the effectiveness of the protected area network, there is little information on the measurement of the effectiveness of networks.

Gaston *et al.* (2006) identified limitations to the Common Standards Monitoring approach, noting that the judgement about when an unfavourable area is 'recovering' is subjective. There is also a challenge in maintaining consistency across sites and over time. In addition, it is sometimes difficult to assess the impacts and benefits of SSSIs for some bird and mammal species which are mobile and can travel between designated and non-designated areas.

Insufficient data are available on species populations in SSSIs to measure extinction risk (Defra, 2004) although for species restricted to rare or semi-natural habitats, it is likely that SSSIs have made a significant contribution to reducing local extinctions and declines.

3.3 Summary of Benefits of the Biological SSSI Network

The conservation benefits of SSSIs are related to their naturalness, size, rarity, diversity and international importance (Ratcliffe, 1997) as well as their uniqueness (SNH, 1999). SSSIs support rare, threatened and declining species and provide protection for valuable habitats. The importance of a SSSI will depend on the importance of the 'feature of interest' (i.e. the reason for the designation) and on the biogeographical importance of the feature (Defra,

2004). Feature importance should take into account its conservation status, its potential as flagship status, ecosystem functions, socio-economic value and its quality (i.e. whether it is in 'favourable condition' or the potential value if it was in this condition). Biogeographical importance relates to the proportion of the habitat or species that occurs within the SSSI - a site may be more important if it protects a high proportion of the total resource (Defra, 2004). Area and international importance can be used as 'proxy' measures of the conservation importance of SSSIs. Large sites are generally higher value as they tend to have greater diversity (Huston, 1994). Where SSSI designation overlaps with Ramsar Sites, SACs or SPAs, sites are deemed to be of international importance.

Bishop *et al*. (1995) found that the strengths of the protected areas approach (from a global perspective) included safeguarding places which are outstanding in terms of natural wealth, natural beauty and cultural significance and maintenance of diversity of ecosystems, species, genetic variation and ecological processes. Designations have encouraged targeted action in terms of habitat recovery (Natural England, 2008). In some cases, intensive management measures such as hand pollination, seeding, fencing and wardening of sites has been required to maintain small populations of certain plant species on protected areas (e.g. lady's slipper orchid, Ramsay & Stewart, 1998).

3.4 Benefits to Habitats

Historically, SSSI designation has provided varying levels of protection for wildlife and geology - protection has gradually improved with the evolution of legislation. No systematic review exists of trends in damage to SSSIs before the Wildlife and Countryside Act (1981) but documentation suggests that SSSI protection was ineffective (CJC Consulting, 2004). With the revision and reinforcing of the Countryside and Rights of Way Act (2000), improvement of SSSIs became a core conservation priority (CJC Consulting, 2004). The Act gave public bodies a statutory duty to promote the enhancement of SSSIs and English Nature (now Natural England) was given authority to ensure proper management of SSSIs. Positive partnerships between government agencies, land owners and managers are promoted and Natural England has the power to give a management notice requiring particular works to be undertaken where SSSI condition has been neglected (CJC Consulting, 2004; Section 2.4).

Progress towards the Public Service Agreement (PSA) target of bringing 95% of SSSIs into favourable or recovering condition by 2010 is on course, demonstrating that management on SSSIs has greatly improved during the last decade. This has been assisted by funding from agri-environment and other land management schemes. Inclusion of SSSIs in AES has been found to enhance condition significantly through improvements in management (Rural Development Service and English Nature, 2006).

Where SSSIs have reached target condition, this will make a significant contribution to the UK Biodiversity Action Plan through the delivery of targets for the restoration and maintenance of priority habitats (such as saltmarsh and lowland calcareous grassland). This should in turn contribute to targets for priority species. Most SSSIs in Wales (82%) were notified for habitat features, such as fen, marsh and swamp, dwarf shrub heath and acid grassland (CCW, 2006). SSSIs include unique habitats and features such as blanket bogs, maritime heathlands and limestone pavements. Blanket bogs act as carbon stores and can limit the effects of global warming (Natural England, 2008). Rodrigues *et al*. (1999) found that a SSSI network of wetland fen sites in Scotland was successful in representing diversity.

Because evidence of the condition of habitats across the wider countryside is not widely available in a form comparable to that of the SSSI condition assessments, an evaluation of the exact impact of SSSI designation is difficult. However, comparative surveys of SSSI and non-SSSI lowland grassland and heathland show that SSSI habitats are in very significantly better condition than non-SSSI habitats (Natural England, 2008). Natural England concludes in their 2008 report 'State of the Natural Environment' that *"Where comparable evidence has been collected, it demonstrates better condition of habitats under SSSI designation compared to non-designated areas."* For example, a study of a sample of non-SSSI

heathland in England found that none was in favourable condition, compared to 17% of UK SSSI heathland assessed by the JNCC (Hewins *et al.,* 2007).

As a result SSSIs make a significant contribution to UKBAP and the England Biodiversity Strategy (Natural England, 2008;

3.1).

SSSI contribution to habitat targets under the UK Biodiversity Action Plan is larger for those priority habitats where a high proportion fall within protected areas. CJC Consulting (2004) summarised the contribution of SSSIs to BAP targets for different habitats in England (Table 4.2). The SSSI network includes all examples of one priority habitat - aquifer fed naturally fluctuating water bodies – and a major proportion of others such as lowland wood pasture and parkland, limestone pavement and most coastal habitats. However, it protects only a minor proportion (<10%) of some agricultural habitats such as hedgerows and arable field margins.

Table 3.1 SSSI contribution to BAP targets

Habitats	Contribution of SSSIs to BAP targets
Aquifer fed naturally fluctuating water bodies	Complete (100% of national habitat area)
Lowland wood pasture and parkland, upland hay meadow, lowland calcareous grassland, upland calcareous grassland, lowland dry acid grassland, purple moor grass and rush pasture, upland heathland, lowland heathland, fen, reedbeds, lowland raised bog, blanket bog, chalk rivers, limestone pavement, vegetated shingle, coastal saltmarsh, mudflats, maritime cliff and slope, coastal sand dunes,	Major (50-99% of national habitat area)
Upland oak woodland, lowland beech woodland, upland mixed ashwoods, wet woodlands, coastal floodplain and grazing marsh, lowland meadows, eutrophic standing waters, mesotrophic lakes, littoral and sublittoral chalk	Significant (10-49% of national habitat area)
Hedgerows, cereal field margins, upland calcareous grassland	Insignificant (<10% of national habitat area)

Source: CJC Consulting (2004), Lawton et al. (2010)

Evidence provided by Natural England for the Making Space for Nature Review found that all BAP priority habitats are represented in SSSIs in every English region in which they occur. On average, 71% of BAP priority habitats are protected in SSSIs, although there is a large amount of variation, with low coverage of some habitats such as coastal and floodplain grazing marsh (18.5%) and broadleaved woodland (24.7%) and very high representation of others, including reed beds (98.3% and coastal vegetated shingle sites (93.1%). One of the reasons for the difference in SSSI coverage across habitats is that for some habitats SSSIs are selected to provide only an exemplar representation (e.g. more common habitats such as broadleaved woodlands and upland heathland), while for others the SSSI guidelines are to designate all occurrences that are of a minimum standard (including most types of grassland).

There are some recognised gaps in coverage. These include geographical gaps for certain habitats, such as lowland heathlands in west Cornwall and, perhaps more significantly, there are also some habitat types which are very poorly represented in the SSSI series as a whole. They include some arable habitats of botanical importance, and two recently listed BAP priority habitats, traditional orchards and open mosaic habitats on previously developed land, which can host a range of rare species (Lawton *et al.*, 2010).

3.5 Benefits to Species

Designation of SSSIs for species is covered by the Guidelines for the selection of biological SSSIs (NCC, 1989) which provide specific criteria for different species groups (vascular plants, non vascular plants, mammals, birds, reptiles and amphibians, freshwater and estuarine fish, invertebrates, butterflies and dragonflies). These criteria relate to species diversity, population size and rarity, as well as referring to the international importance of sites for species conservation.

It has been demonstrated that SSSIs support the majority, but not all, of the species found nationally. For example, recent analyses have found that 88% of the UK's vascular plants, 70% of threatened bryophytes and 100% of BAP butterfly species are represented in the SSSI network (Lawton *et al*., 2010).

SSSIs have helped to protect some species in England which would otherwise be at risk of extinction. For example, the United Kingdom has between 25% and 50% of the world's population of bog orchids which are threatened with extinction throughout Europe. All bog orchids in England are protected within SSSI land and plants on such sites depend on the continued management of the habitat (House of Commons Public Accounts Committee, 2009a). Jackson *et al*. (2009) found that a high proportion of Red List plant species occur within protected areas despite the fact that many of these areas were not originally designated for conserving these species. Protected areas are increasingly important, as fragmentation and intense land use continue to restrict ranges. Despite good overall species coverage, protected areas cover less than one third of the total number of occurrence records for Red List plant species, which limits the extent to which there is effective 'risk-spreading'.

Data provided for the Making Space for Nature Review by Natural England reveal that in total there are 879 habitats and species ('features') for which at least one site has been notified, i.e. the feature is listed as a reason for the SSSI's selection. Of these, 280 features (mostly species) have only one notified site. In some cases, such as the Sussex Emerald moth, this is because there is only one site. In others, the species may occur at many more SSSIs but they are not mentioned in the citation. For example only a single site is notified explicitly for Mute Swan but 150 SSSIs contain wetland bird assemblages in which this species can occur. There are also likely to be many other species that are protected within the SSSI series that are not listed on any citation.

There are known SSSI gaps for certain types of species. SSSI guidelines for the selection of grassland fungi were only published in 2009 and there have so far been few sites selected for this group. Guidelines are also lacking for other less well known groups including types of algae and many soil-living organisms. A number of notably rare species lie outside the SSSI series, including the endemic lichen *Lecidea subspeira* which is known globally only from a single churchyard in West Sussex; similarly the only English population of Pyramidal Bugle *Ajuga pyramidalis* is not within a SSSI, nor are the only two sites of the freshwater snail *Sphaerium solidum*. Furthermore, a recent survey of the biodiversity potential of 478 brownfield sites in the Thames Gateway found that of 113 rated 'high' in terms of invertebrate interest, only one was designated as SSSI (Lawton *et al.*, 2010).

Overall, the Making Space for Nature Review concluded that, with some exceptions, our current wildlife sites broadly do meet the criterion of supporting the full range of England's biodiversity.

Protection of SSSIs contributes to reversing the long-term decline in number of farmland birds, albeit in a minor way, as only a very small proportion of farmland bird habitat falls within SSSIs (Defra, 2004). Ferns and allied plants are likely to have moderate protection through SSSI designation, since they are often associated with habitats which have good protection within the SSSI network, for example ancient woodlands and fens (Page, 2001).

SSSIs are important for threatened species of butterfly and management of SSSIs to achieve favourable condition is important in determining future population levels of these. Davies *et al*. (2007) investigated the relationship between SSSI condition status and population trend for eight threatened or declining butterfly species (*Polyommatus bellargus* (Adonis blue), *Hamearis lucina* (Duke of Burgundy), *Euphydryas aurinia* (marsh fritillary),

Hesparia comma (silver-spotted skipper), *Cupido minimus* (small blue), *Plebeius argus* (silver-studded blue), *Boloria euphrosyne* (pearl-bordered fritillary) and *Argynnis aglaja* (dark green fritillary)). They found that the majority (80%) of population trends for these butterfly species on SSSIs in favourable condition were positive. However, half of these species were found at lower population levels at favourable condition SSSIs than at unfavourable condition sites. Furthermore, not all SSSIs are notified for threatened butterfly species even if those species occur on those sites.

Jackson *et al*. (2009) looked at the extent of restriction of 371 Red List vascular plant species of conservation concern in statutory protected areas. They found that 88% of species were represented at least once within SSSIs and that protected area coverage was the most important predictor of species richness across Britain. A high proportion of Red List plant species occurred within protected areas despite the fact that many of these areas were not originally designated for conserving these species. This shows the increasing importance of protected areas, as fragmentation and intense land use continue to restrict ranges. Despite good overall species coverage, protected areas cover less than one third of the total number of occurrence records for Red List plant species, which limits the extent to which there is effective 'risk-spreading'. Jackson *et al*. (2009) also found that 40 species, some of which are critically endangered, were completely absent from protected areas.

Devictor *et al*. (2007) investigated whether declining species could benefit from protected areas in France (including SPAs and Nature Reserves), using the 100 most common bird species. Although protected areas conserve species or habitats that are under threat elsewhere (e.g. South Africa - Fabricius *et al.*, 2003), less is known about the role of protected areas for more common species, which can be good indicators of ecosystem health and function (Gregory *et al.*, 2005). The study found that declining common species of bird had higher relative densities and showed higher temporal stability in protected areas. They also found that habitat-specialist species such as mistle thrush had higher densities in protected plots than elsewhere but that habitat-generalists such as common blackbird had higher densities in non-protected areas.

Banks *et al*. (1994) found that habitat protection, mainly in the form of SSSI designation, had been effective in safeguarding the natterjack toad (*Bufo calamita*), with safeguarded sites increasing from 60% in 1970 to 83% in 1990. Sites with SSSI or NNR status fared better than sites without any statutory habitat protection, particularly after the Wildlife and Countryside Act came into force.

Assessment of Breeding Waders of Wet Meadow surveys of 1982 and 2002 revealed a 62% decline in the breeding population of snipe (*Gallinago gallinago*) on lowland wet grassland between these two dates (Wilson *et al.*, 2005). Analyses to relate these changes to site characteristics found that designation as a SSSI or nature reserve was a significant positive predictor of snipe presence, with snipe densities also tending to be significantly higher on SSSIs than other sites.

3.6 Benefits to Geodiversity

SSSIs form the main statutory mechanism for protecting nationally important geological sites in Great Britain. SSSI designation provides a high degree of protection for sites although it does not guarantee their long-term conservation (Prosser *et al.*, 2006). Geological SSSIs are subject to similar legal protection and procedures for condition assessment as biological SSSIs.

Like biological SSSIs, geological sites need management to achieve and maintain favourable condition. Rocks, fossils and minerals, exposed in artificial situations such as cuttings, or in natural outcrops, require active management to maintain the exposures and physical access to them. Approximately half of all geological SSSIs currently need vegetation or scree clearance, followed by on-going management to maintain exposures in favourable condition (Stace and Larwood, 2006). Geological SSSIs are generally not covered by agri-environment schemes but attract some funding from other programmes. For example, English Nature's Face Lift project directed £470,000 in 2000 to 2006 to restore more than 260 SSSIs. Enhancement work included vegetation clearance, scree and rubbish

removal and re-excavation of geological sections, as well as the provision of on-site information, improved safety and better access for visitors. A long-term commitment is required to ongoing management, to ensure that sites are maintained in favourable condition (Stace and Larwood, 2006). In 2009, Natural England announced a new Conservation Enhancement Scheme designed to fund management of SSSIs that were not eligible for Environmental Stewardship, which include some geological SSSIs.

The many benefits and services that geological sites provide to society are described in Section 4.4 below.

3.7 Protection from development

Although the level of protection afforded varies from site to site there is evidence that many adverse effects from development are avoided by environmental designation.

In a study for the Countryside Council for Wales, Berkeley Hanover Consulting examined the impact of environmental designation on nine different sectors in Wales (Berkeley Hanover Consulting and TACP, 2004). A main finding was that the planning system was effectively steering development away from designated areas and that developers tended to avoid protected sites. In turn, while some additional costs were incurred from extra study costs, delays, avoidance and mitigation costs the study found that development was not harmfully constrained by the level of designations and though investment was diverted around designated sites they were not curtailed by environmental designations. A study by the University of Sheffield for Natural England analysed development related land use change in protected landscapes and showed that during the last 20 years only two hectares of land within National Parks and Areas of Outstanding Beauty were converted for development for every three hectares that might have been expected (Natural England, 2008).

Differing designations carry different levels of protection from development. Planning Policy Statement 9: Biodiversity and Geological Conservation (ODPM, 2005) makes clear that SSSI status is a material consideration in the planning system, meaning that the SSSI status is weighed in the balance against other material considerations. For SPAs and SACs the Habitats Directive tests applied are more robust. All developments which could have a likely significant effect must be subject to an Appropriate Assessment with the input of NE/CCW, and if the possibility of adverse effects cannot be excluded, development can only proceed if additional strict tests are passed and compensation provided. Development may still take place in SPAs and SACs and in most cases adverse effects can be avoided or mitigated. However, the Habitats Directive sets a 'no net loss' bottom line – there is no such guarantee with SSSI status alone.

3.8 Conclusions

The conservation benefits of SSSIs are difficult to quantify. However, the recent Making Space for Nature Review concluded that, overall, the SSSI series provides good coverage of England's biodiversity. It is clear that it has enhanced the protection of many of our more valuable species and habitats, a significant but variable proportion of which are now concentrated in SSSIs. SSSIs have made a significant contribution to reducing declines and local extinctions in several species groups (Defra, 2004). SSSI policy has helped to improve the ecological condition of sites, to the benefit of habitats and species. It is therefore playing a major role in the delivery of the UK Biodiversity Action Plan and the country biodiversity strategies of the devolved administrations. It has been effective in conserving and maintaining the condition of many of our most important geological and geomorphological sites.

Studies on the effectiveness of protected areas are scarce and tend to focus on management of individual sites. However some studies have attempted to identify new priority areas for conservation and initiatives are underway to investigate whether protected areas are forming functional networks (Gaston *et al*., 2006).

The obstacle to establishing the effectiveness of protected areas in conserving biodiversity and geodiversity, the reason for which they were designated, is the lack of systematically collected data, as well as lack of availability of existing data, due to confidentiality reasons, or because it has not been collated or computerised (Gaston *et al*., 2006). Change also needs to be taken into account, as current conservation value of many sites may change e.g. with the changing climate. Opdam & Wascher (2004) came to the conclusion that effective conservation (taking into account climate change) would require functional ecological networks, to allow distribution shifts in changing environmental conditions.

4 Benefits to People - Ecosystem Services Delivered by SSSIs

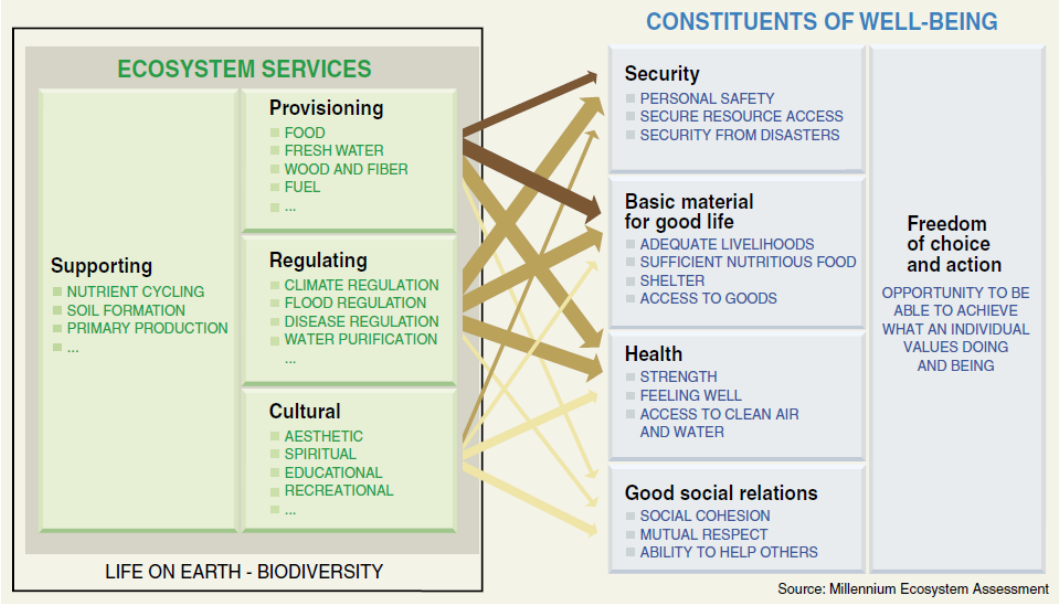
4.1 Overview

As well as being of direct value for wildlife and natural features, SSSIs provide services that contribute to the well-being of people and society as a whole. The Millennium Ecosystem Assessment (MA) distinguishes between four types of ecosystem services supporting human well-being:

- Supporting services (e.g. nutrient cycling and habitat provision);
- Provisioning services (e.g. food and fuel);
- Regulating services (e.g. flood risk regulation); and
- Cultural services (e.g. aesthetic and educational).

Supporting services do not provide direct benefits to people but underpin the provisioning, regulating and cultural services delivered by well-functioning ecosystems.

Figure 4.1 Ecosystems deliver important services that support human well-being



SSSIs deliver a variety of ecosystem services; they provide important cultural and recreational opportunities; contribute to the regulation of air, water, and soils; and provide food, fibre and genetic resources. As well as protecting the ecological processes and geological features on which society depends, SSSIs provide opportunities for people to appreciate nature and geodiversity and often make a direct contribution to the local economy.

Table 4.1 summarises the key services potentially delivered by SSSIs, considering their effects on human well-being[3].

[3] Based on the literature on SSSIs and ecosystem services

Table 4.1 Main Categories of Ecosystem Services Potentially Delivered by SSSIs

Service	Effect of SSSIs	Benefits for Human Wellbeing	Distribution of Benefits
Provisioning Services			
Food, fibre, fuel	Likely negative net effects as SSSI management reduces agricultural and forest yields; possible increases in quality of produce and wild food	Changes in output of food, fibre, fuel	A wide variety of sites provide these services, either commercially or informally, e.g. grasslands, uplands, woodlands and coastal habitats
Genetic resources	SSSIs have been identified as significant in holding reserves of crop wild relatives. Management of some sites employs rare livestock breeds.	Crop wild relatives and rare breeds could play a significant role in future agricultural production	All sites can be expected to conserve genetic resources in some way, though the benefits are variable and often uncertain. Only certain sites use rare livestock breeds.
Fresh water	Water is abstracted directly from some SSSIs; others play an important role in catchment management	Clean water is essential for human life and many economic activities	Benefits are variable and site specific – some sites are regionally significant, notably large upland sites.
Regulating Services:			
Air quality	Improvements of air quality by natural ecosystems, particularly in or around urban areas	Human health benefits measured in reduced cases of ill health	Benefits are potentially widespread but most significant from woodlands in urban and urban fringe locations.
Climate regulation	Reduced impacts on global climate through carbon sequestration/storage; micro-climate effects through shading and evapotranspiration	Reduced damage costs from climate change	Benefits are widespread, especially from bogs, woodlands and some grasslands; microclimatic effects are local.
Water regulation	Localised effects in reducing flooding through water storage/reduced run-off	Protection of property and infrastructure	Benefits are location specific but likely to be widespread and downstream or downslope of site (e.g. woodlands and grasslands)
Water purification and waste treatment	Woodlands, wetlands and other habitats can filter pollutants and enhance water quality	Enhanced water for human consumption and reduced treatment costs; benefits for fisheries and recreation	Benefits are location specific, but likely to be widespread and apply to a range of habitats (e.g. woodlands, grassland, wetlands)
Pest regulation	Possible positive effects in harbouring predators or negative effects in harbouring pests	Changes in crop yields and timber harvests, or changes in costs of pest control	Effects are uncertain but likely to vary by location and surrounding land use
Pollination	Possible increase in insect pollination	Enhanced crop yields	Benefits vary by location, e.g. flower rich grasslands close to insect pollinated crops
Natural hazard regulation (coast protection)	Possible effects of intertidal and coastal ecosystems in	Protection of property and infrastructure	Benefits may be significant in specific coastal locations

	coastal protection		
Cultural Services:			
Recreation and ecotourism	Enhanced opportunities for countryside recreation through biodiversity and landscape effects	Increased enjoyment of countryside	Public use of SSSIs is widespread but variable, with a minority of sites attracting large numbers of visitors
Educational and scientific values	Opportunities for education, research, learning and training	Increased education, learning and scientific knowledge	All sites have scientific and potential educational value; the benefits themselves vary according to access and educational/ scientific use
Sense of place, spiritual and existence values	Conservation of species, habitats and geodiversity for benefit of current and future generations; defining sense of place and local identity	Appreciation, inspiration, non-use values	Benefits of individual sites are likely to vary according to their characteristics and their landscape context and biodiversity. The SSSI series has a collective role in provision of these benefits to society.
Supporting Services	Likely to contribute to a range of supporting services (e.g. soil formation and cycling of nutrients and water)	Supporting services benefit people indirectly by supporting the delivery of other services	Depends on distribution of other services.

Source: This study, various sources

These services vary according to habitats. The functioning of ecosystems is complex, with different processes interacting to produce benefits to different stakeholders at a range of spatial scales (English Nature, 2006; EFTEC, 2005). Although the benefits of SSSIs to people are most immediately felt at the local level (especially where there is easy access for the public) there are significant benefits of preserving bio- and geodiversity at the national as well as the global scale (e.g. through carbon fixation; Millennium Ecosystem Assessment, 2005).

The delivery of these services depends on the condition of sites and the effective functioning of ecosystems, while the benefits to society depend on the use of these services by people, which in turn is influenced by factors such as the location of the site relative to population and economic activities, the accessibility of the site and the services it provides, and public awareness, perceptions and appreciation (Jacobs, 2004).

No overall assessment has been found of the ecosystem services delivered by SSSIs. However, a study by Eigenbrod *et al.* (2009) assessed the coincidence of protected areas (including SSSIs, Local Nature Reserves and other nature conservation designations) with biodiversity (as represented by the occurrence of BAP species) and three ecosystem services (carbon storage, recreation and agricultural production). It found that:

- Protected areas are well placed to protect species of conservation concern, capturing 3.3 times as much biodiversity as would be expected for their area
- Carbon storage is also well represented (1.8 times as high as would be expected on the basis of area alone), reflecting the over-representation of the carbon-rich soils in heather moorland and wetland in protected areas
- Recreation – as measured by the number of leisure day visits - was slightly under-represented in protected areas compared to rural areas as a whole;

- Agricultural production was significantly under-represented in protected areas, reflecting the under-representation of arable farming in these areas.

The authors noted that care is needed in interpreting these results as the extent to which the observed relationships are causal is unclear. For example, carbon storage and agricultural production are functions of land cover as well as site management. Recreational use tends to be higher in areas close to centres of population, while protected areas tend to be more concentrated in areas of lower population density. They concluded that while conservation strategies may enhance certain ecosystem services as well as biodiversity, some trade-offs (for example between biodiversity and agricultural production) are inevitable, suggesting that there are limits to the multi-functionality of landscapes and that different strategies may be needed to optimise ecosystem service delivery.

4.2 Examples of Ecosystem Services

Examples of ecosystem services provided by SSSIs include:

Provisioning services

Provisioning services include the production of food, fibre, fuel, freshwater and genetic resources, including through farming and forestry systems as well as harvesting of wild produce. Most SSSIs therefore support provisioning services to some degree. The impact of SSSI designation on provisioning services could be negative in many cases as SSSI management is likely to reduce agricultural and forestry output, though there could also be increases in the quality of produce. SSSI management could contribute to the production and sustainable exploitation of certain species harvested for food (e.g. fish and fungi) as well as other products such as reed for thatching and coppice products; while in many cases SSSI management may limit the opportunities for harvesting such produce, management regimes may require sustainable exploitation or there may be benefits where SSSIs serve as nurseries – there is evidence, for example, that saltmarsh conservation can benefit the fisheries sector (Stevenson, 2001). Maxted *et al.* (2007) stress the importance of conserving crop wild relatives (CWR) for future agricultural production and highlight the role of SSSIs and other designations in the conservation – all of the 17 CWR hotspots that would need to be protected to conserve two thirds of CWR species are designated SSSI.

Regulating services

Improvement in SSSI condition improves ecosystem functioning and is likely to contribute to the regulation of air, water and soils and increase protection against natural hazards and diseases. An illustration of regulating services (and some supporting services underpinning these) is given in **Error! Reference source not found.**4.3. However, there is little evidence of the effect of SSSI designation and management on the level of service provision.

Table 4.2 Illustration of regulating services for main UK habitats

Habitat	*Ecosystem Function*
Woodland	**Climate regulation** through carbon fixing, **microclimate regulation** through evapotranspiration, **flood protection**, **water quality** by preventing agricultural run off, and **pollution control** and **soil protection** via minimising erosion risk.
Wetlands	Wetlands aid **flood attenuation**, **retain sediment**, **recycle nutrients** and act as **natural filters** providing valuable supplies of **clean water**.
Upland habitats	Sustainable land management in the uplands can provide **water resource management** benefits and **pollution filtering**
Urban habitats	**Pollution filtering**, **noise prevention**, **reduced surface run off**, **climatic benefits** such as increased shade and moisture, **indicators of invisible pollution, waste disposal**
Coastal habitats	Mudflats help **recycle nutrients** and cope with sewage effluent and agricultural run-off, coastal systems **shift sediment** across the coast, intertidal habitats provide **costal protection** and provide **nursery habitats** for some species, plankton provide important **carbon sink** functions helping to maintain a health global atmosphere and climate.

Source: GHK and GFA-Race (2004)

Cultural services: Protection of the UK's rarest and most threatened wildlife, habitats and geology through SSSI designation provides cultural benefits by supporting recreation and education, as well as non-use values as society as a whole benefits from the knowledge that these assets are protected. As well as maintaining and enhancing the key features of these sites, SSSI status may provide a focus for visitors and help to attract funding for access and visitor facilities. Biological and geological SSSIs provide a focus for scientific research and help to enhance our understanding of geological sciences and our natural history and cultural heritage. While there is some evidence of the overall cultural services provided by SSSI sites, the added benefits of SSSI designation are incompletely understood. SSSIs provide a natural focus for education and research, although the degree to which designation affects wider recreational use of the sites concerned is often unclear.

Around 50% of SSSIs are open to the public and more than 39,000 hectares of SSSI land are in or close to urban areas. SSSIs attract around 380 million visits each year and support more than 40 different types of recreational and educational activities (Public Accounts Committee, 2009). Over 50% of open access land designated under the Countryside and Rights of Way Act is also designated SSSI (Lawton *et al.*, 2010). The majority of the visits to SSSIs involve walking and running (ca. 65%) and cycling (6%) (CJC Consulting, 2004) but activities also include water sports, angling, horse riding and hunting. The 2003 Arkenford report found that visits were concentrated on 'honeypot' sites (76% of visits on 6% of SSSIs), and that the relevance of the SSSI status to the use and enjoyment of the site is uncertain. Furthermore, while early valuation studies show a significant willingness to pay by the public to protect SSSIs (EFTEC, 2007), a substantial proportion of this may be accounted for by non-use values (CJC Consulting, 2004).

4.3 Insights from Wider Evidence

While evidence of the ecosystem services delivered by SSSIs is sparse, some insights and evidence can be gained by other studies of ecosystem services in the UK and by protected areas internationally.

4.3.1 'No Charge? Valuing the Natural Environment': A report by Natural England (2009b) reviews the role of the natural environment in providing key ecosystem services:

- Coastal Defence - inter-tidal saltmarshes and mudflats provide us with natural defences against storm surges because as the storm waves pass across them, they lose their energy. Shingle beaches and sand dunes above high water provide a further barrier. However, such habitats are declining due to sea level rise and the supply of sediment to build the inter-tidal habitats is halted by engineered coastal defences. On many low-lying coasts, sea walls have been built to compensate for the loss of these natural defences.

In 2006–2007, approximately £358 million was spent on coastal and inland flood defences, but this is not keeping pace with the erosion caused by sea level rise. It has been estimated that an 80 m deep zone of inter-tidal habitat fronting sea walls can save £4,600 per m in sea defence costs. An alternative approach to engineering is to restore inter-tidal habitats as coastal defences, so called 'managed re-alignment'.

- Flood protection - Habitats such as woodland, heathland and wetland have the capacity to slow the surface flow of water into rivers and streams, and store water within the habitat, reducing flood risk and the need for engineered flood banks. Restoring green space can increase the infiltration of water into the soil, reducing surface run-off. Restoring more natural rivers with well-vegetated river channels conveys floodwaters more slowly and increases the venting of floodwaters onto the undeveloped floodplains, which avoids flooding in built-up areas. In the past, washlands were created for this purpose.
- Provision of clean water – maintaining semi-natural vegetation in catchments improves water quality by reducing the generation of pollution and by assimilating nutrients generated by other land uses and trapping soil particles with nutrients adsorbed on to them. However, management practices such as drainage, over-grazing and burning of peat moorland can result in damage to surface layers, resulting in increased losses of carbon, phosphorus and nitrogen in drainage waters. Projects, such as Moors for the Future Partnership, are seeking to restore large areas of upland habitats and ensure favourable land management practices.
- Climate regulation – carbon sinks in soils, vegetation and the oceans play a vital role in regulating climate. A range of habitats, peatlands, woodlands, agricultural land, coasts and the seas, play a role in greenhouse gas regulation. It is estimated that peat soils in England store 296 million tonnes of carbon, roughly equivalent to 2 years of total UK carbon emissions. In an undamaged state peat remains wet at the surface all year, sequestering between 0.1 tonnes and 0.5 tonnes of carbon per ha per year, and, if effectively managed, offers the potential to be a significant contributor to wider climate change mitigation. In reality, many of our peatlands are degraded by drainage, burning, over-grazing and conversion to other land use. Under current management, the drained and cultivated lowland fen peats are likely to emit around 3–5 million tonnes of carbon dioxide per year, more than domestic aviation and similar to emissions by the UK concrete industry. UK woodlands stores around 150 million tonnes of carbon and sequestered around 15 million tonnes of carbon dioxide in 2006, reducing the UK's carbon dioxide emissions by 3 per cent. Wood has the potential to be used as a renewable carbon neutral fuel and can replace other construction materials that have high fossil fuel use.

Ecosystem services provided by the uplands include:

- Climate regulation through carbon storage - Upland peat soils are the largest carbon store in England – holding nearly 300 million tonnes. In good condition, peatlands can remove carbon from the atmosphere. But soil erosion means we are losing many hundreds of thousands of tonnes of CO_2 every year.
- Water quality and reducing flood risk downstream - Peatlands, in good condition, store, filter and regulate water. Up to 70 per cent of UK water supply is sourced from upland rivers, lakes and reservoirs. Peatlands that are artificially drained, or intensively grazed and burnt, can add a brown stain to water resulting in costly treatment processes, and potentially increasing downstream flood risk.
- Wildlife and recreation - Uplands are home to many rare and internationally important habitats and species – containing 53% of our SSSIs. 75% of the uplands is designated as National Park or Area of Outstanding Natural Beauty. The 70 million visitors to upland National Parks each year contribute to local economies through spend on accommodation and outdoor pursuits.

- Provisioning services - The uplands are an important source of some foods, particularly lamb and beef. They support about 3 million sheep – 45% of the total number of breeding ewes in the country. Upland sheep produce around 5 million kg of wool every year. Conifer plantations cover 6% of the uplands – these are important areas for forestry.
- Archaeology and the historic environment - Uplands retain a rich historic record of climatic and ecological and human development over time including: spectacular monuments, like Hadrian's Wall and the 4,000-year-old Castle Rigg stone circle; evidence of previous agricultural systems; old mineral workings and other upland industry; the pollen record preserved within peat soils.

4.3.2 Naturally at your service

A recent report by the RSPB (2009a) documents examples of ecosystem service delivery in the UK and internationally. UK examples include:

- Lake Vyrnwy - The Lake Vyrnwy catchment, Wales, is a nature reserve, tourist destination, education resource, a source of clean water, and a farm producing organic lamb and beef. European funding is currently being used to carry out restoration of blanket bog on a landscape scale. This restoration work involves reinstating the water tables by blocking moorland drains. This aims to halt habitat degradation. Initial monitoring results suggest that drain blocking reduces peak flow rates and lengthens the lag between rainfall and peak flow, with possible implications for reducing downstream flood risk. Preliminary results suggest that total water colour declines following drain blocking. The site's status as a Natura 2000 site was a key factor in securing EU funding.
- Cuilcagh Mountain – This area on the border between Northern Ireland and the Republic of Ireland, is one of the best and most extensive peatland areas on the island. In the late 1980s, the blanket bog suffered unsustainable pressure from peat extraction, overgrazing, uncontrolled burning of surface vegetation and the damaging use of all-terrain vehicles. This damage reduced the bog's ability to retain water, resulting in flooding and abnormally high water levels in the caves downstream. This, in turn, reduced tourist activity at the Marble Arch caves, a major attraction in County Fermanagh with over 53,000 visitors in 2007. An EU funded project to restore 28 hectares of cut-over blanket bog on Cuilcagh Mountain, for the benefit of wildlife and tourism. The status of the site as a SAC and Geopark was a key driver in securing funding.
- Wallasea Island – This is Britain's biggest coastal wetland restoration project, designed to deliver multiple benefits to a SSSI and Natura 2000 site. The RSPB's plan for Wallasea will see three-quarters of the island restored to saltmarsh, creeks, and mudflats. The project involves long-term, landscape scale restoration and represents an innovative managed re-alignment scheme. It is designed to achieve significant wildlife benefits and to sustainably manage the estuary to ensure delivery of other valuable ecosystem services. Sound management can provide grazing marsh habitats, flood defence, and enhance fishery and recreation opportunities. It also has the potential to increase carbon sequestration, nutrient cycling and water quality. The need to secure no-net loss of an intertidal area of the Natura 2000 site was a key driver for the project.
- Freiston Shore – This managed coastal realignment project in Lincolnshire has been shown to yield net cost savings compared to engineered flood defences, as well as increasing annual recreational visits from 11,000 to 60,000 and supporting 6 full time equivalent jobs. The site has SSSI, SPA, SAC and Ramsar designations, with the need for compensation for loss of intertidal habitat in the Natura 2000 site being a key driver.
- Ouse Washes - The Ouse Washes form the largest area of washland in the UK, providing an important flood control service for the East Anglian fens and beyond, supporting important wildlife habitats, providing grazing for livestock, and attracting significant numbers of recreational and educational visits. However, these different

services are increasingly difficult to provide simultaneously, bringing a need to find new solutions. The site is a SSSI.

- Insh Marshes – This SSSI is the largest floodplain mire in Great Britain covering 1,000 hectares at the foot of the Cairngorms in Scotland. Its diverse habitats contain birds and insects of international importance, and attracting 12,000 people recreational and educational visits annually. The marshes support grazing by local agricultural enterprises, fishing on the floodplain and downstream on the river Spey, potential improvements in water quality, and flood defence benefits to Aviemore, and other settlements and farmland downstream. Constructing and maintaining engineered flood defences for Aviemore could cost more than £83,000 a year.

4.3.3 Ecosystem Services delivered by Environmental Stewardship Scheme

A study by Land Use Consultants and GHK Consulting (2008) assessed the delivery of ecosystem services by the Environmental Stewardship Scheme (ESS), the principal agri-environment scheme in England. The study found that ESS delivers a wide range of ecosystem services. The most significant of these are likely to include protection of soil organic matter (a supporting service); genetic conservation and water provision (provisioning services); water infiltration, flood alleviation and coastal protection, erosion control, water quality and pollination (regulating services); and recreation, education, cultural heritage, aesthetics, and sense of place (cultural services).

The study provided an overall framework for assessing, quantifying and valuing these services, and identified transferable values that could be applied to the more significant services delivered by ESS. A key conclusion was that quantification of service delivery, and especially the net effects of ESS options on the level of services delivered, was a key challenge. SSSIs are a key target for ESS (and particularly for Higher Level Stewardship).

4.3.4 Ecosystem services and benefits provided by Natura 2000

Recent studies on the socio-economic benefits associated with Natura 2000 use the ecosystems services classification developed by the Millennium Ecosystem Assessment, to describe the diversity, importance and source of the network's benefits. With the wider use of the MA classification the focus shifted from a few services such as food, recreational opportunities or employment to valuing the full range of services and goods provided by Natura 2000, including regulating services such as climate regulation, air quality or pollination, and their impact on human wealth fare. In this regard, the recent European Commission study on the costs and benefits of Natura 2000 (Kettunen, 2009) made a first attempt in identifying various ecosystem services provided by the network based on the MA framework, and provided tools to site managers on how to value related benefits at the site level. Figure 4.2 provides an overview of the ecosystem services likely to be associated with the network, as identified by the study.

Figure 4.2 An overview of potential ecosystem services provided by Natura 2000

	Ecosystem service	**Is this service likely to be associated with Natura 2000 sites?**
Provisioning services		
Biodiversity resources	Food, e.g. crops, fruit, livestock, wild berries & fungi, game	
	Fibre / materials, e.g. wool, skins, leather, plant fibre, timber, cork	
	Fuel, e.g. biomass, firewood	

Ecosystem service	Is this service likely to be associated with Natura 2000 sites?
Natural medicines	
Ornamental resources, e.g. wild plants, wood for handcraft, seashells	
Biochemicals & pharmaceuticals	
Water	
Cultural & social services	
Ecotourism & recreation	
Cultural values & inspirational services, e.g. education, art and research	
Landscape & amenity values	
Regulating services	
Climate / climate change regulation	
Water regulation, e.g. flood prevention, aquifer recharge	
Water purification & waste management	
Air quality regulation	
Erosion control	
Avalanche control	
Storm damage control	
Wild fire mitigation	
Biological control	
Pollination	
Regulation of human health (physical and mental)	
Genetic / species diversity maintenance, e.g. protection of local and endemic breeds and varieties	

Ecosystem service	Is this service likely to be associated with Natura 2000 sites?
Supporting services	
Production	These ecosystem processes form the basis for all the services above.
Nutrient cycling and decomposition	
Water cycling	
Weathering / erosion	
Ecological interactions	
Evolutionary processes	
Legend	
Very likely  Likely  Some potential  Unlikely 	

Source: Kettunen et al. (2009)

Although the table refers to ecotourism and recreation as well as landscape and amenity values as those services most likely to be associated with Natura 2000, the study also emphasises the network's importance for the maintenance of genetic/species diversity (e.g. protection of local and endemic breeds and varieties), and clearly highlights that the variety of ecosystem services provided by the network is extensive. However, as for SSSIs, quantification of these services is rare.

Bade and van der Schroeff (2006), on the other hand, considered functions that may be fulfilled by a certain Natura 2000 area. These included:

- support functions: Nature as support for human activities and waste products, e.g. living, working and the absorptions of emissions of substance in the air and surface water;
- production functions: Nature as a producer and provider of water, oxygen, biomass and minerals;
- regulatory functions: Functions maintaining the natural balance on Earth, e.g. by filtering air, storing carbon dioxide or purifying water;
- information functions: Nature as a source of information (e.g. education); and
- recovery functions: Nature as a source of human well-being (recreation) and human health.

Examples above demonstrate that Natura 2000 status can be a key driver for funding for nature conservation projects, especially where EU financial instruments are concerned.

4.3.5 Links between Land Use, Land Management and Ecosystem Services

A recent study by Haines-Young and Potschin (2009) for Natural England developed a conceptual mapping tool for understanding how ecosystem services behave under different management regimes and improving economic valuation of individual services. It found that there was a lack of research into the link between management and ecosystem services. The tool was applied to four ecosystem services examining the drivers of change between them (Drivers **of change in four different ecosystem services**). The report recommended further research linking ecosystem functions, drivers of change and management outcomes.

Figure 4.3 Drivers of change in four different ecosystem services

**= very important; *=important; ?=possibly important

Driver	Carbon	Water quantity	Water quality	Recreation
Grazing pressure	**	**	**	?
Fire regime	**	**	**	?
Liming	*	?	?	
Drainage management	**	**	**	
Land use change	**	*	*	*
Vegetation cover	**	**	**	*
Water table	**	*	*	
Ground Water Temperature			*	
Gullying	**	**	**	
Base saturation			*	
pH			*	
Geology	*	*	*	
Diffuse pollution load	*		*	
Temperature	**	*	**	
Rainfall	**	**	**	
Summer drought	**	**	**	
Adequacy of public transport				*
Parking provision				*
Travel cost				*
Designation				?
Access conditions				**
Information				**

Source: Haines-Young and Potschin (2009)

Similarly, work by Land Use Consultants and GHK (2009) for the Environment Agency investigated the links between land use and selected key environmental services (regulation of water quality, water provision, flood risk management and carbon storage) in England and Wales. The report developed a framework for assessing the effects of land use change and identified transferable benefits for each of these services. However, it found that scientific uncertainties and locational variations in service delivery meant that the quantification of the effects of land use change on service delivery was much more problematic.

Nevertheless, semi-natural habitats such as grassland, woodlands, heath, fen, marsh and bogs were found to play a significant positive role with regard to the delivery of these four services, and that low intensity management and habitat condition are important in influencing service delivery. This suggests that SSSIs, to the extent to which they safeguard and enhance these habitats, can play a positive role in ecosystem service delivery, but that the net effects of designation on levels of services delivered will be difficult to quantify.

4.4 Services provided by Geological SSSIs

England and Wales has some of the most diverse geology in the world – a sequence of rocks that includes every major period of geological history for the last 700 million years. This diversity, and the distinctive landscapes it has helped create, has been central to the development of geological science and is an important factor in our economic wealth and cultural identity (Stace and Larwood, 2006).

The benefits of geodiversity are reflected in:

- Direct appreciation by people, as demonstrated by the large number of visitors attracted to geological sites, and also people collecting fossils, as well as through formation of landscape on which many recreational activities depend.
- Indirect appreciation through artistic inspiration and through cultural heritage. For example, geodiversity features significantly in folklore and helps to define local distinctiveness and sense of place.

- Contribution to human knowledge, helping us to better understand the history of the planet, evolutionary biology, and how the environment around us is changing.
- Provision of products useful to man including building and industrial materials and ornamental resources.
- Provision of energy (through coal, oil, geothermal energy and support for other renewables);
- Provision of ecosystem services. Geomorphological processes contribute to ecosystem services, such as the natural flood defences, water purification, regulation of water flows, protection against natural hazards afforded by beaches and floodplains, and supporting services such as formation of soils and wildlife habitats (Webber *et al.*, 2006, Stace and Larwood, 2006; Prosser *et al.*, 2006).

The overall services provided by geodiversity can be evidenced in terms of:

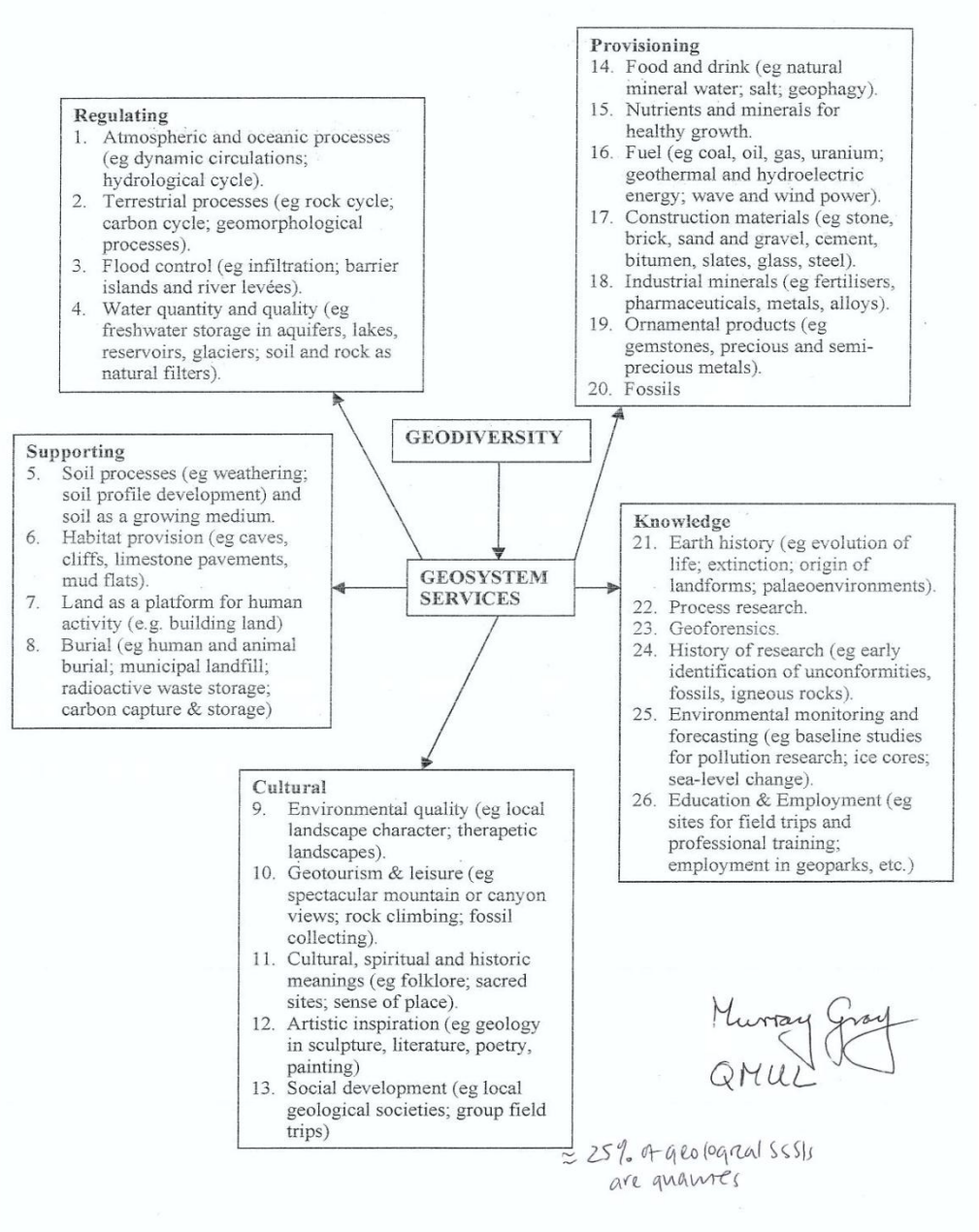
- Numbers of visitors to geological sites (e.g. Dinosaur Isle - 81,486 in 2002/2003; Big Pit 116,278 in 2002/2003; Dan Yr Ogof Caves 79,515 in 2002; Welsh Slate Museum 130,201 in 2002/2003; Wrens Nest National Nature Reserve 10,000 visitors per year)
- Numbers of visitors to general natural history and heritage attractions (e.g. Natural History Museum: 1.66 million in 2000/2001; National Museum and Gallery, Cardiff: 321,968 in 2002/2003; Snowdonia National Park: 10 million visitor days per year; Dartmoor National Park: 8 million day visitors in 1994; North York Moors National Park 9.75 million visitor days in 1999; Dudley Museum and Art Gallery 17,882 in 2004; Black Country Living Museum 229,304 in 2004)
- Participation in, and benefits derived from, particular geodiversity related recreational activities such as rock climibing, mountain biking and beach recreation;
- Numbers of viewers of films and TV programmes featuring geodiversity (e.g. walking with Dinosaurs – BBC, 15 million viewers per episode; The Big Monster Dig – Channel 4, 1.25 million viewers per episode);
- References to geodiversity in art and literature;
- Use of geodiversity to define sense of place and local character (e.g. settlements use of local stone)
- Evidence of geology contributing to scientific and historical discovery;
- Inclusion of geology in educational curricula and courses at different levels;
- Production of coal (31.5 million tonnes, £1028m), oil (117.8mt, £14,732m) and gas (105.8mt, £8,325m) (all in 2001, UK);
- Production of aggregates (£1645 million), other building materials (£138m) and industrial minerals (£717 million) (UK, 2001)
- Willingness to pay for the benefits of geodiversity (see section 5.3.2 below).

The ecosystem services framework focuses on the services provided by ecosystems. Geodiversity, as well as biodiversity, contributes to the delivery of ecosystem services and underpins the delivery of provisioning, regulating, cultural and supporting services. The framework therefore provides a means of assessing many of the benefits of geological SSSIs, providing the geodiversity as well as the biodiversity underpinning ecosystem services are fully considered.

However, the Millennium Ecosystem Assessment (2005) acknowledges that it does not fully capture the benefits of geodiversity and that certain abiotic non-renewable goods from the abiotic environment such as fuel (e.g. coal), aggregates and minerals are not considered. This suggests that some adaptation of the framework may be required if the benefits of geodiversity are to be fully taken into account.

Figure 4.4 gives an illustrative framework for assessment of geosystem services. This work is being developed by Murray Gray at Queen Mary College, University of London.

Figure 4.4 Illustrative Framework for Assessment of Geosystem Services



Source: Murray Gray, Queen Mary College (under development)

4.7 Conclusions

Overall evidence of the ecosystem services provided by SSSIs is limited and fragmented. However, available evidence suggests that SSSIs provide a wide range of provisioning, regulating and cultural services. Quantitative evidence of service delivery is limited, but is available for certain services at some sites.

The net effects of SSSI designation on service delivery are also difficult to assess; it is likely that by improving the condition of sites, SSSI policy enhances the delivery of regulating services, though again this is difficult to quantify. It is also likely to enhance cultural services, including recreational, educational and existence values, although evidence suggests that much recreational use of SSSIs is unrelated to site condition. Net direct effects on provisioning services may be negative, though SSSIs may have indirect benefits through pollination and nursery functions.

The link between SSSI designations and ecosystem service delivery therefore requires further exploration in this study, particularly through the case studies and expert workshops.

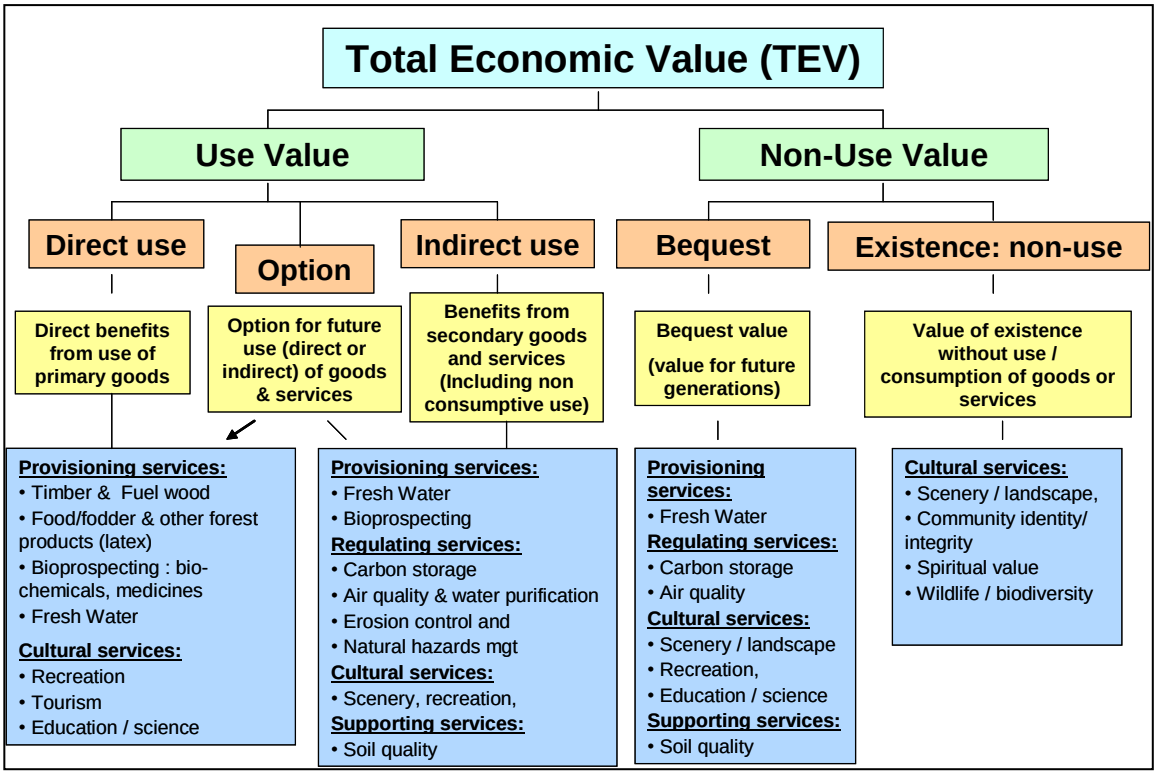
5 Valuing the benefits of SSSIs

5.1 Overall Framework

A comprehensive assessment of the value of benefits provided by SSSIs can be made by employing a Total Economic Value (TEV) framework (Pearce and Warford, 1993), taking account of the effects of the policy on the full range of use and non-use values provided by the sites.

Figure 5.1 provides an overview of the economic values derived from ecosystem services.

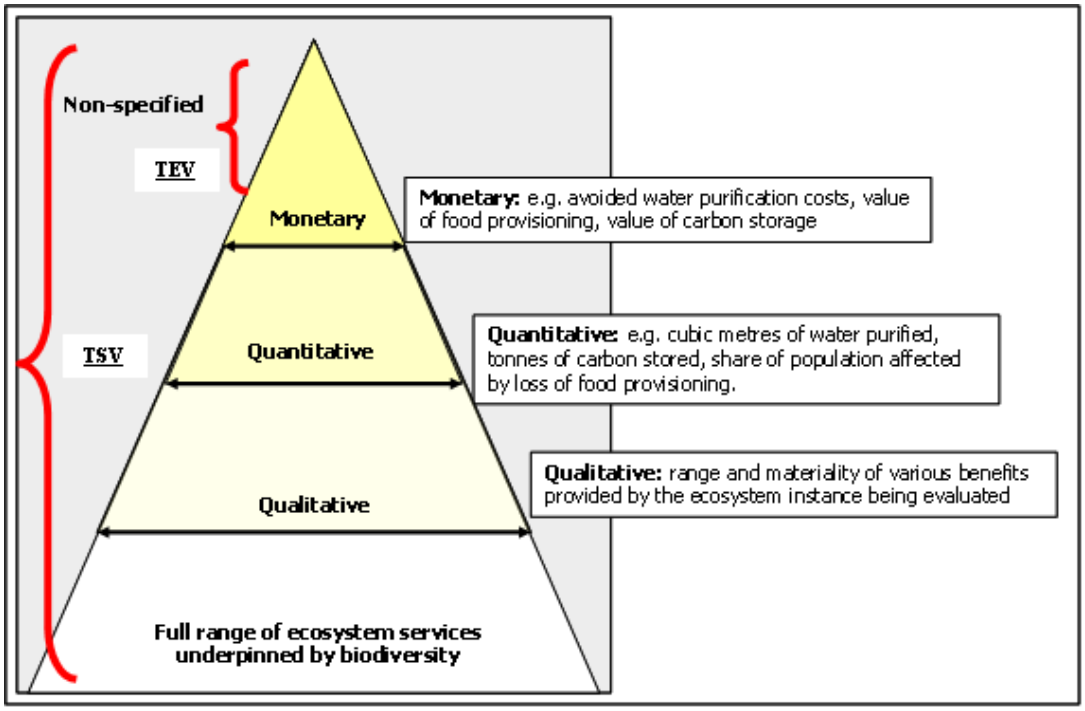
Figure 5.1 Total Economic Value framework and how it relates to ecosystem services



Source: Kettunen et al.,(2009) and references therein

There are limits to the extent benefits can be measured in monetary terms due to the limits of different methodologies available to calculate these values (Kettunen *et al*., 2009; O' Gorman *et al*., 2008). Therefore, while the TEV framework helps all relevant values to be considered, many of these values may be difficult to monetise (Figure 5.2). It is therefore often necessary to consider wider quantitative and qualitative approaches when communicating values associated with protected sites (Gantioler *et al*., 2009).

Figure 5.2 Valuation pyramid



Source: adapted from P. ten Brink, workshop on the Economics of the Global Loss of Biological Diversity, 5-6 March 2008, Brussels, within Kettunen et al. (2009). TSV= Total System Value.

Some of the benefits delivered by SSSIs are traded and can be measured using market prices; others require the application of non-market valuation techniques. A range of potential valuation methods is available, and these are suited to varying degrees to assessing the value of different ecosystem services (Tables 4.1, 5.1 and 5.2)[4].

In addition, the application of such methods to valuing similar goods and services in other studies offers opportunities for benefit transfer. Examples of other relevant valuation studies are given in the following sections.

[4] Adapted from framework in LUC and GHK (2008) for valuing ecosystem services delivered by Environmental Stewardship

Table 5.1 Potential Methods for Valuing Ecosystem Services Delivered by SSSIs

Valuation Method	Element of TEV Captured	Ecosystem Services Valued	Benefits of Approach	Limitations of Approach
Market Prices	Use Value	Provisioning (marketed products - food, timber etc); Regulating (e.g. carbon storage, flood protection through avoided property damage); Priced recreation	Market prices are easily applied so valuation is straightforward so long as level of service provision can be estimated	Applies to only some services; many of the services provided by SSSIs are not traded in markets
Cost Based Approaches	Use Value	Regulating services, where service could otherwise be provided by human activity – e.g. flood defences, wastewater treatment	May be relatively easily applied	Needs to be interpreted carefully as it is based on cost not value of service
Hedonic Pricing	Use Value	Services directly benefiting local living environment and hence house prices, especially aesthetic services	Based on market prices, so relatively robust	Data intensive and limited in scope of services and beneficiaries covered
Travel Cost Method (TCM)	Use Value	Recreational services	Based on observed behaviour	Limited to recreational benefits; more suited to valuing broad scale recreational resource rather than marginal environmental change
Random Utility	Use Value	Recreational services	Based on observed behaviour	Limited to recreational benefits; has advantages compared to TCM in revealing preferences for different environmental attributes
Contingent Valuation Method (CVM)	Use and Non Use Values	All ecosystem services	Capable of capturing all use and non use values	Resource intensive; significant biases
Choice Modelling	Use and Non Use Values	All ecosystem services	Capable of capturing all use and non use values	As CVM

Table 5.2 Applicability of Methods for Valuing Different Ecosystem Services

	Market Prices	Cost Based	Hedonic Pricing	Travel Cost	Random Utility	CVM	Choice Modelling
Provisioning Services:							
Food	**					*	*
Fibre	**					*	*
Fuel	**					*	*
Genetic resources	**					*	*
Fresh Water	**	**				*	*
Regulating Services:							
Air quality	*	*	*			**	**
Climate	**	**				*	*
Water regulation	**	**				*	*
Erosion	**	**				*	*
Water purification and waste treatment	**	**				*	*
Disease regulation	**	**				*	*
Pest regulation	**	**				*	*
Pollination	**	*				*	*
Natural hazard regulation	**	**				**	**
Cultural Services:							
Recreation and ecotourism	*			**	**	**	**
Cultural heritage values				*	*	**	**
Educational values				*	*	**	**
Sense of place			*	*	*	**	**
Aesthetic, inspiration and spiritual			**	*	*	**	**

5.2 SSSI contribution to improvement in ecosystem services

Although the theoretical benefits flowing from SSSIs are well defined and the economic value of some of these benefits has been calculated, it is difficult to estimate the contribution SSSI designation has to this value. Most valuation studies focus on individual habitats or species, particular ecosystem services, or management programmes for areas with multiple designations. A further difficulty is that valuation is often undertaken simply for the net present value of the current (baseline) condition of a site rather than comparing the value of managing an area towards a policy target against counterfactual conditions.

The benefits of SSSIs compared to non-designated habitats derive from improved management – having land designated as SSSI means that as well as receiving a greater level of protection there is a greater chance of attracting financial resources for enhanced management (such as AES payments; Selman, 2009). Few comparative studies exist of SSSI and non-SSSI habitats that can be used to determine the impact of SSSI designation.

Comparing the findings of Hewins *et al*. (2007) on the condition of non-SSSI designated lowland heathland with the first Joint Nature Conservation Committee (JNCC) assessment of the same habitat, shows that 0% of non-SSSI land met PSA targets while 17% of SSSI heathland fulfilled the target. It is a reasonable assumption that the majority of this difference is due to better protection and management of SSSI land. The increasing proportion of SSSIs in target condition suggests that, for most habitats, improvements in management and/or reductions in adverse pressures follow from SSSI designation.

Although there is a lack of studies examining the impact of SSSIs quantitatively, it is possible to give a qualitative overview of the likely impact of SSSI designation according to ecosystem service on the basis of the literature. Where examples and evidence are scarce, assessment of potential impacts have been based on the broader literature on ecosystem services.

5.2.1 Provisioning services

The impact of SSSI designation on provisioning services is often directly observable and is likely to be the most straightforward ecosystem service to value as market prices are obtainable for most changes in production. For example, the re-alignment scheme on the Alkborough Flats, part of which is SSSI, generated changes in land use. The project led to a net loss of barley straw production and an increase in the production of other fibres and fuels mainly due to the introduction of sheep. Based on the market values for the barley straw and wool products the net change was calculated at £26,820 (Environment Agency, 2009). The net effect of SSSIs on provisioning services is in many cases likely to be negative, however, as conservation often entails limited use of land for agricultural production.

SSSI designation also has the potential to affect the value of land. A study of the impact of SSSI designation on land value in Scotland found no significant statistical influence on land prices across Scottish SSSIs (Roberts *et al.*, 2001). The study found SSSI designation is most likely to have a positive effect where conservation and management interests complement each other. Negative impacts are likely to be greater in areas where development or alternative conservation can limit land use and where potential buyers do not value nature conservation highly. While negative impacts on land value are difficult to assess there are tangible benefits of owning SSSI land, e.g. exemption from inheritance tax and increased opportunities for funding. The authors concluded that the findings cannot readily be applied to England because many Scottish sites are far from population centres and thus not subject to demand from development. No further studies on the link between SSSIs and land values have been found.

5.2.2 Regulating services

There is evidence that improved land management, enhancing the condition of sites and the ecosystems they support, translates into increases in regulating services (Sukhdev *et al.*,

2008). These benefits vary according to habitat; their original condition and the scale of improvement. Attributing improvement in regulating services to SSSI management may in many cases be easier than for cultural services as there will often be historic evidence of measures taken and the agents involved.

The value of regulating services may be assessed using a variety of techniques such as the shadow price of carbon, avoided expenditures on flood defence or water treatment, value of property protected from flooding or natural hazards, market prices for agriculture or forestry output indirectly affected by pollination or air quality, or people's willingness to pay to improve water quality or prevent ill health.

An example of improvements in regulating services due to habitat restoration is the Sustainable Catchment Management Programme (SCaMP) in the Peak District. This project restores degraded moorland in a 20,000ha catchment area, more than 40% of which is SSSI. Around 13,500ha of SSSI land has been restored into favourable or recovering condition recreating habitats and enhancing biodiversity. As a consequence the moorland's capacity for sequestering carbon has recovered (the moorland previously had a net loss of carbon) and the area is sequestering an estimated 2000t CO_2 per year valued at £0.86m per year over 50 years (Natural England, 2009). There have also been improvements in water quality in the catchment. The improved management, through a partnership between United Utilities, RSPB, farmers and other local stakeholders, is driven by a variety of objectives, one of which is the SSSI PSA target. Much of the area is also designated as a Natura 2000 site.

5.2.3 Cultural services

SSSI status may enhance cultural services by increasing the number of people visiting sites and/or the value obtained from each visit. Recreational values may be assessed using stated preference (e.g. contingent valuation) or revealed preference (e.g. travel cost) methods. It is important to recognise that many visits would take place whether or not the site was a SSSI, so an assessment of the additional benefits of designation is needed. In addition, it is clear that non-users also benefit from SSSI policy, through the assurance that valuable species and habitats are protected, either for the benefit of society as a whole (existence values), to retain an option to visit the site in future (option value) or to protect it for future generations (bequest value). Stated preference methods such as contingent valuation or choice experiments are needed to estimate non-use values.

In a case study of Ingleborough National Nature Reserve, part of which is SSSI, a report for Natural England valued changes in outdoor recreation (use value) and landscape (non-use value) due to a change from a 'business as usual' baseline to an improved management regime (Natural England, 2009). Recreational benefits were assumed to accrue to Ingleborough's 100,000 yearly visitors while people across the UK enjoy the site's historic and cultural landscape (in varying degrees). The increased recreational benefits were estimated to be £3m and the benefit from improvements to the historical and cultural landscape was valued at a further £3m. This increase entirely relates to increased utility per visit, as the numbers of visits are assumed to be constant. Although these findings cannot be extrapolated to other SSSIs, the study highlights the type of benefits that follow an improved management regime on SSSIs. The same report included a case study of Bleaklow Plateau which estimated that restoration of an extensive area of SSSI peat bog could deliver non use values of £3.0 million and recreational benefits of £1.5 million (the figures representing the present value of benefits over 50 years).

Early valuation studies estimated aggregated willingness to pay of users of SSSIs in Upper Teasdale, Skipworth Common, and Derwent Ings at £150,000, £1m, and £520,000 per year respectively at 1990 prices (EFTEC, 2007). Evidence from these studies suggests that non-use values may well make the largest contribution to the values estimated (CJC Consulting, 2004).

Another early study by Harley and Hanley (1989) of visitors to three RSPB reserves, at Loch Garten and Handa in Scotland and Blacktoft Sands in England, all of which are designated

as SSSIs, estimated a mean willingness to pay of between £1.13 and £3.49 per recreational visit.

Crabtree (2004) estimated the overall recreational value of SSSIs by combining estimates of visitor numbers with estimated willingness to pay from previous studies of SSSIs. Based on an average value of £1 to £3 per visit, the overall value of recreational visits to SSSIs was roughly estimated at between £372m and £1,110m per year. However, it was noted that many of these visits would have taken place whether the sites were SSSIs or not, with the author concluding that the additional benefits of SSSI designation could not be estimated.

A study by Willis *et al.* (1996) adopted a multiple iterative bidding approach to value the Pevensey Levels Wildlife Enhancement Scheme (WES), which paid landowners and occupants to develop schemes which enhance SSSI wildlife habitats. This study therefore provides some insights into the benefits of achieving favourable condition. It estimated a mean willingness to pay of £0.41 for non-users and £0.97 to £1.07 for users. Taking account of use values alone, the benefit cost ratio for the Pevensey Levels WES was 0.5; incorporating non-use values increased the benefit/cost ratio to 2.0.

5.3 Insights from wider literature

5.3.1 Economic Benefits of the UK BAP

A current study led by Aberystwyth University for Defra is examining the value of benefits delivered by the UK Biodiversity Action Plan. This has employed a choice experiment study to estimate the economic value of seven ecosystem services: wild food, non-food products, climate regulation, water regulation, sense of place, charismatic species and non-charismatic species. The choice experiment examined the values of these services across different levels of biodiversity provision. This was combined with an exercise to quantify the relative levels of ecosystem services delivered through implementation of the UK BAP, undertaken using an experimental 'weighting matrix' in which experts were asked to identify the levels of ecosystems services delivered by individual broad BAP habitats. The results of the study are expected to be available soon.

The UKBAP study is of relevance to SSSIs. The current study adopts a similar methodological approach and involves the same lead researchers as the UKBAP study. In addition, some of the ecosystem service values and weightings for different habitats could be transferable to SSSIs.

5.3.2 Economic Value of Geodiversity

The social and economic value of geodiversity was explored by Aberystwyth University (Webber *et al.*, 2006) for English Nature, using a variety of methods, including a literature review and new empirical research. In particular, the choice experiments method was used to assess how much people would be willing to pay to protect and enhance two geological sites: Wren's Nest National Nature Reserve (NNR, also SSSI) and the Jurassic Coast World Heritage Site (WHS, which comprises 14 SSSIs). Economic impact analysis was also carried out on the Isle of Wight to determine the size of the local economic impacts that geodiversity brings to the Island.

The value of 'knowledge' of geodiversity was explored by comparing the value of access to different geological sites both with and without the provision of interpretative material.

At Wren's Nest NNR, access to the whole site with educational material was valued at £21.26 per household per year compared to £7.83 per household per year without the provision of educational material. Similarly, access to the geologically-rich Seven Sisters caverns within the NNR with extensive interpretation was valued at £13.95 per household per year compared to £12.22 per household per year without.

Similar findings were also found at the Jurassic Coast WHS where access with extensive interpretative material was valued at £62.35 per household per year compared to a value of £23.69 per household per year for access without educational material.

In all three cases, the provision of educational material on geodiversity (and hence 'knowledge') clearly enhances the value that people attain from visiting a geodiversity site.

The value that people placed on the opportunity to collect fossils was also explored at both case study sites. People expressed a positive willingness to pay to be able to collect fossils, provided that this was accompanied by sufficient protection of rare and important fossils.

Geodiversity was estimated to attract annual visitor expenditures of £11 million to the Isle of Wight economy, generating between £2.6 million and £4.9 million in local income and supporting between 324 and 441 full time equivalent local jobs.

5.3.3 Value of England's Terrestrial Ecosystem Services

An overall assessment of the value of terrestrial ecosystem services in England was undertaken by Jacobs (2008) for Defra. This provided an aggregate assessment of the levels of provisioning, regulating and cultural services at the national scale, and estimated the overall value of services as far as possible. The report provided a framework for valuing changes in services and provided overall assessments of the value of some services at the national level, including provisioning services, certain regulating services (e.g. carbon sequestration) and some cultural services (e.g. different types of outdoor recreation). While the benefits of semi-natural habitats in the provision of many services was recognised, the report provided limited evidence of the effect of habitat management on service delivery. In general the quantification of service delivery was found to be a barrier in attempting valuations at the national scale. The report provides limited evidence directly relating to SSSIs, but gives some background information that may be relevant to assessing and valuing the changes in ecosystem services resulting from SSSIs.

5.3.4 Benefits of Designation of National Parks

A recent study by Selman (2009) reviewed the effects of National Park designation. The core instruments for protection are strengthening planning and control, increased funding and complementary advice and demonstration: *"The key effect of designation is to divert a number of carrots, sticks and sermons preferentially towards the defined area. These will have the greatest force where designation of the area has been on a formal, legal basis."* The main positive impacts were found to be biodiversity protection and enhancement, recreational and economic benefits. Negative impacts were decreasing housing availability and affordability and potential conflicts arising from increases in tourism (see Powers applied to designated areas and positive and negative impacts of designation).

Figure 5.3 Powers applied to designated areas and positive and negative impacts of designation

Summary of range of positive and negative powers typically applied to designated areas.

- Enhanced planning control – stronger planning policies restricting unsympathetic or non-essential development (or even a general presumption against development), removal of permitted development rights (under certain circumstances) and/or notification of permitted agricultural operations, attaching occupancy and residence conditions to new houses.
- Notification and control of land operations (especially with 'operations likely to damage' the scientific interest of SSSIs).
- Statutory duties on management agencies and other public bodies – e.g. National Park Authorities' responsibilities to balance conservation, enjoyment and socio-economic wellbeing, other public bodies have a responsibility to promote National Park objectives on their land.
- Targeting of payments – e.g. central government grant to National Parks, Sustainable Development Fund for projects in National Parks, Higher Level Stewardship.
- Management and spatial plans – production of Local Development Frameworks by National Park Authorities, preparation of management plans for AONBs.
- Provision of advice and demonstration – e.g. rangers and wardens in National Parks, Land Management Advisory Service (Natural England) to farmers.
- Environmental Assessment – a wider range of projects subject to Environmental Assessment is captured in designated areas (under planning, water management, forestry, highways and agriculture legislation) because of the sensitivity of the environment.
- Targeting of incentives to promote 'virtuous' links between landscape and economy/community;
- Reserve powers, such as rights of entry and enforcement of 'orders'.

Potential positive and negative impacts of National Park designation (based on Colhoun, 2008).

Potential positive impacts
- Additional government funding for the National Park area.
- Direct employment via an established National Park Authority.
- Landscape and built heritage protection and maintenance of the area's biodiversity.
- Increased opportunities for recreation and increased numbers of visitors.
- Increased visitor expenditure and employment associated with the tourism industry and countryside management.
- Increased levels of visitor management.
- Higher property values.
- Support for local services.
- Possible use of the National Park 'brand' for local produce schemes and for attracting visitors.

Potential negative impacts
- Increase in the number of second homes.
- Decline in house affordability and change in social mix.
- Negative effects on some land values due to increased restrictions.
- Possible impacts due to visitor numbers on the landscape, biodiversity and built heritage unless careful management is put in place.
- Potential conflicts between tourism/recreation and landowners, especially if access points are not adequate.
- Potential increases in traffic congestion associated with increasing numbers of visitors.
- Changes in employment profile – tourism jobs which tend to be lower paid and seasonal.

Source: Selman, 2009

This list of positive and negative impacts can be supplemented by a study by Annett *et al.* (2006) on potential impacts of national park designation in Northern Ireland which is based on an extensive review of national parks across the world. Note however, that many of the listed advantages and disadvantaged are related to direct use of the area as a park, which in many cases would not apply to SSSI land.

Table 5.3 Impacts of national park designation in Northern Ireland

Potential advantages	Potential disadvantages
Additional funding to the national park area	An increase in house prices
Jobs in the national park authority	An associated rise in rateable value of houses and property
Protection of the landscape	A related change in the social mix towards the higher socio-economic groups, and retirees
Slowing or stemming loss in biodiversity	A change in land values with development land increasing in cost, and land not zoned for development reverting to agriculturally influenced prices
Protection of built heritage in the landscape	An increase in the number of second homes
Increased opportunities for recreation	More pressure for development of the undeveloped countryside
Increased numbers of visitors	Increased wear and tear on sensitive recreation sites and particularly the uplands
Higher visitor expenditure	Possible negative effects on designated nature conservation sites without careful management
More jobs in tourism	Potential conflicts between landowners and recreational users, particularly because of the scarcity of official access to the countryside compared to national park areas elsewhere
More jobs in countryside management	Increases in tourist related traffic, possibly leading to more congestion
Possible enhanced or top up funding for agri-environment schemes	Change in the balance of employment towards low paid seasonal jobs in tourism – potential in migration of workers to tourism jobs
Increased visitor management and landowner support	Reduction in mineral extraction over time
Higher property values	
Higher value of some land zoned for housing	
More support for local services	
Possible use of the international brand 'national park' for local produce schemes	

Source: Annett et al. (2006)

5.3.5 Improving ecosystem services through better management

The functioning of ecosystem services is closely related to geo- and biodiversity (English Nature, 2006; Kettunen and ten Brink, 2006; RSPB, 2009a; Selman, 2009) and promotion of sustainable use of natural resources and sustainable social and economic development on designated land has the specific benefit of potentially halting geo- and biodiversity loss. Although the level of protection due to improvements in management regimes vary according to the 'carrots and sticks' applied to designated areas the literature concurs that designation generally contributes positively to protect geo- and biodiversity through enhanced management strategies. However, the impact of designation has been found to be generally weaker where there are economic opportunities arising from development and a trade-off between protection and development exists (Selman, 2009).

Changes in management regime on protected land can be valued through the link between management and the condition of ecosystem services. If a difference in the state of ecosystem services can be attributed to a change in management this is an indicator of the value of improving management practices. Various studies have investigated the value of restoration projects across the UK – often these have found a high value for such projects due to the scale of intervention or the often degraded state of the area prior to restoration. As SSSI land does not normally attract intervention on the same scale as restoration projects these studies are not necessarily representative of the monetary value of SSSI designation but similar improvements may take place on a smaller scale.

In a valuation study of 'Tamar 2000', a restoration project on the Tamar catchment in Southwest England, the Environment Agency identified a range of specific ecosystem service benefits from improving the catchment, which covers a mixture of upland and lowland (Environment Agency, 2009, based on Tusa, 2000). These included improvements in regulatory services that could be relevant to different types of SSSI habitat, e.g.:

- improved farming practices (reduced fertiliser inputs, composting manure, under-sowing maize, fencing, rotational ditch clearing, separation of roof and foul water, and hedge cutting regimes);
- enhanced water quality through fencing off stock from rivers and clean/dirty water separation reducing the amount of pollutants entering rivers;
- forestry diversification leading to improved air quality (absorption of carbon dioxide, nitrogen dioxide and sulphur dioxide), capture of airborne particles (dirt, dust and soot), and climatic improvements (shading, suppressed wind speeds, cooling through transpiration, carbon sequestration);
- reduced flooding, e.g. through management of woody river debris;
- 're-wilding' of habitat leading to increased biodiversity, improved pollination and pest control;
- reductions in animal diseases; and
- protection of soil from erosion.

In a report for Natural England, Eftec undertook a similar, systematic review of qualitative changes in upland ecosystems due to improved woodland cover change, blanket bog restoration, grazing regime changes, burning regime changes, and re-wilding (Natural England, 2009). Non case-specific impacts on ecosystem services were largely identical to those listed above. Based on the Defra (2007) framework for valuing ecosystem services the study valued six different habitats that experienced improvements in management regimes. The value of reduced carbon losses from the restoration of an SSSI blanket bog at Bleaklow in the Peak District was estimated at £0.4 million over 50 years. Other regulating services such as water purification, water regulation and wildfire prevention could not be valued but were considered potentially significant at this site.

5.3.6 Benefits of ecosystems to human well-being

Well-functioning ecosystems and the quality of the environment is directly linked to human well-being and improvements to ecosystem services through environmental designation will contribute positively to human well-being (Chivian, 2003; Millennium Ecosystem Assessment, 2005; RSPB, 2009b).

A study by the RSPB (2009b) highlighted the following physical and mental health benefits from diverse natural spaces:

- Access to green space enables physical activity and can reduce the costs of healthcare;
- Proximity and quality of nature can help ease psychological problems;
- Outdoor learning can help improve behaviour and discipline, enhance emotional development and reduce aggression among children.

5.3.7 Benefits of Natural Environment - Evidence from Natural England

Natural England (2009) provided a summary of evidence of the benefits and costs of protecting the natural environment, arguing that the economic evidence is equally compelling at national and local levels. Box 5.1 lists some of the examples given.

Box 5.1: Benefits and Costs of the Natural Environment

The potential benefits of a UK network of Marine Conservation Zones could outweigh costs by a factor of between 7 to 40, with estimated benefits of between £7 billion and £19 billion.

Upland and lowland management to restore floodplains and improve water quality has demonstrated benefit-cost ratios of up to 4:1.

Many managed re-alignment projects deliver positive returns on investments of many millions of pounds.

People who live within 500m of accessible green space are 24 per cent more likely to meet recommended levels of physical activity. Reducing the sedentary population by just 1 per cent would reduce morbidity and mortality rates valued at £1.44 billion for the UK.

Environmental Stewardship is estimated to deliver savings of 3.46 million tonnes of CO2e per year. Without the scheme, greenhouse gas emissions from agriculture in England would be 11 per cent higher. The value of these savings is estimated at around £1.25 billion.

Box 5.2 summarises the economic benefits of a managed realignment scheme.

Box 5.2: Alkborough Flats - Benefits of Managed Realignment

Alkborough Flats comprises 440 ha of low-lying land on the south bank of the Humber estuary which is currently the UK's largest managed re-alignment site. In 2006 a 20 m wide breach was cut into the flood defence bank and 170 ha of land was converted to inter-tidal mudflat, saltmarsh and reedbed. The remaining land serves as storage capacity during extreme storm surges. It is calculated that there is an annual flood protection benefit of £400,667.

The area has been lost as arable farmland though there is some income from grazing livestock. 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 value of wildlife and habitat on the site has been valued at £535,000 per year. The restored intertidal area also plays a role in climate regulation (approximately 539 tonnes per year of carbon are trapped in sediments worth an estimated £14,553 per year), air quality improvement, nutrient and pollutant sequestration, and recreation and tourism. The overall benefit: cost ratio was estimated at 3.2. There are now 23 such coastal re-alignment schemes in England, cost-effectively delivering a wide range of ecosystem services, including commercial fish stock nurseries at other sites.

5.3.8 Economic valuation of Natura 2000 benefits

Initial studies (ten Brink *et al.*, 2002; Halahan, 2002) exploring the benefits linked to Natura 2000 clearly distinguished between environmental (e.g. biodiversity), social (e.g. employment) and economic benefits (e.g. provision of food and raw material). They usually provided a qualitative description of the socio-economic benefits attributed to the network, and included some insights into quantitative aspects (e.g. number of visitors, number of jobs created). They presented, to a lesser extent, monetary estimates of the value of Natura 2000 sites as well (e.g. tourism and its contribution to regional development). Mostly building on case examples, the studies explored different types of benefits, including examples on local and regional branding, attraction of tourists, employment, amenity/leisure and health value, natural and cultural heritage, educational opportunities, capacity building opportunities and the provision of services such as the supply of quality of water and flood control. However, the importance of the network for rural and regional development was particularly emphasised.

According to a first analysis undertaken in the framework of the ongoing European Commission project on the socio-economic benefits of Natura 2000 (IEEP *et al.*, 2010) not many studies have yet been carried out which specifically focus on the economic valuation of the network. Most of them focus on economic values provided by biodiversity in general, or were undertaken from the perspective of other forms of designation such as national parks. However, the few existing examples that specifically address Natura 2000 provide insights into different frameworks and approaches of valuation. Box5.3 provides an example of an in-depth Natura 2000 valuation study.

Box 5.3: Jacobs (2004) Study on the Costs and Benefits of Natura 2000 in Scotland

Jacobs (2004) evaluated the costs and benefits of the Scottish Natura 2000 sites using the concept of use and non-use values. Relevant information on the benefits was collected by using questionnaire survey techniques, mainly contingent valuation methods, to determine the 'Willingness to Pay" in seven case study areas which covered a range of different habitat types. These data were then extrapolated to the national level, covering all 300 Natura 2000 sites within Scotland. Non-use values were determined by asking for a value for all 300 sites.

Final results showed that only around £1.5 million (1%) of the benefits per year related to use values (e.g. walking etc), whereas 99% of the benefits related to non-use values, amounting to £210 million per year (Table 5.5). Of those, around 51% were non-use value accruing to the Scottish general public and 48% to visitors to Scotland. This suggests that the largest benefit accruing from Natura 2000 designation is protection of natural resources so that people are satisfied they will continue to exist in the future.

The study excluded any health related, educational or cultural benefits because the authors considered them difficult to measure. It is therefore likely that the study under-estimated the potential benefits from Natura 2000 sites, although they may have been partly covered by the use and non-use values derived from the surveys.

The study estimated a benefit: cost ratio of 7 over a 25 year period for the full implementation of the network, compared to a scenario involving complete withdrawal of site protection.

Table 5.4 Value of Natura 2000 sites in Scotland (percentage in parentheses)

The annual benefit of SAC and SPA designated areas in Scotland (£000)			
General use value (e.g. walking)	Specialist use value (e.g. angling)	Non-use value	Total
1,535 (0.72%)	99 (0.05%)	210,960 (99.23)	212,594 (100)

Source: Jacobs (2004)

Hernandez and Sainteny (2008) carried out a cost-benefit analysis of Natura 2000 sites in France, by calculating the overall value of benefits linked to certain management activities at a site and comparing it to the costs (including direct, indirect and opportunity costs) arising from the same activities on a per hectare and annual basis. The study estimated the willingness to pay of a group of people living next to the site for different programmes of management activities, and determined the costs related to each of these programmes. The calculated overall benefits amounted to €182/ha/year, and net benefits to €142ha/year (Hernandez and Sainteny, 2008). Benefits were thus estimated to be around 7 times higher than the actual costs associated with the Natura 2000 site.

Bade and van der Schroeff (2006) estimated levels of current spending as direct evidence of the importance attached to goods and services provided by Natura 2000. The authors applied the Financial Economic Decision-making Support model (FEDS) to provide an insight into the economic effects of measures envisaged for the implementation of the

Habitats, Birds and Water Framework Directives[5]. The model takes into account only flow of money considered identifiable ('hard'), such as turnover, profits after taxes, added value (e.g. real estate) and taxation. It was tested at two Natura 2000 sites to identify the economic value linked to certain nature and water functions of an area. One of the sites was analysed because of its high concentration of recreational activities, the other one because of its strong productive function related to inland fishery and inland navigation. The annual real estate value for nature or water was estimated at €705 million at the recreational site and to €251 million at the site with a high productive function. The latter was estimated to generate economic revenues of €91 million annually for the regional economy through indirect and direct flows of money.

A key challenge refers to the appropriate definition of common scenarios against which estimates of costs and benefits can be compared (Gantioler *et al.*, 2009). In the study on Natura 2000 benefits in Scotland (Jacobs, 2004), the authors distinguished between policy-on and policy-off scenarios. The first meant that all 300 Natura 2000 sites within Scotland are fully designated and implemented over a period of 25 years. The policy-off situation was defined as the complete withdrawal of all conservation protection within the same period of time. Others like Hernandez and Sainteny (2008) correlated benefits to certain management activities to be carried out. Rensburg *et al*. (2009 draft) created a Portfolio Allocation model to examine the effect of various policies and subsidies on the farming practices of the 20 farms located in the Burren Natura 2000 landscape in Ireland. The model indicates that the suckler beef and BurrenLIFE Project (BLP) payment systems are crucial for the farms and together produce between €2.6 and €12.9 million (lower bound and average survey based value) in income for the community, if positive cultural, karst landscape and biodiversity externality values as well as multiplied income from tourism are taken into account. If all operating costs of the programme as well as all direct payments are considered at least a 235% rate of return in terms of non-monetary and tourism value for the broader Irish community is envisaged.

The classification of benefits associated with Natura 2000 is strongly influenced by the perspective of the different valuation studies. This can refer to a financial or economic approach or a more holistic point of view that takes environmental and social aspects into account. In addition, many of the existing valuations of Natura 2000 benefits focus on individual sites and do not consider the variation of benefits that might occur between sites or in different geographical areas. The valuation of benefits strongly depends on where they occur geographically and where the beneficiaries are located (Kettunen *et al.*, 2009; RSPB, 2009). The following were identified as key levels where Natura 2000 related benefits can occur:

- local public benefits: a site's role in supporting local identity, local recreation, local non-market forest products, and the local "brand", etc.;
- local private benefits: a site's support to natural water purification resulting in lower pre-treatment costs to the local water supply company, etc.;
- local public sector benefits: a site's ability to mitigate floods resulting in lower public investment in flood control and / or flood damage, etc.;
- regional and cross-border benefits: regulation of climate and floods, mitigation of wild fires, provisioning and purification of water in transnational river basins), etc.;
- international / global public benefits: a site's provision of habitat for a migratory species at some point in its annual cycle, regulation of climate (carbon capture and storage), maintenance of global species and genetic diversity), etc.; and
- international private benefits: new pharmaceutical or medicinal product derived via bioprospecting, etc.

[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:HTML

Within the scope of the literature review, no studies were found that assessed the additional benefits of the Natura 2000 network compared to other forms of designation (e.g. SSSIs). However, this was to a certain extent taken into account by the 2004 Jacobs study on the economic benefits of Natura 2000 in Scotland. According to the authors, additional benefits relate to enhanced visitor values, marketing opportunities and enhanced leverage of funds invested at the sites. Although little information on the additional benefits is yet available, it can be assumed that they strongly relate to the objectives of the two Nature Directives themselves. Another important factor that needs to be analysed is the network's contribution to an increased resilience of ecosystems and ensuring the provision of ecosystem services and goods beyond the site level. All these aspects will need to be carefully considered when defining the additional benefits the network delivers in comparison to national networks of protected areas and will be further analysed in the ongoing European Commission study on the socio-economic benefits of Natura 2000 (IEEP *et al*., 2010).

Other research suggests that good environmental management supports the economy and can even help reverse economic decline in rural areas (BirdLife International, 2009). Although these benefits are related to different ecosystem services the economic impact is broader and cannot be linked to any specific service. Such benefits are relevant mostly to SSSI land that is kept as parks or where the local economy is directly related to the natural environment and the quality of the SSSI designated areas.

5.3.9 International Evidence of Costs and Benefits of Protected Areas

Internationally designated sites provide ecosystem services and benefits similar to those described above. Costs include, for example, financial costs of management; social and economic costs of human wildlife conflict, restricted access to resources or displacement from traditional lands, and opportunity costs of foregone economic options. Therefore, the overall scale of benefits (at local, national, regional or global level) can only be determined by considering them in the context of related costs.

According to the TEEB analysis (TEEB, 2009a), the ecosystems within protected areas provide a multitude of benefits and the benefits of protection can by far outweigh costs at global and national level. However, the picture is more diverse at the local level (Examples of protected area benefits and costs accruing at different scales5.4). A sizable body of case study evidence exists indicating that local benefits provided by ecosystems within protected areas can also outweigh costs. However, there are also cases where local costs clearly outweigh benefits, particularly where groups are displaced or lose access to key resources. In general, studies in developed countries are more likely to provide relevant insights in a UK context than those in the developing world, because of variations in socio-economic conditions and the relationship between people and the natural environment.

In addition to the distribution of benefits and costs between different scales, it is also important to note that specific benefits from individual sites can vary significantly depending on location, ecosystem and the site's management strategy.

Figure 5.4 Examples of protected area benefits and costs accruing at different scales

Table 8.1: Examples of protected area benefits and costs accruing at different scales

	Benefits	Costs
Global	- Dispersed ecosystem services (e.g. climate change mitigation/adaptation) - Nature-based tourism - Global cultural, existence and option values	- Protected area management* (global transfers to developing countries) - Alternative development programmes* (global transfers to developing countries)
National	- Dispersed ecosystem services (e.g., clean water for urban centres, agriculture or hydroelectric power) - Nature-based tourism - National cultural values	- Land purchase * - Protected area management (in national protected area systems) * - Compensation for foregone activities* - Opportunity costs of forgone tax revenue
Local	- Consumptive resource uses - Local ecosystem services (e.g. pollination, disease control, natural hazard mitigation) - Local cultural and spiritual values	- Restricted access to resources - Displacement - Protected area management (private land owners, municipal lands) - Opportunity costs of foregone economic activities - Human wildlife conflict

* These cost categories in effect transfer costs from the local to national level, or from the national or international level. Section 8.3 provides more information on these and related options.

Source: TEEB (2009b)

5.4 Economic Impacts of SSSIs

The above sections relate to the **economic value of the benefits** provided by SSSIs – i.e. the value of the services that they provide to society. There is also an extensive literature on the **economic impacts** of SSSIs, of other designations, and of biodiversity more widely. These economic impacts include the role of sites and the species and habitats they support in supporting employment and incomes, and hence contributing to economic development and regeneration.

For example, a report by the RSPB (Rayment and Dickie, 2001) identifies the following economic development benefits from nature conservation:

- Direct employment in the natural environment sector in the UK is estimated to total 18,000 full time equivalent (FTE) jobs;
- Expenditures by conservation organisations provide revenues and employment for local suppliers and contractors;
- Conservation schemes (such as agri-environment and woodland management initiatives) fund work in the wider countryside, and have been shown to support incomes and employment;
- The tourism sector benefits from conservation activities, as wildlife, habitats and landscapes attract visitors to rural areas, who spend money on local goods and services.

Impacts relating to particular SSSIs include:

- North Norfolk Coast - A study of visitors to six sites on the Norfolk Coast in 1999 estimated that they spent £21 million per year in the local economy. Visitors attracted to these sites mainly by their birds and wildlife were estimated to have spent a total of £6 million in the area, supporting an estimated 135 FTE jobs. The Norfolk Wildlife Trust's Cley reserve and Titchwell RSPB reserve were estimated to bring extra visitor spending of £2.5 million and £1.8 million respectively into the Norfolk coastal economy in 1999. In addition, work by conservation organisations in managing sites in the Norfolk coast area supports 30 FTE jobs.

- Minsmere RSPB Reserve, Suffolk – the site receives almost 80,000 visitors per year, who were estimated to spend £1.1 million in the local economy in 2000, supporting an estimated 27.5 FTE tourism jobs. Direct employment on the reserve totals 20 FTE jobs.
- Symond's Yat Rock, Forest of Dean - each year, the RSPB and Forestry Commission operate a peregrine falcon nest protection and viewing scheme at Symond's Yat Rock in the Forest of Dean, which attracts 50,000 visitors. A visitor survey estimated that Symond's Yat Rock Peregrine Project attracted extra visitor spending of £551,000 to the Forest of Dean area in 1999, supporting an estimated 18 FTE jobs.

More broadly, a series of studies led by the National Trust and entitled "Valuing our Environment" assessed the overall significance of the environment for economic development in different regions. In Wales, for example, it was estimated that 1 in 6 jobs and £6 billion of GDP were directly dependent on the environment in 2001 (National Trust, 2001). Subsequent work has estimated that the coastal and marine environment supports 92,600 jobs and £2.5 billion in GDP, much of this in tourism (National Trust, 2006).

5.5 Conclusions

SSSIs provide a wide range of benefits, some of which are traded and others which are not. These benefits can be valued using a variety of market and non-market valuation techniques, whose applicability varies depending on the particular service being valued.

While there is little evidence of the overall value of SSSIs, a variety of studies have estimated the value of some of the benefits provided by particular sites, while others have assessed related policies or habitats and potentially provide evidence of the value of key services which could be used in SSSI valuation, by employing benefits transfer methods.

As with assessment of ecosystem services, a key challenge lies in the assessment of the net value of the benefits of SSSI designation – the overall benefits of particular sites may be easier to assess than the effect on these benefits of designating the site as an SSSI and the effects of this designation on site management and condition.

The review suggests that there is much existing evidence relevant to the valuation of the benefits of SSSIs, but that limitations in scientific evidence highlight the challenges in quantifying service delivery, and the effect of SSSI designation on it, as a basis for valuation. In other words, it is often more difficult to quantify the change in service being valued, than to identify potential unit values.

Where evidence is available from SSSIs and other protected areas, it highlights that the benefits of designation often significantly outweigh the costs. Evidence suggests that non-use values may significantly exceed use values, while the value of regulation of climate, water flows and water quality may also be substantial in some cases.

The review highlights a number of key methodological issues which need to be taken into account in valuing benefits, such as:

- The need to avoid double counting of benefits, especially when aggregating different values relating to different services
- The importance of distinguishing between the gross values of SSSI sites and the net benefits of the policy;
- The difficulties of distinguishing between the benefits of SSSIs and other designations;
- The need to separate estimates of the economic benefits and economic impacts of SSSIs;
- The site-specific nature of many services and benefits, requiring caution in transferring benefit estimates between sites;
- Caveats regarding particular valuation techniques, such as the various potential biases associated with stated preference methods.

It is also important to reiterate that monetary valuation cannot capture the full value of SSSIs. Biodiversity and geodiversity have intrinsic value in addition to the services that they provide to society. The value of the related scientific importance of sites is also difficult to capture using monetary valuation methods.

6 Overall Conclusions

6.1 Evidence of the Benefits of SSSIs

The review demonstrates that evidence of the benefits provided by SSSIs is far from complete. While the increasing costs of SSSI policy are relatively easily assessed, the benefits are complex and wide ranging. While data on SSSIs is improving, in many areas a lack of comprehensive data makes overall estimates of benefits problematic. Furthermore, scientific uncertainties hamper assessments of the services delivered by SSSIs and their value.

Nevertheless, some evidence is available at each stage of the impact pathway of the policy presented in Section 1:

- It is clear that SSSIs provide substantial benefits for species, habitats, geological and geomorphological features and ecosystems in the UK, and make a significant contribution to UK BAP and geological conservation priorities. More data is available about the contribution of SSSIs to habitat and geological conservation than to species conservation, with much of the evidence for the latter based on samples of particular species groups.
- Overall evidence of the ecosystem services provided by SSSIs is limited and fragmented. However, available evidence suggests that SSSIs provide a wide range of provisioning, regulating and cultural services. Quantitative evidence of service delivery is limited, but available for certain services at certain sites. The net effects of SSSI designation on service delivery are also difficult to assess.
- While there is little evidence of the overall value of SSSIs, a variety of studies have estimated the value of some of the benefits provided by particular sites, while others have assessed related policies or habitats and potentially provide evidence of the value of key services which could be used in SSSI valuation, by employing benefits transfer methods. As for ecosystem services, a key challenge lies in the assessment of the net benefits of SSSI designation. The review suggests that a lack of scientific evidence regarding levels of service delivery are at least as great a barrier to economic valuation as gaps in evidence of economic values.

The review highlights a number of key methodological issues which need to be taken into account in valuing benefits, such as:

- The need to avoid double counting of benefits, especially when aggregating different values relating to different services
- The importance of distinguishing between the gross values of SSSI sites and the net benefits of the policy;
- The difficulties of distinguishing between the benefits of SSSIs and other designations;
- The need to separate estimates of the economic benefits and economic impacts of SSSIs;
- The site-specific nature of many services and benefits, requiring caution in transferring benefit estimates between sites;
- Caveats regarding particular valuation techniques, such as the various potential biases associated with stated preference methods.

Gaps in the evidence base provided significant challenges for the research study, which the case studies, stakeholder workshops and focus groups have sought to address. The literature review demonstrates, however, that assessments of the benefits of SSSIs will inevitably be based on an incomplete understanding of the services and benefits they provide. This confirms the need to design solutions to the inevitable evidence gaps. For example, where scientific evidence does not permit the quantification of individual

ecosystem services, expert judgement, through workshops, can be used to assess the relative importance of different services. Similarly, elicitation of the public's willingness to pay for the services provided by SSSIs can be based on an accurate summary of currently available evidence.

6.2 Summary of Key Findings

Conservation Benefits of SSSIs

It is clear that the SSSI network represents our national biodiversity well and has enhanced the protection of many of our more valuable species, habitats and geological and geomorphological features, a significant but variable proportion of which are now concentrated in SSSIs. SSSIs have made a significant contribution to reducing declines and local extinctions in several species groups and have helped to improve the ecological condition of sites, to the benefit of habitats and species. They are therefore playing a major role in the delivery of the UK Biodiversity Action Plan and country biodiversity strategies. They have been effective in conserving and maintaining the condition of many of our most important geological and geomorphological sites.

Evidence shows that a larger proportion of habitats are in favourable condition inside SSSIs than outside them. In February 2010, 43.4% of the SSSI area in England was in favourable condition, and 47.3% in unfavourable but recovering condition, resulting in the total of 90.7% in target condition.

Examples of the benefits to species include the following:

- SSSIs protect the entire populations of some threatened species, such as the bog orchid.
- A study of 371 Red List vascular plant species found that 88% of species were represented at least once within SSSIs and that protected area coverage was the most important predictor of species richness across Britain.
- Habitat protection, mainly in the form of SSSI designation, has been effective in safeguarding the natterjack toad, with safeguarded sites increasing from 60% in 1970 to 83% in 1990. Sites with SSSI or NNR status fared better than sites without any statutory habitat protection.

SSSIs form the main statutory mechanism for protecting nationally important geological sites in Great Britain. SSSI designation provides a high degree of protection for sites although it does not guarantee their long-term conservation. However, as for biological SSSI sites, geological SSSIs have attracted resources in recent years to enhance management in order to achieve favourable condition.

Ecosystem Services Delivered by SSSIs

SSSIs provide a variety of ecosystem services; they offer important cultural and recreational opportunities; provide a resource for scientific study and education; contribute to the regulation of air, water, and soils; and provide food, fibre and genetic resources. As well as protecting the ecological processes on which society depends, SSSIs provide opportunities for people to appreciate nature and often make a direct contribution to the local economy.

Examples of ecosystem services include:

- Genetic resources - crop wild relatives (CWR) are potentially important for future agricultural production. A paper has shown that all 17 CWR hotspots that would need to be protected to conserve two thirds of CWR species are designated SSSI.
- Climate regulation – carbon sinks in soils, vegetation and the oceans play a vital role in regulating climate. A range of habitats - peatlands, woodlands, agricultural land, coasts and the seas - play a role in greenhouse gas regulation. One study found that SSSIs store 1.8 times as much carbon as would be expected on the basis of their area alone,

especially as they protect carbon-rich soils in habitats such as heather moorland and wetlands.

- Flood defence – Freiston Shore managed coastal realignment project in Lincolnshire has been shown to yield net cost savings compared to engineered flood defences, as well as increasing annual recreational visits from 11,000 to 60,000 and supporting 6 full time equivalent jobs.
- Cultural services - Around 50% of SSSIs are open to the public and more than 39,000 hectares of SSSI land are in or close to urban areas. SSSIs attract around 380 million visits each year and support more than 40 different types of recreational and educational activities. However, there is evidence that overall recreational use of SSSIs is less than for the countryside as a whole, because on average they tend to be located in less densely populated areas.
- Multiple services through habitat restoration – Wallasea Island is the site of Britain's biggest coastal wetland restoration project, involving managed realignment to restore saltmarsh, creeks, and mudflats for the benefit of wildlife and to provide a wide range of ecosystem services (grazing, flood defence, fisheries, recreation, carbon sequestration, nutrient cycling and water quality).

Geodiversity, as well as biodiversity, contributes to the delivery of ecosystem services and underpins the delivery of provisioning, regulating, cultural and supporting services. Many of these services can be assessed within the ecosystem services framework. However, geodiversity plays a distinct role in contributing to our scientific and historical knowledge and understanding. It also provides abiotic materials for use in construction and industry.

The net effects of SSSI designation on service delivery are difficult to assess. It is likely that by improving the condition of sites, SSSI policy enhances the delivery of regulating services, though this is difficult to quantify. SSSI status is also likely to enhance cultural services, including recreational, educational and existence values, although evidence suggests that much recreational use of SSSIs is unrelated to site condition. Net direct effects on provisioning services may be negative, though SSSIs may have direct benefits to fisheries and indirect benefits through pollination and nursery functions. Evidence suggests that agricultural production is significantly under-represented in SSSIs, reflecting the under-representation of arable farming in these areas.

Valuing the Benefits of SSSIs

SSSIs provide a wide range of benefits, some of which are traded and others which are not. These benefits can be valued using a variety of market and non-market valuation techniques, whose applicability varies depending on the particular service being valued.

While there is limited evidence of the overall value of SSSIs, a variety of studies have estimated some of the benefits provided by particular sites, while others have assessed related policies or habitats and potentially provide evidence of the value of key services which could be used in SSSI valuation, by employing benefits transfer methods.

As with assessment of ecosystem services, a key challenge lies in the assessment of the net benefits of SSSI designation – the overall benefits of particular sites may be easier to assess than the effect on these benefits of designating the site as an SSSI and the effects of this designation on site management and condition.

The review suggests that there is much existing evidence relevant to the valuation of the benefits of SSSIs, but that limitations in scientific evidence highlight the challenges in quantifying service delivery, and the effect of SSSI designation on it, as a basis for valuation. In other words, it is often more difficult to quantify the change in service being valued, than to identify potential unit values.

Where evidence is available from SSSIs and other protected areas, it highlights that the benefits of designation often significantly outweigh the costs. Evidence suggests that non-

use values may significantly exceed use values, while the value of regulation of climate, water flows and water quality may also be substantial in some cases.

Examples of the value of benefits of SSSIs include:

- The Sustainable Catchment Management Programme (SCaMP) in the Peak District has restored degraded moorland in a 20,000ha catchment area, more than 40% of which is SSSI. Around 13,500ha of SSSI land has been restored into favourable or recovering condition recreating habitats and enhancing biodiversity. As a consequence the moorland's capacity for sequestering carbon has recovered (the moorland previously had a net loss of carbon) and the area is sequestering an estimated 2000t CO_2 per year valued at £0.86m per year over 50 years. There have also been improvements in water quality in the catchment.
- Based on an average value of £1 to £3 per visit, one study estimated the overall value of recreational visits to SSSIs at between £372m and £1,110m per year. However, it was noted that many of these visits would have taken place whether the sites were SSSIs or not, with the author concluding that the additional benefits of SSSI designation could not be estimated.
- At Ingleborough National Nature Reserve, an improved management regime is estimated to have increased recreational benefits to the site's 100,000 annual visitors by £3m and brought improvements to the historical and cultural landscape valued at a further £3m. This increase entirely relates to increased utility per visit, as the numbers of visits are assumed to be constant.
- Early valuation studies estimated the aggregate willingness to pay of users of three SSSIs in Upper Teasdale, Skipworth Common, and Derwent Ings at £150,000, £1m, and £520,000 per year respectively at 1990 prices.
- A study of the Pevensey Levels Wildlife Enhancement Scheme (WES), which paid landowners and occupants to develop schemes which enhance SSSI wildlife habitats, found an estimated mean willingness to pay of £0.41 for non-users and £0.97 to £1.07 for users. Taking account of use values alone, the benefit cost ratio for the Pevensey Levels WES was 0.5; incorporating non-use values increased the benefit/cost ratio to 2.0.
- A study of the economic benefits of geodiversity estimated willingness to pay to access two sites - Wren's Nest National Nature Reserve (also SSSI) and the Jurassic Coast World Heritage Site (which comprises 14 SSSIs). At Wren's Nest, access to the whole site with educational material was valued at £21.26 per household per year compared to £7.83 per household per year without the provision of educational material. At the Jurassic Coast WHS, access with extensive interpretative material was valued at £62.35 per household per year compared to a value of £23.69 per household per year for access without educational material. People also expressed a positive willingness to pay to be able to collect fossils, provided that this was accompanied by sufficient protection of rare and important fossils.

Other studies assessing the value of related policies and designations (e.g. UKBAP, Natura 2000 sites and agri-environment schemes), habitats, sites and species also demonstrate the value of biodiversity and ecosystems and the services they support. Many of the values obtained are potentially transferable to SSSIs.

There is also evidence that SSSIs can provide positive economic impacts by supporting employment and incomes in local economies, both through site management and by supporting tourism. Examples include:

- North Norfolk Coast - A study of visitors to six sites on the Norfolk Coast in 1999 estimated that they spent £21 million per year in the local economy. Visitors attracted to these sites mainly by their birds and wildlife were estimated to have spent a total of £6 million in the area, supporting an estimated 135 FTE jobs. The Norfolk Wildlife Trust's Cley reserve and Titchwell RSPB reserve were estimated to bring extra visitor spending

of £2.5 million and £1.8 million respectively into the Norfolk coastal economy in 1999. In addition, work by conservation organisations in managing sites in the Norfolk coast area supports 30 FTE jobs.

- Minsmere RSPB Reserve, Suffolk – the site receives almost 80,000 visitors per year, who were estimated to spend £1.1 million in the local economy in 2000, supporting 27.5 FTE tourism jobs. Direct employment on the reserve totals 20 FTE jobs.
- Symond's Yat Rock, Forest of Dean - each year, the RSPB and Forestry Commission operate a peregrine falcon nest protection and viewing scheme, which attracts 50,000 visitors. A visitor survey estimated that Symond's Yat Rock Peregrine Project attracted extra visitor spending of £551,000 to the Forest of Dean area in 1999, supporting an estimated 18 FTE jobs.
- Geodiversity has been estimated to attract annual visitor expenditures of £11 million to the Isle of Wight economy, generating between £2.6 million and £4.9 million in local income and supporting between 324 and 441 full time equivalent local jobs.

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