Natural England Commissioned Report NECR029

Economic valuation of upland ecosystem services

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Derwent Water, Lake District, is hugely important as a recreational resource

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The environment and its ecosystems provide many benefits for people. Collectively, these are known as ecosystem services. England's upland environment supplies a range of valuable ecosystem services. Examples include:

- landscapes and wildlife for recreation, challenge and learning - to improve health and well-being;
- climate regulation through carbon storage in soils and vegetation;
- fresh water supply;
- potential to reduce flood risk downstream; and
- production of energy, food and wood.

This work was commissioned as part of our Upland Futures Project, which is developing our long term vision for the upland environment in 2060.

The scope of this research is to examine the use of economic valuation techniques for valuing the ecosystem service changes due to upland management interventions and policies at a wide range of scales. Applications could range from 'simple' valuation of a farm-scale forestry project, to highly complex combinations of policies at different locations across a whole catchment or national park and wider.

The research aims to develop a methodology and to test its applicability to a number of management changes at a range of scales. The results will lead to recommendations about where and how to apply economic valuation techniques for uplands ecosystem services, and point to where further research is most needed.

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Further information
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Preface

This report forms part of Natural England's "Upland Futures project" (for more details, see http://naturalengland.etraderstores.com/NaturalEnglandShop/NE99).

The work aims to help Natural England to understand the implications of, and provide part of the rationale for, their emerging Upland Vision. Demonstrating the relative values of different options should aid decision making about the choices for upland land use.

Building on work to improve understanding of how a range of ecosystem services function in the uplands (albeit still with some knowledge gaps particularly around issues of scale and transferability of results between areas), the brief for this research was to develop an approach and methodology for valuing the impacts (costs/ benefits) that a series of changes to land use and management might have on the delivery of ecosystem services and benefits.

The changes to be examined were :

- Afforestation (productive conifers and native species)/ regeneration of native woodland and scrub (on existing moorland and grassland habitats);
- Restoration of damaged blanket bog habitats (through grip blocking; soil stabilisation and re-seeding);
- Changes to livestock grazing regimes (reduction or elimination of sheep grazing; switch to cattle grazing) across a range of upland habitat types (moorland; grassland; blanket bog; woodland);
- Elimination/ reduction of the regular burning of moorland/ blanket bog habitats that takes place for game shooting/ grazing-improvement reasons;
- A complete withdrawal of active land-management activity ('re-wilding') .

The potential impacts (positive and negative) of the above changes were to be assessed in terms of the value of variations in:

- The quality of drinking water supplied to downstream catchments;
- The impacts of downstream flood events;
- The use and enjoyment of these environments (including impacts on the historic and cultural landscapes) for recreation;
- The regulation of green house gas emissions;
- The food and fibre (and associated industry) provided by the uplands;
- The potential for renewable energy provision (especially biomass from woodlands);
- Biodiversity and wildlife.

The report and case studies presented here are the results of our research into these issues. The work has benefited greatly from the ideas, knowledge, data and critique provided by numerous individuals in Natural England and other organisations. These include:

Simon Bates, Nesha Beharry, Lesley Blainey, Aletta Bonn, Stephen Chaplin, Rebecca Clark, Jenny Keating, Tom Keatley, Julian Harlow, Andrew Herbert, John Hooker, John Hopkins, Dan Hunt, Paul Leadbitter, Jon Lovett, Jim Loxham, Nick Mason, Martin McGrath, Paul Morling, Colin Newlands, Martin Padley, Mark Phillips, Mick Rebane, Chris Reid, Peter Samson, David Smith, Jon Stewart, Judith Stuart, Flemming Ulf-Hansen, Tom Wall, Ruth Waters, Bill Watts, Simon Webb, Peter Welsh, Chris Woodley-Stewart

We know that some others have also helped at one remove (that is, provided advice or data to those who helped us) and though we can not list these people here, our sincere thanks go to them too. And our sincere apologies to anyone inadvertently omitted from the list above. Needless to say, any remaining errors are the fault of the authors alone.

Dr Robert Tinch, Dugald Tinch, Allan Provins (authors) and Ece Ozdemiroglu (internal reviewer)

30 July 2009

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This report presents the knowledge about how management changes in the uplands can influence ecosystem goods and services. It sets out a toolkit for carrying out economic valuation of changes in ecosystem goods and services arising from land use management changes in UK upland areas.

The steps of the toolkit form a clear and logical framework within which our knowledge and data can be set out and used to construct an economic appraisal of likely service changes. The steps are:

1. Defining the counterfactual or baseline
2. Identifying management options
3. Identifying impacts of management changes on ecosystem goods and service
4. Identifying human populations affected
5. Economic valuation of ecosystem service changes
6. Calculation of discounted costs and benefits
7. Sensitivity analysis
8. Accounting for non-monetised impacts
9. Reporting

The economic values of service changes can be an important support for decision making but must not be seen as replacing the need for deliberation. In particular, there will always be important uncertainties, whether physical, ecological or economic. And there will be some service changes to which we cannot ascribe monetary values. Finally, to the extent that other factors – moral obligations, intrinsic values - are considered relevant to decision making, they must be taken into account in other ways, alongside the cost-benefit analysis.

The toolkit is tested out in a set of six case studies (see Part 2 of the report). The overall conclusion is that it is possible to use economic valuation methods within a simple, logical framework to give useful results regarding the benefits and costs of management changes in the uplands. There are generally substantial areas of uncertainty and further physical, ecological and economic research will always be useful. Nevertheless, it is generally possible to derive indicative figures for the economic values of service changes, and in many cases these can be sufficiently robust to allow some conclusions on whether or not particular changes are likely to be beneficial in economic value terms.

1. Introduction

1.1 Purpose

This report aims to produce guidance on the economic valuation of ecosystem goods and services produced in UK upland areas[1]. The target audiences include non-economists seeking an introduction to the key concepts, issues and methods, and (teams of) economists and non-economists who wish to undertake basic appraisal of ecosystem service changes in upland areas. The report does not aim to provide sufficient information for economists not experienced in valuation of ecosystem services to conduct primary valuation studies. Rather the aim is to set out a simple methodological framework within which appraisals, drawing on existing valuation and scientific evidence, may be undertaken.

This leads on from work by Haines-Young and Potschin (2009) on the conceptual mapping of management regimes to ecosystem services provision. They note four uses of such work, to which we add a fifth:

- Taking stock of and organising knowledge;
- Facilitating communication and discussion of management scenarios;
- Investigating different weights and values for different outcomes;
- Helping users and experts make links across diverse topics, and
- Informing design of policies, for example agricultural subsidies, or payments for ecosystem services.

Although often considered just in the context of cost-benefit analysis of policies, economic valuation of ecosystem services can serve multiple purposes, and is useful in all the above contexts. This is most obvious for exploring weights and values, and for expressing diverse outcomes in a common metric, but valuation is also useful for organising information about, communicating and discussing values. Thus, far from being limited to cost-benefit analysis economic valuation provides a methodological framework for identifying, measuring and valuing upland ecosystem benefits to humans, and this can be useful for:

- Increasing awareness and understanding of the actual and potential service benefits to humans of upland areas;
- Facilitating communication regarding these benefits with different stakeholders and the general public;
- Collating and processing information about the impacts of management

[1] Rather than spell out "economic valuation of ecosystem goods and services" in full each time, the terms economic valuation and ecosystem services valuation are also used throughout the report.

options;

- Expression of impacts in monetary units, commensurable with other economic effects;
- Clear identification of which impacts are included and which are not in the estimates, and avoiding double-counting, and
- Informing debate and decisions about financing options.

The capabilities and limitations of valuation must also be understood. It is a useful method for:

- Processing large amounts of complex information;
- Identifying key knowledge gaps and guiding targeting of scarce research and data-collection resources;
- Measuring benefits (and costs) to humans on a common scale;
- Incorporating information about baselines and time profiles of impacts;
- Communicating with decision-makers and others who may be unaware of the range of ways in which environmental systems support and provide human values;
- Enhancing consistency across different decision processes, and
- Supporting debate and decision making.

But we must be clear too that it is:

- Not a substitute for deliberation and decision making;
- Not foolproof;
- Based on methods that yield approximations, not exact figures;
- Dependent on understanding links from management changes to changes in natural processes and environments;
- Dependent on understanding links from natural processes to human welfare: valuation can incorporate uncertainty and risk, but does not remove it; and
- Restricted to values that derive from individual human preferences: it does not cover "intrinsic" values of nature, or "social values" unrelated to individual preferences and choices.

These points can make use of economic valuation contentious. However, provided they are kept in mind, valuation can be very useful, and this report is based on this understanding.

1.2 Report structure

The natural starting point for the report would be a discussion of the key concepts and theoretical underpinnings of the method. These are:

- **Ecosystem services framework(s)**: for assessing the goods and services provided by ecosystems;
- **Total Economic value**: considering that part of human values that is reflected through preferences of individuals, revealed through trade-off between money (as a representative index of other resources) and changes in the quality or quantity of resources (termed willingness to pay or willingness to accept);
- **Economic appraisal**: the measurement of changes in social welfare by aggregating indices of individual values;
- **Environmental valuation** techniques for estimating the economic values of changes in goods and services, and
- **Benefits transfer**: the use of economic value evidence from one site for application to appraisal in another site.

But these concepts are widely discussed in existing literature, and to enhance readability and avoid a lengthy read-in for those familiar with the concepts, the conceptual background is presented in Annex 1.

Section 2 below takes this material as read, and discusses the application to upland areas in the UK, setting out briefly what we know about ecosystem goods and services in UK upland areas, and explaining briefly how the different management options under consideration in this report might be expected to influence goods and services.

Section 3 moves on from this to develop a step-by-step methodology or toolkit for the purpose of assessing the economic value of changes in ecosystem goods and services arising through changes in the management of uplands areas.

Section 4 presents six worked case studies, illustrating and discussing the use of the toolkit in practical examples from UK uplands, and highlighting some of the strengths and weaknesses of the approach, and ongoing research needs. Spreadsheets showing the calculations underpinning the case studies are available separately (contact Natural England). Section 5 draws conclusions.

In addition to the conceptual framework and background information presented in Appendix 1, two further appendices accompany the report. Appendix 2 summarises the relevant valuation literature, for each ecosystem service under consideration, and Appendix 3 provides a more technical discussion of errors and uncertainties in benefits transfer.

2. Using economic valuation for upland ecosystem services

The scope of this research is to examine the use of economic valuation techniques for valuing the ecosystem service changes due to uplands management interventions and policies at a wide range of scales. Applications could range from 'simple' valuation of a farm-scale forestry project, to highly complex combinations of policies at different locations across a whole catchment or national park, or at a national or European scale.

The research aims to develop a methodology and to test its applicability to a number of management changes at a range of scales. The results will lead to recommendations about where and how to apply economic valuation techniques for uplands ecosystem services, and where further research is most needed. This Section discusses the types of management options, counterfactual and links the changes in these options to changes in ecosystem service. It also comments on the applicability of economic valuation techniques to these changes.

2.1 Uplands management options

Major human activities taking place in uplands include:

- Agriculture (particularly livestock grazing);
- Forestry;
- Water catchment management, as part of the water supply industry;
- Quarrying and mineral extraction;
- Game production and sport;
- Recreation;
- Renewable energy production;
- Conservation activities, and
- Human habitation, though population densities are generally low.

The number of possible interventions is large. However they can be grouped into categories and it is at this level that we conduct the analysis.

Any particular implementation of these options will involve different specific activities in different locations. The management options must be seen as general approaches to be adapted to any given case, and the quantitative impacts on ecosystem services and values will vary. However it is possible to make general statements about the impacts to expect, guiding data collection and valuation efforts.

While in some cases we may be interested in a single management option at a local scale, valuation could also be applied to packages of options at wider scale. Interactions among management options and objectives are inevitable. This is most obvious for a specific piece of land (for example, it cannot be high-quality peat bog *and* forest[2]) but also applies across landscapes through “externalities” between different areas – for example associated with water flows, animal movements or human work and leisure activities. Similarly, there will be interactions between ecosystem services – for example, between outdoors recreation and field sports.

Therefore it may not be sufficient to evaluate the direct impact of each management option on each ecosystem service individually. Rather the impacts may need to be considered across the whole study area in a more holistic fashion.

Land ownership in the uplands has an historic and cultural significance for people beyond its market value, and this is likely to be particularly significant with some large, historic upland estates. In principle such values are taken into account in the Total Economic Value framework (see Appendix 1). More generally, any policy change will result in winners and losers, and there may be calls for compensation, or other hurdles to implementing policy. At a minimum, widespread stakeholder consultation is likely to be necessary for most significant changes. The tools identified in this report can be a useful support for decision making but do not replace such consultation. In particular, the tools presented here deal with economic analysis in which the value figures presented do not take into account who gains and who pays, but just the net result for society as a whole. Winners and losers can be identified separately as part of the process, but these distributional/equity issues may require additional consideration beyond the methods presented here.

2.2 Upland ecosystem services

Upland areas contain a wide range of complex ecosystems, directly or indirectly providing many benefits to humans. Uplands tend to be sparsely populated, but can be heavily used for recreation, and have major impacts on downstream areas through the flow of water. Thus a large part of the ecosystem services of upland areas may provide benefits outside the area, or to those living outside the area. In many cases these benefits are provided free of direct charge[3], and may not be taken into account in management, in which case there can be a problem of externality (see Appendix 1, section 1.4). Upland ecosystems, and their services, are vulnerable and subject to major changes, including social and economic change, climate change, alterations in UK and European agri-environment policy and support, global market conditions and so on.

[2] Trees can grow on bog, but the peat bog will be impacted on and become degraded. However it may be possible to remove trees and restore the bog.

[3] Much public money is spent on the uplands, so taxpayers are paying indirectly for ecosystem services: but there is generally no direct link between use of the service and payment for it.

Many different management options exist, with potentially complex implications for services across a wide geographical scale. Funding for management can be important, and there is potential scope for much greater use of payments for ecosystem services such as water supply and carbon storage. Communication about services delivered may be required, both with landowners, occupiers and land managers impacting on services, and with beneficiaries; all of whom may be little aware of the services delivered.

Ecosystem service valuation in the uplands context therefore needs to take into account a wide range of end benefits that may be derived directly or indirectly from functions and services within the area, and to track winners and losers from different changes. The boundaries of the management area are much narrower than the boundaries of service benefits, and communication needs may also pass well beyond the geographical boundaries of the area.

The main ecosystem services that we seek to value are:

- Food and fibre;
- Renewable energy provision;
- Water supply (quantity and quality of drinking water) for downstream catchments;
- Costs associated with downstream flood risks;
- The use and enjoyment of uplands for outdoors recreation;
- The use and enjoyment of uplands for field sports;
- The non-use values of historic and cultural landscapes;
- The regulation of green house gas emissions, and
- Biodiversity and wildlife.

This list differs slightly from the original specification, as follows:

- Food and fibre originally included “and associated industry”; however we consider that the values here are of a different nature, and are better kept separate;
- Water quality has been extended to include water quantity, to make a clearer distinction between the water supply service (continuous) and the flood control service (active under extreme conditions), and
- “Impacts of downstream flood events” has changed to “costs associated with downstream flood risks” because upland management could influence either or both of damage costs and flood protection costs.

The former “Use and enjoyment” category has been sub-divided into field sports, non-consumptive recreation, and non-use values of cultural heritage. The same environmental resource may influence all three services; separating them out facilitates valuation and accounting.

Geodiversity, defined as the natural range of geological (rocks, minerals, fossils), geomorphological (landforms, landscape-shaping processes) and soil features, and sometimes extended to include the built (stone) heritage and historical geological literature, is fundamentally important to many uplands ecosystem services, including recreation, cultural/historical values, water values and biodiversity. We have not included or attempted to value this category separately, but its value is implicit in most of the other value categories. We have not considered values associated with mining/mineral extraction in the uplands.

Valuation of these services is discussed below. Each service must be considered within the context of an overall valuation strategy for the ecosystem services of upland areas. In particular, they cannot be treated as stand-alone. For example the "food and fibre" valuation deals only with the direct, consumptive use value of food and fibre. Aspects relating to recreational or non-use values for uplands agricultural landscapes, or to the impacts of uplands agriculture on downstream water quality or flooding, are dealt with in the relevant sections. The objective is to avoid double-counting, within a logical framework that links clearly with management choices. But for purposes of investigating or discussing the total service impacts of uplands agriculture, it would not be sufficient to consider only the "food and fibre" service.

2.3 Counterfactual conditions

Economic appraisal involves the comparison of different "states of the world" – the state of the world under counterfactual conditions (without the change(s) appraised), and one or more states of the world with the change(s) or intervention(s) that lead(s) to different outcomes. Establishing a consistent and appropriate counterfactual is crucial to providing an accurate assessment of the ecosystem service impact of upland management changes.

The choice of counterfactual is not always clear-cut. Changing conditions, in particular climate change, but also social and economic changes, mean that the counterfactual is not a static 'status quo' scenario; and the choice of counterfactual, or comparison case, may depend on the specific question to be answered. The 'counterfactual' is often called the 'baseline' in economics – meaning the baseline for comparison, with no implication that this be the status quo scenario – however this can cause confusion in natural sciences where 'baseline' generally refers to conditions at a particular point in time. Hence we prefer the term 'counterfactual' here, and this refers to the scenario against which other changes are measured. This is not necessarily the 'most likely' alternative scenario in the absence of a specific policy intervention (though it often will be) and can in some cases be more of a 'baseline' than a realistic counterfactual. In fact there are several possible options for the counterfactual:

- "No uplands": this may be appropriate for estimating the total "ecosystem services of uplands". However it is very difficult or impossible to implement, and in fact the question "what is the total value of uplands?" may be considered ill-formed, economic valuation being a concept about the value of relative change rather than absolute value.

- “Pristine” environment: land-management has shaped the uplands, so defining this scenario is difficult (we do not have the data), and it is not the most relevant counterfactual, bearing little relation to the current ongoing impacts of management and possible changes.

- “Pre-industrial”: similar to pristine, except that we are more likely to have suitable data for defining the scenario. Various other historical baselines could also be used – most likely dates just before major social/environmental changes (for example 1914, 1939) or ‘arbitrary’ dates based on when good data happen to have been collected.

- “Status quo”: in effect, the most recent possible historical baseline, and one with substantial policy relevance, because policy options involve changes from current practices. Its strength is that, in principle anyway, it can be directly measured. However it may be too static, ignoring climate and other exogenous changes, and ongoing trends.

- “Business as usual”: similar to “status quo”, but a dynamic counterfactual, taking into account our best estimates of the likely evolution of activities in response to key drivers such as climate change.

- “No active policy intervention”: this does not measure against hypothetical pristine conditions, but rather against hypothetical no-active-policy-intervention-from-now conditions. “No active policy intervention” does not imply “no activities”, since various actors will continue to use the uplands in many ways. In fact this can be quite difficult to define, since management impacts on so many activities, and it can be hard to determine how these would evolve in the absence of management interventions.

- “No activities”: a scenario of abandoning human activities in the uplands; we could still derive ecosystem services such as water supply, biodiversity conservation and climate regulation. This is not a realistic counterfactual, and has little to recommend it. A variant that may be more useful is abandonment of non-profitable activities – which might mean farming, some sporting estates and forestry would cease, but recreation would continue.

Some counterfactuals are easier to define and measure than others, and data requirements differ. Different counterfactuals are appropriate for different research / policy purposes. The two most likely scenarios are:

- To provide an overall appreciation of the gross ongoing impacts of the upland land management (overall or within a case-study area): then “no active policy intervention” is probably most appropriate.

- Cost-benefit analysis of a proposed policy change: then “business as usual”, or in some cases “status quo”, will be the appropriate counterfactual.

In any particular case, additional considerations arise concerning the determination of system boundaries in space and time – essentially, all changes between the counterfactual and the scenario under analysis need to be taken into account, and we need guidelines to ensure the boundaries are set appropriately to allow for this.

This does not mean that the area under analysis should be extended to encompass all impacts. The main focus of interest can remain the management interventions in the uplands. But we need to take into account impacts that are “external” to the uplands area under consideration – for example, water supply impacts downstream, or the impacts of displaced energy production arising through renewable energy generation in the uplands.

Similarly, the time horizon needs to be set in such a way as to encompass the main impacts of the policy option. For many uplands management decisions, this could imply quite a long term assessment. Rewilding, afforestation, or peat-bog restoration, for example, may take 100 years or even longer to reach full fruition – and even then, ongoing change is to be expected – though initial impacts of policy will be experienced earlier. Predictions over such long time scales are unlikely to be reliable, even though broad assumptions may be made.

In economic appraisal, the use of discounting makes costs and benefits far in the future much less important than present costs and benefits. There is some debate concerning the appropriate use of discounting for ecosystem services, in particular for the far future; hyperbolic discounting (that is discounting, but at a declining rate) has been proposed. In the UK this is the official approach, with the discount rate dropping from 3.5% in years 1 to 30, to 3% in years 31 to 75 and 2.5% in years 76-125 (HM Treasury, 2003). But this still leaves £1m 100 years from now worth just £50,000 today. Thus even if we could make accurate predictions beyond 100 years, the present values of those costs and benefits would be very low (unless we are dealing with some catastrophic scenario locally or globally – a nuclear accident, say, or runaway global warming). This is not to say that time horizons beyond 100 years, which have great meaning in terms of some ecological processes, should be rejected out of hand, but there is a need to keep the appraisal effort proportionate to the decisions in hand, and the likely impact on decisions of extending horizons beyond 100 years is small. In fact, 50 years may often be enough, depending on the options under consideration.

With a dynamic counterfactual, we need to account not only for current services and changes to them, but also future potential services and changes to them. For example, an area currently little-used for recreation may nonetheless have substantial future recreation value potential, if one or more of the following occur:

- Infrastructure is improved;
- Alternative recreation sites deteriorate;
- Site characteristics change;
- Human population characteristics change, and

- Climate changes.

A study which (say) took into account the recreation improvements arising from the policy proposal, but failed to take into account possible recreation improvements in the baseline, would risk overstating the benefits of the policy proposal.

The fact that a particular use is not current (for example, field sports or hydro-power) need not mean that it is not an alternative use of the area, and that may need to be reflected in a counterfactual; or it could be considered as an alternative scenario.

2.4 Management changes: linking management to services

In this Section we investigate a number of management change options and illustrate what these changes may mean in terms of their impacts on ecosystem services. The options considered are only examples – though important ones – and many others could be employed, and analysed using the tools presented in this report. The options covered are:

- Woodland cover change;
- Blanket bog restoration;
- Grazing regime changes;
- Burning regime changes; and
- Rewilding.

For each management option, description, rationale, scale and scope and interactions of the option are presented followed by a discussion.

Tree cover change: afforestation, regeneration of natural woodland

Description: Various forms of management change ranging from planting new woodland, to removal of monoculture and replanting with more native species, to natural regeneration; or measures to suppress natural regeneration where this is damaging.

Rationale: One fifth of England's forestry is found in upland areas, but in natural woodlands there is little regeneration of young trees due to the impacts of grazing animals; outside woodlands, grazing and burning mean there is no natural spread of trees. Before grazing and burning became a major upland management practices, forest cover was far more widely distributed. The forestry policy of the last century tended to be one of maximum timber yields, more recently there has been a move towards a fuller multifunctional forestry management from agencies such as the Forestry Commission.

Scale and scope: Can take place at small scales (quite quickly) up to landscape scales (long term). Full impacts and benefits take time.

Interactions: Grazing and burning regimes may have to be altered to protect young trees. The water cycle and impacts on wetland systems including blanket bogs[4] need to be considered. Tree cover may influence renewable energy capacity: reduced run-off for hydropower; and planting near wind farms may impact on load factors. There may be implications for fire management in the uplands (possibly reduced risk, since most wildfires and arson are associated with heather) and changes in other forestry may be required if natural reseeding to succeed. Table 1 shows the impacts of tree cover change on ecosystem services and the quantification of these impacts.

[4] Planting on blanket bogs would not be permitted under environmental legislation, however some natural regeneration likely to be acceptable / not damaging.

Table 1 Ecosystem service impacts of changes to tree cover

Service	Impacts	Quantification
Food and fibre	Changes in timber quantities / types Reduction in agricultural output if land taken out of agriculture.	Well understood May be minimum viable areas.
Renewable energy provision	Local fuel wood Biomass production possible – but management purely for biomass likely to reduce wildlife and recreational benefits.	Well understood Distance to combustion site important
Water quality to downstream catchments	Direct improvement through reduced run-off sediment and water colour, resulting in lower treatment costs; but negative impact of leaf-fall into water courses Indirect improvement if agricultural inputs (fertilizers, pathogens from muck) and pesticides (for example, sheep dip) displaced; Buffering effect if planted and fenced along watercourses Decrease in run-off volume and in percolation to groundwater, with possible implications for flow levels and costs of abstraction to meet water demand.	Principles understood but difficult to quantify changes in quality with existing data Better understanding of quantity impacts. Values dependent on use/population.
Cost associated with downstream flood events	Positive value as water cycle impacts of forestry reduce the likelihood of flash floods. Net effect depends on baseline: for example, relative water inception to heath and bracken.	Reasonably well understood, but practical measurement requires data-intensive modelling.
Use and enjoyment for outdoor recreation	Forestry valued for some recreational pursuits and landscape quality. Natural woodland tends to be more highly valued than conifer plantations. But open landscapes also valued – increasing tree cover not necessarily beneficial in all cases.	Some understanding of key features promoting value: access, facilities, characteristics Difficulty accounting for alternative sites
Use and enjoyment for field sports	Can be managed for some game species, can promote red deer However stalking and shooting on open ground may be preferred (Bullock and others 1998) Water quality impacts on downstream fishing possible.	Mosaic values may be important: trees for supporting game, open space for sport May be incompatible with other access, at times.
Non-use values of historic, cultural landscapes	Direct value potentially important, depending on specific area, history, management Risk of serious damage to archaeology if new planting	Quite poorly understood Variable attitudes: likely to be some for and some against any specific change.
Regulation of greenhouse gas emissions	Direct carbon sequestration in trees Protection of soils from erosion Need to account for previous land use (in the baseline) Possible negative impacts if wetland areas dry out due to water cycle impacts of forestry.	Carbon sequestration in trees well understood Soil storage has been measured (for example, Bradley and others 2005) but processes less well known.

Service	Impacts	Quantification
Biodiversity and wildlife	Provides habitats for a range of species – nature of management and species of tree have major impact upon diversity. There are some areas where an increase in tree cover would lead to a loss in biodiversity.	Reasonable understanding of habitat requirements of key species Much less knowledge of links from biodiversity to other services.

Discussion: The ecosystem service impacts of forestry depend heavily on the species, spacing and mix of trees grown, the types of habitat they replace, and their context/ location in the landscape. Willis (2002) suggests that, at the margin, native broadleaved woodland is largely beneficial, while conifer plantations are largely detrimental, but the optimal overall balance between wooded and open habitats is not obvious. Conifers are not 'all bad' and provide refuge for red squirrels, for example. All types of forestry can reduce soil erosion and downstream flooding. Forestry can be very damaging to archaeological remains. Woodlands have a local effect on climate, and under climate change scenarios this may be beneficial for a range of activities in the uplands, by providing cooler micro-climates. Overall, all ecosystem services could be impacted, but the details will be case-specific.

The valuation of recreational, aesthetic and cultural aspects of trees is heavily influenced by the nature of the existing landscape, and any associated activity. Willis and Garrod (1993) found a preference for the existing landscape of the Yorkshire Dales over any form of land use change, whereas the restoration of scrub and trees was strongly preferred in the more monotonous landscape of the southern uplands (Bullock and Kay, 1997). Bullock and others (1998) found that British red deer stalkers expressed a preference for stalking in open moorland rather than native forest, where good quality animals are available, but noted that native woodlands have a role as a wintering habitat for deer, and that they can contribute to attributes such as body and antler weight that are valued by hunters. MacMillan and Duff (1998) found a majority in favour of natural forest regeneration in Glen Affric and Strathspey, but with sizeable minorities against.

'Changes in tree cover' can also apply to removal of trees to restore open habitats. This does not imply tree-free landscapes: open habitat SSSIs (Sites of Special Scientific Interest) can be in "favourable" condition with some tree cover (10% for upland heathland and blanket bog, and 5% for upland hay meadow; these figures fall to 1% if non-native species). GHK Consulting Ltd (2006) estimate £622 per ha costs of restoring open habitats, but Forestry Commission (2008) suggests these are too low and propose £1164/ha on average. Upland hay meadows cost £1,245/ha, blanket bog costs £500, while upland heathland restoration costs are just £150. The study also suggests adding 20% for administrative costs. Open habitats are stated to cost around £200/ha/year (£175-£336 per ha per year) more to manage than forestry, including the value of timber income foregone. For bigger areas, economies of scale and reduced 'edge effects' can reduce costs. Forestry Commission (2008) reports RSPB estimates that the costs of managing heathland are £207 per ha per year for a 20ha heath and £72 per ha per year for a 500ha heath[5], and also FEE calculations that the net cost of open habitat can be reduced to £57 per ha per year by focussing on low yield class sites, those where restoration is easiest, and through economies of scale. HLS agreements are made for a ten-year period and funding of £200 per ha per year is typically available for open habitat maintenance.

Blanket bog restoration

Description: Various interventions to aid restoration of bogs, including re-vegetation of bare peat, rewetting through “grip blocking”, geo-textile lining of gullies to stabilise against erosion, manipulation/removal of grazing and burning management, reduction in heather monoculture, and the re-introduction of peat forming species where no longer present.

Rationale: Peatlands are the single largest carbon reserve in the UK, containing around 3 billion tonnes of carbon (cf 150 million tonnes in woodlands). Peatlands in good condition sequester carbon; peatlands in degraded condition emit carbon, and also discolour water supplies (good condition “peatlands” will also emit coloured water, but at lower levels). There can be offsetting effects for other GHGs, notably methane, which can be emitted more from wet peat in good ecological condition.

The UK has 75% of Europe’s upland heath, and 10-15% of the world’s blanket bog. Both upland heath and blanket bog are priority habitats. Upland heath is generally associated with mineral soils, apart from wet heath which is found on shallow peat soils. This is not the same as heathy vegetation, typically heather, dominating on deep peat soil: that is blanket bog degraded by a combination of drainage and/or burning. Abundance of heather on deep peat is damaging to blanket bog and research shows an increased frequency of under soil piping (which disrupts and damages hydrological integrity of blanket peat) in these areas. Restoration of blanket bogs can generate benefits across several categories including greenhouse gas regulation, water quality, biodiversity conservation, recreation and non-use values.

Scale and scope: Bog restoration can take place at small scales up to landscape scale.

Interactions: Successful restoration may require other management changes, in particular less intensive grazing regimes and reduced burning. Wind farms, telecommunications masts and excessive traffic (vehicular, livestock or human) can damage bogs. Peat bog is not compatible with forestry, with intensive game management or with intensive livestock management. But where forestry has been practised on peat bog, restoration may be possible after clear-felling. Bog restoration / grip blocking may be important parts of rewilding plans. Table 2 shows the impacts of the blanket bog restoration on ecosystem services and the quantification of these impacts.

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[5] It is not specified if this refers to upland or lowland heath. The costs will be different, but the point about economies of scale should hold across the board.

Table 2 Ecosystem service impacts of blanket bog restoration

Service	Impacts	Quantification
Food and fibre	No direct impact May be associated reduced grazing	See “Grazing regimes”
Renewable energy provision	No direct impact, but generally incompatible with wind farms.	-
Water quality downstream	Positive impact through improved colour and reduced sediment. Some suggestion that water colour may be controlled by sulphur deposition and recent trends reflect reduced sulphur deposition (but reducing colour nevertheless valuable).	General principles partly understood but quantitative data scarce; data being collected for example, in SCaMP project (see case studies) but time series not yet long enough for confident results.
Cost associated with downstream flood events	Reduced risk of flash flood events (MFF 2007)	Principles understood but quantification difficult at present.
Use and enjoyment recreation for outdoor	Probably positive, as restored bog more attractive than bare peat But may be restricted access, at least during restoration.	Little hard evidence.
Use and enjoyment for field sports	Direct reduction in heather cover/dominance; may require changed burning regimes; but also likely to improve game food supply, as well as aesthetics of sporting experience. Reduced risk of sedimentation of salmon spawning beds (MFF 2007).	Net impact on the value of field sports not obvious
Non-use values of historic and cultural landscapes	Potentially: values for restoring habitats to better condition Wetting will conserve archaeology. But restoration techniques can damage archaeology.	Likely problems with scale of values (part-whole bias)
Regulation of greenhouse gas emissions	Strongly positive for carbon: reduced emissions/enhanced storage BUT can be negative impacts for other GHGs, notably methane, and this is less well understood. Also reduced risk of wildfires.	Data availability variable across sites. Generalisations possible, but with loss of accuracy
Biodiversity and wildlife	Positive impact: priority habitats, and on species using them.	Possible to measure areas of habitat in recovering or favourable condition (full recovery likely to take considerable time). Beyond that, difficult.

Discussion:

There are three primary motivations for peat bog restoration: biodiversity conservation, water catchment management (especially improvement in water colour) and greenhouse gas regulation (carbon storage). Re-vegetation of bare peat can lead to a 40-70% vegetation cover within two years and thereby stabilise peat.

MFF (2007) notes that, across the Peak District, moorlands in ideal pristine condition could fix an average of 18.9 (max 35±12.6) tonnes Carbon/km^2 per year; in a worst case scenario, they could on average emit up to 7 (max 100) tonnes Carbon/km^2 per year. The combined created sink and avoided loss by gully/grip blocking could equate to 64-135 tonnes Carbon/km2 per year. Worrall and others (2007) report evidence from a catchment in the North Pennines, which is an increasing, net source of carbon, due in particular to higher DOC (dissolved organic carbon) due to droughts. Extrapolating across UK uplands, Worrall and others. suggest that peats could be a net source of between 0.26 and 0.45 MtC/year, but with respect to carbon alone they would be a net sink of between 0.35 and 0.23 Mt C/year.

Valuation of carbon impacts is “straightforward” since there are official UK values that must be used (Defra 2007b). Valuation of water quality impacts is in principle feasible, but data may not yet be available to support this (at least in the public domain: water companies do hold data, for example, for the SCaMP project, but there is reluctance to draw firm conclusions from short time-series, especially given statistically ‘unusual’ summers in recent years). Valuation of biodiversity and landscape impacts is much more complex.

Defra project SP0572 “Ecosystem Services of Peat”, being carried out by MFF and others, is due to report in November 2009. This transdisciplinary project combines biophysical and socio-economic analyses, including economic valuation of service changes, and will be an important reference for valuation of peatland services.

In addition, bogs have a high scientific interest for the fossilised pollen and other plant remains within them, as well as their structure, which provide some of the most valuable information we have about past environments. They have played an important role in our understanding of impacts of climate change. Restoring bogs helps protect this scientific value.

Changes to grazing regimes

Description: Changes to timing and intensity of grazing, mix of species grazing, or specific locations of grazing.

Rationale: Grazing livestock holdings make up two thirds of agricultural land in less favoured areas in England, and this plays a major role in shaping landscapes, communities and the economy of the uplands (IEEP and others, 2004). Overgrazing of the uplands, resulting in particular from (former) agricultural subsidies such as the CAP headage payment, and on common land, impacts on soil erosion, water quality, biodiversity and landscape quality in many upland areas; grazing pressure is a major reason for the unfavourable condition of many upland SSSIs.

But under-grazing can also have negative impacts, since both wildlife and grouse management benefit from some grazing (Felton and Marsden, 1990). Complete cessation of grazing would have major implications for habitats and species dependent on them. Biodiversity conservation requires a balance of different grazing levels: there are some areas where no grazing would be acceptable to allow tree and scrub establishment, but other areas where some grazing is essential to maintaining habitat in favourable condition. Grazing changes required to improve habitat quality for biodiversity (IEEP and others, 2004) include more cattle on grass fells during summer, fewer sheep in many areas (but more sheep in some – for example North York Moors) and changes to shepherding practices, and controlled supplementary feeding.

Restrictions on grazing in specific areas can be an important management measure, for example to help regeneration of trees, for restoration of blanket bogs, or to prevent pollution of watercourses or erosion of banks.

Scale and scope: As the dominant land use in the uplands grazing regime can be considered on large to landscape scales. A lack of boundaries can mean that smaller scale changes (for example, at the holding level or for protecting specific areas or watercourses) can be costlier to implement.

Interactions: Grazing impacts upon most other management. Grazing intensity can influence the need for burning, the condition of habitats including peatlands, watercourses, and forestry regeneration. Managing grazing (but not necessarily eliminating it) is central to rewilding. Table 3 shows the impacts of changes to grazing regimes on ecosystem services and the quantification of these impacts.

Table 3 Ecosystem service impacts of changes to grazing regimes

Service	Impacts	Quantification
Food and fibre	Changes in output and in type of output Potential indirect impacts on lowland production (fewer store lambs)	Well understood and quantifiable
Renewable energy provision	No direct impact.	-
Water quality to downstream catchments	Impact through condition of soil (erosion/sediment load) Possible contamination impacts: pesticides (sheep dip); cryptosporidium, E. coli. E. coli.(pathogens), herbicides, and nutrients NPK.	Understood in principle but not quantitatively in practice.
Cost associated with downstream flood events	Changes in run off may lead to changes in flash flood risks	Partly understood but difficult to quantify.
Use and enjoyment for outdoor recreation	Impacts on bird species can impact on bird watching. Eroded landscapes tend to be muddy and hoof marked and are likely to be less valued for recreational pursuits. Values from observing livestock, especially unusual breeds / wild. Reduced access / risks associated with animals	Will be site specific. Variable knowledge on impacts.
Use and enjoyment for field sports	Moderate grazing intensity can help keep suitable conditions for game birds and other hunting, and may reduce the frequency of burning. Overgrazing can reduce bird numbers. Water quality issues may impact on fishing downstream.	Partly quantifiable.
Non-use values of historic and cultural landscapes	"Iconic" moorland landscape dependent upon some level of grazing. Over grazing leads to degraded landscape. Possible non-use values for wild cattle. Grazing can prevent scrub and tree encroachment (major threat to archaeology) but can also pose direct problems to archaeology	Poorly understood. Probably site specific. Likely part-whole bias.
Regulation of greenhouse gas emissions	Hoof trampling of peat lands leads to erosion and release of greenhouse gases. Trampling dependent not only upon intensity but timing (winter grazing, often with supplemental feeding, leads to trampling in wetter conditions and deep hoof impressions). Cattle can contribute to emissions, including methane from digestion. May influence frequency of burning (see "burning regimes") and condition of soils/bogs (see "blanket bog restoration")	Broad principles understood, but quantitative knowledge limited. Research ongoing..
Biodiversity and wildlife	Sward height dependent upon grazing regime and many species (in particular ground nesting bird species) in turn dependent upon sward height. Some grassland and heath are semi-natural systems reliant on burning or grazing. Bracken becoming a problem in some areas, cattle grazing one solution to this problem.	Broad knowledge of species favoured by different regimes.

Discussion: Grazing plays an important role in maintaining open upland habitats - without grazing (or burning – but this causes damage to blanket bog), “all but the wettest blanket bog would, below the tree line, naturally succeed to trees” (IEEP and others, 2004) – although this make take a very long time for areas that are distant from existing sources of tree seeds. But overgrazing can have significant negative impacts. The optimal level of grazing will depend very much on the objectives of management; or we could say that the values of different grazing regimes may depend on multiple factors, including landscapes and activities present across a wider area than the grazing area under consideration. Grazing can also be used to reduce live vegetation and litter build up, thereby reducing fire risk, and this could become of high economic importance under climate change. There has been a huge amount of research into grazing and burning, linking different grazing regimes to a wide range of impacts on habitat conditions, birds, invertebrates, soil erosion, runoff, and so on.

Overgrazing can be particularly prevalent on common land, and can be considered an ‘institutional failure’ (that is, a sub-optimal outcome due to lack of appropriate rules) in such areas. But in some commons, specific habitat and biodiversity have been maintained by grazing for centuries, and the condition and biodiversity of these habitats can be under threat from undergrazing due to poor agricultural returns. Grazing can be a costly management measure where the agricultural returns are negative. There can be path-dependent effects: it is costly to re-establish grazing once it has been lost, in particular if re-hefting is required.

Changes to burning regimes

Description: Burning is a key management practice which has occurred for over 150 years and has played a significant role in shaping the heather moorlands of England; 27% of the heather moorland in the English Uplands shows evidence of recent burning (MFF 2007a). While a mosaic of burning can help to maintain some types of ‘moorland’, on other types (for example, blanket bog) it can cause substantial damage. Burning happens at different scales, frequencies and intensities depending on land use.

Rationale: Burning heather removes woody growth and promotes new shoots. For grouse management, the selective burning of older woody stands aims to create a mosaic of differing aged stands of heather (new shoots for forage and older stands for shelter) and gives grouse moors a typical ‘checker board’ appearance. Burning can also be carried out for sheep management (bigger areas, non-selectively burned). Burning takes place most commonly on dwarf shrub heath but there is also burning of blanket bog (in particular degraded blanket bog dominated by heather), enclosed and unenclosed grassland, bracken and scrub (English Nature, 2001).

Burning for grouse moor management can have some benefits for biodiversity, but also a lot of disbenefits depending on how frequent it is and how it is done. The burning regime can impact on biodiversity and landscape features of the uplands. The mosaics associated with grouse moor burning regimes can be considered overall to lead to increased biodiversity within the English uplands (Cranfield University Research quoted in MFF 2007a), but cause biodiversity loss where burning occurs on blanket peat, and even where true dry dwarf shrub heath is burnt (that is on mineral soils) where the older components of heather stands are rare or missing, leading to unfavourable condition. Overall approximately a million hectares of SSSIs are considered to be in unfavourable condition as a result of burning (MFF research note 6).

Burning plays a central role in “carbon and nutrient budgets, landscape and patch biodiversity and has influence on hydrology, erosion and water quality” (Davies and others 2006). There is some uncertainty about the full impacts of different burning regimes, and ongoing research into the impacts of burns of different intensities.

Scale and scope: Individual burns for game management tend to be of quite small areas, since the aim is a mosaic of heather at different stages: a single hillside can have several differently aged stands of heather. Large scale burns are quite rare. Individual land managers can be responsible for the burns over large areas of land so management intervention may be best considered at the estate scale.

Interactions: Grazing and burning interact to determine habitat condition and the need for burning. Burning damages blanket bog, and blanket bog restoration requires cessation of burning. Wetland areas may be impacted by water quality and run off impacts (though draining wetland areas for grouse management no longer occurs since the wet areas provide invertebrate food for chicks – but in any case there is little left to drain; heather dominance is further drying out former wetland areas). Forestry can be protected by reducing the fuel bed for wild fires. Wild-fire risks can be influenced by grazing and burning regimes, and controlled burning can be an important tool for reducing wild-fire risks; this may be of increasing importance due to climate change. Changes to burning regimes may be an important part of rewilding. Burning for grouse management tends to be accompanied by predator control, including illegal control in some cases; this impacts on species conservation (positive for waders, negative for raptors). Table 4 shows the impacts of changes to burning regimes on ecosystem services and the quantification of these impacts.

Table 4 Ecosystem service impacts of changes to burning regimes

Service	Impacts	Quantification
Food and fibre	Burning increases grazing available. Game provide food (but probably better to subsume within sport values)	Possible
Renewable energy provision	No obvious direct impact Indirect impact through reduced risk of wildfires (forest resources)	-
Water quality to downstream catchments	Different burn intensities can lead to run off erosion, increased colour and sedimentation.	Uncertainty about exact relationship, though water companies are collating data on this
Cost associated with downstream flood events	Run off and erosion can result from managed burning But also reduced risk of these problems from wildfires.	Uncertain, highly context dependent
Use and enjoyment for outdoor recreation	Landscape impacts may have positive or negative values. Short-term impacts likely negative but long-term mosaic may be valued. Biodiversity impacts on species (bird watching). Downstream recreation values impacted by water quality.	Very subjective – different people will have different views
Use and enjoyment for field sports	Burning vital to red grouse shooting in particular. Shooting may conflict with other uses	Partly understood.
Non-use values of historic and cultural landscapes	Possible non-use values for historical management practices or landscapes But also possible non-use values for other uses.	Likely to be highly context dependent. Burning can seriously damage some features.
Regulation of greenhouse gas emissions	Burning releases GHGs However new growth is encouraged. Wildfires in dry seasons can lead to deep peat burns which can last for years.	Limited information on reduction in risk of wild fire, deep peat burns and therefore carbon budgets for managed burning
Biodiversity and wildlife	Frequent burning can lead to soil and diversity loss. Burning impacts will differ from mineral soils to peat soils, but are a key issue and a common cause of unfavourable condition	Basic impacts (which species favoured) understood but details of mosaic impacts not well known.

Discussion: English Nature (2001) reports that the best dwarf shrub heath communities on mineral soils for wildlife are those with a wide variety of vegetation structures, including areas of short heather and bare ground to un-burnt areas, and a complete range of vegetation in between. But some other upland habitats such as blanket peat bog are damaged by any burning. Most upland bird species breeding on moor, heath and bog do not spend all their time there but depend also on a range of adjacent habitats, including adjoining farmland, marginal hill grasslands, and woodlands. Areas of native woodland and scrub benefit black grouse.

Controlled burning can play an important role in the management of the risk of wildfires by breaking up fuel beds (though burning has also helped create wildfire risk: drainage through installing grips compounded by burning management has increased abundance of heather on peat soils, and this has significantly increased fire risk). Wildfires can cause massive environmental damage. Weather conditions, in particular precipitation, have implications for timing of burning to avoid deep peat burns and accidental 'wild' fires. There is possible interaction with climate change in determining wildfire risks.

Overall the ecosystem service impacts of changes to burning regimes are rather poorly understood. We know that frequent and widespread burning carries substantial costs and risks; and that complete cessation of burning over wide areas will lead in time to substantial changes in landscape and services. But the details of service provision at intermediate levels of burning are difficult to quantify, not least because the total impacts depend not on the burning regime or state of a specific area, but rather on a complex interaction of different areas with vegetation at different stages, and with different underlying soils.

Rewilding

Description: Rewilding is a process of change that involves reducing the intensity and changing the type of human intervention, and allowing natural processes greater freedom to operate. But this is not the same as complete abandonment, either in practice or in principle, and in particular rewilding does not imply excluding people, though it does change the nature of the benefits derived from an area.

Rationale: As explained in the Wild Ennerdale Stewardship Plan (2006) "the words 'natural' and 'natural system' are not used in an ecologically pure way and the term 'wild' is used to describe a philosophical approach" to management, covering two key areas:

- The degree to which natural processes influence the environment (physical attributes); and,
- The sense of wildness which people experience/perceive (emotive reactions).

There may be clear conservation and biodiversity benefits from rewilding, but the aesthetic and recreational qualities of the environment are also brought to the fore in this kind of management approach. The impacts may be positive or negative and this can be a contentious option that is appropriate in some areas, but definitely not in others. Depending on the area, the impact of re-wilding on most people's use and enjoyment of the uplands, and in particular on historical and cultural values, could be strongly negative. For example the Yorkshire Dales and North York Moors are open landscapes formed historically by grouse moor management and upland farming. Open land and historical farming infrastructure are attractions, and the Dales and NYM National Park Authorities have a statutory duty to conserve open landscapes. And the UK has a commitment through international designations to conserve heather moorland and associated bird assemblages. Clearly in these areas rewilding could not be a large-scale option, though it may be locally appropriate.

Rewilding remains a form of management, distinct from abandonment. This is both because landscapes and species lists have been so modified by humans that they need help to move back towards a more natural state, and because humans seek to derive valuable services from wildlands. Browning and Yanik (2004) note for example the absence of a natural “large dynamic disturbance factor” in Wild Ennerdale, and explain plans to introduce this via a herd of (eventually) free-roaming wild cattle (noting the public safety and animal welfare issues raised).

Scale and scope: basic ‘rewilding’ can be applied at micro-scale, up to wide-ranging management changes at scales big enough to give humans the sense of being in a wild area. As noted above, the appropriate scale of rewilding is highly context dependent. Rewilding is a long-term project: Natural Capital Management (2002) suggests that areas simply abandoned would show little clearly visible habitat change within 10 to 15 years. Active intervention can help speed the process up, but radical landscape changes take time.

Interactions: rewilding will likely entail changes in tree cover and changes to grazing in most cases. Where relevant, changes to burning regimes, and blanket bog restoration, may also be expected. Rewilding does not require exclusion of human activity but it does require sensitive development and various changes to human infrastructure are likely to be desirable. Rewilding is likely to be inconsistent with major renewable, transport or industrial developments and this may need to be considered as a baseline or alternative scenario for an area. Table 5 shows the impacts of rewilding on ecosystem services and the quantification of these impacts.

Table 5 Ecosystem service impacts of rewilding

Service	Impacts	Quantification
Food and fibre	Likely reduction in timber and agricultural output	Quantifiable
Renewable energy provision	Limited local fuelwood Possible opportunity cost of larger scale renewable options.	Quantifiable
Water quality to downstream catchments	Probably positive through lower intensity agriculture and better habitat conditions. Reduced inputs of pesticides, manures (pathogens) and inorganic nutrients (NPK). Possibly reduced run-off/flow through afforestation.	Understood in principle but not quantified in practice.
Cost associated with downstream flood events	Case-specific, likely to be positive or zero.	Understood in principle but not quantified in practice.
Use and enjoyment for outdoor recreation	Likely to be positive, possibly major, in certain areas, though some may be against changes. In many areas, rewilding could lead to reduced access (due to landscape changes, or deliberately restricted) and/or may destroy open landscape features that are highly valued by users. These opportunity costs must be considered. Possible risks with wild animals / free-ranging livestock (Browning and Yanik, 2004)	Case specific. Major changes are likely to be easier to value than modest ones.
Use and enjoyment for field sports	Case-specific Likely to be positive if "wildness" enhances sport experience Wilder land/ lower livestock likely to support more game overall But some cases may exclude sport (no-take/conservation/quiet ethic)	Case specific.
Non-use values of historic cultural and landscapes	Positive, perhaps major, provided local buy-in, and appropriate area for rewilding. But increasing tree cover can damage historic environment. In traditionally open landscapes, medium to large scale rewilding could have strongly negative impacts.	Case specific. Major rewilding may be unique and important enough to overcome part-whole bias.
Regulation of greenhouse gas emissions	Probably positive – lower intensity agriculture, better soil conditions, more trees.	Mechanisms and measurement reasonably understood. Details case specific.
Biodiversity and wildlife	Positive, perhaps major, depending on base scenario. Where designations exist for open landscape biodiversity, rewilding likely to damage this. Total abandonment likely to have negative impact Impact/value will depend on other areas: too much wild land could put species dependent on grazing or burning at risk.	Case specific. Hard to measure.

Discussion: rewilding is a holistic approach to management of a whole area, generally covering several habitat types and uses. So in practice it involves combinations of several "management options", potentially including all the others considered in this report, though the details will be location-specific. In many cases it may be appropriate to consider rewilding as part of a continuum of options for appraisal - for example "business as usual", "extensive grazing" and "rewilding".

Valuation of certain benefits associated with rewilding areas is likely to be complicated by factors associated with scale and with scarcity, as well as specific location. Aykroyd (2004) argues that substantial economic gain from wildlands can be derived through a wide range of recreational activities, including nature-based tourism. Ancillary benefits such as 'wildland' branding could also capture benefits.

The recreational and non-use values of "wilderness" will depend on the size of the area, and the characteristics of adjacent areas (such as traffic noise and visual intrusion), and also on the relative scarcity and accessibility of wilderness in the surrounding area and further afield – the marginal value of these aspects of rewilding may decline rapidly as more and more sites are "rewilded". These points need to be taken into account in valuation studies, and in particular in benefits transfer.

2.5 Ecosystem service valuation

Following from the identification of management options and their impacts on ecosystem services, this section explores the economic valuation of individual ecosystem services. Each subsection contains a brief description of the service, its classification in terms of ecosystem service and total economic value typologies, appropriateness of each valuation technique and a discussion of the main issues.

- A "Brief description" of key aspects of that service in the UK uplands.
- A "Classification" of the type of ecosystem service, its scale, and its economic values – for details of the classifications, see Appendix 1, section 1.1.
- A table setting out the applicability of different valuation methods to the service, with assessment of pros and cons, and examples
- A 'discussion' section following each table. These cover some general points to keep in mind when carrying out valuation of the ecosystem service under consideration in an uplands context. Note that the conclusions are in some cases specific to the public sector in England and Wales, where they refer to Defra or DECC guidance and official values.

The methods discussed here can apply to valuation of a whole ecosystem service, or to valuation of changes in ecosystem service provision. Generally, the latter is required, since management interventions tend to result in changes in service levels more often than complete destruction of a particular service, or creation of an entirely new service. Valuing small changes is also generally easier and more accurate. However both are possible, and the object of valuation will be dictated by the effects of the management option under appraisal.

The tables below identify which valuation methods can be applied for each ecosystem good/service in an uplands context. The costs of valuation methods vary substantially – new stated preference studies are particularly expensive and time consuming, revealed preference studies are also expensive and time consuming but generally less so, and market, proxy and production function techniques tend to be cheaper, if data are available. However, the more expensive methods allow greater coverage of types of economic value: market, proxy and production function techniques can only generate a minimum value for some types of ecosystem services that are traded in actual markets, while stated preference techniques can in principle be used to estimate the full economic value of any kind of service.

In all cases the relative costs and applicability will depend on the context, on the state of scientific and economic knowledge and data, on the level of statistical precision required, and so on. In practice, most applications using a toolkit such as the one set out in this report will rely primarily on benefits transfer techniques, using adjusted values from existing studies rather than primary valuation research, at least in the first instance.

Food and fibre

Brief description: 'Food and fibre' has become a standard composite category for the products of agriculture and forestry, both important activities in upland areas, even though they are also often economically marginal. In practice, valuation of food services and fibre services would of course take place separately, but many of the issues faced are similar (estimating the net values of marketed primary products, often economically marginal and produced under subsidy). Most uplands agriculture is grazing, primarily sheep but also cattle. The service / benefit under consideration here relates to the use value of the output (which would be 'lost' if land was taken out of agriculture). Values associated with recreational or non-use benefits from agricultural landscapes, greenhouse gas regulation, impacts on water supply, flood risk and biodiversity are treated separately.

Classification: Final, provisioning service. Variable scale. Consumptive direct use value.

Table 6 summarises the appropriateness of economic valuation techniques for food and fibre services including their applicability, pros, cons and examples. In this and subsequent similar tables, only applicable techniques are presented.

Table 6 Economic Valuation Techniques for Food and Fibre

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Yes – produce or land prices Premiums on labelled produce	Based on actual prices and costs	Need to take account of costs (often data are not available however) and subsidies Premiums may be non-use value: double counting risk	Best method	Multi-coloured manual estimates (Penning-Rowsell and others, 2005) Organic food; FSC timber
Proxy value	Yes – costs of alternative inputs (for example, using man-made fibre instead of wool)	Based on actual costs	Not related to WTP for produce; costs may exceed values	Limited use	
Production function	Yes – including land area or quality in estimated production function for marketed agricultural outputs	Takes account of changes in land quality	Need to take account of costs and subsidies	Used as part of market price approach	
Stated preference	In principle, for example WTP for “wildland” labelled food		Would be valuing non-use and aesthetic aspects of food production as well as use values	Double counting risk	

Discussion: the general rules for agricultural valuation set out in the “Multi-Coloured Manual” (MCM) (Penning-Rowsell and others., 2005) are a key reference point for this service. The MCM is used by Defra and Environment Agency for England and Wales in the evaluation of flood risks and damages, and covers both temporary losses in output, and complete loss of land. Complete loss (to agriculture) is relevant where the management option involves excluding existing agricultural uses. Where the loss is partial or qualitative – for example, reducing sheep stocking rates, or replacing intensive sheep with extensive cattle – then an approach based on the value of produce is needed.

In both cases, it is necessary to adjust values to take account of agricultural subsidies. Adjustment is required even where the subsidies are intended to secure environmental benefits, because these environmental benefits will be valued separately (that is, valued through one or more of the other services) and the costs of providing them (the subsidies) need to be deducted, to avoid double counting.

The MCM recommends valuing land lost to agriculture at 65% of agricultural market value, to take account of the subsidies, but this may be too high for upland farms which are the most marginal. Warren (2002) notes subsidies for farms in Scotland's Least Favoured Areas as forming by far the largest part of farm income – sometimes the only farm income (all other activities making a loss).

In some cases, changes may be to forms of uplands agriculture that demand a premium – for example, organic farming or local produce, including farm shops and B&B. In such cases the values used should be increased appropriately, and if possible based on actual prices. There may be a risk of double-counting here to the extent that these use values also capture part of non-use or recreational values (for example, people may pay more for organic partly for health reasons and partly for nature conservation reasons) and this needs to be considered as part of the overall valuation and benefits transfer strategy.

Renewable energy provision

Brief description: Renewable energy provision is increasingly important throughout the UK. Upland areas are well-suited to wind and hydro electricity generation, and can also be used for fuelwood. Here we are interested not only in the value of energy produced, net of costs, but also in the indirect impacts of renewable energy generation that occur outside the uplands.

Classification: This is a general term for a complex set of ecosystem services, with quite different characteristics (for example, wood, wind and hydro) but all potentially used for energy. Although energy may be a final consumer good, or an input into other production processes, here we are concerned with the implications of producing energy from renewable sources in the uplands rather than producing it elsewhere; that is the focus is on the displaced impacts and costs (total economic value, in principle). Table 7 summarises the appropriateness of economic valuation techniques for renewable energy provision including their applicability, pros, cons and examples.

Table 7 Economic Valuation Techniques for Renewable Energy Provision

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Price of energy produced from different sources Premiums on renewable energy	Based on actual prices Can consider as reflecting WTP for lower environmental impact	Need to take account of costs and subsidies, and external costs Not a clear measure of WTP. Risk of double counting with other estimates	Useful but only part of value sought method Not the preferred option	
Proxy value	Yes – costs of alternative energy	Based on actual costs	Not directly related to WTP; costs may exceed values; need to account for external costs	Official approach for electricity in principle, useful, but only part of method	DECC 2008 – see below.
Hedonic pricing	Not directly applicable			May be used for aesthetic impacts of structures – see recreation and cultural values	
Travel cost	Not directly applicable			May be used for aesthetic impacts of structures – see recreation and cultural values	
Stated preference	Applicable	Direct measurement of WTP for lower environmental impact	Possibly low awareness of all impacts. Risk of double counting	Could be useful, but cannot be mixed with cost estimates (double counting)	

Discussion: the valuation framework proposed for this service – focusing on displaced energy – rests on the assumption that the real impact of renewable energy production in the uplands is not to change the total amount of energy produced/consumed in the UK, but rather to change its source – therefore the relevant values are associated with costs avoided, not the value of energy itself. The assumption is probably fair for electricity generation, though not necessarily for fuelwood, because people burning wood may well heat more than they would otherwise do, but we assume this to be a minor issue.

IEEP and others (2004) note concern about the negative effects of habitat loss during construction, and ongoing impacts on local and migratory bird populations (disturbance of breeding sites and increased risk of bird strikes). Landscape and amenity impacts can also be expected. Bergmann and others (2006) report WTP values for reducing these impacts. These values will need to be taken into account, but in this toolkit we propose to do this through valuation of changes in other services (see recreation, cultural heritage, and biodiversity). Care may be required to avoid double-counting, depending on the source studies used for the different value categories.

In principle the greenhouse gas regulation impacts arising through displaced conventional power generation should be considered. The carbon intensity of the "average grid mix" is 0.49 kgCO_2/kWh (Carbon Trust, 2006[6]). However new official guidelines (DECC, 2008) are that new renewable investments should be considered as displacing not conventional but rather renewable sources: "Changes in the level of renewable energy delivered should be valued using the marginal cost of delivering it from other sources: £118/MWh." This is a target-based approach: the UK has a commitment to meet certain levels of renewables, and the impact of producing renewables in the uplands, under this approach, is to reduce the need for renewables investments elsewhere. If valuing in this way, we should not take account of the external costs of conventional energy, because it is not conventional energy that is displaced.

Other costs associated with renewables production should be taken into account. These include the construction and running costs for producing the energy. These may be quite site specific, in particular for woodfuel, for which the efficiency depends on transport costs, though "unless transport distances are very high, the embodied energy of the fuel is generally a small percentage of the energy output from the fuel" (Ayling, 2005). Local impacts of transport could be significant and for larger renewable power plants these costs would need to be taken into account.

Water supply to downstream catchments

Brief description: Upland areas form most of England's key watersheds, with high precipitation and water storage, and upland land cover and land-use are key to particle load and timing of runoff. Pollution to water can also be a problem, associated with inappropriate management of sheep dip and in some cases heavy metal pollution in peat soils (MFF, 2005). Uplands impact on downstream catchments both in terms of water quality and quantity, which can in turn impact on drinking water and on water for irrigation and industry as well as recreational use of water courses. Key upland habitats for quality improvements are forest cover and healthy blanket bogs. During periods of low precipitation, these can negatively impact on water quantity; forestry in particular reduces runoff to the point where a negative value due to low flow has been suggested for some areas of England (South West, Willis 2002) and Ireland (Brander and others 2009). Gripping and burning negatively impact on

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[6] Differs from 0.43 kg CO_2 per delivered kWh often quoted: "figure quoted here uses different data sources and covers a more recent time-period" (Carbon Trust, 2006)

both quality and quantity. Upland areas also offer opportunities for man-made water storage facilities and flow management (see also costs associated with flood risks). Table 8 summarises the appropriateness of economic valuation techniques fro water supply services including their applicability, pros, cons and examples.

Classification: Regulating service. Regional directional. Primarily use value.

Discussion: The main value of impact on downstream water quality arises through the abstraction and treatment of drinking water. Although price is generally not the same as value, as noted above, since the water is actually treated, the cost of treatment is a good measure for this aspect of the service. If the water were not treated, WTP for treatment, or avoiding expenditures on bottled water, would be more appropriate; but it is treated, and there is no impact on the quality of consumed water, just a change in the costs of treatment. Water discolouration nutrient load, pathogens and pesticides are factors which impact upon treatment cost. It may be possible to identify an industry standard coagulant dose for different levels of water discolouration. Alternatively, values could be considered on a treatment-plant or water company specific basis.

There may be other quality issues to consider: health risks through cryptosporidium and E. coli, contamination from pesticides, and in some areas lead pollution (MFF 2005). IEEP and others (2004) note in particular that “poor management of sheep dip leads to direct discharges and leaching of pesticides into watercourses and groundwater with impacts on aquatic invertebrates” and cite an estimate of the cost of water related pollution incidents in the uplands at £2 million per year.

Table 8 Economic Valuation Techniques for Water Supply

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Price of water Water demand functions	Based on actual price and consumption	Price often not related to value	Price not best. Demand curves good, though more intensive	Moran and Dann 2008
Proxy value	Cost of water treatment Avoiding expenditures on bottled water	Actual costs incurred	Careful treatment for costs of existing plant. Estimates relate to costs of treating water not benefits of clean water.	Most promising, if data on costs can be acquired.	Moran and Dann 2008
Damage Costs	Value of damage from low water quality	Actual costs	Costs of low quality water not benefits of clean water		Pretty and others 2003

Technique	Applicability	Pros	Cons	Overall	Examples
Production function	Yes – including water quality or quantity in production function	Takes account of changes in water quality and quantity in the production of marketed goods (for example, agricultural goods via irrigation, manufacturing and potentially water treatment).	Limited to role of water supply in production of marketed goods	Used as part of market price approach	Several North American examples Moran and Dann 2008
Hedonic pricing	May be applicable in limited situations for example, lake water quality impact on surrounding housing or values of fishing permits.		Limited transferability, limited coverage (only residents' use values).	Limited.	
Travel cost	Direct use for example, fishing, kayaking, etc.	Relatively easy to implement	Only relates to downstream recreation	For recreation values	Johnstone and Markandya (2006), Hynes and Hanley (2006), Shultz and Solitz 2007
Stated Preference	Yes	Widely applicable – can easily include a range of quantity and quality issues.		For recreation, aesthetic and conservation values	Willis and Garrod 1999 Hanley and others 2006a Hanley and others 2006b; NERA and Accent, 2007

The impacts on water supply may also impose costs. Willis (2002) argues that forestry and land-management decisions are long-term and that the value/cost of the water supply service impact can be estimated via the long run marginal costs (LRMC) of water supply in the area. These are estimates for the total cost of abstracting the next cubic metre (m^3) of water, including any capital investment costs. Estimates of Long Run Marginal Cost are available from water companies via OFWAT. (Willis 2002) (see Table 9).

Table 9 Long-run marginal costs of water supply: estimates for selected water companies

2000-01 prices, p/m^3	Resources	Treatment	Bulk Transport	Local distribution	Total LRMC
Northumbrian	11	5	28	13	57
United Utilities	20	5	11	12	48
Yorkshire	25	0	0	2	27

Source: Willis 2002. Long Run Marginal Cost (LRMC) for steady demand = cost of incremental load for which peak demand equals average weekly demand

If the area under assessment drains into a hydro-electric dam, then there may be a need to assess the opportunity cost of reduced flows (renewable electricity generation foregone, and associated increase in conventional energy and emissions – see renewable energy provision) and any impacts on the running costs or expected lifetime of the power station (for example, associated with reduced sediment loads). In principle this can apply also to hydro-power potential: some management options may facilitate hydro-power and others preclude it. This would need to be taken into account in the definition of the environmental baseline and the options.

In principle, reduced water availability could also reduce agricultural values due to reduced irrigation. However Willis (2002) notes that, because of subsidies, the marginal social cost of agricultural production exceeds its marginal value to society, so the cost of reduced water for agriculture is likely to be low at the margin.

Where recreational downstream benefits are also of importance, the techniques available for valuation or benefits transfer are identical to those for outdoor recreational values (see outdoors recreation section). University of Brighton (2008) provides a review and assessment of valuation of water-based recreation in the UK context, and makes a list of recommendations for research in this area.

Costs associated with Downstream Flood Events

Brief description: In addition to the impacts on water quality and quantity discussed above, management can influence the frequency, severity and/or control costs for flooding downstream. Land cover and land management influence water storage capacity and risks of excessive runoff. Man-made water storage facilities and flow management are also possible. Valuation can be carried out through estimating the expected damage costs avoided plus any change in flood defence expenditures. Values could also be estimated through willingness to pay to reduce flood risks. Care is needed to avoid double counting if mixing these methods.

Classification: Regulating service. Regional directional. Mainly use values. Table 10 summarises the appropriateness of economic valuation techniques for costs associated with downstream flood events including their applicability, pros, cons and examples.

Table 10 Economic Valuation Techniques for Costs Associated with Downstream Flood Events

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Costs of flooding – damages to properties and possessions	Direct measurement of costs of impacts	Only covers market losses and need to estimate economic value of damage, not replacement value	Correct method for assessing physical damages from flooding events	Multi-coloured manual estimates (Penning-Rowsell and others., 2005)
Proxy value	Yes, in particular for reduced costs of flood defence	Based on actual costs (avoided cost = benefit)	Based on costs, not value, but that does not matter if costs incurred	Correct method for assessing opportunity cost of flood defences	
Production function	Yes, for agricultural damages from flooding				
Hedonic pricing	Yes	Measures WTP via impact on property prices	In theory covers 'perceived' risk of flooding; in practice awareness of susceptibility to flooding may not be great and not evident in property prices.	Potentially useful but care needed re double counting.	Pope (2008)
Stated preference	Yes	Can cover non-market aspects of flood damages (for example, inconvenience and stress)			

Discussion:

To assess values of changes in this service, we need a clear determination of the link between upland land management and flood risks downstream. Assuming this link can be demonstrated – and data availability is likely to be a problem - the costs of flood risk can then be broken into two main components:

- The impact on flood protection expenditures arising from changes in flow and gross risks, and
- The *residual* risk of flooding and the damage costs associated.

Both are location specific, though it may be possible to derive ballpark figures for rough assessments.

Full valuation of the benefits of flood risk management is a complex exercise. In addition to risk-mapping with hydrological and geomorphological data and analysis, damage valuation requires detailed information on man-made and natural assets at risk, traffic flows, agricultural and recreation activities, and so on. Although extensive guidance exists for this (see Penning-Rowsell and others 2005) full application may require disproportionate effort for upland management purposes.

Much will depend on the scale of assessment – if we are looking at the catchment scale, then detailed analysis may be warranted. Alternatively it may be possible to make approximate assumptions linking overall land use to changes in flood risks, and to conduct a rough valuation based on average values for damage to flooded properties. If we are looking at much smaller scale, then it is likely to prove difficult to demonstrate any clear connection to flood risk, though this may depend on local conditions.

Outdoors Recreation

Brief description: Upland areas support a wide range of values associated with human use and enjoyment, including non-consumptive forms of recreation include walking, rock-climbing, observing nature (notably bird watching), picnic sites and viewpoints, and simply tourist-driving along uplands roads. Recreation values are dependent on both the biodiversity and the geodiversity of the upland landscape.

Some forms of outdoors recreation are consumptive in that they are significantly damaging for the uplands environment – for example, motor rallies, and off-road driving with 4x4s, motorbikes or quad bikes. Field sports (consumptive recreation) and cultural/non-use values are covered separately.

Upland areas also influence human use and enjoyment of other environments, notably downstream recreation including water-sports and fishing, and these indirect impacts may require separate consideration when evaluating management outcomes.

Although the term used is “recreation”, values under this category can include the health and educational benefits of outdoors activities.

Classification: Primarily cultural service. Any scale. Use value and option value.

Table 11 summarises the appropriateness of economic valuation techniques for outdoors recreation services including their applicability, pros, cons and examples.

Table 11 Economic Valuation Techniques for Outdoors Recreation

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Entrance fees; local expenditures	Easily observable and based on real payments	Relate to prices not values; free access does not mean zero value	Important data that must be processed carefully. Key input for travel cost.	
Hedonic pricing	In principle, via housing and hotel/holiday let markets	Based on actual behaviour/ expenditures	Data may be hard to get. Problems defining market boundaries and participants.	Potentially useful if data are available but not recommended for primary study.	
Travel cost	Any site or activity which involves travel to the uplands.	Based on actual behaviour, relatively straightforward	Hard to value prospective changes	Useful if available. Primary studies possible.	Liston-Heyes and Heyes (1999), Grijalva and others (2002), Hanley and others (2002a)
Stated Preference	Yes	Can be used to value all recreational activities. Additionality can be internalized.	Can be complicated to implement and analyse.	Very useful if available. Difficult to separate use and non-use – bear in mind for avoiding double counting (easier to separate user and non-user). Primary study expensive.	Euromontana (2005) Hanley and others 1998 Brouwer and Bateman 2005, Grijalva and others (2002) Hanley and others 1998, Hanley and others 2002b

Discussion: The Countryside Agency (2003) presents data on visits to the countryside from the Great Britain Day Visitor Survey 2002/2003. A quarter of all leisure day visits in England are to the countryside, with walking the most common activity. People spend money on about half of the countryside trips they make, resulting in average expenditure of just under £12 per person per trip: total spending on countryside day trips amounts to around £9 billion per annum in England. Thirty eight per cent of people who had taken a day trip in the previous 12 months had visited a National Park, with the Peak District (23%) and Lake District (22%) being the most popular.

It is important to note that the expenditures by tourists, though useful information, are not the same as the value of recreation. Tourist expenditure is important when conducting assessments of the impacts of tourism on local economies, on employment, and so on. But for assessing the ecosystem service ‘recreation’, we are looking for a measure of the benefit to tourists, much of which is not directly paid for, in particular for outdoor recreation on public access land.

The main methods for valuing recreation are travel cost and stated preference. Travel cost has the advantage of being based in real behaviour, but it is difficult to measure prospective changes in sites, other than via benefits transfer. It would be relatively straightforward to carry out more travel cost estimates of visitor benefits, especially where visitor surveys are being conducted anyway. For example TNS (2008) / Forestry Commission (2008) collected in their “All Forest Visitor Survey” most of the information that would have been necessary to carry out a travel cost analysis for several Scottish forests; it would be a very low-cost extension to any future such surveys to add a travel cost component.

Stated preference studies have the advantage of being able to value prospective changes in recreational opportunities. However restricting responses to recreation values may be difficult: Willis and others (2000) report their “lingering concern” that stated preference estimates do not result in purely recreational use values but may also contain parts of recreational option value, landscape amenity, wildlife habitat and associated biodiversity values, bequest and existence values. This may give rise to a risk of double-counting. Of course, a study could be designed explicitly in order to take into account both use and non-use; the key issue is knowing what components of total economic value the result from a study relates to.

The Multi-Coloured Manual (Penning-Rowsell and others, 2005) recommends an alternative approach, “Value of Enjoyment per adult visit” (VOE). VOE is in many ways similar to contingent valuation but asks actual users to report the value they put on their enjoyment of a day’s visit in monetary terms, rather than asking what they would be willing to pay. This aims to avoid “protest” responses, but has the disadvantage that it is does not take account of income constraints, and there is no implied trade-off between the visit and alternatives, which makes the responses impossible to interpret within an economic framework.

Additionality is a key issue in estimating the economic value of recreation (and also some other services). ‘Additionality’ refers to the fact that the demand for recreation is not perfectly elastic or infinite, and providing more and more recreational resources will lead to a declining value for each additional unit of the resource. An improvement that leads to increased visitors at a given site may draw many of these visitors from other sites – that is the extra trips are displaced, not additional. Similarly, the value of an increment to a particular feature will depend on how much of that feature already exists. For some particular cases, this could be quite severe. For example GHK and GFA-Race (2004) report RSPB figures that a nesting pair of ospreys was estimated to attract additional spending of £420,000 to the Lake District in 2003, from 70,000 visitors, supporting 11 FTE jobs. Clearly a second pair of ospreys would not double these figures, though it would nonetheless be highly valued[7]; and to the extent that the figures in the Lake District increase, visit rates and spending elsewhere might decline.

There is conflicting evidence on the reliability of benefits transfer methods to recreational values. Scarpa and others (2000) report contingent valuation evidence from 42 forests and suggest that transferability and reliability of the multi-attribute benefit functions (not individual unprocessed values) is reliable in 60-70% of the sites. Lindhjem and Navrud (2008) report acceptable mean (47%) and median (37%) transfer errors from value-function transfer of contingent valuation results for non-timber forest benefits in Scandinavian studies. Hill and Courtney (2008) find that trip-generating functions (like travel cost, but without the values) are unreliable for benefits transfer purposes. More generally there are few studies available that are suitable for benefits transfer to any specific uplands management option. Overall it seems that benefits transfer is likely to be acceptable for ballpark estimates, but if greater precision is required primary studies should be considered.

Field sports

Brief description: Field sports are an important economic activity in upland areas. Many upland areas are used and managed for shooting game, especially grouse and stag, and may also be used for clay-pigeon shooting. Uplands also support angling, in situ or downstream, including in particular salmon fishing.

Classification: Primarily cultural service, with some provisioning. Regional, national and international depending on type. Direct, consumptive and non-consumptive use values.

Table 12 summarises the appropriateness of economic valuation techniques for field sports services including their applicability, pros, cons and examples.

[7] Noting again, as discussed above, that the expenditure is not the same as the value.

Table 12 Economic Valuation Techniques for Field Sports

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Price of permits or payments for shooting	Based on actual prices.	Price not same as value, except at margin.	Valuable first step in analysis, good approximation for small changes.	
Proxy value	Not applicable				
Production function	Not applicable				
Hedonic pricing	Yes, to lease/market values of rights; to capital value of land	Based on actual transactions, focus on value of different characteristics	Data hungry, methodologically difficult	Results useful but not recommended for primary study	Hussain and others 2007 Bell Ingram 2007
Travel cost	Direct use for example, fishing or shooting	Based on real behaviour, taking account of all costs		Results useful. Primary study possible.	Knoche and Lupi 2007
Stated preference	Yes.	Can cover hypothetical improvements/ changes; can cover values of non-users.	Risk of confounding use and non-use values.	Results useful. Primary study possible but expensive.	Hussain and others 2004 Bullock and others 1998

Discussion: The Countryside Alliance (2002) states that country sports - including shooting, hunting and fishing - are the fifth most popular recreation and leisure activity in the Britain (based on participation figures). Total direct expenditure is estimated to exceed £3.8 billion per annum and this expenditure is estimated to support direct employment equivalent to 60,150 full time jobs in Great Britain. Of this, £419 million is from shooting, £243 million from hunting and £2,300 million from fishing.

Again, the values of the activities may be even higher than simple expenditure figures suggest, since individuals will benefit over and above the amount of money they pay for sport. The net economic value of field sports can be estimated through the total willingness to pay of participants, minus the costs of provision, plus any net external benefits associated with the activity. There is a risk of double-counting if the WTP for the recreation activity also includes some element of non-use value, and this may need to be considered, depending on the valuation method used.

On the other hand there are also negative externalities from field sports, including the exclusion of other users for certain periods, and the impacts of noise on surrounding areas.

Much more research and data are available for the US than for the UK. The US annual "National Survey of Fishing, Hunting, and Wildlife-Associated Recreation" regularly uses travel cost and contingent valuation techniques, and is a significant resource for benefits transfer, within the limitations of US to UK benefits transfer. Groothuis (2005) for red deer hunting in the US shows that benefits transfer for non-site-specific hunting are relatively accurate (30% error for contingent valuation and 35% for travel cost). Benefits transfers from US studies may be defensible for some sports, on the grounds that US sportsmen can form a significant proportion of shooting clients for UK grouse moors. IEEP and others (2004) report that “Grouse moors do not compete against pheasant shoots but operate in a high value international market, where estates’ main competitors may be dove shoots in South America, some African shoots and duck shoots in India”.

UK studies on field sports relate to Scotland. Several studies examine the economics of grouse moors from a profitability and employment perspective: IEEP and others (2004) reports that most grouse moors are loss-making, and need to be subsidised by their owners, but losses had reduced and employment increased since an earlier 1996 study. MacMillan and Phillip (2008) report data on the impacts of hunting on capital values and incomes for upland estates.

Market prices for shooting or fishing days, where they are available, give a partial indication of the value of consumptive recreational use, but for a full value estimate we would need to subtract costs of provision and add consumer surplus. However we can argue that the price is a good approximation of marginal WTP provided the market “clears” (that is, there is no unsold supply, and no unsatisfied demand, at the prevailing price). If in fact the market is not clearing, then the WTP may be higher (if there is unsatisfied demand) or lower (if there is unsold supply).

As with outdoor recreation, additionality is a potential problem: the marginal value of additional shooting days will depend on the population of potential users, and on alternative resources in the “area”. And “area” could be quite wide as people can be willing to travel substantial distances – including across oceans – for certain field sports activities.

Field sports may be incompatible with other uses, in particular other forms of outdoor recreation, at certain times. In principle any externality associated with impacts on these uses can be taken into account via the value of those activities.

There may be another externality related to individuals who are against field sports and would be willing to pay to prevent this activity. There can be debate regarding the legitimacy of such values: they are in principle admissible under the total economic value framework (this is simply the economic expression of the same motivations underpinning, for example, the ban on hunting with hounds and the ban on dog and cat fur) but to include them would be highly contentious; estimating the values would be very difficult, and heavily dependent on the assumed property rights[8].

[8] That is, who has ownership of the right to shoot animals – landowners, local communities, the state? Should those who wish to avoid hunting have to pay hunters to desist, or should those wishing to hunt have to compensate society for their actions, or …? This intricate debate is beyond the scope of this report.

Cultural and historic values

Brief description: Uplands often contain areas of significant cultural or historic importance. These include cultural and historical aspects of landscapes, land use practices, archaeological features, historic built environment and so on. Geodiversity plays a fundamental role in cultural and historic values. Quarrying in the uplands has resulted industrial heritage areas and historic environmental features.

There are both use values, and non-use values, and both need to be estimated for a full assessment of cultural and historic values. However, the use values are likely to be largely captured through techniques for valuing outdoor recreation (see above) since the primary use value of culture and heritage in the uplands arises through going to see and learn about it. The non-use values need separate estimation. In assessments covering both recreation and cultural/historic values, it will generally be necessary to take steps to avoid double-counting, for example by limiting consideration of the cultural/historic category to its non-use values.

Classification: Final, cultural service. Any scale. Use and non-use values.

Table 13 summarises the appropriateness of economic valuation techniques for cultural and historic non-use values services including their applicability, pros, cons and examples.

Table 13 Economic Valuation Techniques for Cultural and historic non-use values

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Not applicable				
Proxy value	Not applicable				
Production function	Not applicable				
Hedonic pricing	Not applicable				
Travel cost	Not applicable				
Stated preference	Yes	Can account for non-use	Standard design issues problems. Double-counting risk if survey covers use values also valued under other categories (for example, recreation)	The only option if monetary non-values are to be included.	Willis and Garrod 1993 eftec 2006

Discussion: Cultural values are highly context specific and can be contentious – different people can have different views of the desirable state of a landscape, for example. There is some evidence that people place a value on the current intensity of management over either more intensive or less intensive management. For example Willis and Garrod (1993) found strong preferences for the status quo landscape in the Yorkshire Dales, with more conserved landscape also favoured, and strong preferences against intensive and semi-intensive options. Bullock and Kay (1997) found strong preference for landscapes with more extensive grazing and more tree cover than at present. White and Lovett (1999) found preference for heather moorland or semi-natural woodland over unimproved pasture, but for different reasons – moorland being liked for landscape value, and woodland for biodiversity and scarcity.

There is a basic choice between valuing whole landscapes/areas, and valuing specific features. Examples of the “features” approach include Hanley and others (1998), who found strong preferences for increases in broad-leaved woodland, heather moors and wet grasslands, and lower values for dry stone walls and archaeology, for an ESA in Scotland. The Environmental Landscape Features (ELF) model (IREM/SAC 1999, 2001, Oglethorpe 2005) is a form of meta-analysis / benefits transfer for valuing landscape features in England. Values, based on contingent valuation studies, were included for rough grassland, heather moorland, salt marsh, woodland, wetland and hay meadow (1999) and hedgerows and field margins (2001). The estimates are intended only to account for values of residents, and to allow for diminishing marginal values of additional units of a feature, but aim to value the entirety of a given resource within an area. The ELF model “assumes that the base reference amount of a particular feature referred to in a study relates to the total abundance in that region” and then “assumes that the average ‘loss’ … that each study is referring to and attaching a WTP estimate to is equivalent to a fall in abundance in the region of 10%”. This is a reasonable approach to take, given the problems of the data, but the weaknesses are clear. There is a need for more work that clearly specifies both reference abundance levels and specific and measurable changes (Oglethorpe, 2005). A major problem with the use of the ELF method for specific sites is that the valuation has been calculated at a regional scale, and therefore cannot take into account location specific features at smaller scales. It may well be that (for example) people in Yorkshire and Humberside are willing to pay more to avoid a 10% decline in woodlands (£5.60 per household per year) than to avoid a 10% decline in heathlands (£2.15 per household per year) but this does not in itself imply that woodland would be more valued at a specific site.

Eftec (2006) reports results of choice experiments examining the value of environmental changes in Severely Disadvantaged Areas across England, and for comparison present these alongside values processed from the ELF to represent 1% changes in the feature within a government region. The results are generally broadly consistent.

Swanwick and others (2007) conclude that “there are strong arguments for a whole landscape approach as representing more realistically the way that people view and value landscapes”, but temper this with the observation that the choice between whole landscape and component based valuation can depend on the proposed use or policy application of the results. They further suggest that contingent valuation is more suited to whole landscape approaches, whilst choice experiments are more suited to landscape component (or feature) valuation.

A general issue with all these valuations is that they are very likely to contain elements of both use and non-use values. People, and survey instruments, may not be able to distinguish clearly between values for viewing and experiencing a landscape in a particular configuration or quality, and non-use values associated with the same features. This is not a problem for assessing the total (use and non-use) value of a given area, but it does give concern regarding possible double counting if values for cultural heritage and values for recreation are estimated separately and both included in an assessment. This needs to be kept in mind and treated / reported on a case by case basis.

Regulation of greenhouse gas emissions

Brief description: Upland management has an impact on greenhouse gas (GHG) emissions, both directly through use of fuels for land use activities, and indirectly through the absorption and emission of carbon from the land and vegetation. Other GHGs than carbon dioxide are impacted, however our knowledge of these fluxes is currently very limited.

Carbon is stored in soils, in particular peat soils, and in forests; the total amount in the UK soils is two orders of magnitude greater than the amount in standing forests. Bradley and others (2005) describe a database of UK soil carbon for different soil types and land uses. Healthy peat bogs accumulate carbon, while degraded bogs with bare peat emit substantial quantities of carbon. The ability of upland ecosystems to sequester and store carbon is highly sensitive to land management decisions, in particular concerning grazing, draining and burning, as well as long term climate change (Holden and others. 2007; Orr and others, 2008). MFF Research Note 12 reports that if Peak District moorlands were in ideal pristine condition, they could on average fix 18.9 (max 35±12.6) tonnes carbon/km^2 per year across all habitats within the Peak District. In a worst case scenario, they could on average emit up to 7 (max 100) tonnes Carbon/km^2 per year. Worrall and others (2003) report 15.4 ± 11.9 tonnes carbon/km^2, also for the Peak District.

Changes in tree cover and energy crops will also have significant impacts on net greenhouse gas fluxes from the uplands. Cannell (2003) notes that for the UK "the 'realistic potential' and 'conservative achievable' estimates for energy crop substitution were 3.4–13.6% and 0.7–4.1% of current annual emissions, respectively, compared with 2.0–3.4% and 0.7–1.3% for carbon sequestration" – but the biodiversity and land use implications of achieving such levels would be significant.

Although carbon storage in vegetation or soils is reversible, this does not detract from the value. Future emissions from the land would need to be accounted for separately. Taylor (2005) notes that new forested land in Britain can accumulate carbon at 2 teC/ha for over 100 years; peat bogs can sequester carbon indefinitely. Over the time horizons of appraisal, it is valid to consider sequestered carbon as a quasi-permanent solution. Other GHG fluxes may offset the carbon benefits, and should be considered.

Classification: Regulating service. Global omni-directional. Total Economic Value, in principle.

Table 14 summarises the appropriateness of economic valuation techniques for regulation of green house gas emissions services including their applicability, pros, cons and examples.

Table 14 Economic Valuation Techniques for Regulation of Greenhouse Gas Emissions

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Yes, following carbon trading markets.	Observable price; principle of consistency	At present markets cover only major industrial sources of emissions. Based on emission targets, not WTP. Sensitive to market fluctuations.	OFFICIAL approach for ETS sectors .	DECC 2008: use price from EU Trading Scheme
Proxy value	Yes, through UK official "shadow price of carbon"	Consistent value across government.	Not necessarily based on WTP / damage.	Official value, progressive increase in value over time.	DECC 2008 table 12. Rising from £27/tCO_2 in 2009 to £60.8/tCO_2 in 2050 (in 2008 prices)
Production function	Yes, for calculating damage costs	Full damage cost estimates based on WTP	Very complex.	Applicable in principle, but use official values	
Hedonic pricing	Not directly applicable				
Travel cost	Not directly applicable				
Stated preference	Yes	Based on WTP	Complex effects and trade-offs over time	Applicable in principle, but use official values.	

Discussion: The valuation of greenhouse gas regulation can be attempted based on willingness to pay estimates for final damages of climate change. However these are extremely complex and will impact most strongly in the future. For practical purposes in uplands management we can restrict attention entirely to benefits transfer, and there are two key elements facilitating this: firstly, climate change is a global problem and the specific location of emissions or storage is not relevant to the damage potential; and secondly there is a great deal of ready-processed research to draw on. There are essentially three main kinds of value available:

- Damage estimates based on WTP;
- Market values based on carbon trading markets (themselves based on emissions policy), and

- "Official" values from government guidelines – based on assessment of evidence relating to damages, costs of abatement, carbon markets and policy.

Although official values need not be directly related to WTP estimates, they are clearly the most suitable choice for appraisal purposes, for reasons including consistency in appraisal across the public sector and ease of application. There is new guidance (DECC, 2008) setting out in some detail (see in particular Table 12, shadow price of carbon from 2007-2050) the official approach to valuing GHG regulation, and this should be followed. Generally, all the sources under consideration in an analysis of uplands management options will be non-ETS (Emissions Trading Scheme) sources, so the shadow value of carbon should be used.

All greenhouse gases impacts should be taken into account. This means (a) considering not only ecosystem-based emissions, but also the emissions from management activities, and (b) taking account of not only carbon, but also the global warming potential of other greenhouse gases. In fact we know very little about other GHGs in uplands, but these, notably methane, may offset some or all of the carbon benefits. If lack of data makes it impossible to value other GHG fluxes quantitatively, the issue needs to be addressed in sensitivity analysis and reporting.

Non-ecosystem emissions, in principle the emissions from management and land-use activities, including agriculture and recreational visits, should be accounted for. These are aspects that can be influenced by management, and that involve emission costs. Against the value of additional recreation service we should set the costs of recreation, including emissions. However for presentational purposes it may be preferable to keep this analysis separate, so that ecosystem-based net greenhouse gas emissions are presented separately from management- and human activity-based emissions.

Conversion factors are used to express other greenhouse gases in carbon dioxide equivalent. This is sufficient for taking into account the climate change impacts of emissions or sequestration of these gases. Any additional effects (such as ozone depletion or local effects of air pollution) need to be taken into account separately, and this does not constitute double counting (see Table 15).

Table 15 Greenhouse Gas conversion factors: global warming potentials to convert to carbon dioxide equivalent

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
HFC-134a	1,300
HFC-143a	3,800
Sulphur hexafluoride (SF_6)	23,900
Carbon Dioxide as Carbon	3.67

Source: Defra (2007b) How to use the Shadow Price of Carbon in policy appraisal.

Biodiversity and wildlife

Brief description: UK uplands are rich in biodiversity and wildlife: almost a quarter of the English upland area is designated SSSI. Many upland habitats are key to meeting the COP[9] 2010 Biodiversity Target and are listed as UK Biodiversity Action Plans (BAP) habitats: blanket bog (active blanket bog also under EC Habitats Directive); mountain heath and willow scrub; upland calcareous grasslands; upland flushes, fens and swamps; upland hay meadows; upland heath; upland mixed ashwoods; upland oakwoods; wet woodland (mainly hillside and plateau alder woods); and wood pasture and parkland. The biodiversity of the uplands is underpinned by its geodiversity, and many SSSIs are notified for geological importance.

As well as losses in wildlife and flora and a reduction of semi-natural habitat diversity and extent, biodiversity losses linked to changes in hill and upland agriculture include the erosion of genetic diversity in farmed livestock and crops, and a reduction in soil diversity. The loss of local knowledge and farming culture is also associated with declining biodiversity (OCW, 2004).

Classification: Final, cultural service. Any scale. Non-use and use values, but often the use values will be picked up through other services (for example, recreation).

Table 16 summarises the appropriateness of economic valuation techniques for biodiversity and wildlife services including their applicability, pro, cons and examples.

[9] Conference of the Parties to the Convention on Biological Diversity

Table 16 Economic Valuation Techniques for Biodiversity and Wildlife

Technique	Applicability	Pros	Cons	Overall	Examples
Market price	Very limited – possible premium on labelled products; donations to conservation NGOs	Based on real transactions	Very limited coverage and applicability. Donations usually too general, and/or may include use values	Not a likely option	Premium on FSC timber
Proxy value	possible to calculate cost of creating habitat; some use of stewardship payments as proxy	relatively easy to calculate	Creation cost: measures cost, not value; stewardship payments: not necessarily related to value at all	Useful information, but not value estimates. Can be used if costs actually incurred.	Costs of creating compensatory habitats under EC directives.
Stated preference	Yes	Possible to address non-use values fully	May be difficult to separate from use values. Requires very careful study design.	The only real option.	See Annex 1.

Discussion: The upland habitats support all of the other services listed previously, and the biodiversity present plays an important role in many of them: both in their use values, and as one factor influencing non-use values for upland areas. So there is a clear risk of double-counting values if we value both the contribution of biodiversity to other services, and the services. For example, if we value recreational use of wildlife under "outdoor recreation", then we should not also value it under "biodiversity and wildlife". Similarly, if landscape conservation is considered under "cultural and historic non-use" then we need to be clear whether or not those values also include biodiversity conservation. What we seek to cover under this category is just the non-use value of biodiversity – the existence and bequest values – over and above any use and non-use values for biodiversity that are captured within values for cultural heritage, landscape, recreation, food and fibre, water quality and so on.

Of course, any given study may cover more than one of these features – such studies may be used, but care is required to record and report exactly which services have been valued.

Stated preference techniques can be used to value individual species populations, or complete habitats; the sum of separate valuations of the individual species within an ecosystem will generally result in a value much higher than those expressed for the system as a whole. The values are dependent on individual perceptions and understanding, and may be more related to the iconic or charismatic nature of particular species than to any measure of ecological 'importance'. Some habitats or key species may be relatively undervalued as they are not 'attractive' – peat bogs, for example. It can be difficult to determine what part of value is really non-use, and what is related to current use, to future personal use or to option value. The complexity of the ecological systems that support biodiversity makes it difficult to generate scenarios that are both simple enough to be suitable for use in stated preference valuation with members of the public, and complex enough to reflect reality reasonably well. Nevertheless well-conducted SP studies, and benefits transfer can give an acceptable approximation of non-use values that might otherwise be overlooked.

2.6 Implications for valuation in uplands

Although the principles and techniques are quite well understood and developed, valuation of uplands ecosystem services faces significant uncertainties of two key sorts regarding:

- Important links from management to function to service: for some services, such as water supply and flood risk, we know how to conduct valuation, but we lack strong quantitative evidence of the connection between changes in management and changes in levels of the service, and

- Valuation evidence available for benefits transfer purposes: for some services, such as landscape (cultural) and biodiversity, we know quite well how management changes lead to changes in provision, but lack transferable value evidence.

A particular issue arises in the avoidance of double-counting, especially with respect to the use values of recreation, biodiversity and cultural/heritage value. Much of the use value of cultural heritage will be picked up through studies of recreation – cultural heritage being an important attraction for visits to the uplands. This is also true of biodiversity, where use values will be picked up in recreation, and also food and fibre, and other uses where biodiversity enhances the value of the natural service.

One possible solution is to limit the valuation of cultural heritage to the non-use values – leaving the use values to be detected through recreation. Non-use values include existence, bequest and altruistic values, and must be valued using stated preference techniques. It is straightforward to separate out users from non-users, but users will generally also hold non-use values in addition to their use values, and though it is possible in principle to separate these out, in practice it is difficult and requires carefully controlled questions and study conditions.

Before moving to the stage of proposing a methodology, it is worth considering the implications of this for the scope and objectives of valuation.

Precaution and use of valuation results

Realistically, economic valuation of uplands ecosystem services, while potentially quite accurate for some services, is going to give only ballpark figures for others, and in some cases, no satisfactory valuation may be possible (although quantitative assessments may be possible where valuation is not, and qualitative assessments may be feasible where quantitative measurement is not). Decisions about uplands management could have important, long-reaching, and in some cases irreversible consequences. Clearly in such a scenario the precautionary principle must be brought into play.

This means that economic valuation should not be seen as an alternative to targets and minimum standards for biodiversity conservation or other key features. Rather, it is a complementary method for aiding decisions about additional and/or unavoidable trade-offs, and can be an important input for setting targets and minimum standards. Ecosystem services, and their values to humans, do not begin and end with minimum standards for conservation of protected areas, but accrue to various extents from all uses of the environment. It is in stressing the value to humans of these services, over and above precautionary minima, that the economic valuation framework has an important role to play – even in cases in which the values can only be ballpark, or where valuation is not possible and only the conceptual framework can be applied.

The methodology for valuing ecosystem service impacts of management changes needs to keep these points to the fore; in particular, it should not aim to replace all other criteria and decision processes, but rather to complement them, and it should pay particular attention to full reporting of service impacts that have not been addressed via economic valuation techniques.

Focus on directing research

Not enough is known about the various links in the management option – ecosystem services chain: how management policies influence land use, how land use influences ecosystem function, and how function influences services and their values. There are important knowledge gaps in the science and in the economics evidence base. Priorities need to be set for targeting scarce resources to reducing the key gaps.

Economic valuation can play an important role here, by exploring how management and land use decisions might change under different value scenarios. In any given situation, do we already know enough to reach an acceptable decision? And if not, what are the key sensitivities – what values are conceivably large enough to tip the balance of the decision? These are important questions, and to answer them sensitivity analysis is an essential component of the method, aiming to take account of the substantial risks and uncertainties inherent in assessment of uplands management and its impacts on ecosystem service values.

Presentation of assessment

The substantial scientific and economic uncertainty and complexity in the results of assessments has implications for the best ways of presenting information. Generally it will not be scientifically or economically justifiable to attempt to present a single 'bottom line' figure, combining all the knowledge and all the uncertainty. It will be more justifiable, and more helpful for decision makers, to focus on ranges and sensitivities, and to attempt to identify individual services, their values, and the uncertainty attached (for example through high-low ranges). At the same time, it will be useful to identify winners and losers (the ‘Sugden approach’: Sugden, 2004, Defra, 2007d). These aspects need to be presented on a summary sheet alongside an overall assessment, and sensitivity analysis.

3. Developing a toolkit

Defra's "Introductory Guide to Valuing Ecosystem Services" sets out five key steps that a valuation process needs to follow:

- Establish the environmental baseline;
- Identify and provide qualitative assessment of the potential impacts of policy options on ecosystem services;
- Quantify the impacts of policy options on specific ecosystem services;
- Assess the effects on human welfare, and
- Value the changes in ecosystem services.

Below, we set out a 9-step process that follows this framework, and extends it to include sensitivity analysis and reporting stages. This incorporates the uplands specific analysis of management options – ecosystem services – economic valuation chain explored in Section 2.

Valuation itself is a data intensive and complex process and it is of course only possible here to give a broad overview and point to general principles which might be applied to any specific study.

It is important to note that many of the following steps, and in particular steps 1 to 4, should in practice be discursive, stakeholder led, and probably iterative (time permitting).

3.1 Step 1: Defining the Counterfactual/Baseline

At this stage of the analysis, it is usually sufficient to describe the counterfactual in terms of current status and trends, and any anticipated major changes (unless a historic counterfactual/baseline has been chosen). Where the dynamics are important, and where quantitative projections are feasible, this will need to be taken into account at Step 3.

Table 17 presented here is suggested as a first step in this process. Depending on the size and complexity of the area, its habitats, species, and activities, and the management options under consideration, it may be sufficient to identify total areas of habitat, or it may be preferable to sub-divide the study area into ecologically or economically meaningful units, perhaps using GIS or mapping to overlay habitats, species, services and changes. The level of effort commensurate with the decision context should be considered. In any event, assessment can start simple, with complexity added later as found necessary and justifiable.

It is important to keep in mind that this step is about characterising the *counterfactual*. The "future expectations" column is for changes that might be expected to occur over time in the counterfactual scenario not in the "policy change" scenario(s) to be considered at Step 2. Expected changes will include numerous externally driven changes: climate change, changes in the policy environment, profitability of different crops (including timber), land use (including housing on site and downstream), and human demographic changes will all be relevant.

Table 17 The template for defining the counterfactual

Characteristic/service	Current status	Future expectations (counterfactual)	Notes
Descriptive statistics			
Area			
Populations			
Human Activities			
Management			
Habitats (types, areas, conditions)			
For example, Broadleaved forest			
Coniferous forest			
Blanket bog			
(etc)			
Ecosystem services			
Food and fibre			
Renewable energy			
Water quality to downstream catchments			
Cost associated with downstream flood risk			
Use and enjoyment for outdoor recreation			
Use and enjoyment for field sports			
Non-use values of historic and cultural landscape			
Regulation of greenhouse gas emissions			
Biodiversity and wildlife			
Other?			

3.2 Step 2: Identify management options

This step may or may not be completed in advance. In some cases, there will be a clear proposal for a management option that needs to be evaluated. In others, options may be more vague and it will be necessary to explore and develop clearer descriptions.

Even where the option and the baseline are clear and pre-defined, it is generally worth considering what other options might be feasible – this could include radically different options, but equally could be different degrees of the main option under consideration (for example, a greater or lesser area of afforestation). Again, there is a need to keep things proportionate and manageable.

Management options could range from quite general overarching approaches to very specific, localised interventions (see Section 2). It will be necessary, in any case, to determine what the management means for the environmental processes in the area. This is the purpose of step 3.

3.3 Step 3: Identify impacts on ecosystem services

This is the main step at which detailed ecological knowledge is likely to be required: it is here that Bayesian Belief Networks or other methods of linking management changes to changes in services may also be needed. Key steps are:

- Identify the key changes of interest, keeping in mind the purpose of the assessment, and the resources available. If the main interest is in restoration of specific habitat types, is it sufficient to consider an index of habitat quality? If the focus is conversion of habitats, is it sufficient to keep track of areas of different types? Is it essential to consider spatial distribution of habitats and activities? Answers to these, and possibly other, questions will determine how complex modelling needs to be.

- Identify effects in terms of **areas** of different habitat types, including scale and timing of changes. For simple habitat area or quality tracking, a table like Table 18 can be used. More generally it may be necessary to create a spreadsheet to keep track of changing areas of different habitat types and/or qualities, especially if dynamics over time are complex. If spatial distribution is important, more formal modelling will be required.

Table 18 Habitat changes from counterfactual to management option – an example

Habitat type	Area	Quality	Change to	Area	Quality	Timing
A	100ha	Unfavourable, declining	A	50ha	Favourable	*Within 5 years*
			A	25ha	Unfavourable, no change	*Within 5 years*
			B	25ha	Favourable	*Over 20 years*

- Identify effects of changes in **extent**, **quality and/or quantity** of services in habitats. The tables in Section 2 on management options should be used to help determine the likely impacts of specific management changes on ecosystem services. Table 19 can be used for most simple cases, but more complex applications may need additional calculations and more detailed reporting than could be inserted in a simple table.

Table 19 Template for presenting the changes in quality and extent of ecosystem services

Characteristic/ service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food and fibre				
Renewable energy				
Water quality to downstream catchments				
Cost associated with downstream flood risk				
Use and enjoyment for outdoor recreation				
Use and enjoyment for field sports				
Non-use values of historic and cultural landscape				
Regulation of greenhouse gas emissions				
Biodiversity and wildlife				
Other?				

3.4 Step 4: Identify human populations affected

Assess the type and scale of the affected population which may consist of users (local residents, visitors, people downstream consuming food, water, renewable energy, flood protection, the global population benefiting from carbon sequestration) and non-users (that is those holding non-use values, where that is likely to be a significant concern). For different ecosystem services, the size of the relevant user/non-user population(s) may differ. For larger sites, populations may differ for different areas – for example some parts may be used for recreation and others not – and it may be useful in such cases to identify populations for sub-areas within the site.

In some cases it may be useful to record key characteristics of populations in order to improve benefits transfer: average income levels for affected populations, or distances from recreation sites, for example. These can be added to the table as required during the valuation/transfer stage.

Table 20 Template for presenting the populations affected

Service	Type of population	Number	Characteristics
Food and fibre	Producers Purchasers		
Renewable energy	Purchasers		
Water quality to downstream catchments	Utilities Customers Recreational users		
Cost associated with downstream flood risk	Environment Agency Householders		
Use and enjoyment for outdoor recreation	Local residents Walkers Bikers etc.		
Use and enjoyment for field sports	Owners Shooters Anglers		
Non-use values of historic and cultural landscape	Interest groups? General population		
Regulation of greenhouse gas emissions	Global		
Biodiversity and wildlife	Interest groups General population		
Other?			

3.5 Step 5: Economic valuation of ecosystem service changes

The specific steps for valuation will vary somewhat depending on the case, and may be iterative where suitable studies for transfer prove hard to locate. If there are no suitable studies of the chosen type, (i) select a different valuation method; (ii) omit, or (iii) consider commissioning a primary valuation study.

Note that it may be justifiable, under certain conditions, to use valuation methods, including benefits transfer, even where there is no firm quantitative estimate of service change. For example, even if the most we can say about the biodiversity service is that it will change from "severe decline" to approximately "stable", valuing this change or transferring estimates from studies using similar characterisations may be better than omitting the service.

Of course this can yield only a ballpark figure, and would have to be reported in full. But the point is that we are not seeking "the right answer" but rather an additional source of evidence (about economic value), and weak evidence may be better than no evidence at all.

- Using the service valuation tables in Section 2.5, determine the most appropriate method for valuing each ecosystem service impact.
- Select relevant studies. There may be more than one relevant study, and it may be appropriate to use different studies to derive ranges for possible values.

Transfer value estimates making adjustments where necessary and reporting these clearly.

- Consider double counting risks, and interactions between different impacts, and determine appropriate action. At a minimum this requires reporting on possible double counting. More generally it may be necessary to omit one or more service categories, if there is reason to believe that their value is captured through the valuation study(ies) used for another service.

Table 21 provides a template for reporting the results.

Table 21 Template for presenting the economic value evidence for ecosystem service changes

Service	Valuation method(s)	Unit Value(s) / Functions	Range(s)	Confidence	Notes
Food and fibre					
Renewable energy					
Water quality to downstream catchments					
Cost associated with downstream flood risk					
Use and enjoyment for outdoor recreation					
Use and enjoyment for field sports					
Non-use values of historic and cultural landscape					
Regulation of greenhouse gas emissions					
Biodiversity and wildlife					
Other?					

3.6 Step 6: Calculation of costs and benefits over time

This step aims to estimate the annual environmental cost or benefit within each year, accounting for the profile of costs and benefits over the appraisal time horizon, and to apply discounting to make all costs and benefits comparable in present value terms (for example, in this report, figures are reported in 2008 values, as that is the most recent year for which conversion factors are available).

Table 22 is one possible template for presenting the costs and/or benefits for different services. Additional rows could be used to show sub-categories within a given service, or to account separately for impacts on different affected groups, provided care is taken to avoid double-counting. The actual calculations will require a spreadsheet, since the values will differ from year to year due to the dynamics of the situation (see the case studies) and to facilitate application of discounting.

Costs and benefits should be converted to present value terms using Green Book (HM Treasury, 2003) guidance on discount rates; this is most easily done using a spreadsheet. Discounting practices are constantly under discussion (for example, at present in the TEEB project) and it is quite possible that the UK approach may change in future. However this is beyond the scope of this project, and we present only the current practice. The methodology and spreadsheets could be adapted easily to changed discounting practices.

A net present value (NPV) for the overall option may be calculated. Here 'net' simply means benefits minus costs, and 'present' means that these have been discounted back to present value terms. However it is likely that some ecosystem service changes will not have been valued in monetary terms, so this step needs to be treated with caution. It may be more appropriate simply to report individual present values for different ecosystem service changes, alongside qualitative assessments of other (non-monetised) changes (see Step 8 below).

In the case studies for this report, we have considered timescales for assessment of 50 years and 100 years. Natural England is currently entering agreements to manage land over a 10 year period only, but include prescriptions which relate to longer time periods (for example moor burning rotations of 25 years) and it is recognised that the impacts of management may occur over even longer periods. Current expenditures may be justified on the basis of predicted change in habitats and landscape (compared with the counterfactual) that could take more than 50 years. The choice of time frame is an important step for any given appraisal: in principle all impacts should be covered, but in practice it is very difficult to make accurate predictions far into the future. However, discounting at UK government rates (see HM Treasury 2003, and Appendix 1) means that a benefit of £1m in 100 years' time is worth just £50,000 in present values. This means that the error involved in truncating appraisal at 100 years will in most cases be acceptable, however this needs to be considered on a case-by-case basis.

Table 22 Template for presenting economic values for ecosystem service changes over time

Service	**Present Value (50 Years)**	**Present Value (100 years)**	**Notes**
Food and fibre			
Renewable energy			
Water quality to downstream catchments			
Cost associated with downstream flood risk			
Use and enjoyment for outdoor recreation			
Use and enjoyment for field sports			
Non-use values of historic and cultural landscape			
Regulation of greenhouse gas emissions			
Biodiversity and wildlife			
Other?			
Total service changes			sum of above figures
Costs			the costs of management intervention, other than any ecosystem service costs accounted for above
Net present value			sum of benefits, minus costs

3.7 Step 7: Sensitivity analysis

For most economic valuation of ecosystem services there will be uncertainties about:

- The changes arising through the change in management, and/or
- Interactions between services, and/or
- The human populations impacted, and/or
- The economic value of the service changes, and/or
- Factors affecting benefits transfer or other economic valuation technique used.

Sensitivity analysis seeks to explore how the final value estimate varies when these key assumptions are varied.

At a simple level, low-high value ranges can be developed for different ecosystem services: this is already incorporated in the steps above. Where probabilistic information is available, for example confidence intervals from scientific or economic analyses, this should be used (for example, through Monte Carlo Analysis). Failing that, assumptions will be required.

This step can simply involve reporting on the key sensitivities and ranges, but often it can be useful to conduct ‘switching analysis’ to see how high or low specific values would have to be in order to become more significant than other values, or in order for the whole ‘bottom line’ to change sign. Full Monte-Carlo simulation may be attempted in more in-depth analyses but may generally be disproportionate or not possible due to lack of probabilistic data.

The Green Book (HM Treasury, 2003) specifically allows sensitivity analysis for different discount rates, but states that the reasons for conducting this must be clearly stated. One such reason could be the very long term nature of changes in upland landscapes and services – for example, rewilding, forestry projects, or activities to prevent very gradual changes in state. Here the costs are up-front, and the benefits occur much later, and it can be useful to explore how low a discount rate needs to be in order for the project to show a net benefit.

These analyses can help prioritise research needs for clearing up key uncertainties, identifying those whose resolution could materially impact on the decision process. However the value is somewhat limited if there are substantial ecosystem services that have not been valued in monetary terms.

3.8 Step 8: Accounting for non-monetised impacts

It is essential to provide a detailed assessment of the environmental effects that cannot be expressed in monetary terms. This can be quantitative or qualitative depending on data and knowledge available. The key point is to ensure that all impacts are covered in the reporting stage, and in particular to ensure that the fact that no monetary value has been applied cannot be mistaken to mean that the value is zero.

Non-monetised impacts can also be included the sensitivity analysis (step 7) via switching analysis looking at how high the values of non-monetised impacts would have to be before they would impact on the 'bottom line' result. This can be very useful, but is not in itself a fully adequate way of covering non-monetised impacts: they should also be written up separately (step 8).

3.9 Step 9: Reporting

The reporting should summarise the assessment of economic value and non-monetised impacts. Net present values may be presented, or it may be preferred to give present values for changes in each ecosystem service separately. In both cases presenting low-high ranges should be considered. Non-monetised changes should be fully reported. Particular care should be taken to report uncertainties and caveats in some detail. Key points include:

- Assumptions and uncertainties about the impacts of management changes on ecosystem services: timing, magnitude and significance;
- Assumptions and uncertainties about population estimates for different impacted groups;
- Assumptions and uncertainties about the transfer of economic values or functions;
- The potential significance of non-monetised impacts;
- Potential significance of key missing data, and
- Broad caveats associated with the resulting value estimates.

4. Case Studies

This Section presents six case studies intended to demonstrate the potential use of the valuation methodology / toolkit presented in the main report. The case studies (presented in order of increasing geographical area) are:

- Bleaklow: an area of approximately 600 ha, primarily consisting of blanket bog severely damaged by fire, within a much larger plateau. This case study seeks to appraise the ecosystem service impacts of the restoration project that is currently underway in this small (by uplands standards) area. The case is "simple" in the sense of focusing on restoration of a single habitat type; however complications arise because it is difficult to assess some ecosystem service changes at this small scale, independently of the wider catchment / landscape level. Although there are significant uncertainties, the results strongly suggest that the restoration project is cost-beneficial.

- Ingleborough National Nature Reserve: this is relatively small-scale site, 1014ha, with known habitat areas and specific management treatments. The main management options relate to maintenance of relatively rare habitats and biodiversity of the area, through change of grazing regimes to include traditional cattle breeds on part of the site, and "rewilding" at South House Moor.

- "X-Dale": anonymised for confidentiality reasons, X-Dale is a fictional site based on more than one real case in which a sizeable area around 4000ha is at risk of changes associated with gradual decline in traditional grazing and management patterns, leading Natural England to initiate agreements with landowners and graziers to maintain these practices. The ecosystem service impacts arise through avoiding a rather long-term process with few immediately apparent differences in the short run between the counterfactual and policy cases.

- Wild Ennerdale: is a 'rewilding' project on 4711ha in the Lake District. This case study is a broader-scale assessment of diverse management interventions within an overall package, but at a relatively small scale. Data availability is a problem, in particular with regards to determining how the various interventions and general principles of the rewilding management will combine to change ecosystem services in the area.

- SCaMP: the Sustainable Catchment Management Project is a flagship conservation project carried out by United Utilities and partners on 20,000ha of catchment land. The primary rationale for the project is improving SSSI condition whilst protecting raw water quality, however only very rough estimates of possible benefits are possible. Nevertheless the results support the conclusion that SCaMP is highly likely to be cost-beneficial, taking all ecosystem service changes into account, in the long run.

- North Pennines Area of Outstanding Natural Beauty (AONB): an overview of a wide-ranging management strategy over a very large geographical area (almost 200km^2). While economic valuation techniques could certainly be useful at this scale, the data requirements are substantial, and this case study is only an introductory, broad-brush assessment.

For each of the case studies, the nine steps of the methodology from the main report are worked through. The level of detail is dependent on the data and time resources available. Each case study is intended as a stand-alone demonstration of the methodology, and so there is some repetition from study to study. Together, the studies are intended to demonstrate the range of different possible applications – including small scale to large geographical scales, and specific interventions to general long-term visions. The methodology can be useful in all scenarios, but the scale of challenges faced varies significantly.

It should be noted that these case studies have been carried out by a small team of economists, using information kindly provided by various people involved in uplands management plus such information as we have been able to find through basic web and literature searching. We have not conducted interviews with land managers or users, or organised workshops, or designed field work, or completed multiple iterations of the analysis, or various other things that might be expected in a 'full' assessment for decision support purposes. Such an assessment would probably result in reduced uncertainty over some important factors, or at least in consensus among stakeholders regarding the most likely scenarios, and this would enhance the robustness of, and confidence in, the results of assessment.

4.1 Bleaklow

Bleaklow is an area primarily consisting of blanket bog severely damaged by fire. Work on the plateau to restore sites historically damaged by fire was planned and commissioned, before another major fire in 2003. This case study seeks to appraise the ecosystem service impacts of the restoration project that is currently underway.

Location: Bleaklow plateau, Peak District National Park, (53.27.58N, 1.51.09W).

Area: a little over 6km^2 (for the restoration area only). The Kinder Scout/Bleaklow plateau extends up to 47km^2.

Altitude: 510-620 meters.

Characteristics: Upland or blanket bog with a peat depth up to three meters; heavily impacted by erosion gullies and large areas of bare peat, resulting from a series of large wildfires, the last one in 2003. Damage exacerbated through past inappropriate grazing and increased acidity of soils caused by pollution. Major problems of deep gullies where all peat cover has been lost, and exposed peat suffering wind, frost and rain erosion. Public water supply reservoirs. No habitation. Used for recreation, being intersected by the Pennine Way.

Designations: Peak District National Park

Ownership: National Trust, United Utilities, private land owners

Management: Moors for the Future, National Trust, United Utilities, private land owners

Stakeholders: MFF, National Trust, Peak District National Park, Natural England, private land owners, recreational users, water users.

Data sources: data potentially available for the MFF restoration sites on Bleaklow:

- Restoration treatment and costs;
- % cover of plant species and bare peat 2004-to date;
- Breeding bird counts before restoration (not yet after restoration);
- Carbon flux measurements, all C components (spatial design to include all restoration stages, funded by Natural England and Defra);
- Water quality (Dissolved Organic Carbon);
- Run-off (water retention capacity of restored sites, some tentative data);
- Erosion rates (sediment flux, Particulate Organic Carbon);
- Visitor usage;
- Wildfire risk probability (ongoing work by McMorrow and others, Manchester University), and
- Other parameters which can be derived are transport emissions etc.

These data were not yet available: the data used below have been derived from personal communication with Aletta Bonn who has based her estimations on ongoing work by Martin Evans, Fred Worrall and Tim Allott (University of Manchester and Durham). Data identified cover the key parameter of soil loss and carbon budget. Full data will eventually be available to Natural England via reports from the above scientists. The framework for valuation set out below could be adapted once full data are available. MFF (Aletta Bonn, *pers comm,* May 2009) has indicated the intention to conduct a fuller analysis in the near future.

Management options: business as usual; restoration of fire-damaged blanket bog.

Ecosystem services: The ecosystem services of primary interest for the Bleaklow plateau are GHG regulation, water quality and quantity, and non-consumptive recreation. There is potential for food production and field sports in the future once restored. The site is bisected by the Pennine Way and is overlooked by one of the main tourist roads running through the National Park (the Snake Pass). The Pennine Way is one of the main footpaths used by walkers in the Peaks, and access has been eased by flag stone paving to channel walkers along the paths and avoid erosion through trampling. The Woodhead Reservoir, River Etherow, River Ashop, Derwent Reservoir and Ladybower Reservoir are all in part fed from the Bleaklow Plateau and it is the source of the River Derwent. So water quality issues are of great importance for this site (however these need to be understood in the wider catchment context).

The area contains the wreck of a US Air Force Boeing RB-29A Superfortress of the 16th Photographic Reconnaissance Squadron which crashed in 1948; this is of cultural heritage interest and may have use and non-use values.

Step 1: Defining the Baseline/Counterfactual

This case study aims at appraisal of the restoration project in a heavily damaged landscape. In principle a “business as usual” counterfactual is to be preferred, and we assume that in this case "business as usual" means making no intervention, leading to an ongoing annual soil loss from the site of approximately 260 tonnes per square kilometre per year (Evans, *pers. comm*. via Aletta Bonn, May 2009) (see Table 23).

Step 2: Identify management options

The management approach at Bleaklow is restoration of degraded landscapes, with the aim of preventing further environmental degradation and the eventual recovery of the area to a natural system. This involves protecting ecosystem services through direct intervention until the natural vegetation can re-establish.

Restoration of fire damaged upland landscapes using heather brash, geojute, nurse crops, liming and fertiliser support for nurse crops. Nurse crops, heather brash and geojute provide protection to the peat whilst natural vegetation becomes re-established. Nurse crops, mainly grasses, are dependent upon fertiliser application as they would not persist in the landscape without this; once natural vegetation establishes, fertiliser applications can cease and nurse crops will die back. Liming is used to help recovery of natural pH levels: the goal is around pH4-4.5, but some sites have a pH as low as 2.8 with an average of 3.5.

Grazing is stopped during recovery period, but may be required later as part of habitat management.

Table 23 Bleaklow: Characterising the Counterfactual

Characteristic/service	**Pre-restoration status**	**Future expectations (baseline)**	**Notes**
Description			
Area	6km^2	Same	
Populations	Zero resident	Same	
Human Activities	Grazing; Walking.	Same	
External Management	path maintenance (Pennine Way)	Same	
Habitats			
Blanket bog	Whole area badly degraded.	No improvement/ further decline due to overgrazing and erosion	
Ecosystem Services			
Food and fibre	Sheep production – low level	Continuing low level, possible cessation due to further degradation	
Renewable energy provision	None	None	
Water quality to downstream catchments	High DOC levels	Ongoing high DOC levels.	soil loss 1560 tonnes/annum
Costs associated with downstream flood risk	Quick run-off through erosion gullies, possible exacerbation of flash floods	Same	
Use and enjoyment: outdoor recreation	Used, but degraded landscape	Same; further degradation may lead to footpath erosion.	
Use and enjoyment: field sports	None	None	
Non-use values from historic and cultural landscapes	Degraded landscape	Same	
Greenhouse gas emissions	Significant source	Significant source	soil loss 1560 tonnes/annum
Biodiversity and wildlife	Unfavourable status	Unfavourable status	

Step 3: Identify impacts on ecosystem services

The primary impact of interest in this case study s the condition of blanket bog (table 24). As this improves in condition, various changes in ecosystem services are expected, as summarised in Table 25.

Table 24 Bleaklow: Habitat changes from counterfactual to policy scenario

Habitat type	Area	Quality	Change with project	Timing
Blanket bog	$6km^2$	Unfavourable, declining, with areas of bare peat.	Revegetated, gradual move to favourable status	2-3 years for initial revegetation; 15-20 years for good condition.

Table 25 Bleaklow: Changes in quality and extent of ecosystem services

Characteristic/service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food and fibre	Blanket bog	Revegetation, grazing exclusion	Short term losses. Possible long term gains.	Requires measurement of stock levels and productivity.
Renewable energy provision	Not considered in this case study – there is future potential in both scenarios.			
Water quality to downstream catchments	Blanket bog	Reduced erosion	Reduced sediment loads, potential reduction in DOC in the future, but currently no indication of improvement	Requires measurement of water quality (DOC) and erosion rates (sediment flux)
Costs associated with downstream flood risk	Blanket bog	Increased water retention. But likely a relatively minor impact considered in isolation from rest of catchment.	Potentially reduced flood risk	Requires measurement of water retention capacity and flood risk
			Important alluvial floodplain habitats in Lower Derwent Valley: potential impacts (slightly reduced flash flood risk / improved continuous flows).	As above plus estimation of habitat impacts. But any impact is likely to be very minor.
Use and enjoyment: outdoor recreation	Blanket bog	Vegetation over bare earth	Visual improvement; easier access.	Visitor usage; visitor enjoyment and/or travel cost surveys.

Characteristic/service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Use and enjoyment: field sports	Blanket bog	Field sports could be taken up again, as bird distribution patterns change/recover.	Some land may be shot, and some migration of birds to shot moors may take place.	Estimate of 2-3 pairs of red grouse per square km based on levels found in blanket bog habitats in Ireland[10]. Roughly 18 pairs for the area being restored, some chicks will migrate out (improve shooting elsewhere).
Non-use values from historic and cultural landscapes	Blanket bog	Habitat condition	Improvements in condition. Assuming zero impact on aircraft wreck.	Possibly from stated preference survey or benefits transfer
Greenhouse gas emissions	Blanket bog	Rewetting, revegetation	Reduced carbon emissions. Increased methane only to a minor extent as water tables very low.	Carbon flux measurements ≈600 tonnes of atmospheric CO_2 per annum
Biodiversity and wildlife	Blanket bog	Habitat condition, revegetation	Increased biodiversity	% cover of plant species and bare peat 2004-present; breeding bird counts before restoration (not yet after restoration). Future projections.
Other?				Restoration treatment and costs Wildfire risk (unknown)

Step 4: Identify human populations affected

Bleaklow itself is unpopulated. The water from the site in part feeds a series of reservoirs in the Derwent Valley which provide water to the populations of Sheffield, Derbyshire, Leicester, Nottingham and a series of smaller settlements. According to the Pennine Way coordination project in the region of 18,000 people are estimated to access this southern end of the Pennine Way each year (see Table 26).

[10] http://www.ipcc.ie/infoblanketbogfs.html

Table 26 Bleaklow: Populations affected

Service	Type of population	Number	Characteristics
Food and fibre	Producers		We assume that the production in this area is not significant enough to have national-level impacts on food or timber markets.
Renewable energy provision	not applicable		
Water quality to downstream catchments	Utilities		United Utilities, Severn Trent Water and customers in NW England: but this not only source. Major reservoirs in Derwent valley, 623 million litres supplied daily. Difficult to assess Bleaklow independently of catchment.
	Customers	Perhaps around 2 million people with some part of their supply from this area.	
	Recreational users	No data	Likely primarily local users in downstream catchments, for general recreation and for angling.
Costs associated with downstream flood risk	Environment Agency		Responsible for flood protection expenditures
	Householders	Large number	High rainfall in this area could create flood risk for some heavily populated areas. Improved bog condition relevant to reducing this risk.
Use and enjoyment: outdoor recreation	Local residents, walkers bikers	No accurate data. Peak District NP ≈ 10 million day *visits* per year. 18,000 visits to southern end of Pennine way. Air craft wreck of interest.	Peak District National park is within an hours drive of a third of the UK's population.
Use and enjoyment: field sports	Private landowners		May consider selling shooting in the future; may well shoot privately.
	Grouse shooters	Unknown	Best considered as part of the national stock of shooting areas.
Non-use values from historic and cultural landscapes	Interest groups General population	Several million ≈1.8m households in East Midlands; but also close to big populations in West Midlands and North West.	National Park designation: likely to be salient at least to regional population, and potentially to national population.
GHGs	Problem of global interest. Sequestration potential contribution to UK response. May even have financial value to landowner in long run.		
Biodiversity and wildlife	Interest groups General population	Several million	Key conservation interests likely to be salient to local to national interest groups, and perhaps to general population at local, regional and potentially national levels.

Step 5: Economic valuation of ecosystem service changes

Although some valuation evidence is available for all the service categories considered, use of this evidence depends on having data on the likely service changes. As discussed above, the information on service changes is quite vague, and so any valuation will be similarly approximate. Bearing this in mind, Table 27 summarises the assumptions and calculations required to derive some rough estimates of service change values.

Table 27 Bleaklow: Economic valuation of ecosystem service changes

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Food and fibre	Market values	Low or negative value, after costs. Could be major loss if high cost to re-establish grazing.	Currently no grazing during recovery. Future grazing limited, management tool if required. Assuming density of 0.5 sheep /ha gives potential herd of 300.
Renewable energy provision	Not considered in this case study.		
Water quality to downstream catchments	Potential reduced cost of treatment	Assume zero (conservative); there is currently no measurable benefit of regevegetation on DOC (Evans and Worrall, pers comm.), and the trajectory of DOC development with restoration is unclear	Likely to be some value in future but high uncertainty because also dependent on management of surrounding areas. Full estimation would need catchment approach and data from water industry
Costs associated with downstream flood risk	Risk of flooding, loss of agricultural yields.	Assume zero (conservative)	Will relate to wider catchment issues, predominantly the timing of water released from different landscapes. As such restoration could contribute to or mitigate against flood events in different conditions.
Use and enjoyment: outdoor recreation	CV/CE and BT; Tinch 2009[11], Kaval (2006).	Assuming 18,000 visits per year, £8 per visit, ≈ £144,000. Similar values from 10% improvement with Kaval estimate. Actual visitor numbers likely rather higher (not just Pennine Way) but needs correction for area (visit may cover more than Bleaklow). Very rough assumption of £100,000 (main case).	Value of visitors for less intensive management in the Peak District National Park: Tinch finds £8 per visit, range £6 to £9. Focus is reduction in land use intensity – different from restoration, but value likely to be at least as high. Kaval (2006) supports average values around £40/day, but nearer £90 for national parks. Values apply over wider area. Realised costs of day visitors to Peak District moorlands were on average £14.97 (MFF visitor

[11]Unpublished PhD research to be submitted 2009.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
			survey: travel only £4.81, £18.17 for staying visitors; Davies 2006) – but these are costs, not value estimates.
Use and enjoyment: field sports	Market price	£130-150 per brace for driven shoot £70-80 per brace for walked shoot	Values based on Environment Council[12] using National Game-bag Census. Total values unlikely to be significant in context of other values, though could be locally important.
Non-use values from historic and cultural landscapes	CV/CM via BT; eftec (2006)	Area is approx 0.6% of East Midlands SDAs, c.1.8m households (hh). Change from highly degraded to good conservation: assume £20 for whole region. Gives c.£200,000 for Bleaklow (12 pence per hh). Low confidence in specific numbers. May well be higher because near large populations in adjacent regions (North West, West Midlands).	Based on eftec (2006) £8 (small improvement) to £23 (large improvement) per hh for SDAs in whole region; alternatively, £1 per hh for 1% increase in heather moorland and bog. Quite wide CIs in the study: £-2 to £23 for small change, £12-£37 for large; £0 to £2.3 for blanket bog.
Greenhouse gas emissions	DECC values	Phased in over years 3 to 20 gives c. £370,000 PV over 50 years (£670,000 over 100 years).	Using particulate organic carbon loss estimates only: 100 tonnes of POC carbon loss per square km, 6km^2, 30% POC conversion to gaseous flux to atmosphere in riverine processes (Evans, pers comm, via Aletta Bonn, May 2009), 90% of this total prevented after restoration: ≈160 tC ≈ 600 tCO2 per year, valued at DECC rates (£27 in 2009 rising to £196 in 2109). See comments below.
Biodiversity and wildlife	BT from SP, for example, Hanley and others (2002)	Omit in order to avoid double counting	Likely to be partly covered in recreation and in non-use values above. Likely future benefits for birds, vegetation, and other.

Note: CV – contingent valuation; CE – choice experiment; BT – benefits transfer SP – stated preference.

Fred Worrall and Martin Evans are completing a report on carbon storage and flux, for Natural England. Aletta Bonn of Moors for the Future was willing to make some estimates, based upon their work, for the purposes of aiding the development of a valuation framework. This underpins the values in Table 27: it is important to note that these values are not final, and that the correct data be used for carbon flux once

[12] www.the-environment-council.org.uk/index.php?option=com_docman&task=doc_download&gid=105

they are available. It is also important to consider that under the counterfactual scenario, the Bleaklow site predominantly suffers from losses of particulate organic carbon. In the restoration scenario, carbon budgets will be made up of gaseous, riverine and particulate organic carbon. There is a step in the calculations underlying the figures presented here that identifies the percentage of particulate carbon likely to make its way into the atmosphere (estimated at 30% as suggested by M Evans). The appropriate value would have to be identified separately for other sites.

The main impact at this site is the changes in erosion and associated carbon losses. This will have subsidiary impacts in particular on river water quality for abstraction. It is estimated that in its eroded state 260 tonnes of soil was lost annually per square kilometre in the catchment; this contains approximately 100 tonnes of particulate organic carbon, of which 30% would find its way into the atmosphere. After initial restoration (stabilisation through nurse grass species within three years) this was reduced to the normal erosion levels of pristine moor. A rough estimate of a 90% reduction in losses was applied (but again actual data should be used when available), a conservative assumption allowing for some losses from “pristine moor”. This gives an estimated total of 600 tonnes of carbon dioxide/yr from the 6km^2 restoration site. Note that this is not the total flux, but rather the change from the counterfactual.

Valuation of water quality changes could be carried out via changes in the costs incurred by water utilities, either through treatment of water to reduce Hazen[13] values (reduced ongoing costs, or costs of new treatment infrastructure avoided) or reduced costs of dredging reservoirs. However, these data are not yet available, and currently there is little indication of water quality benefits from current restoration. Furthermore, it is difficult to assess the values arising from Bleaklow independently of the whole catchment context. A conservative approach of omitting these values has been adopted.

For recreation, unpublished work (Tinch, 2009) for this area of the Peak District National Park shows average willingness to pay of £8 per visit for an unmodified managed landscape in the Peak District (recreational, biodiversity and non-consumptive use value). The focus was not on heavily degraded landscapes (but we assume restoring these has higher value) and applies to a wider area. Alternatively, Kaval (2006) suggests total values per visit of £40-£90, similar to Tinch's values if we consider the restoration to represent roughly 10% improvement. Considering only the 18,000 accessing the southern end of the Pennine Way, and making an *ad hoc* adjustment of about minus 30% to remove non-use values (on the assumption that the value figure from Tinch (2009) includes some non-use element) suggests an annual recreation value associated with the restoration project in the region of £100,000. Note that these values do not include any increase in visit rates, but just improvement in the value of a visit (due to the re-vegetated and more biodiverse landscape).

[13] An index of water colour.

There is a risk of double-counting with the non-use category, because the recreation and non-use values are difficult to separate out. But the recreation value has been derived from considering a small number of visits (18,000), while the non-use category is estimated at a rate of 12 pence per household (on average) across the whole region. (1.8m households). So although many of the recreational visitors will also live in the region, only a small fraction of the non-use value arises from considering their non-use values. so it is not unreasonable to consider these as different categories.

The costs of restoration on Bleaklow are difficult to identify clearly. Figures from the Peat Compendium[14] give the budget for phase 1 is given as £1.7m, for an area of 383ha. Costs per hectare are given as £5,400 for stabilisation, £900 for re-seeding and £2,700 for replanting: however the exact combination of treatments depends on the condition of the peat and full costs will not apply to each hectare. Most recent calculations (Walker, Buckler, pers. comm.) suggest that restoration to date (4.3 km^2) has cost £1,235,000, or £2,900 /ha. This is the cost to restore half of the Bleaklow 2003 fire site – including all the historic damage. About 3 km^2 of the Bleaklow fire site is 'unrestored'. We assume that the total costs for restoration of 600ha site £1.75m. For the high cost scenario, we assume that the cost is £3.5m, while for low costs, we assume £1.25m. Using these total estimates ignores the impact of discounting (which would reduce the figures slightly because the expenditure is spread over initial years of the project) but also ignores any on-going management costs (though these are thought likely to be relatively minor).

Step 6: Calculation of discounted costs and benefits

Table 28 below summarises the present values of impacts. The separate spreadsheet for the case study shows the calculations of net present values based on observed changes, unit values, and discount rates. Values have been calculated over 50 years and over 100 years.

[14] www.moorsforthefuture.org.uk/mftf/downloads/research/PeatCompendiumFormMFF.xls

Table 28 Bleaklow: Economic valuation of ecosystem service changes

Service	**Present value (50 years)**	**Present value (100 years)**	**Notes**
Food	0	0	assumed negligible
Water quality	0	0	uncertain, could be significant?
Flood risk	Not valued – positive, could be significant.		
Recreation	£1.5 million	£2 million	based on significant value for small number of visits per year: probably lower value, for more visits
Field sports	Not valued – positive, probably minor.		
Non-use: historic and cultural	£3 million	£4 million	based on small household WTP (12p) among population of region. Some risk of double counting with recreation.
GHGs	£0.4 million	£0.7 million	based on official values and estimated reduction in soil loss
Wildfire prevention	Not valued – positive, could be significant.		
Biodiversity /wildlife	Not assessed because suitable values for transfer not available, and due to risk of double counting with non-use and recreation. But likely additional value.		
Total service changes	**£4.9 million**	**£6.7 million**	sum of above figures
Costs	c.£1.75 million	c.£1.75 million	approximate figures from
Net present value	**£3.1 million**	**£5.0 million**	very approximate estimates

The above estimates need to be treated with caution, given all the assumptions and simplifications that underlie them. The next section considers the sensitivity of this result to changes in the main assumptions and uncertainties.

Step 7: Sensitivity analysis

Recovery Period: landscape recovery relies upon seeding and growth of native upland species which has not been attempted elsewhere before, so there is significant uncertainty about recovery period. The main case assumes first impacts in three years, with a 20 year recovery period. Assuming recovery runs from years 5 to 40 instead reduces values to a loss of £0.5m (50 years) and a benefit of £1.4m (100 years). In both cases we have assumed a linear recovery profile over the relevant period, and the same rate of recovery for all different services. Clearly these are major oversimplifications, and could be addressed with better data. The results reflect that although short to medium term returns will be very sensitive to the time to recovery, in the long term benefits will show through – partly this is due to low and declining discount rates for official cost benefit analysis, and partly the increasing value over time of GHG regulation under the DECC valuation guidelines.

Costs: uncertainty associated with cost estimates is discussed above. With the higher estimate of costs, the net present value can also drop to a loss over 50 years, but remains positive over the 100 year horizon.

Food: the value of food service from sheep grazing, after accounting for costs, is assumed to be negligible in the main case. If we allow for a grazing density of 0.5 sheep per hectare, giving potential herd of 300, and assume an annual return of £40 per head, with grazing starting in year 10, the present value of this service would be approximately £110,000 (50 years) or £160,000 (100 years). In other words, the value of upland sheep would have increase rather sharply for this service to become important relative to the other values considered. Therefore further consideration of these values is not a priority.

Water quality: the value estimates ignore the impacts of restoration on water quality, because of the difficulty of considering this $6km^2$ area independently of the surrounding catchment, and because key data on particle loads and treatment costs are uncertain. While this could be significant there is currently no conclusive evidence of benefits of restoration to water quality available, yet. Further research into these values would be very useful.

Recreation: the recreation values are highly uncertain, due to underlying uncertainty about the numbers using the area, the values per trip, and the prospects for future changes in these figures. The value of £8 per visit for improvements (that is not total value per visit) may seem a little high, but the estimate of visit numbers (18,000) is low. It is likely that the "real" value of recreation changes would include more visits, and more modest additional values per visit (just the value for improvement in the recreation experience, with no non-use component). The landscape improvements are considered unlikely to lead to increases in visitor numbers, but this assumption may be wrong. But alternative methods of calculating recreational values could give similar or higher figures than those noted above. The Peak District National Park attracts around 20 million visits per year. Bleaklow is approximately 1% of the Park area. Making a very rough calculation of 1% of 20 million times a value for improvement of £1 gives £200,000. This could bring recreation values to the £3m to £4m level (present values over 50 and 100 years). On the other hand, if only a small number of visitors would actually be willing to pay for an improved landscape the contribution of recreation could be negligible overall. We believe that the most likely scenario does involve significant values from recreation improvements. However the uncertainty highlights the importance of recreation values to the overall assessment of the restoration, and the need for further research in the field of assessing the recreational values of landscape improvements.

Non-use values: this category is also highly uncertain. The main case estimates are based on values for improving Severely Disadvantaged Areas (SDA)s for the East Midlands. However Bleaklow is on the edge of the region, and close to major populations in adjacent regions: the PDNP is within an hour's drive of about 20 million people, or about 8.5 million households. This suggests that values of £0.5-£1m per year or even more might be feasible; if so, these values would be substantially greater than the other categories.

GHG regulation: the key uncertainty here relates to the actual levels of carbon reaching the atmosphere under each scenario, and to the possible impacts of changes in methane production. However the results are not very sensitive to the GHG values, which are an order of magnitude lower than the estimated non-use vales, and much less than recreation values. Further research here is nevertheless warranted, because the values are non-negligible, and accounting for carbon is increasingly important for policy purposes.

Summary: Overall, the sensitivity analysis shows that the results are particularly driven by the highly uncertain non-use and recreation categories, and efforts to reduce uncertainty there would be warranted. That said, it seems very likely that the restoration project has a positive net present value, unless non-use and recreation benefits are significantly lower. This can be sufficient to push the project overall into deficit, however this is thought unlikely, and there are non-monetised benefits (see Step 8) to consider.

Step 8: Accounting for non-monetised impacts

Several categories of value / service have not been included in our calculations. These include the following ecosystem services.

Renewable energy: we have not considered this possible source of value. There is undoubtedly potential for renewable energy investments in the area (which is not to say that this would necessarily be a good place to do this, just that we are not aware of reasons why it would be impossible). However this was considered to be beyond the scope of this case study, because there is nothing in the restoration project that irreversibly precludes, or determines, future investments. The costs and benefits would need to be considered separately. We could have considered additional scenarios including renewables, however we decided to keep it simple and focus on the key issue of restoration versus counterfactual.

Biodiversity: one of the main impacts of the restoration project will be to protect blanket bog, a key BAP habitat. These impacts have not been valued directly, partly because of the difficulty of doing so, and partly because of the risk of double-counting with the non-use values estimated for cultural heritage and landscape and with recreation values. Nevertheless there could be additional values here and they might be significant.

Field sports: we have not given any value to changes in field sports. As discussed above, any change is likely to be positive, but probably minor in comparison to other categories.

Water quality: though omitted from the estimates, there may be some positive value associated with water quality improvements. These are difficult to assess at the local scale, and depend on catchment-wide processes. At any event, the restoration will not make matters worse, so the value is definitely non-negative.

Flood risks: blanket bog restoration is likely to reduce risks of flash flooding in downstream areas, and the values associated with this could be significant. However we have no data on which to base an assessment. In particular, it would be difficult to make this assessment without considering other areas in the catchment.

Food and fibre: not included in the main case, but addressed in sensitivity analysis. As noted there, this is not likely to be a material concern from the perspective of the overall benefit-cost assessment.

In addition, two factors that could affect the changes in ecosystem services due to the management option are also not taken into account:

Fire risk: we have not attempted to value changes in fire risk, or associated greenhouse gas emissions. There is likely to be a reduction in risk associated with restoration, and it is possible that the value of this reduction could be significant. On the other hand, we have not taken into account in the other service categories any risk of costs associated with fire.

Climate change: we have not taken full account of the possible impacts of climate change on the area and the ecosystem goods and services it provides. There will undoubtedly be impacts, but their precise nature is difficult to assess. It seems likely, however, that the damages of climate change might be less under the restoration scheme than under the counterfactual: the revegetated landscape will be less vulnerable to fire, and better able to deal with extremes of weather, than the degraded peat.

The above categories are likely to give higher benefits under the restoration scenario than in the counterfactual. So although we have not been able to ascribe monetary values to all categories, we can be confident that we are much more likely to have under-counted benefits than to have under-counted costs.

Step 9: Reporting

There is substantial uncertainty about both the physical and monetary values of service changes. Under the assumptions made in the main case presented above, the restoration project seems to be beneficial, with a benefit: cost ratio of almost 2:1 (over 100 years). Broadly speaking, this is robust to realistic changes in the assumptions, but the sensitivity analysis does show the key importance of the two most uncertain categories valued, non-use and recreation. Of particular concern is the risk of double-counting when considering both: however the assumptions made aim to minimise this risk, and the sensitivity analysis shows that the NPV remains positive even if the recreation category is reduced to zero (that is assuming the value to be covered under the estimates of "non-use" used here).

Overall, we conclude that it is highly likely that the restoration scheme provides net ecosystem service benefits, after accounting for scheme costs. If the non-use and/or recreation values are substantially higher than presented here – which is entirely possible, given the location in a National Park, near over 8 million households, and the highly degraded nature of the landscape in the counterfactual – then the restoration could be very highly beneficial, with benefit-cost ratios approaching 10:1. In addition, there are several positive values that have not been expressed in monetary terms.

For a fuller, less uncertain assessment, priority should be given to more accurate assessment of recreation and non-use values, perhaps via a primary study, and taking care to tease out the different components. Secondly research into how the Bleaklow area fits within the wider catchment, and the implications of this for water quality and flood risk values, should be considered. There is currently a Making Space for Water under way within the Upper Derwent catchment (2009-2011). Thirdly, research into carbon and methane balance is of interest, but unlikely to swing the balance in cost-benefit terms. As an interim conclusion, we can be modestly confident that the scheme is rather more likely to be beneficial than not.

4.2 Ingleborough National Nature Reserve

The case study of Ingleborough National Nature Reserve (NNR) presents an appraisal of a specific, relatively small-scale site, with known habitat areas and management treatments.

Location: North Yorkshire (near Selside, Ribblesdale and near Chapel-le-dale, Twisleton Glen) 54°9′57.32″N 2°23′51.02″W

Area: 1014ha (186ha changed grazing regimes, 200ha rewilding project, and 628ha business as usual (sheep grazing))

Altitude: around 300 to 723m

Characteristics: Main habitats are limestone pavement (rare geological formations which provide habitat for rare species), moorland, woodland and scrub. Ingleborough itself is the second highest hill in the Yorkshire Dales and attracts many tourists, mainly for walking. The remains of an Iron Age Fort have been found on the hill. Two aspects of Ingleborough are listed in the Geological Conservation Review: its Karst and cave features (the cave features are also recognised as being of international importance) and the presence of the Norber Erratics, perched blocks of Silurian grit which were moved by the ice of the last glaciation to rest upon limestone pedestals. Ingleborough contains Britain's finest karst area characterised by limestone landforms formed under glacial conditions. Extensive limestone pavements, dry valleys and gorges, shakeholes and sinkholes that include Gaping Gill, the highest single-drop waterfall in Britain are important features. Many of these features are classic teaching examples and can be considered as having significant cultural/historic value. Underlying geology exerts strong influence on the ecology of the area. Limestone pavement landscapes provide habitat space for small base-rich wetlands with Yorkshire primrose, limestone pavement with bloody crane's-bill, calcareous grassland with common rock-rose and limestone rock outcrops, cliffs and scree with juniper. Elsewhere on deeper acid soils the full range of moorland and moorland fringe habitats occur. Upland dry heath can be seen with dwarf shrubs including bilberry and bog habitats dominated by hare's-tail cotton grass, with cranberry, round-leaved sundew and bog asphodel in the wetter areas. 'Rewilding' of some of these moorlands is underway at South House Moor. In addition to all of the plant life there is of course a whole host of animal species which rely on these habitats, such as northern brown argus butterfly, eurasian curlew, roe deer and bats in the cave systems. Ingleborough NNR has also been an important site in the Limestone Country Project. This aims to restore habitats within the Ingleborough Complex and Craven Limestone Complex Special Areas for Conservation (SACs) by encouraging a return to mixed farming using traditional hardy upland cattle breeds. In Ingleborough, grazing is carried out with the NNRs own cattle herd and dedicated farmers[15].

[15] http://www.yorkshiredales.org.uk/ingleborough_nnr.htm

Designations: National Nature Reserve (NNR), Site of Special Scientific Interest SSSI and a Special Area of Conservation SAC. Part of the Yorkshire Dales National Park.

Ownership: Natural England

Management: Natural England in partnership with Yorkshire Dales National Park, Yorkshire Wildlife Trust and local farmers.

Stakeholders: include Yorkshire Dales National Park Authority, National Trust, Grazing Animals Project, Yorkshire Dales Millennium Trust, Natural England, National Beef Association, Rare Breeds Survival Trust, Lancaster University, CEH (Lancaster), Newcastle University and Askham Bryan College.

Data sources: Most academic research on the area is now rather dated. NNR data for the sites may be useful in determining a baseline and changes brought about through management changes. The Limestone Country Project identifies that baseline data collection was carried out between 2004 and 2007 in relation to grazing regime changes.

http://www.yorkshiredales.org.uk/ingleborough_nnr.htm,
http://www.limestone-country.org.uk
http://www.english-nature.org.uk/special/nnr/nnr_details.asp?NNR_ID=92
www.malhamdale.com/limestonecountrybeef.htm.

Management options: The main management options relate to maintenance of relatively rare habitats and biodiversity of the area; change of grazing regimes to include traditional cattle breeds; and the 'rewilding[16]' at South House Moor compared to a business as usual baseline.

Ecosystem Services: Mixed grazing with sheep and upland cattle helped create the diversity of plant species and other wildlife protected by the national nature reserve. The landscape is dependent upon the underlying geology and soils are fairly thin. During the last 50 years, there has been a decline in this mixed grazing with a move towards sheep "ranching" (Tinch 2009), mainly due to agricultural policy such as the hill headage payment. Sheep are more selective grazers, leading to a rise in rank grasses, which has a negative impact on diversity, with risk of loss of some species or assemblages. Grazing with the less-selective traditional cattle breeds (modern breeds tend to be heavier which can itself cause problems) therefore has positive biodiversity impacts. This can also improve the food and fibre service from the area, via a marketing strategy for the traditional breed beef from the project area as a premium product. Recreational use of the area also provides an important service.

Step 1: Defining the Baseline/Counterfactual

Baseline ecological research was carried out between 2004 and 2007 by the Limestone Country Project, comparing the effects of grazing with different livestock.

[16] Used as a shorthand here; a more accurate description might be 'managed in line with natural processes', and there is no intention to exclude human activity completely.

A baseline has also been developed to determine the economic impacts on farm enterprises of establishing hardy cattle enterprises[17]. NNR vegetation cover data can be used to identify a baseline for some measures of biodiversity.

The valuation interest is in identifying the impacts of rewilding and grazing regime compared with a "business as usual" counterfactual, for which baseline data from before the policies came into effect would be required. The baseline data available was collected between 2004 and 2007 so some initial effects of the scheme could be confounded in the baseline, but the assumptions made below are intended to represent the counterfactual case.

Table 29 Ingleborough: Characterising the Counterfactual

Characteristic/service	**Pre-change status**	**Future expectations (counterfactual)**	**Notes**
Descriptive Statistics			
Area	1014 ha	Same	Part of a wider 1500 ha limestone pavement project which includes Whernside and Mallam.
Populations	Zero resident; small settlements adjacent: Ingleton, Stainforth, Austwick, Clapham...	Same	
Human Activities	Grazing; Walking.	Same	
External Management	Limited	Same	
Habitats	>90% of all habitats in favourable or unfavourable recovering condition[18]	Same, or some decline through overgrazing.	
Limestone pavement	186ha	Same areas. Risk of declining condition through overgrazing.	
Blanket bog, peatland, mosses, cotton grass, heather, montane heath	200ha		
Upland Grassland	628ha		
Ecosystem services			
Food and fibre	Predominantly sheep grazing. Economically marginal.	Overgrazing may cause declining returns	
Renewable energy provision	None	None	

[17] http://www.limestone-country.org.uk/NetBuildPro/process/17/ActionsandTargets.html

[18] http://www.natura.org/DOC/uk_limestone_summary.pdf

Characteristic/service	Pre-change status	Future expectations (counterfactual)	Notes
Water quality to downstream catchments	Water coming from the site is of good quality	Same	No discolouration of water from limestone pavements, indicator species for clean water observed in the river valleys [19]
Costs associated with downstream flood risk	No extended area of flood risk.	Same	Ingleton (nearest impacted settlement) has flood risk <0.5%. Some flood risk from River Lune but mostly across traditional flood plain with little development. City of Lancaster has some level of flood risk but this appears to be associated with coastal location so flooding is likely to be as the result of high tide in combination with high rivers.
Use and enjoyment: outdoor recreation	Significant, but degraded somewhat due to overgrazing	Same, or decline if further habitat degradation	Less diverse somewhat degraded landscape with shifted species assemblages.
Use and enjoyment: field sports	None	None	
Non-use values from historic and cultural landscapes	Important but degraded somewhat due to overgrazing	Same, or declining.	Internationally important landscape.
Greenhouse gas emissions	Carbon stored in geology, no significant loss to the atmosphere.	Same	
Biodiversity and wildlife	Degraded from traditional levels with loss of some species and assemblages	Stable or ongoing loss.	

Step 2: Identify management options

There are three separate management areas within Ingleborough NNR. There are a number of landscapes traditionally associated with upland landscapes: blanket bog, peatland, mosses, cotton grass, heather, montane heath. Generally these areas are managed for diversity although they are traditional manorial commons and tenants

19 http://www.yorkshiredales.org.uk/index/learning_about/nature_in_the_dales/best_places_to_see/ingleton_waterfalls_trail.htm

have grazing rights. However there are two specific areas of distinct management upon which this case study will focus.

Ingleborough is designated as a National Nature Reserve partly because of its unique geological formations and associated habitats, it contains the largest limestone pavement habitat in the country (1/3 of the total national habitat area) and has other important areas such as gorge woodlands. The management aim over a 186ha area is to return to a more traditional grazing regime to undo the damage that has been done to these landscape through intensive sheep grazing. Management introduces traditional native breeds of cattle into the grazing regime.

Management also includes a 200ha area of rewilding involving grip blocking to restore bogs and the exclusion of grazing animals (erection of boundary) to allow natural regeneration. Some very limited tree planting as a seed source is likely to take place and there is consideration of cattle grazing.

The remainder of the site is being managed as before, and in this area (628ha) the counterfactual and policy scenarios are not different.

Step 3: Identify impacts on ecosystem services

The habitat impacts vary across the area as summarised in Table 30. The ecosystem service impacts of these changes are generally difficult to pin down with existing data: our best estimates of these changes are described in Table 31.

Table 30 Ingleborough: Habitat changes from counterfactual scenario to policy scenario

Habitat type	Area	Quality	Changes under project	Timing
Limestone pavement	186ha	Impacted by past overgrazing and grazing mix (sheep).	Semi natural higher diversity limestone pavement. Favourable	Ongoing management changes required.
Blanket bog, peatland, mosses, cotton grass, heather, montane heath	200ha	Managed landscape with dominant sheep grazing.	Rewilded habitat (target bird species: short eared owl, red grouse and black grouse.) Semi-natural landscape with more favourable attributes	Unknown: natural revegetation being allowed, so some change within a year, but decades before woodland naturally regenerates.
Upland Grassland	628ha	Somewhat degraded due to overgrazing	No changes: no improvement, and possible further degradation, but identical to the counterfactual (except for any possible spillover impacts from adjacent areas that we are not able to assess).	Current and ongoing.

Table 31 Ingleborough: Changes in quality and extent of services

Characteristic/ service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food and fibre	All	Changed grazing regime on limestone landscapes; fencing off areas for rewilding. Some potential for timber in long run.	Unclear, depends on relative prices between cattle and sheep, a management plan for marketing may mean long term increases. Fencing of areas for rewilding short and long term losses.	Value of produce (see below).
Renewable energy provision	Not considered in this case study.			
Water quality to downstream catchments	Blanket bog	Grip Blocking – reduced DOC	Expected improvements; but monitoring activity limited, small site and good baseline levels.	
Costs associated with downstream flood risk	Blanket bog, woodland	Increased water retention	Possible reduced flood risk, mainly from South House Moor, further investigation of water retention required, but likely to be minor.	
Use and enjoyment: outdoor recreation	All sites	Shift to more diverse “natural” systems. Possible value of seeing native cattle	Visual improvement, sight of cattle, more "natural" area, improved biodiversity.	Visitor usage; potentially travel cost or stated preference
Use and enjoyment: field sports	Not considered in this case study – no field sports present, or likely to be.			
Non-use values from historic and cultural landscapes	Limestone Pavements, Common lands, Blanket bog	Habitat condition, native cattle	Improvements in condition; introduction of cattle.	Potentially stated preference
Greenhouse gas emissions	Blanket bog	Rewetting, revegetation	Reduced carbon emissions. Increased methane. Possible differences between sheep and cattle.	Measurement
Biodiversity and wildlife	Limestone pavement and rewilded habitats	Habitat condition, revegetation	Increased biodiversity / improved habitat and species conservation status. There appear to be some positive impacts to biodiversity from changed grazing regimes but the time scale between the baseline and secondary analysis of biodiversity impacts was too short to identify significant impacts (LIFE final report)	

The wider limestone project contracted Askham Bryan Agricultural College to determine the economic impact of the project on the farm businesses of the agreement holders.

The main findings of this research reported in the LIFE final report were that:

- 60-80% of farm incomes consisted of subsidies and environmental grants.
- Substituting Limestone Country Project cattle for sheep had a positive impact on the farm business and was a profitable enterprise.
- It was only profitable, however, if premium prices (above the mainstream market) were achieved for the beef produced.
- It was only profitable if the capital costs of cattle purchase and related infrastructure changes were supported (as in the Limestone Country Project) otherwise income levels were not high enough to repay this initial investment.

Therefore for the purposes of valuation of the food service alone, a relatively low economic value from the project is expected, given access to the full research by Askham Bryan a fuller analysis would be possible and this should be conducted when this data becomes available.

Newcastle University also analysed the results of grazing changes in terms of the impact on biodiversity between 2003 and 2006, stating that this “showed that the diversity of plant species that are most typical of calcareous habitats (known as indicator species) were higher in calcareous grassland and limestone pavement grazed by cattle rather than sheep and that in the case of limestone pavement overall species richness was nearly as high as ungrazed limestone pavement. However, many of the results were ambiguous as the period between sampling was too small and further repeat monitoring should be considered in 2010 and beyond in order to determine long-term changes.” (LIFE Final Report, 2009).

Step 4: Identify human populations affected

The NNR itself is unpopulated, but is heavily used for tourism, and is a unique landscape with national and even international value.

Table 32 Ingleborough: Populations affected

Service	**Type of population**	**Number**	**Characteristics**
Food and fibre	Graziers	1	Farm level management plans to encourage altered grazing regimes.
	Consumers		Marketing of products through local markets
Water quality to downstream catchments	Utilities, customers, recreational users	Further investigation required, but water quality not thought a major issue in this study.	
Costs associated with downstream flood risk	Environment Agency Householders	EA flood risk maps suggest limited risk to downstream housing; some agricultural land may be impacted.	
Use and enjoyment: outdoor recreation	Walkers	100,000 per year	tourists to the NNR[20]
Use and enjoyment: field sports	Not considered		
Non-use values from historic and cultural landscapes	Interest groups General population	≈ 1 million (N. Yorks) ≈ 5 million (Yorks.+Humber.) ≈50/60 m (England/UK)	Nationally important landscape.
Greenhouse gas emissions	Problem of global interest. Sequestration can contribute to UK targets. Could have financial value to landowner in long run (if payments for carbon sequestration introduced).		
Biodiversity and wildlife	Interest groups General population	Potential national importance of habitats	

Step 5: Economic valuation of ecosystem service changes

Table 33 details the economic valuation of changes in each service category. We have assumed that the changes take place gradually over years 2 to 20 of the project, with the exception of the food service, which is assumed to change from the start (when cattle are introduced). The timing assumptions are varied in the sensitivity analysis, below.

[20] http://www.natura.org/sites_uk_ingleborough.html

Table 33 Ingleborough: Economic valuation of ecosystem service changes

Service	**Valuation method(s)**	**Values (unit, functions, range, totals)**	**Notes**
Food and fibre	Market values	Present value £70,000 over 50 years, £83,000 over 100 years, but true value likely close to 0 after costs.	Values from FMHB and grazing densities reported in LIFE report. 0.14/ha cattle, 0.5/ha sheep. Only marginally profitable. NPV close to zero: sheep grazing was economically marginal, cattle grazing is not profitable unless initial costs supported. Generally farming dependent on subsidy Returns depend on grazing mix and relative prices. Local market prices as part of marketing strategy need to be investigated.
Renewable energy provision	Not considered in either scenario.		
Water quality to downstream catchments	Change in treatment costs	≈0	Little or no impact anticipated
Costs associated with downstream flood risk	Change in expected flood costs	≈0	Little or no impact anticipated
Use and enjoyment: outdoor recreation	SP, TC, meta-analysis and BT. Tinch 2009 Kaval 2006 Christie et al (2000) Bateman et al (1993)	"Total" value studies times ≈5% improvement in experience ≈ £2 -£4 per trip. "change" studies suggest ≈£2-£8 per trip. 100,000 visits per year, ≈£200,000 to £800,000 per year. Does not consider possible increases in visits. Only part of site impacted. Take £200,000 estimate for main case.	Tinch: £8/visit for less intensive management. Derived for Peak District, landscape value, may include non-use and biodiversity. Christie et al: £2-£5 for specific facility (but not "quality of experience") improvements in Grampian region. Kaval: meta-analysis, £40 (mean) to £90 (national parks) per trips. Bateman et al (1993) £35 mean WTP for visit to Yorks Dales Unique nature of landscape suggests primary valuation survey.
Use and enjoyment: field sports	Not considered: neither present nor likely.		

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Non-use values from historic and cultural landscapes	Stated preference: eftec (2006); White and Lovett (1999)	Considering 1% of Y+H value from eftec (2006) suggests very roughly £200,000 per year. Considering £3.75 for households in North Yorks suggests £1.5m, but that includes recreation, so estimate £1m for non-use. Possible higher values from national-level WTP. These are speculative values and the unique nature of the site suggests that primary study would be necessary.	eftec (2006) change from "rapid decline" to "better conservation" for Yorks and Humber: £12 (£8.50-£15.50) per hh. From "rapid decline" to "no change": £3 (£0-£6.50). In this case study decline in counterfactual would be gradual or no change, rather than rapid: rough assumption of £10 per hh. Ingleborough area is approx 1% of the SDA in Y+H, but only 1/3 of area impacted, however value is not directly proportional to area: this area is much higher conservation value than average area in the SDA. White and Lovett estimate £3.75 per year to maintain or enhance Levisham Estate in the North York Moors. Relevant population uncertain.
Greenhouse gas emissions	DECC values	≈0	Little overall impact anticipated
Biodiversity and wildlife	Stated preference	Omitted to avoid double counting	Risk of double counting with recreational and cultural values.

The site had a relatively good existing quality, although there were some issues with overgrazing by sheep. The two specific management activities are ongoing on the site with the intention of managing the landscape in a less intensive way for biodiversity. The major uncertainty in valuing this landscape, and more specifically the impact of changes to it, is the unique landscapes involved, suggesting that some primary analysis may be required. However, values for a generally lower intensity management in upland landscapes can be applied and give some measure of the value associated with management changes.

The unique nature of the landscapes involved means that transfer of values from other sites is complicated. Results above are based on relatively general values in order to give indicative orders of magnitude for valuation, but location specific data would significantly improve results. From the available literature information about the site it is anticipated that there will be limited impact on a range of services; water quality, flood events, renewable energy, field sports and GHG regulation. For example whilst drainage blocking is being carried out within the NNR, to improve the quality of blanket bogs, no impact for GHGs is identified. There is uncertainty about the function of blanket bog in climate change as whilst carbon is laid down and stored methane and NOx are lost to the atmosphere and are many times more potent GHGs than carbon dioxide . Environment Agency flood risk data suggests that downstream areas at risk have limited habitation and water quality from the site, as identified by indicator species, is good. However, some further investigation of these issues may be warranted to confirm these assumptions.

Step 6: Calculation of discounted costs and benefits

The separate spreadsheet shows the calculations of net present values based on observed changes, unit values, and discount rates. Values have been calculated over 50 years and 100 years.

Table 34 Ingleborough: Economic valuation of service changes

Service	Present value (50 years)	Present value (100 years)	Notes
Food and fibre	£69,000	£83,000	But accounting for the costs, likely to be close to zero.
Renewables	Not assessed.		
Water quality to downstream catchments	≈0	≈0	Assumption that marginal change in quality will not impact on treatment costs.
Downstream flood risk	≈0	≈0	Assumption that little or no impact (but see sensitivity)
Use and enjoyment: outdoor recreation	£3 million	£4 million	Very approximate figures, low confidence
Use and enjoyment: field sports	Not assessed		
Non-use values from historic and cultural landscapes	£3 million	£4 million	Order of magnitude estimate at best – very low confidence
GHG regulation	≈0	≈0	Assumed negligible, but low confidence
Biodiversity and wildlife	Omitted in absence of suitable studies, and to avoid double-counting with non-use or recreation categories.		
Totals	£6 million	£8 million	Ballpark figures

Because of the uncertainties underlying the unit values, the figures presented above can be considered only as ballpark estimates.

Step 7: Sensitivity analysis

The key uncertainties in this study are the unit values for recreation and non-use values, and the populations holding non-use values.

Food: the values presented above are based on assumptions about changed grazing regimes and returns. In fact these may overstate the values, because set-up costs are not considered, and the estimates depend on a premium price for the product. In any event, any conceivable values under food are going to be trivial for this area, in the context of the much larger recreation and non-use categories.

Recreational use: we have data for visits to the reserve, and although no valuation studies have been identified as ideal for benefits transfer, nevertheless we could make a reasonable estimate of the total value of recreation an Ingleborough. What is especially difficult, however, is estimating the extent of the *change* in recreation value between the counterfactual and policy cases. We are confident that this value is positive, with higher values for a more attractive landscape and less intensive management, however attempts to put a figure on this, whether directly through benefits transfer from other studies looking at recreation values of management changes, or from guesstimated proportions of total value, are somewhat speculative. With the higher range of values from Tinch (2009), total values of £800,000 per year could be justified, with a present value over 100 years of £20 million; though such values would likely include a fair component of non-use value. If the actual value of improved recreation experience were much more modest, around 50p per visit, present values would fall to £500,000 over 100 years; this is still an order of magnitude greater than any likely food values.

Non-use and cultural heritage values: these are highly uncertain, partly because of the unique nature of the area, and because the condition in the counterfactual was not one of sharp decline The main uncertainty is the relevant population holding non-use values for such a special area. The central case values have been estimated based on a general return to more traditional farming practices across the region, but this does not do justice to the particular nature of Ingleborough and that £200,000 estimate may be considered conservative. An estimate based on WTP for conservation of a specific estate (White et al 1999) could justify much higher values, however these would include a use/recreation element. Correcting for this, an upper value of up to £1m could be feasible, for households in North Yorkshire. Alternatively, we might consider a small value for some proportion of households in England. More work is required on the population holding non-use values for this area, and the extent of these values.

Timing of impacts: the present values are clearly highly sensitive to the timing of impacts. Some changes (introduction of cattle, grip blocking) occur very early, but the longer-run ecological impacts of this will take time to work through. The main calculations here have assumed impacts are phased in from years 2 to 20 of the project. This is speculative, and should be kept in mind when considering present value estimates – though here we have been more concerned with rough estimates of the annual benefits of a fully-implemented project.

Step 8: Accounting for non-monetised impacts

Several categories of value / service have not been included in our calculations. In particular:

GHG regulation: no value has been placed on changes in carbon storage or emissions from the project, because the net impact of carbon sequestration and methane/NOx emissions are not known. Further research into these services may be warranted, although we expect that the net monetary values would be modest in comparison to other categories.

Renewable energy: we have not considered this possible source of value. There is undoubtedly potential for renewable energy investments in the area, but this is extremely unlikely given the NNR designation; we do not think the project results in any change in potential renewable energy values.

Biodiversity: impacts certainly exist, but have not been valued directly. This is partly because of the difficulty of doing so (site specific impacts and lack of valuation studies), and partly because of the risk of double-counting with the non-use values estimated for cultural heritage and landscape and with recreation values. Nevertheless there could be additional values here and they might be significant.

Field sports: we have not given any value to changes in field sports, as there are none at present and there is no realistic prospect of field sports here in the future.

Flood risks: there could be reduced risks of flash flooding in downstream areas, due in particular to increased water retention in bog areas following grip blocking. However our assessment of flood risk maps suggests that no major changes should be expected. This is not an expert judgement, and the question may warrant further assessment.

Climate change: we have not taken account of the possible impacts of climate change on the area and the ecosystem goods and services it provides. There will undoubtedly be impacts, but their precise nature is difficult to assess.

Step 9: Reporting

The values for the changed management at this site are mainly in recreational use and non-use and cultural heritage services. There are major problems related to identification of suitable studies for benefits transfer in the context of small changes in the quality of a very important site. Identification of relevant populations for non-use values is also challenging. The values presented here must be considered as ballpark indicators of possible values of ecosystem service changes for Ingleborough. They indicate possible orders of magnitude for the values, demonstrating that non-use and recreation values are likely to dominate.

To go further would require primary study, which should attempt to untangle non-use, recreation and biodiversity values, and should address issues of distance decay and identification of human populations affected. A separate study on the specific water/peat impacts of no grazing at South House Moor would also be valuable, since this situation remains very rare at present in the North Pennines.

4.3 X-Dale

This case study has been anonymised for data confidentiality reasons, and is not in fact based on any single case but on key features of more than one. It is presented as an illustration of valuation techniques applied in a situation in which the distinction between the counterfactual and management option scenarios, in ecosystem service terms, is a rather long-term process with few immediately apparent differences in the short run.

Location: North East England

Area: approximately 4000 ha

Characteristics: The land is mostly upland heath: around 2000ha wet heath and 1400ha dry heath. There are 150ha of eroded dry heath, largely as a result of a fire. There are around 300ha of bracken, and small areas of blanket bog, flushes and mires. The land is owned by a large estate and is managed for grouse shooting. In addition, there are around 200 local commoners with grazing rights attached to their properties, however fewer than 20 currently use these rights – primarily for sheep, and a few horses. The land is also heavily used for walking / general recreation purposes, and there is a car park and visitor facilities near a high-point in the landscape renowned for clear views over the surrounding moors and river valley.

Designations: The entire site falls within the North York Moors (SSSI/SPA/SAC and National Park).

Ownership: Local estate.

Management: Local estate, commoners, Natural England, National Park Authority.

Stakeholders: the main stakeholders include the landowner (shooting estate), the local populations (commoners), Natural England (conservation interests), National Park Authority, grouse shooters, and recreational visitors to the area.

Data sources: there are good data on habitat types and costs of management options, but few data on ecosystem services now or under future scenarios.

Management options: The pattern of grazing and burning has been ongoing since before the industrial revolution and has shaped the landscape. Deteriorating economic conditions for sheep farming have led to a steady decline in stocking levels and the whole area is at risk of under-grazing. The landowner's reaction to this is uncertain: the estate would likely preserve shooting interests either by more frequent burning, or by introducing its own flock of sheep. The former option in particular would be very damaging to habitats and biodiversity. The alternative is for Natural England to steer a management agreement with the landowner and the commoners, aiming for a controlled, ongoing level of grazing and less frequent burning.

Ecosystem services: the key ecosystem services provided by the area at present are recreation, field sports, historic and cultural values (traditional land use practices, landscape, and access rights), and biodiversity values, and food. There are also impacts on greenhouse gas regulation. The area also has an impact on water supply to a length of a river used for angling, though not for domestic or industrial abstraction, and could have an impact on flood risk along this river; but none of the scenarios under consideration involve significant water quality or flood risks associated with the area. There are no plans at present to use the area for renewable energy provision: this would be possible but might conflict with other values, in particular recreation and cultural heritage values.

Step 1: Defining the Baseline/Counterfactual

This case study aims to assess the main management option of Natural England entering an agreement with commoners/grazers and the landowner to ensure controlled ongoing grazing and limited burning in the area.

Defining a counterfactual for this option is difficult, however, because although we can be reasonably confident that commercial grazing would gradually die out without external support, we cannot be sure about how long this would take, nor about how the landowner would respond. There are three main possibilities for the landowner:

1. accept loss of grazing, and compensate by increasing burning to maintain grouse productivity;
2. compensate by creating own grazing flock, and
3. abandon management – but this is not thought realistic, both because the grouse shooting is quite valuable, and because it is a traditional activity valued by the owners over and above the economic returns.

In the abandonment scenario, the area would "scrub up", gradually moving towards scrubbier vegetation, with increased bracken encroachment round the periphery, and ultimately tending towards scrubby mixed woodland over a rather long period. But in the more realistic scenarios (1) or (2) above (or most likely, some intermediate combination of them) this path would not be taken. There would likely be some gradual bracken encroachment onto the moor, and quite regular burning, as the least cost approach to maximising grouse returns. The main difference from the envisaged management intervention would be less control over burning and grazing numbers – probably more burning, less grazing, and less attention to important habitat and biodiversity interests. There would also be a loss of cultural heritage from cessation of commoner grazing / livestock flocks.

Despite the uncertainties, for the purposes of argument we need to specify some assumptions about the counterfactual scenario. We assume that all current grazers would cease activities within a few years and that the landowner would buy up some of the stock and maintain a flock of around 500 animals (we will not consider nuances about hefting[21] but note that this is potentially important and defer discussion of the topic to Step 8 below). We assume that burning is more frequent,

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[21] Hefting is the process of training a flock of sheep to recognise the area within which its owners wish it to remain; a “hefted flock” is one so trained.

more widespread and less controlled in the counterfactual than in the management option scenario: every 5 years instead of every 15 years. We assume that bracken treatment would be less rigorous than in the policy scenario, so that some bracken encroachment is to be expected (see Table 35).

Table 35 X-Dale: Characterising the Counterfactual

Characteristic/service	**Pre-project status**	**Counterfactual (future expectations without project)**	**Notes**
Descriptive statistics			
Area	4000ha		
Populations	zero in area; approximately 200 households around edge	No major change	
Human Activities	Grouse shooting Grazing sheep Walking/viewing	Much less grazing Maintained shooting Similar recreation	Ongoing reduction in uptake of grazing rights. Recreation ongoing but perhaps less valuable due to poorer quality experience (fewer sheep to see, less varied landscape), perhaps declining numbers.
Management	Complex traditional system of grazing rights with many participants	Managed by single landowner, primarily for grouse	
Habitats	Mixed, but most habitats in "unfavourable no change" condition	Gradual shift towards "unfavourable declining"	Result of reduced grazing and more frequent burning.
Wet heath	2000ha	1900ha	small loss to bracken
Dry heath	1400ha	1100ha	loss to eroded dry heath and to bracken.
Eroded dry heath	150ha	350ha	Rough assumption of further fire damage, without restoration.
Bracken	300ha	500ha	Gradual encroachment
Blanket bog	50ha	50ha-degraded	Damaged by fire.
Flushes/mires	100ha	100ha-degraded	Damaged by fire
Ecosystem services		General decline	
Food and fibre	Sheep grazing (grouse considered below)	Greatly reduced sheep numbers	Grazing not economic, assume landowner prefers burning to grazing
Renewable energy provision	None	None	No plans for this, and would not be ruled out by scheme: not a focus for assessment.
Water quality to downstream catchments	Yes.	No change, or perhaps slight decline	Not an important concern in this case.
Costs associated with downstream flood risk	Yes.	No change, or slight increase in risk.	Not an important concern in this case.

Characteristic/service	Pre-project status	Counterfactual (future expectations without project)	Notes
Use and enjoyment: outdoor recreation	Heavily used, scenic area.	Similar use levels but perhaps lower value.	Reduced landscape diversity, loss of livestock
Use and enjoyment: field sports	Grouse shooting important.	Ongoing at similar level.	
Non-use values from historic and cultural landscapes	Generally high quality area; some parts of particular importance.	Reduced through loss of traditional management system, loss of grazing flocks.	Also archaeological interests potentially at risk.
Greenhouse gas emissions	Uncertain	Probably more emissions	Difficult to be sure on this. Likely that wet heath over peat soils could be sink for carbon, but that regular burning would prevent this. Also emissions associated with eroding dry heath.
Biodiversity and wildlife	Yes: internationally important bird assemblage and mire and heather moorland communities	Likely declines due to increased burning including burning on/near sensitive habitats.	Again hard to be sure, but we assume that burning carried out differently in the scenarios.

Step 2: Identify management options

The land management under assessment is the creation of a Partnership Agreement drawing together the landowner, commoners (grazers) and Natural England to ensure a number of outcomes:

- Maintain and improve the moor as a driven grouse moor;
- Maintain the condition of the moor to provide good quality moorland grazing for a sustainable number of sheep;
- Sustain economically viable livestock and grouse moor businesses (where "viable" may imply "with subsidy"); and
- Preserve and enhance landscape character, the natural and historic environments and the economic wellbeing of the people living and working in the area.

Step 3: Identify impacts on ecosystem services

We have very little data on which to base assumptions about how the scenarios differ, in particular as regards the timing of these changes. The assumptions made about habitat areas and timing are summarised in Table 36 below, and the assumed impacts on ecosystem services in Table 37.

Table 36 X-Dale: Assumed habitat changes from the counterfactual to management option scenario

Habitat type	Initial Area	Counterfactual	Policy scenario	Timing
Wet heath	2000ha	1900ha	2000ha, better condition	For all these changes, very difficult to be precise about the timing. The policy scenario will lead to gradual improvements over the mid-term (10 years plus) while the counterfactual scenario involves gradual deterioration over the mid- to long-term. For the purposes of assessment, we might assume that the scenarios diverge gradually and increasingly over the next 50 years – but this is very rough, for the purposes of argument only.
Dry heath	1400ha	1100ha	1550 ha, better condition	
Eroded dry heath	150ha	350ha	0 ha – restoration	
Bracken	300ha	500ha	300ha	
Blanket bog	50ha	degraded	50ha, favourable	
Flushes/mires	100ha	degraded	100ha, favourable	

Table 37 X-Dale: Assumed changes in quality and extent of ecosystem services with the management option

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food and fibre	All	More grazing – not more than in past, but more than in counterfactual	Sheep production maintained, but the economic value of this alone is negative, because the activity is loss-making without subsidy	2000 adult sheep equivalents instead of 500.
Renewable energy provision	Not relevant to this case study: potentially renewable energy could feature in the area, and this could be considered separately.			
Water quality to downstream catchments	All	May avoid some minor risks or deterioration	Improved quality possible due to reduction in eroded heath area HOWEVER this not thought significant in this area.	Not significant.
Costs associated with downstream flood risk	All	May avoid some minor risks or deterioration	Reduced risk of flash flooding however not thought significant.	Not significant.
Use and enjoyment: outdoor recreation	All: open landscapes and activities	Improved habitat condition, maintained grazing levels, less frequent burning.	Landscape remains open, more wildlife/birdlife, sheep present.	Estimate changes in visitation rates and values per visit.

Service	**Key habitats**	**Key changes**	**Qualitative impact**	**Quantitative impact**
Use and enjoyment: field sports	Upland heath	Less frequent burning, maintained grazing.	Most likely that changes will maintain or perhaps improve grouse production, despite reduced burning, as habitats generally will be in better condition. More attractive landscape in which to shoot.	Probably small difference.
Non-use values from historic and cultural landscapes	All	Less frequent burning, maintained grazing, improved habitat.	Favourable habitat status instead of move towards unfavourable declining. Traditional management / grazing maintained. Archaeology protected.	Estimate willingness to pay for such improvements.
Greenhouse gas emissions	Blanket bogs, wet heaths, eroded heaths.	Improved bog and heath condition; reduction in eroded heath.	Main impact will be through restoration of eroded heath and prevention of erosion elsewhere	Precise details need measurement and calculation; rough estimates possible
Biodiversity and wildlife	All	Improvement in habitat condition	Higher populations of key plant and animal species (than in counterfactual)	Requires monitoring of populations

Step 4: Identify human populations affected

Information and assumptions about populations affected by service changes are summarised in Table 38.

Table 38 X-Dale: Populations affected

Service	Type of population	Number	Characteristics
Food and fibre	Grazers	≈12	Production in this area is not significant enough to have national-level impacts on food markets. Local impacts on livelihoods of grazers.
Renewable energy provision	Although renewable energy is a possibility in the area it is not a key feature of either the counterfactual or the policy scenario. Could be assessed separately.		
Water quality to downstream catchments	Anglers (salmon and other)	Unknown	Expected to be only negligible differences in this service.
Costs associated with downstream flood risk	Environment Agency, householders, farmers.	Few households at risk from flooding. Some risks to agriculture.	Expected to be only negligible differences in this service.
Use and enjoyment: outdoor recreation	Day visitors and holiday makers	North York moors attracts 10 million *visit days* per year. Visitor centre approximately 120,000 visits per year.	Primarily from surrounding urban areas, but significant minority from further. Walking/sightseeing most common use. Not all will go to visitor centre: assume approx. 200,000 visits to the area each year.
Use and enjoyment: field sports	Grouse shooters	Unknown number of individuals (some data on values, see below)	Best considered as part of the national stock of shooting areas.
Non-use values from historic and cultural landscapes	Interest groups General population	≈ 1 million (N. Yorks) ≈ 5 million (Y+H) Friends of North York Moors (≈800 members)	Some important designated areas, likely to be salient at least to regional population, and potentially to national population.
GHGs	Problem of global interest. Sequestration potential contribution to UK response. May even have financial value to landowner in long run.		
Biodiversity and wildlife	Interest groups General population	≈ 1 million (N. Yorks) ≈ 5 million (Y+H) Friends of North York Moors (≈800 members)	Key conservation interests likely to be salient to local and national interest groups, and perhaps to general population at local, regional and potentially national levels.

Step 5: Economic valuation of ecosystem service changes

Although some valuation evidence is available for all the service categories considered, use of this evidence depends on having data on the likely service changes. As discussed above, the information on service changes is quite vague, and so any valuation will be similarly approximate. Bearing this in mind, Table 39 summarises the assumptions and calculations required to derive some rough estimates of service change values.

For the value (cost) associated with grazing, note that it does not matter, from an economic efficiency perspective, who pays for something. In this case study, the taxpayer bears the full cost in the policy scenario while the residual cost falls on the landowner in the counterfactual case. Such distributional issues are of course of interest from an equity (fairness) perspective, but are not relevant to the raw calculation of costs and benefits in a cost benefit analysis (CBA) framework. In particular, it is important not to consider such subsidies as direct costs of a project in a CBA. But they can sometimes be used as (very rough) proxies for the economic costs for which they compensate, as explained below.

In a cost-benefit analysis (unlike a financial or cash-flow analysis) it is not directly relevant that Natural England pays £x million to a group of grazers: that is a welfare-neutral transfer payment that does not in itself increase or decrease economic welfare. What is relevant is that this payment is linked to grazers agreeing to carry out an activity, and that activity does have effects that influence economic welfare. The grazing makes an economic loss (that's why the subsidy is required) and it is this loss that should be recorded in the CBA. But since the subsidy is worked out via calculations of the grazing loss, it can be used as a proxy for the loss. In fact we are making a short-cut here: we could include just the value of the sheep under "food and fibre" and account for the costs of sheep management elsewhere, however the method adopted is simpler, and also reflects more clearly the non-economic nature of the grazing.

One additional consideration is the impact of grazing on the grouse moor productivity and/or management costs. For the counterfactual scenario, we are assuming that the landowner would graze a small flock of sheep. Since this would be loss-making, the implication is that the benefits in terms of maintaining the grouse moor, or reducing the costs of burning or cutting, would justify this loss (estimated at around £15,000 per year). This does not matter directly since it balances out for the two scenarios (that is we only need to assess cost for the *additional* sheep in the policy scenario), however we must assume that these additional sheep do bring some additional benefit for the grouse moor – roughly speaking, we need to assume that the landowner would set the marginal benefit of grazing about equal to the marginal cost, which we assume is about £30 per head. We have no hard data on which to base this, but make an ad hoc assumption that this additional saving is worth about £10,000 per year.

Table 39 X-Dale: Economic valuation of ecosystem service changes

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Food and fibre	Market: sheep	Loss ≈ £30/head.yr Total excess loss ≈1500*30 ≈£45000 /yr ≈£35000/yr after ad hoc adjustment	The sheep have value, but this is less than the costs of maintaining the activity. The value of sheep is taken into account in calculating the proposed payment to grazers, and we can estimate the economic loss from grazing using these calculations and the additional number of sheep in policy scenario (2000-500=1500). But we also need an ad hoc adjustment for benefits to the grouse moor (productivity or reduced costs).
Renewables	Not valued: assumed zero difference between scenarios considered.		
Water quality	Not valued: assumed little or no difference between scenarios. Possible minor impact on downstream angling, but very uncertain.		
Flood risk	Not valued: assumed little or no difference between scenarios.		
Use and enjoyment: outdoor recreation	Stated preference or travel cost; meta-analysis. Christie 2000, Kaval 2006, Hynes and others 2007	Assume 200,000 visits per year; assume £20/visit; assume 5% difference between scenarios: gives very rough estimate of £200,000/yr	Bateman and others (1993): mean visitor WTP for Yorkshire *Dales* (not Moors) £34.70 Liston-Heyes and Heyes (1999) around £15 for visits to Dartmoor National Park Kaval (2006) £41/day on average, but £87/day for national parks Hynes and others (2007) £26 /trip for farm commonage site in Ireland (but coastal). No single ideal study for BT, however general order of magnitude estimate of £20 per visit is reasonable. We will assume that the difference in service (more visits or greater quality of visits) in the policy scenario, compared with counterfactual, is approximately 5%. See also sensitivity analysis.
Use and enjoyment: field sports	Market values; SP/TC	≈£150/brace; ≈£350,000 per year total value	Probably minor difference between scenarios. However quite uncertain, so to be considered in sensitivity analysis. Possible difference in value of shooting associated with improved aesthetic quality.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Non-use values from historic and cultural landscapes	Stated preference: eftec 2006; White and Lovett (1999)	Main case estimate £220,000/yr: eftec (2006), 10p per hh in region. High estimate £1.3 million, White and Lovett (1999), £3.75/hh across county, reduced to account for recreation value.	eftec (2006) change from "rapid decline" to "better conservation" for Yorks and Humber: £12 (£8.50-£15.50) per hh. From "rapid decline" to "no change": £3 (£0-£6.50) per hh. In this case study decline in counterfactual would be gradual rather than rapid: rough assumption of £10 per hh. X-Dale area is approx 1% of the SDA in Y+H; c.2.2m hh in Y+H. Simple multiplication gives ≈ £220,000 per year, however value is not directly proportional to area: this designated area is of higher conservation value than average area in the SDA. White and Lovett estimate £3.75 per year to maintain or enhance Levisham Estate in the North York Moors – this is smaller, but more varied, than X-Dale. However this value likely to contain some recreation value (not just non-use). Relevant population uncertain.
Greenhouse gas emissions	Official carbon values DECC 2008	Not included in central estimates; sensitivity analysis	Service uncertain. There is likely to be carbon loss associated with eroded heath, which will be avoided in the policy scenario. Total amounts uncertain, and not clear what proportion ends in atmosphere. Other gases (notably methane) may also be important.
Biodiversity and wildlife	Stated preference		Various options however (a) difficult to be precise about improvements expected and (b) serious risk of double counting with "non-use" category above. Conservative approach to assume non-use values of biodiversity included in that.

Step 6: Calculation of discounted costs and benefits

Table 40 below summarises the present values of impacts; the separate spreadsheet shows the calculations of net present values based on observed changes, unit values, and discount rates. Values have been calculated over 50 years and over 100 years.

The central estimate scenario assumes that impacts start to be experienced in year 5 and full impacts are felt by year 40; this corresponds to the assumptions that current grazers give up quite quickly in the absence of an agreement, and that the "steady states" of the competing scenarios are achieved over 40 years. These are very rough assumptions that are tested further in the sensitivity analysis.

The costs are estimated from information on payments to be made for management activities, and general costs of management. The costs associated with headage payments are not included, as these are already counted under "food" (see above). The residual costs come to approximately £28 per hectare. As discussed previously, the fact that Natural England will be making these payments is not itself relevant:

they are included as a proxy for the real costs of activities to be carried out in the area. It is worth noting that the cost figures may be overestimates for two reasons: we have assumed they must be incurred each year throughout the appraisal period, and we have not made any allowance for any additional costs of management that would have to be incurred (by the shooting estate) under the counterfactual scenario.

Table 40 X-Dale: Economic value of ecosystem service changes from the counterfactual to management option scenario

Service	Present value (50 years)	Present value (100 years)	Notes
Food	-£860,000	-£1,000,000	This is the value after costs
Fibre			value of wool negligible
Renewables			area could be used for renewables but not considered in these scenarios
Water quality			negligible or small positive
Flood risk			negligible or small positive
Recreation	£1,900,000	£2,900,000	based on small increase in value for large number of visits per year
Field sports			probable small positive impact
Non-use: historic and cultural	£2,100,000	£3,200,000	based on small willingness to pay per household among population of region. Some double-counting risk with recreation
GHGs			uncertain – probably small positive
Biodiversity /wildlife			No suitable / reliable values available for transfer, but probably partly included in recreation and non-use categories.
Total service changes	**£3,100,000**	**£5,100,000**	sum of above figures
Costs	£2,700,000	£3,300,000	not including headage payments that are included in "food" category
Net present value	**£340,000**	**£1,800,000**	very approximate estimates

The above estimates need to be treated with caution, given all the assumptions and simplifications that underlie them. The estimates suggest that the scheme is marginal (in cost-benefit terms) over the shorter time horizon, but moves into steady profit beyond that. This is as we would expect, given the assumption that the benefits of the scheme accrue slowly as the scenarios diverge over the first 50 years. The next section considers the sensitivity of this result to changes in the main assumptions and uncertainties.

Step 7: Sensitivity analysis

Timing of impacts: there is significant uncertainty about the time required before the main impacts are fully experienced. The main case assumes first impacts in 5 years, and full impacts after 40 years, phased in a linear fashion. If instead the impacts are phased in over 70 years, the net present values become negative. In effect, this scheme involves spending money now to prevent negative impacts which may occur after many years: in the long-run, ignoring discounting, benefits significantly exceed costs, but with discounting, the delay is critical in determining the NPV of the project.

Further work to establish better the period over which benefits are "phased in", and the functional form, would be very useful to establish better the NPV.

Costs: if the actual costs of the scheme are higher than expected, by up to 50%, the main-case net present value remains positive over the 100 year horizon. Again, only the administrative and management costs are considered – the subsidy to farmers is a transfer payment (from taxpayer to farmer) which is not a real economic cost. The economic cost of food production is considered under the food service heading.

Food: the losses associated with sheep production could be slightly higher or lower than the estimates in the main case. But, although these costs are significant overall (main case PV of £1m loss over 100 years) they are rather lower than the administrative costs, and overall the food losses are not a key sensitivity for the appraisal.

Recreation: because of the high number of visitors, and the uncertainty about the change in value per visit, recreation values are rather uncertain and the NPV is very sensitive to this. While the central case involves a £2m-£3m (over 50 and 100 years) benefit, the use of the lower range recreation estimate could cut this to £0.5m - £0.7m and that is sufficient to drive the whole NPV into the negative. The central case valuation equates to just £1 extra value per visit (at maximum, once the project takes full effect) and so it seems reasonable to think the lower range of values is rather less likely. However the uncertainty highlights the importance of recreation values to the overall assessment, and the need for further research in the field of assessing the recreational values of landscape improvements.

Non-use values: this category is even more uncertain. The main case estimate is based on a study of values for conservation of traditional landscapes and practices in SDAs in the region, and so is well-suited to benefits transfer. While it seems likely that this estimate is reasonably conservative, much higher values could potentially be justified – based on higher WTP from populations near the area, and on small but non-zero WTP from populations at the national level. Such values are highly uncertain, but could potentially swamp other values and make the scheme indisputably beneficial. On the other hand, at the more modest rates considered in the main case, there is a sensitivity to double-counting – if the non-use figures used in fact contain a significant proportion of the recreation value, then the NPV could fall into the negative. This is thought to be unlikely – the non-use value is based on a few pence per household across the region, while the recreation value is based on a larger value and visit numbers – but more work is required on the population holding non-use values for this area, the extent of these values, and the separation of non-use and recreation categories.

Summary: Overall, the above discussion of sensitivities, and calculations presented in the spreadsheet, suggest that the results are particularly driven by the rather uncertain non-use and recreation categories. Although on balance it seems more likely that the NPV is positive than not, and value estimates are kept conservative, there are feasible scenarios under which the NPV of the project is negative. Key sensitivities here are the timing of impacts, recreation values, and non-use values and populations.

Step 8: Accounting for non-monetised impacts

Several categories of value / service have not been included in our calculations. The following ecosystem services are not included in the monetary analysis:

Water quality and flood risk: we have not assessed water quality or flood risk values. These are not thought to differ greatly between scenarios, but any likely impacts would be beneficial.

Fibre: the value of wool is thought to be negligible, but will be reflected in the loss estimates for the "food" service. There are no plans to use the area for timber production under either scenario considered, though it would potentially be possible.

Renewable energy: this is not considered under either of the scenarios assessed here, though again the area could be used for renewable energy production.

GHG regulation: the impacts on GHG regulation have not been taken into account. They are uncertain, but their inclusion would likely favour the management option scenario, due to less eroding peat and less frequent burning.

Biodiversity: one of the main impacts of the restoration project will be to protect important habitats. However these impacts have not been valued directly, partly because of the difficulty of doing so (lack of suitable transfer studies), and partly because of the risk of double-counting with recreation values and landscape/heritage non-use values. Nevertheless there could be additional values here and they might be significant: at least, this can be taken as providing additional support for the non-use values identified.

Other factors that are not included in the analysis are the following:

Social and multiplier impacts: we have not accounted for social or multiplier effects, for example relating to agricultural employment and expenditures. Although the subsidies in the project are considered a transfer payment, there may be additional social benefits through such multipliers and the fact of transferring money from government to rural communities. The bulk of the social/multiplier benefits will impact on the local community.

Re-hefting: the continuation of existing hefted flocks is not fully or directly incorporated in the above cost and benefit estimates. If these flocks were lost, then there would be substantial shepherding costs associated with any future decision to reintroduce sheep, because the flocks would have to be rehefted. Protecting against such costs can be considered as a form of option value, and its inclusion would favour the policy scenario.

Cool/hot burns and wildfire risk: we have not considered wildfire risk fully, because we do not have data on which to base an assessment. We have made a rather ad hoc assumption that the more frequent, less controlled burning in the counterfactual scenario would lead to a greater area of eroded peat. Further assessment of these costs and risks may be warranted. Valuation of these impacts would be likely to favour the policy scenario.

The above categories are likely to give higher benefits, though the total impact is likely to be minor in comparison with the recreation and non-use categories. At any event, the non-monetised categories do not increase the risk that the project could be loss-making in cost-benefit terms.

Step 9: Reporting

There is substantial uncertainty about both the physical and monetary values of service changes. In particular, the non-use and recreation values, and the timing of the changes in values, are the main uncertainties to which the NPV is sensitive. On balance it seems likely that the project is beneficial, with a benefit cost ratio slightly greater than 1:1 over 50 years and rather less than 2:1 over 100 years. It is entirely possible that the project might in fact be loss-making over 50 years. It seems most likely to be beneficial over 100 years, unless our assumptions about the timing of impacts are wrong. But these conclusions must be seen as tentative.

As in other case studies, further research into the recreation benefits, non-use benefits, and biodiversity benefits, and into the populations affected, would be useful. If this is important to supporting a case for continued intervention in the area, a primary study may be justified, and could also be useful for transfer to other areas.

4.4 Wild Ennerdale

Wild Ennerdale is a major "rewilding" project in the Lake District. In contrast to the more option-specific case studies, this study demonstrates a broader-scale assessment of diverse management interventions within an overall package, but still at a relatively small scale.

Location: Ennerdale Valley, West Cumbria. 54 27 52 N, 03 13 39 W.

Area: 4711ha.

Characteristics: Forestry, public water supply reservoirs, a few scattered farms. Upland Fell, including much SSSI and SAC, woodland and grassland. Multiple rights of way, two YHA and a Field Centre, large area of CROW Dedicated land.

Designations: SAC and SSSI (>40%), Lake District National Park

Ownership: Forestry Commission, National Trust, United Utilities - together forming the Wild Ennerdale Partnership

Management: Participants in the "Wild Ennerdale Partnership", directly or through tenant farmers; Liaison Group and Advisory Group.

Stakeholders: Wild Ennerdale Partnership, via Liaison and Advisory Groups with wide range of stakeholders including The Lake District National Park Authority, Environment Agency, Ennerdale Parish Council and Friends of The Lake District.

Data sources: The main data sources are Wild Ennerdale Stewardship Plan 2006[22] . Extensive survey of the valley mapping of over 80 separate National vegetation habitats. Visitor Survey Results 2005, Wild Ennerdale.

Management options: business as usual pre 2001; rewilding of the area.

Ecosystem Services: Ennerdale Water is the most westerly lake in the Lake District National Park; the remainder of the area is the river valley associated with this lake. The Wild Ennerdale river valley provides a wide range of ecosystem services, including water quality and quantity, recreation, biodiversity and non-use values, and also food and fibre and GHG regulation. The valley bottom east of the lake is dominated by coniferous forestry planted in the 1920s to 70s which produced high quality timber for structural uses as well as lower grade material for pulp (paper), fencing, chipboard and pallet. The higher slopes, mountains and ridges are dominated by extensive sheep grazing. The area west of the lake is given over to more intensive grazing dominated by sheep associated with inbye land close to the valley's farms. Ennerdale Water is managed as a reservoir by United Utilities and supplies around 60,000 customers in West Cumbria. The river system is recognised as one of the most natural in the country, with little or no management of the path

[22] www.wildennerdale.co.uk/stplan/Stewardship%20Plan%20Text.pdf Browning and Yanik (2004) ECOS 25 (3/4):pg 34-38

taken from source to the lake. The area is crossed by the Wainwright's Coast to Coast footpath as well as enclosed by many high peaks approaching 3000 ft high. The landscape is not typical Wordsworthian Lake District, more rugged and wild akin to Western Scotland or Canada.

Step 1: Defining the Baseline/Counterfactual

This case study is about valuation of the rewilding project, which is a long-term process of management. The rewilding scenario is based on management aiming at a more natural environment, and is not the same as abandonment of the area: active management will continue, and in certain cases may be quite costly and elaborate. The counterfactual for comparison should in principle be a "business as usual" scenario based on management practices prior to 2001 and how these would be expected to evolve in the absence of the rewilding project. That may be difficult to determine, in which case the use of a status quo counterfactual based on environmental quality and services prior to introduction of rewilding could be adopted (see Table 41).

Table 41 Wild Ennerdale: Characterising the counterfactual

Characteristic/service	**Pre-change status**	**Counterfactual (expectations WITHOUT project)**	**Notes**
Descriptive statistics			
Area	4711ha		
Populations	270 Ennerdale bridge 70000 Borough of Copeland <20 within Wild Ennerdale boundary only 3-4 east of the lake.	Stay roughly the same	
Human Activities	Farming, forestry, tourism, informal recreation and water extraction	Perhaps less commercial forestry and farming	Will depend on economic / agri-economic conditions and policy . Pre Wild Ennerdale Forest Design Plan saw a small (≈ 15%) reduction in conifer forest but still conifers being planted right up to and including the eastern valley. Unlikely to have any cattle grazing in the forest so no new tenancies
External Management	No coordinated approach	Stay the same	No coordinated attempts to manage area for ecosystem service benefits

Characteristic/service	Pre-change status	Counterfactual (expectations WITHOUT project)	Notes
Habitats		Possibly not able to achieve agreement over improving Pillar SSSI boundary fence leaving the SSSI in unfavourable condition. Mires left planted with spruce. No juniper planting	Aerial photos, photos, satellite images and postcards being used to identify habitat change.
Mixed Native woodland	Approx 90ha (1999)	Probably some small increase say to around 130 to 150ha	FC forest 1999 data set
Coniferous forest	Approx 1000ha (1999)	Probably reduce by 100 to 200ha to around 800ha	
Lake	338ha	Same	
Ecosystem services			
Food	Yes, grazing by tenant farmers.	Ongoing grazing, perhaps overgrazing	
Fibre	Timber products for construction, fencing, pulp and chipboard	Same	
Renewable energy provision	1999 No micro hydro, some woodfuel collection Existing 30 to 50KW woodfuel boiler at Field Centre		Quite possibly no micro hydro increase as now Wildland drivers and no coordinated management approach / "Wild Ennerdale" brand for YHA to use to gain funding.
Water quality to downstream catchments	Yes, United Utilities are landowners. Ennerdale Water acts as a reservoir serving 60,000 customers daily.	No change	Pre-project, already one of UU's better surface water supplies
Costs associated with downstream flood risk	Yes, Ennerdale Water is one of the largest lakes in the Lake district. Ennerdale a short, natural river valley	No change.	From visual analysis of the EA flood risk maps it appears that some property may be at risk of flooding in the river valley – in particular the lower areas of Egremont.
Use and enjoyment: field sports	Occasional deer hunting (one shooting party every few years)	No change	Part of cull to reduce damage to woodlands. (only 4 or 5 stags taken annually across FC holdings in Cumbria

Characteristic/service	Pre-change status	Counterfactual (expectations WITHOUT project)	Notes
Use and enjoyment: outdoor recreation	Yes, low-intensity recreational use but little or no interaction between landowners and community/users	Continued low-intensity use	Two Youth Hostels and a field centre present.
Non-use values from historic and cultural landscapes	Yes, valley already quite "wild" and best example of settled medieval valley in Lakes. Pre Wild Ennerdale archaeology knowledge was limited to knowledge of some features only.	Little change in sense of wildness as timber harvesting and haulage continuing right up to eastern valley, forest roads fully maintained and little increase in opportunities for people involvement.	No Historic Landscape Document so no increase in scheduled Ancient Monuments
Greenhouse gas emissions	Bogs and mire impacted by trees and grips.	Bogs and mire continue to be impacted by trees and grips.	
Biodiversity and wildlife	Wild area with number of important habitats and species	No major change	Bird survey

Step 2: Identify management options

The management option (in fact underway since 2001) is the rewilding of 4300ha including upland fell, native woodland, lake and lakeshore, inbye, conifer forest, grassland and mire. Specific activities include:

- Allowing conifer clear fells to regenerate naturally with no specific preference towards what habitat develops;
- Planting juniper and native broadleaves to provide an alternate seed source to spruce;
- Allowing natural regeneration of all species;
- Controlling spruce regeneration so that the species does not dominate future woodland at the landscape scale;
- Reducing sheep grazing;
- Introducing extensive cattle grazing;
- Removing physical and administrative boundary structures;
- Restricting vehicle access;

- Removing/reducing modern human artefacts such as bridges and concrete revetments; and
- Exploring the social aspects of how people are involved in landscapes.

However this is not the same as land abandonment: "Wild Ennerdale is not about abandoning land, excluding people or trying to recreate a past landscape. On the contrary, human activity is a crucial part of the process, along with the need to provide quantifiable economic, social and environmental benefits which are sustainable over the long term." (WESP, 2006)

The valley can be split into four zones. The westerly two are the least wild and will continue to be managed commercially with water extraction staying unchanged (speculate possible increasing demand to support increased population on the back of West Cumbria Energy Coast developments), grazing staying similar although some de-intensification likely, timber production remaining similar. The middle zone will continue to be harvested for the next 20 to 50 years, with a change to Continuous Cover from Clearfell and Restocking (that is lower intervention). The eastern third of the valley is the main focus in terms of rewilding. The adjustment of existing contracts has been used to remove spruce-dominated plantations in this area. Young conifers are being removed (at a cost in the region of £500 to £600 per ha) but this activity is being combined with timber sales which are economic. This eastern "wildest" end has the least timber species diversity at present so additional planting has occurred to provide a seed resource. 10-15,000 junipers, 10,000 oaks and 25,000 birch have been planted. The Forestry Commission report that planting would have been required anyway so there has been no real extra cost from this activity. However, this area will only be managed for health and safety (that is minimalist intervention only where required for health and safety reasons) 30 to 50 years in the future, so no commercial timber value for this area will be recouped. The area lost to commercial forestry would have become available for harvest in 30-50 years. The future value is uncertain but the present (discounted) value is thought to be quite low.

Step 3: Identify impacts on ecosystem services

The projected impacts of the rewilding project on Ennerdale habitats are described in Table 42. These changes will lead to a number of changes in ecosystem services, over a long time period, as summarised in Table 43.

Table 42 Wild Ennerdale: Habitat changes from the counterfactual to the management option scenario

Habitat type	Area	Quality	Changes in project	Timing
Conifer plantation	≈1000ha	Commercial, low diversity before project started except a few areas esp. in valley bottom.	Large swing from coniferous to mixed broadleaved/mixed conifer via removals and replanting; some matured via thinning; some ongoing commercial. Move away from clearfell and restock to Continuous Cover should see more diverse woodland structures develop offering potential for increasing biodiversity of flora and fauna as range of forest habitats increase. No more massive swings from Forest Canopy to open ground	Move away from clearfell and restock almost complete. Perhaps 10 to 20ha left to clearfell (excluding removal of young conifer regeneration at east end). Remaining forest managed through thinning on a 40 to 60 year rotation
Mixed Native woodland	≈90ha in 1999 now approaching 145ha if sub 10 year old planting and regeneration included	Favourable	Expanding to perhaps 300 to 400ha over 50 years. Wild Ennerdale especially responsible for increasing planting of Juniper and increasing development of scrub woodland habitats both rare or lacking elsewhere in England.	Already underway but establishment of woodland ecosystems from plantation monoculture likely to take some 3 or 4 decades.
Lake	338ha	Favourable	No major changes; some visual improvements; possible water quality improvement. Lakeshore habitats currently unfavourable but improvements by removing lakeshore revetment wall should see habitats improve to favourable in the future.	Monitoring ongoing by Natural England
Sheep grazed moorland	Approx. 1800ha	Varies from Unfavourable improving to Favourable	Shift to cattle grazing; favourable condition. Blurring boundaries between forest and grazing should see biodiversity gains and improved graduation between habitats.	Already underway and opportunities will continue to be sought .

Table 43 Wild Ennerdale: Changes in quality and extent of ecosystem services

Service	**Key habitats**	**Key changes**	**Qualitative impact**	**Quantitative impact**
Food	Upland moorland and grassland	Shift from sheep to cattle grazing. . Two additional tenancies introduced as part of management.	Reduced sheep production, increased cattle production. Potential increase in venison from deer as woodland develops more favourable habitats and Red Deer become established.	Impact on farmer's income. Income from subsidy increased (20k by annum) since project started due to grazing areas of forest with cattle. Move away from sheep has reduced income from lambs but also reduced expenditure.
Fibre	Commercial conifer plantations	Change from conifer to mixed forestry in eastern end of valley; removal of saplings, cost £500-£600 ha	Potential increase in woodfuel from increasing native woodland. Decrease in logs for construction industry.	Reduced value from timber production although gained from reduced expenditure in restocking and future harvesting costs.
Renewable energy provision	Forested areas	Shift to mixed forest cover.	No likely large scale biomass options. Local wood use not quantified but minor. Potential to increase woodfuel as native woodland increases.	Approximate assumption: 100ha of birch growing at yield class 6 could produce 1000 to 1500 tonnes of woodfuel every 5 years
	Buildings (two Youth Hostels and a field centre.)	Micro-hydro to replace diesel	One YH done, diesel generator used only a few days last year during a period of low flow. Two further sites identified and permissions granted. YHA also considering photo voltaic solar generation. One micro hydro scheme (Ennerdale YHA- approx 10,000kwh per annum two more planned (adding approx 19,000kwh per annum), Increasing woodfuel usage. Would like to see increase in woodfuel production but unknown figures.	Diesel saved, cost of renewable technology. Values for an increased sense of wildness from reduced noise unavailable.

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Water quality	All	Changes to species mix rather than landcover.	Little impact expected as current water quality among best of United Utilities surface water resources.	Increase in native woodland expansion above existing forest and move to continuous cover may improve water retention within the catchment helping with possible future increased drought risk due to climate change.
Costs associated with downstream flood risk	All, especially forest cover.	Intermediate stage of deforested area naturally regenerating. Wider spacing of trees in mixed “wild” forest.	May impact if large areas consecutively clear felled in a short time period. Expected under commercial forestry Note that western end of the valley has microclimate with additional meter of rainfall annually.	Flood Risk quantification of change of risk from such changes requires some primary catchment level analysis.
Use and enjoyment: outdoor recreation	Entire site (main use is around lake, on rights of way on western edge, and the Coast to Coast footpath)	Landscape level changes. Shifts to forest cover and changes to grazing regimes.	Ongoing improvement from increasing sense of "wilderness" but Wild Ennerdale has significantly increased opportunities for people to be involved in the valley. Difficult to separate out various factors: Wild Ennerdale brand may increase visitor numbers through increased awareness of the valley, better accommodation and better information.	Visitation rates, may increase, change to willingness to pay (Wild Ennerdale has no plans to charge for car parking). Approximate assumption: valley sees an increase of 10 to 15% because of Wild Ennerdale.
Use and enjoyment: field sports	Occasional deer hunting	Some possible change in the quality of the experience in a rewilded habitat	Quality of experience	Higher WTP. Price currently based on quality of the stag taken plus daily rate; price could change, or greater consumer surplus for trips.

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Non-use values from historic and cultural landscapes	Entire site for non use value of a wilder landscape.	Impact of less intensively managed landscape	Wild Ennerdale could be one of the "wildest" areas in England so could have particularly high non-use values Valley will become wilder. Wild Ennerdale commissioned and made available significant study of Historic Landscape. Likely to see number of Scheduled Ancient Monuments rise from current 2 to 15.	Stated preference: original study or perhaps benefits transfer.
GHG emissions	Forest, mire, bog. Also management impacts (for example, renewable energy)	Different rates of carbon uptake for different forest types, etc. Mire restoration through sapling removal and grip blocking.	Overall the net impact is probably quite minor, because major changes in land-use are not on the cards. FC suggests no impact. Mire / blanket bog habitats lay down about twice the carbon of forestry but release methane and NOx which are stronger green house gases. (Driver, 2008) Increase in woodfuel and continued supply of construction timber from western end of valley support carbon offset against non renewable fuels and carbon sequestration through locking up carbon in construction timber.	Could be calculated, but net impact probably minor.
Biodiversity and wildlife	Entire site	Vegetation, mammal and bird diversity.	Photographic evidence, significant increase in knowledge and available to wider audiences. Regular guided walks giving people access to wildlife. Cattle introduction and reliance on natural processes creating more diverse habitats and boundaries between habitats becoming more blurred.	Vegetation data, bird survey and otter survey.

Step 4: Identify human populations affected

The Ennerdale Valley site itself has a low population around 20 within the project area, only 3 east of the lake. The adjacent settlement of Ennerdale Bridge is home to

270 individuals. The water from the site provides 60,000 users. Daily automatic counters estimated visitation between 2005 and 2007 (see Table 44).

Table 44 Wild Ennerdale: Populations affected

Service	Type of population	Number	Characteristics
Food	Producers	Two new herds and two new tenancies have been formed.	Tenant Farmers
	Wild Animals	Increasing deer herds as habitats improve. Current cull may increase	
	Purchasers	Unknown.	Only 4 cows sold so far, all locally. Premium market for rewilded local cattle? Number of lambs and sheep sold? Wood burnt in valley not worth selling.
Fibre	Producer	Forestry Commission	Supplier to construct fencing, pulp and chipboard industries. Tonnage produced skewed by forest reaching peak production regardless of Wild Ennerdale. Future production could be around 3,000 to 4,000 tonnes per annum around £15,000 to £20,000 value.
Renewable energy provision	Local building occupiers	3 sites adopting micro hydro to replace diesel generators	2 Youth Hostels and a Field Centre. Once all installed future production around 29,000kwh Woodfuel potential is increasing and could be around 1000 to 1500 tonnes per annum once native woodland established.
Water quality to downstream catchments	Utilities	1	United Utilities
	Customers	60,000 daily	
	Recreational users	Unknown	

Service	Type of population	Number	Characteristics
Costs associated with downstream flood risk	Environment Agency Householders	Small number of houses in Egremont estimated at about 5% of the town given a population of 8000 and an occupancy rate of 2.33 per household gives approximately 170 households at risk.	
Use and enjoyment: outdoor recreation	Local residents	270	
	Walkers Bikers	Counter figures from 2005-07 survey show two car parks see average of 76 cars per day. Blacksail gate sees an average of 24 persons per day. The Coast to Coast reportedly sees 10,000 visitors per annum. Assuming an average of 2 persons per car that would give an average of 64,240 visitors pa.	Data from automatic counters so may not be truly representative of use, and do not cover summer months.
	YHA Hostels	Approx 5000 bed nights per annum between Blacksail and Gillerthwaite YHA	Data from YHA
	Broadmoor Scout Hut	900 scouts per annum	Data from Warden
Use and enjoyment: field sports	Permit Deer Stalking	1 stag every few years.	4 or 5 Permit Stalkers annually across whole of Cumbria, Wild Ennerdale occasionally used.
Non-use values from historic and cultural landscapes	Local population	7000	Borough of Copeland
	Interest groups	≈7000 members (FotLD)	Friends of The Lake District. Whitehaven Ramblers Association. Ennerdale Anglers, Fell and Rock Climbing Club
	Regional and National populations	≈7m; 50m (England)-60m (UK)	National population potentially relevant since one of the wildest areas in England

Service	Type of population	Number	Characteristics
Greenhouse gas emissions	Problem of global interest. Sequestration potential contribution to UK response. May have financial value to landowners in long run.		
Biodiversity and wildlife	Interest groups General population	(As non-use)	(As non-use)

Step 5: Economic valuation of ecosystem service changes

There are some data availability issues for this case study, partly because much of the project data are in GIS format and would require significant additional analysis to be useable. Biodiversity and habitats are represented through vegetation cover: proportions have been calculated from maps by eye. Data on Ring Ouzel, Dipper and Grouse are available, but biodiversity values for specific species are difficult to identify.

A particular complication in the valuation of Wild Ennerdale is that there is no intention to change the habitat areas of the site, with the exception of a gradual shift from conifer to mixed or broad leaf forest. The rate of this shift is not set as it relies upon felling of conifer plantations, after which natural revegetation will be allowed; the Stewardship Plan details timing of felling operations into 5 year phases with the majority of the clear felling completed by the end of 2010. Removal of conifer regeneration and cut to waste of young conifer, both cost operations, will take until around 10 years to complete.

Recreation and non use values for the site are likely to be key because management is aimed at enhancing "the sense of wildness". Because of the unique nature of the site benefits transfer is difficult – no truly suitable source studies have been identified. Some extremely rough guesstimates have been made, but these cannot be relied upon. A primary study of recreational and non-use values in Wild Ennerdale would be valuable research addressing these key uncertainties, and could be designed with transferability to other rewilding schemes in mind. See Table 45 for an overview of the economic value evidence for this case study.

Table 45 Wild Ennerdale: Economic valuation of ecosystem service changes

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Food and fibre	Value output, after costs	≈0	Based on Gillerthwaite business plan and the report of 1 farmer ("the outputs from that land (outwith the ESA) wasn't worth the extra inputs" (Farmer's Weekly). But supported from evidence elsewhere for example, Peak District Rural Deprivation Forum, 2004 showed negative net farm incomes without subsidy support. Farm business plans only identify single farm payment and ESA schemes as sources of income.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Fibre	Change to incomes from forestry	≈0 (-£500 to -£600 per ha cost of removing young conifers with no value, but better considered as a management cost)	Woods are managed at a net revenue cost to the FC: continuing a regime of clearfelling and restocking with conifers is unlikely. Given that current forest cover is already sold under contract service change will not impact on income. Could consider shift to mixed woodland managed for health and safety only as a loss of value compared to plantation forestry but economic yield would not be achieved for 50 years so discounted value low.
Renewable energy provision	Value of energy produced	≈20kWh per day, at ≈15p per kWh ≈£1100 per year.	Three buildings switch diesel to renewable. Not valued at DECC generation rates because not big enough to contribute to UK targets. Forestry products sold on contract basis and no expectation of use for large scale biomass.
Water quality to downstream catchments	Treatment cost changes; WTP	≈0	Marginal change on water resource in United Utilities portfolio – no change to treatment costs anticipated.
Costs associated with downstream flood risk	Damage costs: Werrity and others (2007); Pope 2008	Main case: ≈0;	Current risk is identified by the EA as between 0.5 and 1.3% (moderate flood risk). For sensitivity analysis the impact of becoming an area at significant risk will be analysed. Werrity and others (2007): £34,720 for 100% chance of damage to buildings and £14,318 for contents; Pope: 4% of property values in flood zones.
Use and enjoyment: outdoor recreation	SP, TC methods, or BT. Zanderton and Tol (2008); Kaval (2006); Tinch (2009)	Current 64000 visits/year: assume improvement associated with rewilding £8: ≈£510,000 per year. Assume 10% increase in visitor numbers: 6400 more visits. Also value at £8 per visit, to take account of fact that these are marginal visitors, and displacing activities from elsewhere: ≈ £51,000. Total £560,000 per year. Confidence in this figure is not very high.	Unique "wilderness" characteristics of Wild Ennerdale make assessment difficult without primary study. Assume values from higher end of ranges in studies: Zanderton and Tol find mean consumer surplus of forest trips around £15 (travel cost meta analysis). Kaval gives mean values around £40 for outdoor activities, and approx £90 for National Parks. Tinch finds £8 per visit, range £6 to £9, value of visitors for less intensive management in Peak District National Park, compared with current upland management.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Use and enjoyment: field sports	Impact of quality on uptake of hunting opportunities and on value	For main case, ≈0.	£200-400 for a days stalking and payment of £1500 for high quality stag[23], but only 1 stag every 4 years. Conceivable that this could increase. Also likely that value (WTP) will be greater in wilder area. However total amount is going to be negligible.
Non-use values from historic and cultural landscapes	SP or BT; eftec (2006); MacMillan and Duff (1998); Hanley and others (1998)	Ennerdale area ≈1% of North West SDAs; c.2.8m hh; ≈£100,000 per year. Some with special interest may be WTP more: ≈7000 Friends of Lake District and ≈3000 local households at £5 each ≈£50,000 per year. Also possible that some locals may oppose scheme. £100,000 used, but these values are no more than rough guesses	eftec (2006) change from "rapid decline" to "better conservation" for heritage in North West SDAs: £4.75 (£1.50-8.00) per hh. Study values heritage defined as traditional farming practices and farm buildings, not rewilding. "Rapid decline" is not the right counterfactual. Results for Breadalbane support values of £40-£130 /hh but sites different and populations uncertain.
Greenhouse gas regulation	DECC values (£27/tCO2 in 2009 rising to £196 in 2109)	Present value over 50 years ≈£5000, over 100 years ≈£8,500.	1kg Co2 / KW assumed from diesel generator, ≈ 20 kWh daily. Giving ≈7 tonnes of carbon saved a year. No account taken of carbon costs of micro hydro technology. Carbon budget of change between forestry regimes could be investigated: balance of carbon sequestered against methane and NOx released suggest that would not provide a net GHG sink (Byrne and others, 2004)
Biodiversity and wildlife	SP and BT; White and others (2001)	Evidence of otters: White and others found hh WTP ≈£14 for the otter BAP but not possible to convert to value for this specific site.	Baseline data held but data for comparison will not be collected until 2011 at the earliest. Primary study may be required due to the unique features of this project. Difficult to pin down values for individual species.

Note: TC – travel cost; SP – stated preference and BT – benefits transfer.

Step 6: Calculation of discounted costs and benefits

Given the major uncertainties surrounding the key value estimates, attempting to produce present value figures in a full cost-benefit framework would not be productive in this case, on the basis of the evidence currently available. We suspect that the project is beneficial, due to significant non-use values, and also recreational values, but have no firm evidence on which to base monetary estimates at present.

[23] Estimate by Gareth Browning, Forestry Commission based on current payments for hunting.

The present value calculations are presented in the accompanying spreadsheet, and can be experimented with, and are used to support the sensitivity analysis / exploration of uncertainties below, but no "main case" table of best estimates can be presented.

Step 7: Sensitivity analysis

Timescales: the timescales for the different impacts in this case are varied and uncertain. Some impacts occur early in the project (for example the installation of renewables) while others are to occur more gradually over a flexible timetable. It is expected that most landscapes will take at least 25 years to reach a recognisably “wild” state, in some cases longer, and they will continue to evolve after that. The whole rewilding project is seen as a very long term commitment. The ways in which the different ecosystem service values will evolve over time are therefore very difficult to predict, and could have an important role in determining the net present benefits of the project.

Down-stream flood risks: the "main" scenario assumes no impacts on flood risks, however there is a chance that intermediate stages in land management (between removal of forest cover and natural regeneration) could increase flood likelihood, especially given the high rainfall in the area. Assuming 170 hh exposed to an increased risk of 0.5% of damage costs of approximately £50,000 (Werritty and others 2007) gives total costs around £43,000 per year. However this only applies in years between cutting and regeneration, not throughout the project, so sensitivity to this value is likely to be low unless the actual flood risk changes are much greater.

Field Sports: occasional deer hunting takes place in Ennerdale, about once every 4 years, normally stalking of one stag. This brings a revenue of approximately £400 for the stalking and £1500 for a good stag. Culling of deer is also undertaken by the Forestry Commission, so it is possible that there may be additional capacity for paid hunting, if there is demand for it. An increase in quality of stalking could lead to an increase in demand / value. Hunting could also become slightly more frequent. However, even assuming a four-fold increase in field-sports values would not generate significant values, compared to other categories.

Recreation: the recreation values are uncertain, due to underlying uncertainty about the numbers using the area, the values per trip, and the prospects for future changes in these figures. The site is relatively unique and no ideal studies were found for benefits transfer. The estimates presented above are based on approximate estimates of visitor numbers to Wild Ennerdale, derived from automated counts, assumptions about increase in visitor numbers, and a value from Tinch (2009) based on improved quality in the Peak District National Park from a reduced intensity of management. The (additional) value per visit is uncertain, but supported by Kaval's (2006) meta-analysis, taking account of the uniqueness and national park setting.

Non-use values: this category is the most uncertain, but perhaps also the most significant. No really suitable studies are available for benefits transfer. eftec (2006) deals with traditional management, not rewilding. The closest studies found were for Breadalbane in Scotland, and were rather dated. The figures derived in table 45 above are no more than guesses and cannot be relied upon at all. It seems likely that the actual non-use values could be rather higher: given that Ennerdale is one of the "wildest" places in the country, and located in a popular National Park, it could realistically be of interest to a wide range of people. Again as a speculative guess purely for the purposes of illustration, if 1 English household in 10 were willing to pay 50p towards Wild Ennerdale, that would sum to £1m.

GHG regulation: the key uncertainty here relates to the net carbon balance, taking into account changes to forest cover and emissions from soils. Overall the impact of rewilding is probably minor, but this is a tentative conclusion and further research is warranted.

Summary: The uncertainties in this case study are such that it is not possible to draw many firm conclusions, other than to state that the most important uncertainties relate to:

- the non-use values (how significant they are, and what population holds them);
- the recreation values (current and likely future visit rates, and the added value of increased wildness); and,
- timing of impacts.

Step 8: Accounting for non-monetised impacts

There is a range of services for this site for which data restrictions have prevented a full valuation. In particular biodiversity and food and fibre impacts from a rewilded site are unclear and need further investigation in order to identify appropriate values.

Biodiversity: there is evidence that several important species are present in the area, and the rewilding project may be key to establishing and maintaining these species. Some valuation evidence is available at the UK level. However it is not possible to convert this to the local scale. Nevertheless, these values will be positive. They may also be partly reflected in non-use and/or recreation values, depending on the methods used to estimate them.

Food and fibre: these values have been assessed as approximately zero, and this is probably accurate since both food production and forestry are economically marginal. The main benefits of the rewilded patterns of cattle grazing and mixed forest will arise through non-use, recreation and biodiversity benefits, not food and fibre. The food losses compared with the counterfactual are negligible: less meat overall will be produced, but it is likely to have a higher value. Timber production will fall, but this represents a loss 50 years or so into the future, and the present value of this is small. These conclusions are uncertain, but it is unlikely that these are priority areas for research.

In addition to the above, we have not reported in detail on the **costs** of the rewilding project, although costs are touched on under several categories above. The aspirational, long-term process and partnership aspects of the project make costs difficult to assess. At present, the Wild Ennerdale Partnership management costs are probably in the order of £15,000 per year (funded equally by the partners) and capital costs for items such as removing a bridge or new signage range from £5,000 to £20,000 per annum (funded by partners and other incomes from NE, HLS and donations).

Step 9: Reporting

Data issues have been a problem for this case study and the changes through management may vary somewhat from those identified. Further information should be available but has not been accessible to date. The values derived are highly uncertain in the key categories, and we cannot be confident that we have accurately assessed the values associated with rewilding in this area. Primary research into the non-use and recreation values in particular would be very useful. Biodiversity values are also uncertain but probably important, and should be considered along with non-use in any study, with attention given to avoiding any double-counting. The most useful kind of primary valuation study would focus on marginal values – that is, the changes in biodiversity values arising from changes in management – rather than on overall estimates of “the value of biodiversity”.

4.5 SCaMP

United Utilities (UU) “Sustainable Catchment Management Programme” (SCaMP) is a flagship conservation initiative in the UK. A partnership of UU, local farmers and a wide range of other stakeholders has been formed to invest in conservation activities in 20,000ha of water catchment land in the North West of England, aiming to secure improvement in SSSI condition while protecting water quality.

In this case study, we will use SCaMP as an illustration of "broad-brush" application of valuation techniques at the strategic, large-scale level. Data available are limited, but nevertheless it is possible to draw some broad conclusions and to make suggestions about research directions and transferability of results.

Location: United Utilities owned catchment land in Bowland, the Goyt, Longdendale and the Peak District.

Area: 20,000 hectares, of which 90% covered by SCaMP agreement.

Characteristics: The SCaMP area is mostly upland moorland, farmed primarily for sheep, with some cattle grazing. There are 45 land holdings and 21 farms. There are some woodland areas, a mixture of native woodland and some conifer plantations. It is mostly open access land, and has been since before the Countryside Rights of Way (CRoW) Act; parts are extensively used for recreational purposes. There is also upland grouse shooting.

A major use of the land is gathering water for human consumption: much of the land consists of peaty, wet soils that can retain, filter and clean rainwater. However habitat degradation can seriously compromise these functions. The peat soils store substantial quantities of carbon: healthy peat bogs can sequester carbon, while carbon can be lost from degraded areas.

Designations: 13,500 hectares are designated as Sites of Special Scientific Interest (SSSI). Part of the SCaMP land falls within the Bowland Fells SPA (Special Protection Area) which is within the Forest of Bowland AoNB (Area of Outstanding Natural Beauty); SCaMP also intersects the Peak District National Park

Ownership: United Utilities.

Management: United Utilities, SCaMP National and Local stakeholder groups, farmers.

Stakeholders: SCaMP is United Utilities (UU) project with, a number of key UK stakeholders including OFWAT (water industry regulator), Environment Agency for England and Wales, Drinking Water Inspectorate, Natural England, Defra, RSPB Consumer Council for Water, Forestry Commission, Peak District National Park Authority, Bowland AoNB, Moors for the Future and local stakeholder groups.

Data sources: some published sources; primary source United Utilities website. There are reasonably good data on management activities, but very limited data on ecosystem service impacts.

Management options: business as usual pre 2001 as baseline; SCaMP project. Other options could be identified.

Ecosystem Services: the key ecosystem services provided by the SCaMP area are:

- Biodiversity conservation (see "designations" above);
- Farming and associated economic activity: but farming is economically marginal and dependent on agri-environment payments;
- Recreation, including general outdoors activity and field sports, and associated economic activity. Much of the land has high scenic value (though in degraded peat areas, this has declined);
- Water supply, including both quantity and quality regulation: dependent in particular on condition of peat bogs; and
- Greenhouse gas regulation: dependent especially on the condition of peat bogs.

Step 1: Defining the Baseline/Counterfactual

This case study seeks to evaluate the SCaMP, so the appropriate counterfactual is "business as usual" without the SCaMP. The business as usual baseline does not assume zero intervention in the area, but rather that UU would have continued with its pre-SCaMP level of catchment management, that agri-environment schemes would have continued, and so on.

Table 46 SCaMP: Characterising the counterfactual

Characteristic/service	Pre-project status	Counterfactual (expectations WITHOUT SCaMP)	Notes
Descriptive statistics			
Area	20000ha		
Populations	Very low in area, but densely populated cities nearby (Manchester, Sheffield, Lancaster etc.)	No major change within area.	Assumption of no growth.
Human Activities	Farming. Some forestry Recreation: walking, tourism, field sports Water extraction	Likely the same.	Farming dependent on subsidy – assume this continues in base case.
Management	Managed by tenant farmers with some support from landowner	Similar approach.	Assume that without SCaMP, ongoing low-intensity farming with some intervention/ investment from UU
Habitats		No major change	
Upland moorland	Main habitat type: mostly in poor condition / eroding.	No improvements, some risk of deterioration (more bare peat, more erosion)	
Mixed woodland	Some	No change	
Coniferous forest	Some	No change	
Ecosystem services		General decline	
Food and fibre	Yes, primarily sheep grazing by tenant farmers. Some timber.	No change.	Assumption that existing agricultural support would continue. Without subsidy, farming likely not sustainable.
Renewable energy provision	None	None	No plans for this, and would not be ruled out by scheme: not a focus for assessment.
Water quality to downstream catchments	Major use, but quality poor due to degraded bogs.	Risk of decline in quality/increase in colour.	United Utilities hold the land primarily for water supply purposes. Without action, risk of continued decline (as in other areas).
Costs associated with downstream flood risk	Yes, risks increased by poor landscape condition.	No change, or increase in risk.	Without action, risk of decline.

Characteristic/service	Pre-project status	Counterfactual (expectations WITHOUT SCaMP)	Notes
Use and enjoyment: outdoor recreation	Open access land, primarily for walking and sightseeing, also cycling, bird watching; but the value of the use is diminished by degraded land. Close to major population centres.	Ongoing use.	
Use and enjoyment: field sports	Grouse shooting in area.	Ongoing.	
Non-use values from historic and cultural landscapes	Generally high quality area; some parts of particular importance.	Ongoing, though some damage from degraded landscape.	
Greenhouse gas emissions	Overall negative balance due to degraded peat.	Ongoing negative balance, may worsen.	
Biodiversity and wildlife	Value reduced by degraded landscape: less vegetation cover, unfavourable habitat condition.	Some gains possible via ongoing/future agri-environment schemes.	

Step 2: Identify management options

The overall aim of SCaMP is to develop an integrated approach to catchment management incorporating sustainable upland farming which delivers:

- Government targets for SSSIs: 95% of SSSIs into favourable or recovering condition by 2010;
- Biodiversity plans for priority habitats and species under the UK BAPs;
- Improved raw water quality, and
- Viable living for tenant farmers.

This is being achieved via long term agreements with tenant farmers which define farming plans compatible with the above objectives. Greenhouse gas regulation is not mentioned as a SCaMP objective, but the project will have a significant impact on this (and in the proposed SCaMP2, UU states an explicit objective of “Securing and improving the carbon flux management of our land”).

The main activities being undertaken to achieve SCaMP objectives include:

- Blocking drainage ditches to re-wet peat bogs that had been drained, creating new habitats for wildlife;

- Restoring areas of eroded and exposed peat and heather moorland;
- Establishing woodland by planting thousands of new trees and replacing existing coniferous trees with native broad-leaf species;
- Providing new waste management facilities to reduce run-off pollution of water courses, and
- Fencing to keep livestock away from areas such as rivers and streams and from special habitats

In an initial programme running from 2005-2010, United Utilities are working to restore blanket bog (c 5,500ha) and to establish clough woodland (450ha planted with 300,000 trees). Most SCaMP land has seen a reduction in the number of grazing animals, especially cattle, and also exclusions at particular times of year, in particular to remove winter grazing on moorland, or specific areas. To these ends, 200km of fencing and nine new stock buildings have been constructed. Burning is also reduced.

The most recent assessment (McGrath, 2008) states that, relative to targets for the SCaMP project:

- 96% of SSSI in SCaMP area are in favourable or recovering condition;
- 294 ha of woodland already planted ~ 70% of target;
- 33 km of grips blocked ~ 40% of target;
- 60 ha of bare peat restoration underway ~ 30% of target;
- 9 farm buildings constructed ~70% of target;
- 5000 m of farm tracks improved ~ 134% of target;
- 101 km of fencing installed ~ 70% of target;
- 15 km of fencing removed ~ 65% of target;
- 1200 m of walls restored ~ 15% of target;
- 23 water troughs installed ~ 30% of target, and
- Around 60% of programme overall complete.

Step 3: Identify impacts on ecosystem services

With the data available only for a quick analysis, it is not possible to be very accurate about the specific changes in habitat types and conditions, nor can we be precise about the timescales over which changes are expected. The information available is summarised in Table 47 below. It is important to note that there is some overlap in the information presented – the SSSI areas are not additional to the habitats listed.

Table 47 SCaMP: Habitat changes from the counterfactual to management option scenario

Habitat type	Area	Quality	Change with SCaMP	Timing
SSSIs	13500ha	Variable – many in "unfavourable" condition, or becoming so over baseline scenario	All unfavourable recovering (limited possibility for moving to favourable).	Start of recovery within short period. Years to decades for full recovery, depending on case.
Blanket bog	less than 13500ha	Generally unfavourable, drained and eroding.	Rewetting, reduced burning. Resulting in improving condition: healthy blanket bog, supporting native communities	Quite rapid rewetting once grips blocked. Recovery dependent on extent of initial damage.
Bare peat	approx 200ha	Bare: eroding, fire risk.	Revegetated, eventually improving bog.	Initial cover within couple of years; high biodiversity value over very long term.
Upland Oak Woodland	450ha	Planted on scrubby grassland	New clough woodland: high biodiversity value.	Planting within 5 years; decades to establish fully.

Table 48 SCaMP: Changes in quality and extent of ecosystem services

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food and fibre	Moorland	Reduced grazing density; improved condition of moorland	Short term losses offset by longer term gains due to more productive habitat	Requires measurement of stock levels and productivity
	Conifer plantations	Not replanted	No loss: non-commercial	
Renewable energy provision	Not relevant to this case study: potentially renewable energy could feature in the area, and this could be considered separately from the SCaMP. Neither the baseline nor the SCaMP preclude such investments.			
Water quality to downstream catchments	Blanket bog	Most of the management changes listed above will have additional potential to improve water quality.	Improved quality (DOC/colour) due to improved bog condition.	Requires measurement of water quality. So far, some signs of stabilisation of colour, versus increase in non-SCaMP areas.
Costs associated with downstream flood risk	Blanket bog, forest	Improved bog condition and increased forest cover	Possible reduced risk of flash flooding due to increased water storage	Requires modelling of flood risks

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Use and enjoyment: outdoor recreation	All, especially in designated areas	Improved bog condition and increased woodland cover	Habitats will be more attractive and this may enhance recreational experience.	Estimate changes in visitation rates, or values.
Use and enjoyment: field sports	Moorland, woodland.	Improved bog condition and increased woodland cover; reduced burning.	Most likely that changes may improve grouse production, despite reduced burning, as habitats generally will be in better condition. More attractive landscape in which to shoot.	Estimate changes in number of shooting days, or values.
Non-use values from historic and cultural landscapes	All	General improvement in habitat quality. Revegetation may reduce values of archaeology (peat diggings, plane crash sites).	Better conservation status of important designated areas (SSSIs, AoNB, SPA, National Park).	Estimate willingness to pay for such improvements.
Greenhouse gas emissions	Blanket bogs, forests.	Improved bog condition; increased forest cover.	Main impact will be through gas flux of bogs and reduced erosion.	Precise details need measurement and calculation; rough estimates possible
Biodiversity and wildlife	All	Major improvement in condition: all areas gone from unfavourable declining or no change to unfavourable recovering, and shift to more native forms of woodland cover	Ongoing increase in native populations of key plant and animal species.	Bird and vegetation survey data.

Step 4: Identify human populations affected

There is rather limited information available on the populations affected by the service changes. For recreation, some evidence is available. The Peak District National Park attracts up to 30 million visits per year[24], largely from quite nearby - over 17 million people live within 60 miles of the Park. Most visitors cite scenery/landscape as a motive, and for 39% this is the primary reason for visiting. The Forest of Bowland AoNB is much less intensively visited due to its remote location; here 76% of visitors are from Lancashire, with most others coming from surrounding areas; 12% live in the AoNB; 59% are day visitors, and 29% stay

[24] http://www.peakdistrict-education.gov.uk/Fact%20Sheets/fz2tour.htm

overnight. Most arrive by car. Almost half were regular visitors. Visits were mostly for walking and/or general sightseeing (see Table 49).[25]

Table 49 SCaMP: Populations affected

Service	Type of population	Number	Characteristics
Food and fibre	Producers	approximately 60	Tenant Farmers. We assume that the production in this area is not significant enough to have national-level impacts on food markets.
Renewable energy provision	not applicable		
Water quality to downstream catchments	Utilities		United Utilities
	Customers	Helps supply some of the 6.7 million UU customers	Customers in NW England: but this not only source
	Recreational users	No data	Likely primarily local users in downstream catchments, for general recreation and for angling.
Costs associated with downstream flood risk	Environment Agency		Responsible for flood protection expenditures
	Householders	Large number downstream	High rainfall in this area could create flood risk for some heavily populated areas. Improved bog condition relevant to reducing this risk.
Use and enjoyment: outdoor recreation	Local residents, walkers bikers	No accurate data. Peak District up to 30 million *visits* per year: pro rata by area, and ignoring the low-visited Bowland area, suggests very roughly 2million for SCaMP land.	Primarily from surrounding urban areas, but significant minority from further away. Walking/sightseeing most common use. Many of the *visits* will be repeat visits – that is many fewer than 2 million *visitors.* The 2 million figure is a very rough estimate.
Use and enjoyment: field sports	Grouse shooters	Small number	Best considered as part of the national stock of shooting areas.
Non-use values from historic and cultural landscapes	Interest groups General population	Several million ≈2.8m households in North West	Some important designated areas, likely to be salient at least to regional population, and potentially to national population.
GHGs	Problem of global interest. Sequestration potential contribution to UK response. May even have financial value to landowner in long run (that is if carbon storage subsidised).		
Biodiversity and wildlife	Interest groups General population	Several million	Key conservation interests likely to be highly salient to local and national interest groups, and of interest to general population at local, regional and potentially national levels.

[25] Forest of Bowland AONB Visitor Survey Report, Summer 2008

Step 5: Economic valuation of ecosystem service changes

Although some valuation evidence is available for all the service categories considered, use of this evidence depends on having data on the likely service changes. As discussed above, the information on service changes is quite vague, and so any valuation will be similarly approximate. Bearing this in mind, Table 50 summarises the assumptions and calculations required to derive some rough estimates of service change values.

Table 50 SCaMP: Economic valuation of ecosystem service changes

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Food and fibre	Market: sheep	Negligible value	Firstly, hill farming is economically marginal and dependent on subsidy. Secondly, despite short-term losses from lower stocking, in the mid- to long-run the land will be more productive. Expect little net change here from the perspective of the regional economy, but the impacts on the farmers themselves are important.
Renewable energy provision	Not applicable		
Water quality to downstream catchments	'End of pipe' water treatment costs avoided.	Unknown	It is possible that SCaMP's impact on water colour could lead to delayed or perhaps even avoided costs for upgrading some treatment works in the future. Current data show some signs of stabilisation in water colour in restored plots, compared with deterioration elsewhere. However there is very high uncertainty whether any water quality improvement will be detectable on the catchment scale, thus it is not possible at this stage to determine with any accuracy the expected level of cost savings. Savings could potentially be significant if upgrades were avoided, however due to the complicated nature of an interconnected water supply it is impossible to quantify potential at this time.
Costs associated with downstream flood risk	Avoided costs	Unknown	Costs avoided either by Environment Agency (reduced flood defence expenditures) or by households and insurers (reduced damage and claims). However we have no data on risk reduction.
Use and enjoyment: outdoor recreation	Stated preference or travel cost; meta-analysis. Christie 2000, Kaval 2006, Zanderson and Tol 2008	Evidence could support a few pence to a few pounds per visit; for ≈ 2 million visits per year, value ≈£500,000 (main case), £1m (higher case)	There is undoubtedly some recreational value to improving the landscape. Better conditions mean greater consumer surplus per visit, and perhaps more visits. We have no hard evidence on likely effects on visitor numbers. The estimate of 2 million visits per year is very rough. We need a value for improvement in a visit, not the total visit value. Christie (2000) supports £2-£5 for improved facilities. Kaval (2006) supports average values around £40/day, so £2-£4 would equate to a 5-10% improvement in value. Zanderson and Tol (2008) find lower values for forest trips: mean £15. Overall it is quite reasonable to suggest that recreation improvements could be worth £500,000-£1million per year, and perhaps more.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Use and enjoyment: field sports	Market values, stated preference or travel cost	Probably minor value	It is likely that SCaMP may lead to some improvement in quality of shooting experience (better landscape) and perhaps to availability of grouse (restored habitat) but against this must set reduced burning (possibly fewer grouse). On balance, likely to be some positive value, but this is likely to be small relative to other values at stake.
Non-use values from historic and cultural landscapes	Stated preference: eftec 2006.	£500,000 per year, conservative estimate	Change from "rapid decline" to "better conservation" in heritage for North West SDAs: £4.75 (£1.50-8.00) per hh. Good study for transfer: deals specifically with heritage defined as traditional farming practices and farm buildings, in the same region. SCaMP area approximately 4% of North West SDA area; c.2.8m hh in North West. So very roughly, allow £0.5 million per annum for cultural heritage value. This equals 19p/hh which seems "reasonable". Higher values could be justified based on % improvements in heather moor and bog (£0.75 per hh for 1%); broad leaved and mixed woodland £0.60 per hh for 1% (same study)
GHG emissions	Official carbon values DECC 2008	Assuming 2000 tCO_2 phased in over years 5 to 40 gives present value over 50 years ≈ £860,000 and ≈ £1.9m over 100 years.	Service uncertain. Without SCaMP, net carbon loss. With SCaMP, carbon sequestered, but possible increases in methane/NOx. MFF (2007) states Peak District moorlands *on average* fix c.19tC/km2 in pristine condition or emit $7tC/km^2$ in worst case. Allowing for less extreme change, assume $10tC/km^2$ difference between baseline and SCaMP, over $55km^2$ restored bog ≈ 550 tC ≈2000 tCO_2 per year. This is a rough assumption that ignores details of ongoing deterioration in the baseline. To account for delays in recovery of bog habitats, assume no benefit until year 10. Note that the escalator in carbon values partly offsets discounting. Carbon budget of change between forestry regimes could be investigated but overall likely to be minor.
Biodiversity and wildlife	Stated preference for example, Hanley and others (2002)	In order to avoid double counting, these values are assumed included within the non-use category above.	Hanley and others (2002): approx 50p per hh for 12000 ha for changing “upland conifer” to “upland new native”,: very roughly £50,000 for 450ha and North West population. Various other options however (a) difficult to be precise about improvements expected and (b) serious risk of double counting with "non-use" category above. Conservative approach to assume non-use values of biodiversity included in that.

The above estimates are preliminary, in the face of physical/ecological and economic data uncertainties. A key unresolved issue is that of water treatment costs. Water treatment can be very expensive, in particular where capital investment is required to increase treatment capacity, so this is clearly of great potential importance. There is a general trend of increasing water colour from upland peat areas, and this can lead to the existing treatment infrastructure having insufficient capability to remove all of the colour and other (often uncoloured) organic material from the treated water. There is then a risk that this material can react with chlorine, added for disinfection and (in the uplands) manganese removal, to form a class of compounds called trihalomethanes. The concentration of this class of compounds permitted in potable water is very tightly regulated at no more than 100ug/l. The potential benefits of controlling and stabilising (or reducing) raw water colour include reducing the risk of an infringement of this standard, and potentially reducing the need for investments to increase water treatment capacity.

There are initial indications that SCaMP is stabilising water colour from the area – set against on-going increases in non-SCaMP areas – and water colour could potentially improve further in future. There are long-term physical and ecological processes at work and it is too early for data to show clear results, and therefore the future benefits remain uncertain. Estimating changes in future costs is extremely difficult, not least because the additional treatment required to deal with increasing colour and organic load varies from site to site and depends on factors as diverse as the existing treatment process, location, alternative supplies, site constraints, production volumes, sludge treatment processes and host of other site specific issues.. Although it is clear that water quality benefits could be very significant, there can at present be no certainty that such benefits will exist. Water quality monitoring is of course ongoing and better estimates of future cost savings may become available in time.

Step 6: Calculation of discounted costs and benefits

The costs of SCaMP activity are split between UU funds (£9m) and public support (£3.5m); enabling expenditures such as farm buildings and fencing are £2m, while habitat restoration expenditure is £10.5m.

Table 51 below summarises the present values of impacts. The attached spreadsheet shows the calculations of net present values based on observed changes, unit values, and discount rates. Values have been calculated over 50 years and over 100 years.

Table 51 SCaMP: Economic valuation of ecosystem service changes

Service	Present value (50 years)	Present value (100 years)	Notes (and see details of unit estimates above)
Food	0	0	assumed negligible
Fibre	0	0	
Renewables	Not applicable.		
Water quality	Not valued – positive, could be very significant, but high uncertainty		
Flood risk	Not valued – positive, could be significant.		
Recreation	£4.7 million	£7.3million	based on small increase in value for large number of visits per year
Field sports	Not valued – positive, probably minor.		
Non-use: historic and cultural	£4.7 million	£7.3 million	based on small willingness to pay per household spread over population of region. Some risk of double counting with recreation.
GHGs	£0.86 million	£1.9 million	based on official values and assumed sequestration potential
Biodiversity /wildlife	Not assessed separately due to risk of double counting with non-use and recreation, and because suitable values for transfer not available,. But likely additional value.		
Total service changes	**£10.2 million**	**£16.4 million**	sum of above very approximate estimates. True benefits will be higher due to omitted categories.
Costs	£15 million	£16 million	making small *ad hoc* allowances for ongoing costs after first 10 years
Net present value	**-£4.8 million**	**£0.4 million**	Note that omitted categories likely to bring substantial benefits, hence the NPV figures are not reliable.

The above estimates need to be treated with caution, given all the assumptions and simplifications that underlie them. It is not possible to draw firm conclusions on the net present value, or the cost-benefit ratio, since we have not been able to value the water quality benefits that could potentially be substantial. The next section considers the sensitivity of this result to changes in the main assumptions and uncertainties.

Step 7: Sensitivity analysis

This case study is intended to illustrate quite a rapid appraisal applied at a wide-scale, with very uncertain data on services and values. Therefore it is particularly important to consider how the results vary as assumptions are adjusted.

The first point to note here is that the scheme looks to be breaking even over 100 years, just on the basis of those service categories for which we have estimated values. Since it is likely that there will be some water quality benefits in future, and potentially flood risk benefits, and biodiversity benefits not covered by the non-use figures above, overall it is likely that SCaMP will provide net benefits to society over the long term.

Over the shorter evaluation period of 50 years, the NPV is negative on the basis of those service categories valued. Generally, it is to be expected that investments in improving long-run ecological processes in habitats such as blanket bogs may take a long time to bear fruit. As water quality improvements are linked to these biological processes it is unlikely that SCaMP will produce short-term monetary payback. The front-loading of project costs, and the delay before benefits arise, mean that it is necessary to consider the longer time periods to get a full appreciation of the net impacts of the project.

The "low" value scenario in the spreadsheet is based on assuming a longer delay before the first benefits arise (10 years), a longer period before full benefits arise (60 years) and a lower overall level of benefit. In particular, the non-use category is omitted, considering the "recreation" figure to cover both use and non-use. The combination of these changes result in a negative NPV over 50 years and over 100 years. Again, the water quality benefits are not estimated and it is possible that they could reverse this conclusion. Generally, the benefit cost ratio is quite sensitive to the assumed time delay parameters – the longer the wait for the first impacts, and the longer the period over which the benefits are phased in, the less beneficial the project.

The greenhouse gas regulation estimates are rather uncertain, not because of the monetary value (which is fixed by DECC) but rather because of uncertainty about the exact amounts of carbon sequestered / emitted in the SCaMP and baseline scenarios, and in particular because of uncertainty about methane emissions from restored bogs. However the total value arising through the GHG regulation service is likely to be a relatively small fraction of total benefits. For other areas, where the greater distance from population centres makes recreation less important, and/or where no water quality benefits can be expected, carbon values (along with biodiversity values) could be important in justifying moorland restoration expenditures, and further research here is clearly justified.

The non-use (cultural heritage) values are significant, even though conservative assumptions are used: the average value is under 20 pence per year per household for the region, based on SCaMP covering 4% of the SDA in the region. But it could be argued that this land is of higher than average cultural value, given the SSSI, AoNB, National Park designations of large parts of the site. This could also mean that there may be some cultural/heritage value accruing outside the region, if these designated areas are considered of national importance. Similarly, the recreation benefits are based on a quite conservative assumption, that the improvement in recreation experience amounts to only 25 pence per visit, and higher values might be justified. Nevertheless, even at these levels, the non-use and recreation values provide significant support for the scheme.

The costs of SCaMP are estimated at £12.5 million, for the various restoration and construction expenditures. We have rounded this up to £15 million present value (over 50 years; £16 million over 100 years) to make an ad hoc allowance for ongoing expenditures after the restoration is complete – for example for monitoring. The ongoing expenditures could be higher though it is not possible to be precise. In practice, there will probably be additional work going forward, with additional costs, but also additional benefits not considered above. We have not considered discounting of the costs (not knowing the precise years in which they arise), which would reduce their present value somewhat.

There are other benefits not included in the monetised impacts (see Step 8 below) but these are all likely to be positive values. The exception to this is the food and fibre category, but this will have a very low value. This is a reflection of the economics of upland farming, which is essentially dependent on subsidy for survival, and in any case the SCaMP may enhance food production benefits slightly over the mid- to long-term. Overall, we do not think it conceivable that any costs under the food and fibre category could overturn the benefits arising from other services.

We have also conducted some simple assessment of possible underestimates in the values covered. The "high" value scenario in the spreadsheet considers a higher estimate of recreation values (double the base case) and a higher value of non-use (based on North-West region households' WTP for 1% increase in moorland, from eftec 2006). With these assumptions, net present values are substantial and positive over both 50 and 100 year horizons.

Taking all the above together, we think that it is likely that SCaMP has net benefits to society, compared with the "business as usual" counterfactual, and it is possible that the net benefits will be significant.

However, the scheme does not necessarily pay back immediately. In our main case, it takes over 50 years for positive returns; though in fact payback may be faster, since impacts on water quality have not been evaluated, and values may be higher. Overall the analysis suggests that the time delays are a key sensitivity that should be explored further.

This may also have implications for funding future SCaMP-like projects: our assessment has used official government discount rates, but private companies may use much higher discounting. On the other hand, water companies are required to use Green Book discount rates in official CBA (for example, under PR09) and the cost of capital to water companies may be lower than to other private sector entities; further discussion of these points is beyond the scope of this case study. In addition, many of the benefits are external to the water utility. Both points could mean that it is possible that some sustainable catchment management schemes could be socially desirable, but uninteresting to privately-run companies, and this could justify government subsidy to catchment management programmes. There are equity (fairness) as well as efficiency issues to consider here but again these are beyond the scope of this work.

Step 8: Accounting for non-monetised impacts

Several categories of value / service have not been included in our calculations including the following.

Water quality: this is undoubtedly the most important category excluded from the estimated values above. The SCaMP area is important for water supply, and in principle the activities within SCaMP should be expected to prevent further deterioration of raw water quality, and perhaps improve quality in the medium to long term. This is likely to lead to benefits in terms of reduced water treatment costs, perhaps delaying the need for upgrading treatment works, or even avoiding certain upgrades altogether. The cost savings could be substantial, however it is too early to make confident predictions of the likely values. Ongoing water quality monitoring should start to reveal better information about the impacts on water quality, and making estimates of the medium to long term savings should be a priority for future work.

Renewable energy: we have not considered this possible source of value. There is undoubtedly potential for renewable energy investments in the area (which is not to say that this would necessarily be a good place to do this, just that we are not aware of reasons why it would be impossible). However this was considered to be beyond the scope of this case study, because there is nothing in SCaMP that irreversibly precludes future investments. The costs and benefits would need to be considered separately. We could have considered additional scenarios including renewables, however we decided to keep it simple and focus on the key issue of SCaMP versus baseline.

Biodiversity: one of the main impacts of SCaMP will be to protect SSSI and important habitats. The values here are likely to be large, but have not been valued directly in this study. This is partly because of the difficulty of doing so and partly because of the risk of double-counting with the non-use values estimated for cultural heritage and landscape and with recreation values. In effect we assume that the biodiversity values are incorporated within those categories – in recreation for use aspects (viewing/enjoying biodiversity) and in non-use for “pure” conservation aspects. Nevertheless there could be additional values here and they could very well be significant.

Field sports: we have not given any value to changes in field sports. As discussed above, any change under SCaMP is likely to be positive, but probably minor in comparison to other categories.

Flood risks: SCaMP is likely to reduce risks of flash flooding in downstream areas, and the values associated with this could be significant. However we have no data on which to base an assessment.

Food and fibre: As discussed above, these values are likely to be low, approximately zero. There are physical changes (for example, reduced grazing density) but the economic values of these changes are negligible. Although there may be some costs here they are very unlikely to be significant.

The following are also excluded from the analysis:

Fire risk: we have not attempted to value changes in fire risk, or associated greenhouse gas emissions. There is likely to be a reduction in risk associate with SCaMP, and it is possible that the value of this reduction could be significant. On the other hand, we have not taken into account in the other service categories any risk of costs associated with fire.

Social and multiplier impacts: we have not accounted for social or multiplier effects, for example relating to agricultural or forestry employment. Nor have we accounted for similar effects relating to expenditures on the SCaMP (for example arising through payments to contractors for stock shelter construction, grip blocking, tree planting). Multiplier effects associated with increased tourism might also exist. These values could be significant, in particular from the social cohesion / employment in rural areas perspective. Some part of the social impact may be included under the "non-use" value of cultural heritage (that is the WTP for cultural heritage may include a WTP for supporting rural employment as part of the "package" in respondents' minds).

Climate change: we have not taken full account of the possible impacts of climate change on the area and the ecosystem goods and services it provides. There will undoubtedly be impacts, but their precise nature is difficult to assess. It seems likely, however, that the damages of climate change might be less under the SCaMP than under the counterfactual.

Almost all of the above categories are likely to give higher benefits under SCaMP than in the baseline. So although we have not been able to ascribe monetary values to all categories, we can be confident that we are much more likely to have under-counted benefits than to have under-counted costs.

Step 9: Reporting

There is substantial uncertainty about both the physical and monetary values of service changes. Considering only those service categories for which a value has been estimated, SCaMP appears beneficial over the long-run, but this is not a firm conclusion. However, several other categories have not been valued in monetary terms, but are generally thought to have positive values under SCaMP. In particular, SCaMP has the potential to generate significant water quality benefits in the future, and although it is not possible at present to be confident of this, or to estimate a value, it seems likely that even relatively modest water quality savings could be enough to ensure that SCaMP produces net benefits for society overall.

In terms of distribution of benefits, the local population should benefit overall, with the highest benefits for local farmers, and for those using the area for recreation. People throughout the UK who care about conservation in important designated habitats will also benefit (the “non-use” category above). If there are future water quality improvements or cost savings, this will bring benefits to United Utilities and its customers.

Overall, we conclude that it is likely that SCaMP provides net ecosystem service benefits, after accounting for scheme costs, suggesting that SCaMP is likely to be a sound investment for the UK as a whole. Looking to the future, there is strong justification for assessing benefits and costs of similar schemes elsewhere.

4.6 North Pennines AONB

The case study of North Pennines AONB is an overview of a wide-ranging management strategy over a very large geographical area. While economic valuation techniques could certainly be useful at this scale, the reality of this case study is that, at present, we do not know enough about how the management plan actions will influence the very wide range of ecosystem goods and services to make any quantitative predictions about service changes. This in turn means that it is not really possible to put economic values on the changes, in any more than a highly speculative fashion. The case study discusses these issues, in the context of a future fuller analysis such as is envisaged under one of the Management Plan actions.

Location: North Pennines

Area: 1985 km^2 (198,500 ha)

Characteristics: Uplands, moorland shooting estates, upland farming, headwaters of 4 major rivers, distinctive landscape, dramatic waterfalls, large areas of blanket bog, several other key habitats. High tourism use. The varied landscape of the North Pennines includes a wealth of earth science features and sites which contribute to the distinctive character of the area, and have an international as well as national importance. Geodiversity underpins the National Character Areas within the AONB; for example, Moorland Ridges are characterised by grit and limestone outcrops as well as extensive blanket bogs that have accumulated over millennia and the Moorland plateau is a landscape formed by the actions of a large ice sheet that sat on the North Pennines 20,000 years ago.

Designations: Area of Outstanding Natural Beauty (AONB). The North Pennines is also a UNESCO European and Global Geopark (reflecting outstanding geological heritage, and a leading role in using geology to support sustainable development through nature tourism, education and conservation). There are eight European sites (seven SACs and one SPA) wholly or partly within the AONB – these overlap (in particular the North Pennines Moors SAC and SPA (see Table 52). Almost 100,000ha of the AONB is designated SSSI 36.5% of the AONB area, including 23 sites notified primarily for their geological importance.

Ownership: Forestry Commission, National Trust, United Utilities - together forming the Wild Ennerdale Partnership.

Management: North Pennines AONB Partnership (NPAONB); local communities, landowners, farmers and estate managers.

Stakeholders: NPAONB Partnership, Natural England, Environment Agency for England and Wales, European Geopark Network, Moorland Association, local authorities, Forestry Commission, Tourism partnerships, Game Conservancy, landowners and tenants, Regional Development Agencies, water companies (Northumbrian Water, UU), RSPB, Joint Nature Conservation Committee and many others.

Data sources: The main data sources are the Management Plan 2009-2014, the environmental report for the SEA of that Plan, and the screening and baseline reports for the Habitats Regulations appropriate assessment of the plan.[26]

Management options: the individual management options are numerous. This case study seeks to compare a "business as usual" scenario without the management plan, and the management plan scenario. Since the management plan is extremely wide ranging, and the case study is necessarily very broad brush in its approach.

Ecosystem Services: the North Pennines AONB provides a full range of ecosystem services, including notably food and fibre (primarily from grazing), water supply, flood risk management, outdoor recreation, field sports, cultural and historic landscapes, and biodiversity conservation.

Table 52 European sites in the North Pennines AONB. Source: Habitats Regulations Baseline Report

Site	Area	Description	Status	Issues
Helbeck and Swindale SAC	136ha (100% in AONB)	Mostly broad-leaved deciduous woodland (72%) and dry grassland/steppes (16%)	6.9% unfavourable 75.5% unfavourable recovering; 17.6% favourable	Overgrazing with sheep, addressed in most areas.
Moorhouse-Upper Teesdale SAC	38,807 ha (100% in AONB)	Mostly bogs/fens etc (50%) and dry grassland/steppes (39%) but numerous Annex 1 habitats present	Not explicitly stated, but "deleterious effect on virtually all the Annex 1 habitats" noted. Assume largely unfavourable, with some recovering	Problems with overgrazing, inappropriate burning, drainage of bogs. Some localised problems solved but general issues require "fundamental policy change"
North Pennines Moors (SAC)	103,129 ha (54,419ha ≈ 53% in AONB)	Mostly bogs etc. (41%), heath etc. (32%) and dry grassland/steppes (26.5%)	Not explicitly stated, but "all interest features have been affected"	Problems of overgrazing, drainage, inappropriate burning, acid and nitrogen deposition. Some starting to be overcome.

[26] Further details available on http://www.northpennines.org.uk.

Site	Area	Description	Status	Issues
North Pennine Moors (SPA)	147,280 ha (97,923ha ≈ 66% in AONB)	Mostly bogs etc. (51%), heath etc. (42%) and humid/mesophile grassland (6.5%)	Not explicitly stated, but noted that key interests depend on sympathetic grazing and burning, in turn reliant on economics/subsidy.	Notes that problems are partly addressed via agreements, access management, pollution control.
North Pennine Dales Meadows SAC	492 ha (159 ha ≈ 32% in AONB)	99% humid grassland / mesophile grassland	Stated to show "good conservation of structure and function"	Dependent on traditional management, uneconomic so requires ongoing agreements
River Eden SAC	2427ha (42ha ≈ 2% in AONB: but AONB part of catchment).	Mostly inland water bodies (93.4%); also some key species including otter, salmon, lampreys	Not explicitly stated	Various problems noted but generally outside the AONB
Tyne and Allen River Gravels SAC	36ha (11ha ≈ 31% in AONB)	Various, mostly dry grassland/steppes (50%), heath etc (20%) and broad-leaved woodland (15%)	Not stated.	High uncertainty about ecological processes and impact of stopped mining upstream.
Tyne and Nent SAC	37ha (100% in AONB)	Mostly dry grassland/steppes (57%), mixed woodland (21%) and inland water bodies (14%)	Not stated, but problems noted	Dependent on high metal content, from mining that has now stopped.

Step 1: Defining the Baseline/Counterfactual

This case study seeks to assess the management plan 2009-2014, and the counterfactual for comparison should in principle be a "business as usual" scenario without that plan, considering how the area would be expected to evolve in the absence of the management plan. However this is difficult to determine, both because of the complexity of the area, and because the 2009-2014 plan is in many respects a continuation of work already underway through previous management, so the current trends (and "business as usual") reflect a "with management" scenario. We must address this by attempting to make realistic assumptions about what would happen in the absence of the management plan.

Indeed, the Strategic Environmental Assessment (SEA) Directive requires that the assessment should consider the projected impact on the environment of *not* implementing the plan or programme. But in the SEA for the NPAONB management plan, this step was accorded a low priority on the grounds that not implementing a plan is not a legal option. This is a debatable decision, since the obligation is to have *a* management plan, not the specific one under consideration; and in order to assess the overall impact, and value, of the management plan, it is essential to consider the counterfactual case. However trend data for environmental indicators are presented (where available) in the SEA, and can be drawn on to help determine the counterfactual case. As noted above, it should be stressed that these data, and this case study, include in the baseline/counterfactual case such work as has already been carried out towards improving the AONB – that is, the assessment here is not of the impact of AONB designation, but rather of the management plan for 2009-2014 (see Table 53).

Table 53 North Pennines: Characterising the counterfactual

Characteristic/service	Pre-plan status	Counterfactual, (without management plan)	Notes
Descriptive statistics			
Area	198,500 ha		
Populations	50814 (but includes some towns/villages slightly outside boundary)	probably some decline	65 parishes in or partly in AONB. 31 have >5% second homes, 9 have >10% second homes – implications for use and non-use value populations
Human Activities	agriculture, tourism, field sports, forestry	perhaps some decline in many uses	May depend more on economic / agri-economic conditions and policy than on management plan
External Management	30.6% of AONB area under ELS or HLS	Unclear what ESA/CSS agreements to be renewed under ELS/HLS	No targets
Habitats	JCA10: 96% of JCA 10 is "maintained", 3% "diverging" and 1% "neglected	Gradual decline:"	Overall "Joint Character Area" 10 (North Pennines) covers 93% of the area, and AONB is 88% of JCA 10
SSSI condition	14.1% favourable; 66.3% recovering 16.3% no change 3.3% declining	Recovery slowed or stopped	NE target of 95% favourable by 2010
Hay meadows	440ha: declining, even in SSSIs	accelerating decline	require specific management that is not economic without subsidy

Characteristic/service	Pre-plan status	Counterfactual, (without management plan)	Notes
Ancient woodland	1545ha: 1045ha native woodland, 500ha PAWs.. 25% favourable, 22% recovering, 49% declining, 3.3% part destroyed	accelerating decline	various pressures, require sensitive management
Blanket bog	60,068ha. Generally recovering: 9.3% favourable, 77.6% recovering, 11.3% no change, 1.8% declining	recovery slowed, perhaps reversed. No further grip blocking.	Over 3000km grips blocked so far, target to block another 1000km grips in plan; 10 year target to block all under discussion.
Ecosystem services			
Food	Uplands farming, mostly grazing, economically marginal	No concerted effort to co-ordinate agri-environment payments. Risk of ongoing overgrazing, and loss of hay meadows. No new investment in farmer training or in promoting local products.	
Fibre	Commercial forestry plantations in area	No removal of 200ha commercial forestry; no new native woodlands. No new promotion of local products	
Renewable energy provision	Wind farm at Stainmore has been proposed	Without management plan, probably more likely that wind developments go ahead	Wind development contrary to Management Plan
Water quality to downstream catchments	No data. Condition of blanket bog will be key factor.	Ongoing/increasing costs associated with water treatment costs	
Costs associated with downstream flood risk	No data. Grips in blanket bog key factor.	Ongoing risk associated with open grips	

Characteristic/service	Pre-plan status	Counterfactual, (without management plan)	Notes
Use and enjoyment: outdoor recreation	127,700ha (63%) is open access. Approx. 2000km of PROW. Pennine Way maintained, unobstructed. AONB 85% "highly tranquil" in CPRE survey. 35 tourist establishments in GTBS, 1 ecolabelled.	Declining condition of PROW. Risk of reduced accessibility of Pennine Way. Less investment in facilities and promotion of tourism.	No data on visitor numbers for AONB area
Use and enjoyment: field sports		"Business as usual", with no change to more sympathetic burning	
Non-use values from historic and cultural landscapes	SAMs (183) and Grade I/II* listed buildings (51); 13 "at risk".	Ongoing risks. Continued loss of dry stone walls. No promotion of AONB, history, understanding, and associated values.	
Greenhouse gas emissions	No data. Condition of blanket bog will be key factor.	Likely increase in emissions through degrading blanket bog	
Biodiversity and wildlife	See above for specific habitats and SSSIs.	Continued decline. Ongoing persecution of raptors.	No trend data for BAP priority habitats and species.

Step 2: Identify management options

This case study is about valuation of the Management Plan 2009-2014, which is one step in a long-term process of management of the AONB. It sets out:

- A framework under 7 thematic headings that gives guidance and direction towards achieving the long term (twenty year) Vision for the North Pennines AONB;
- 61 objectives that are intended to guide progress towards the Vision within the five year lifespan of the plan, and
- 197 detailed individual Actions required to achieve these Objectives.

The plan is therefore very broad-ranging in scope. Only five of the actions specifically identify habitat changes to be achieved, as detailed in Table 54. There is also a Geodiversity Action Plan (GAP) - the first GeoPark and UK protected landscape to produce such a plan.

Table 54 Themes, Objective and Actions in the NP AONB Management Plan

Thematic chapter	Objectives	Actions	Specified habitat impacts?
Landscape and Geodiversity	10	22	LG7:2 create 400ha of new native woodlands LG:3 restructure or remove 200ha of commercial forestry
Land management and biodiversity	11	39	LB2:1 block 1000km of moorland grips LB4:1 bring 100ha of ancient semi-natural woodlands into favourable management LB4:3 bring 100ha of plantations on ancient woodland sites into favourable management
Historic environment	7	19	No
Enjoying and understanding the NP	9	42	No
Economy and business	11	41	No
Community and culture	8	22	No
Increasing knowledge about AONB	5	12	No

The fact that the plan focuses on more "general" actions and outcomes makes it difficult to apply the economic valuation methods from the toolkit directly. This is not in the least a criticism of the plan, but rather of this toolkit – or at least, there is a great deal of additional work required to move from the statements in the Management Plan, to the identification of impacts on ecosystem services (Step 3 below). Undoubtedly the many actions in the plan will have major impacts on:

- The habitats and species and ecosystem services in the AONB (through various direct interventions, influence over agri-environment agreements, coordination of management, training land users and so on), and
- The values of ecosystem services (through promotion and marketing activities, investments in facilities, interpretation and education - overall

encouraging greater use of more services, and greater awareness of the values).

At present, we do not have enough information to make confident predictions about what all these changes would be. That would be a major undertaking, and indeed several of the actions listed under "Increasing Knowledge" in the Management Plan aim to carry out related work. Objectives in this theme include to:

- Develop baseline data and future research areas;
- Understand and plan for the potential impacts of climate change;
- Increase knowledge and understanding of geodiversity and biodiversity;
- Undertake research into tourism in the AONB, and
- Conduct research into how children benefit from the AONB.

One specific action is "Develop a project that assesses the value of the area's ecosystem services". The framework and values set out in this case study might be a useful contribution to scoping this exercise, but cannot reach the depth of analysis required for a full assessment, due to the lack of data and resources and the need to make broad-brush assumptions about service *changes*.

Step 3: Identify impacts on ecosystem services

Although we do have some quantified indications of specific habitat changes under the Management Plan (see Tables 53 and 54 above) these are patchy and we do not attempt here to estimate areas of different habitat types under the counterfactual and management plan scenarios.

Table 55 North Pennines: Changes in quality and extent of ecosystem services

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Food	Upland moorland and grassland	More environmentally sensitive management	Possible small reduction in output, offset by promoting AONB produce	Impact on profitability.
Fibre	Commercial conifer plantations; other woodland	Reduction in commercial conifer plantations. Broadleaved planting, but not commercial.	Reduced returns from timber.	Lost value of timber for paper
Renewable energy provision	Upland habitats	Uncertain. Possible that Management Plan cuts prospects for wind development	Possibly less renewable energy with management plan	Renewable capacity that has to be installed elsewhere to meet targets

Service	Key habitats	Key changes	Qualitative impact	Quantitative impact
Water quality to downstream catchments	Blanket bog especially	Likely improvement due to bog recovery	Reduced colour	Reduced treatment costs
Costs associated with downstream flood risk	Especially forest cover and blanket bog.	Blocking grips, restoring bog and planting woodland will tend to reduce flood risks	Reduction in flood risk / damages	Flood Risk quantification requires primary catchment level analysis.
Use and enjoyment: outdoor recreation	Entire area, with various key attractions.	Recovery/prevented decline of key features. Promotion of tourism, investment in facilities.	More visits, and higher value per visit.	Visitation rates, change to willingness to pay.
Use and enjoyment: field sports	Grouse shooting	More appropriate burning regimes. Some possible change in the quality of the experience	Quality of experience	Changes in grouse numbers, or prices.
Non-use values from historic and cultural landscapes	Entire site, and key natural / human built features within it.	Better conservation, and better information / promotion of these features	Greater awareness and values	Stated preference: original study or perhaps benefits transfer.
Greenhouse gas emissions	Especially bog and woodland.	Widespread bog restoration and tree planting likely to be net sinks of carbon	Mire / blanket bog habitats lay down about twice the carbon of forestry but release methane and NOx which are stronger green house gases.	Would require data on carbon flux.
Biodiversity and wildlife	Entire site, in particular SSSIs	Better conservation of SSSIs	Moving towards favourable status	Monitoring data, stated preference

Step 4: Identify human populations affected

The AoNB is a huge area and the populations affected are, for some services, difficult to specify precisely. Table 56 summarises some basic information about the service-using populations, but this could be refined with further research and data.

Table 56 North Pennines: Populations affected

Service	Type of population	Number	Characteristics
Food	Producers	Many	Mostly subsidy-dependent, or reliant on tourism / off-farm income
Fibre	Producer	Some	
Renewable energy provision	Producer	Potentially a few	Potential interest in wind power, but AoNB location makes this unlikely
Water quality to downstream catchments	Utilities	2	United Utilities, Northumbrian Water
	Customers	8 million across companies (but not all water from AONB)	
	Recreational users	Many	salmon anglers
Costs associated with downstream flood risk	Environment Agency Householders	Many	
Use and enjoyment: outdoor recreation	Local residents	50000, plus second home owners	More over 65, fewer under 25 than UK average
	Walkers Bikers	No data for AONB overall. Pennine Way: 12,000 long-distance walkers and 250,000 day-walkers per year.	
Use and enjoyment: field sports	Grouse shooters, estate owners	Many	
Non-use values from historic and cultural landscapes	Local population	50000, plus second home owners	More over 65, fewer under 25 than UK average
	Interest groups	Local interest groups, RSPB, etc.	
	Regional and National populations	Several million ≈2.8m households in North West; ≈1m in North East	
Greenhouse gas emissions	Problem of global interest. Sequestration potential contribution to UK response. May have financial value to landowners in long run.		
Biodiversity and wildlife	Interest groups General population	(As non-use)	(As non-use)

Step 5: Economic valuation of ecosystem service changes

Economic valuation is difficult *at this stage* because we do not have much in the way of quantified estimates of service changes. So the estimates in Table 57 are just rough indications of possible values. A full assessment would require a more detailed inventory of service changes, and would probably break this down into a number of smaller areas in some cases.

Table 57 North Pennines: Economic valuation of ecosystem service changes

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Food and fibre	Value output, after costs	≈0	The management plan does not target changes in agricultural output. Some changes can be expected via agri-environment agreements and so on. It is likely that the economic value of such changes will be minor relative to other values.
Fibre	Change to incomes from forestry	≈0	Within the context of the AONB, removal of 200ha of commercial conifers represents a small opportunity cost (income foregone 50 years or so in the future) and the forestry is economically marginal.
Renewable energy provision	Marginal cost of renewable capacity	potentially significant	If the impact of the management plan is to prevent wind investments, this might be a significant opportunity cost of protecting the area as an AONB.
Water quality to downstream catchments	Treatment cost changes; WTP	likely significant	although the short-term impact is limited, grip blocking and blanket bog restoration envisaged in the management plan may imply substantial savings in the future via reduced water treatment costs / investments
Costs associated with downstream flood risk	Damage costs: Werrity and others (2007); Pope 2008	possibly significant	though few households in and immediately around the AONB, there may be some reductions in flood risks downstream. Detailed modelling/mapping required to estimate changes.

Service	Valuation method(s)	Values (unit, functions, range, totals)	Notes
Use and enjoyment: outdoor recreation	SP, TC methods, or BT. Zanderton and Tol (2008); Kaval (2006); Tinch (2009)	highly significant.	Without information on visitor numbers, it is not possible to determine values. It is clear however that many of the actions in the management plan will either enhance the visit experience, or draw more visitors in, or both. This will result in increased recreation values, likely to be substantial. Assume values from higher end of ranges in studies: Zanderton and Tol find mean consumer surplus of forest trips around £15 (travel cost meta analysis). Kaval gives mean values around £40 for outdoor activities, and approx £90 for National Parks. Tinch finds £8 per visit, range £6 to £9, value of visitors for less intensive management in Peak District National Park, compared with current upland management.
Use and enjoyment: field sports	Impact of quality on uptake of hunting opportunities and on value	For main case, ≈0.	Although burning regimes are to be moderated, no major impact on grouse shooting is expected. The quality of the experience may increase as for general tourism.
Non-use values from historic and cultural landscapes	SP or BT; eftec (2006); MacMillan and Duff (1998); Hanley and others (1998)	Highly significant. AONB area ≈15% of North West SDAs; c.2.8m hh; and ≈35% North East SDAs. Could support values around £2-4million per year but not clear if all can be attributed to management plan.	eftec (2006) change from "rapid decline" to "better conservation" for North West SDAs: £4.75 (£1.50-8.00) per hh. Values heritage defined as traditional farming practices and farm buildings: quite close to actual plan. No value given for North East (results not significant, probably due to high protest bids)
Greenhouse gas regulation	DECC values (£27/tCO_2 in 2009 rising to £196 in 2109)	Possibly significant	The management plan could have a substantial impact on GHGs, in particular via blanket bog condition, and also through forestry. However the impacts are highly uncertain.
Biodiversity and wildlife	SP and BT; White and others (2001); Christie and others (2006)	Highly significant, for example, Christie and others values for Northumberland – stop decline in rare and common farmland spp., values around £100/hh/yr. But cannot claim full "stop", or ascribe all to management plan. Risk of double counting with non-use.	Baseline trend data not available. Likely that management plan will have crucial role in protecting biodiversity in key SSSIs and in the AONB more generally. Valuation not possible on the basis of information available; also risk of double-counting with non-use category.

Notes: TC – travel cost; SP – stated preference, BT – benefits transfer.

Step 6: Calculation of discounted costs and benefits

Given the major uncertainties surrounding the key value estimates, attempting to produce present value figures in a full cost-benefit framework would not be productive in this case, on the basis of the evidence currently available. We suspect that the management plan is beneficial, due to significant non-use, biodiversity and recreation values, but have no firm evidence on which to base monetary estimates at present.

Step 7: Sensitivity analysis

Since we have not attempted a full valuation of ecosystem service changes, formal sensitivity analysis is not possible. Rather, this section discusses some of the key sensitivities and issues that a full valuation would have to face.

Timescales: the management plan is for the 2009-2014 period, but considers a longer (20 year) vision. However a large part of the value of actions in the plan will be experienced over the longer term – the values arise in the future because of the potential based on where the plan leaves us in 2015, though the realisation of these values will depend on future policy and management too. While it would be possible to focus just on the values over the plan period, this would bias against the plan, because many of the benefits will take much longer to arise, in particular where the service changes relate to long-run habitat recovery. Equally, it would be “unfair” to consider the full value of future service benefits without also considering the ongoing management costs beyond 2014. The issue of timing and determination of the baseline/counterfactual will be key issues in a full assessment.

Recreation: the recreation values cannot be estimated without data on visitor numbers. Even with such data, estimates would be highly uncertain, due to underlying uncertainty about the values per trip (which will vary for the wide range of recreation types), and about how exactly the management plan will lead to changes in (a) the value of recreation experiences and (b) the number of visits. Many of the actions in the plan target recreation (improving rights of way, interpretation, promotion, green tourism and so on) and a comprehensive analysis is required – as recognised in objective IK4 of the plan, “to undertake research into tourism in the AONB...” Given the scale of the AONB and associated values, it is possible that primary economic valuation studies would be justified. If primary data are to be collected from visitors anyway via site surveys, there would be a strong rationale for extending the questionnaires slightly to allow for travel cost modelling; stated preference studies may also be indicated.

Non-use values: this category is highly uncertain, but may be the most significant. No really suitable studies are available for benefits transfer, and in particular it is unfortunate that the study in eftec (2006) did not find significant results for the North East area, due to problems with protest bidding. Nevertheless transfer from the adjacent North West area may be justified (and the AONB straddles the North West-North East boundary). There may also be non-use values for populations further afield, given the major importance of this iconic area. Double-counting is a constant problem and teasing out the strands of cultural/historical non-use values, biodiversity values and recreation values will require care. A primary study of these different values should be considered.

GHG regulation: the key uncertainty here relates to the net carbon balance, taking into account changes to soil conditions (particularly blanket bog) and forest cover. Research that will facilitate this task is proceeding and it is likely that a mapping exercise could allow at least a broad brush appreciation of the carbon flux. What may be more difficult is determining exactly how the management plan will influence this – however, to the extent that simple estimates of future forest cover and bog condition can be made, the GHG service should prove tractable in a full analysis.

Biodiversity: the values associated with biodiversity in the AONB are likely to be significant, though also possibly confounded with non-use and with recreation values in existing estimates. It may be possible to determine how the management plan will influence biodiversity – one of the plan objectives includes developing baseline data and indicators – however moving from this to economic valuation is likely to be difficult unless primary studies can be undertaken.

Step 8: Accounting for non-monetised impacts

In this case study we have not attempted full economic valuation of the ecosystem service changes, and in effect all are "non-monetised", although some flags have been raised regarding likely relative significance of different values. In a full valuation exercise, there will inevitably still be some service changes that cannot be expressed in monetary terms and it will be important to give consideration to these services, and report insofar as is possible on the quantitative or qualitative changes expected.

Step 9: Reporting

The key problem in this case study is in linking the very wide range of actions in the management plan to specific changes in ecosystem goods and services from the AONB. With what we know at present, this has not been possible to any significant extent, and the best we can do with resources available is to comment on the likely relative magnitudes of changes, and on the strategies to be adopted for a deeper assessment: such an assessment is envisaged under the "Increasing Knowledge" theme (IK2:2 "Develop a project that assesses the value of the area's ecosystem services"). The magnitude of such an undertaking, and the prerequisites in terms of data and modelling of the impacts of management plan options, should not be underestimated.

4.7 Summary of lessons learnt from the case studies

Inevitably, some (possibly most) of the assumptions in the above case studies are naive. The science is complex and the data are uncertain. A full application of the toolkit would require a larger team of experts from many disciplines, more detailed local knowledge, and a longer period for data collection and assessment. This was beyond the scope of this project, and the expertise of the staff involved, but could be achieved within the framework of an ongoing assessment of any particular case. The uncertainties would not be fully resolved, but the assumptions would be more robust.

Nevertheless, despite the uncertainties and the over-simplifications, the case studies have a number of useful features.

The six case studies together demonstrate some of the strengths and weaknesses of the assessment methodology proposed. Overall, the method is useful in providing a clear and consistent framework within which the analysis and economic valuation of ecosystem service changes arising from management interventions can be set out in a logical sequence.

The main problems facing the case studies, and the methodology generally, relate to data gaps and uncertainties. In order to complete a valuation exercise, it is necessary to determine how the management interventions will change the environment, how this will influence ecosystem goods and services, who is affected, and what the values of these changes are.

One strength of the framework used here is that it shows where key data gaps and uncertainties lie – for any given service category, do we know what the change will be in qualitative terms, quantitative terms, and monetary terms? We might have good physical data, but no valuation evidence; or we might have good unit economic values, but no physical data to apply them to; or the key uncertainty might relate to the size of the human population benefiting from a service; and so on. This is useful information for each service, showing what steps need to be taken in order to complete valuation for changes in that service, or showing what factors are responsible for according a low confidence value to an estimated value.

It is also useful for demonstrating which uncertainties are most important to the overall evaluation of the management intervention. The calculation of net present values, augmented by the sensitivity analysis and consideration of non-monetised factors, can help to determine the robustness of conclusions and to prioritise research needs by flagging up those service changes most likely to influence the "bottom line" result.

In some circumstances, there is uncertainty about the (physical) size and (economic) value of the non-monetised changes, but near certainty concerning their direction or sign. Where we can construct a clear argument is that the omitted values could only enhance the conclusions based on monetised values. This suggests that these conclusions can be considered robust, and that resolving the uncertainties may not be a priority, unless there are other reasons for needing these values (for example, as a basis for payments for ecosystem services).

The results of the case studies presented here also allow some general conclusions regarding the values of ecosystem service changes in upland areas. Although agriculture and forestry are important uses of uplands areas, food and fibre values are generally a minor part of the overall value of ecosystem services. Indeed, these activities are economically marginal at best, and in many cases dependent on subsidies. Agricultural practices can have high values in some cases, but this is due to their role in maintaining landscape, heritage and biodiversity more than the raw value of agricultural output.

For the areas considered here, recreational and conservation non-use values are thought to be very significant, but difficult to measure with precision and rather uncertain using benefits transfer techniques. Biodiversity values may also be high, but even harder to measure, and to disentangle from recreation and non-use (the concepts can be kept separate in principle, but the valuation studies available do not allow clear boundaries to be drawn). Nevertheless, using conservative assumptions, and sensitivity analysis, it is generally possible to generate ballpark estimates for recreation and non-use service changes. This can be enough to demonstrate that it is highly likely that some management scenario is more beneficial than a "business as usual" approach, in cases for which the differences in environmental conditions, and therefore in service values, are large. The substantial uncertainties would be more of a problem where we need to select the best option from a set of more similar management regimes.

The uncertainties are not just related to economic values. Often, there are major uncertainties regarding the physical or ecological impacts, and/or how these influence services. For water supply quality, and for greenhouse gas regulation, the economic valuation step is not the problem – we have official values for GHGs, and have (or could find) reasonable estimates of water treatment costs. What is missing is the clear relationship between specific management interventions, and the impact in terms of GHG fluxes or raw water quality. This data/knowledge gap is being addressed through a number of research and monitoring projects, and there are excellent prospects for better valuation of these services in the near future.

For the recreation, non-use (cultural/heritage) and biodiversity values, there are important uncertainties at all levels: how specific management changes will affect these services, what populations are affected, and what their values are. Resolving these issues can be done to some extent using better data collection and monitoring (for example on visitor numbers and how these change) but there is also a need for further economic valuation studies aimed specifically at valuing changes in uplands management.

One particular problem is that it is difficult to tease out the differences between use and non-use values in some contexts. They are *conceptually* distinct, and both 'exist' in the sense that people will have values for their own use (recreation) and also values for bequest, altruism and existence, but the separate elicitation and reporting of these values in studies requires care. There is a need for clearer distinction between recreation values and non-use values in valuation studies. At present, these values are difficult to separate out and this leads to a double-counting / under-counting risk.

New studies should seek to tease out different sources of value, should explicitly address the ways in which values vary among different affected populations, and should be designed to facilitate benefits transfer to other uplands areas. Scale issues should be addressed – it is likely that studies should be conducted at the landscape / catchment scale, but attention needs to be given to how values can be scaled down to more local management interventions, or up to a regional level. An additional problem encountered in the case studies is the appropriate treatment of region-based values (in particular, the eftec (2006) values for conserving SDAs) when the assessment area lies on borders. Generally, a more sophisticated approach to identifying populations, and distance-decay of values, would be desirable, and valuation studies should be designed with this in mind.

The overall conclusion to be drawn from the case studies is that it is possible to use economic valuation methods within a simple, logical framework to give useful results regarding the benefits and costs of management changes in the uplands. Although there are significant uncertainties, and much more physical, ecological and economic research could be useful, it is generally possible to derive indicative figures for the economic values of service changes, that can be sufficiently robust to allow some conclusions on the likely range of benefit:cost ratios. The level of precision that is possible using benefits transfer and existing knowledge is quite low, however, and only really supports broad-brush assessment. It is unlikely to help distinguish between similar competing management options, but can be useful in demonstrating the value of management compared to 'do nothing' or 'business as usual' scenarios, in contrasting very different management options, and in building a business case for interventions.

5. Conclusions

The toolkit presented and tested above aims to provide a framework for conducting economic valuation of changes in ecosystem goods and services arising from land use management changes in UK upland areas. The approach is based on five main concepts or paradigms, discussed in more detail in Annex 1:

- Ecosystem services framework(s);
- Total Economic value;
- Economic appraisal;
- Environmental valuation, and
- Benefits transfer.

The framework is therefore fundamentally anthropocentric, and to the extent that other factors – moral obligations, intrinsic values - are considered relevant to decision making, they must be taken into account in other ways, alongside the cost-benefit analysis.

The steps of the toolkit form a clear and logical framework within which our knowledge and data can be set out and used to construct an economic appraisal of likely service changes. The steps are:

1. Defining the counterfactual or baseline;
2. Identifying management options;
3. Identifying impacts of management changes on ecosystem goods and service;
4. Identifying human populations affected;
5. Economic valuation of ecosystem service changes;
6. Calculation of discounted costs and benefits;
7. Sensitivity analysis;
8. Accounting for non-monetised impacts, and
9. Reporting.

The steps 1 to 4 are primarily concerned with gathering and setting down all important information about the case, how it will evolve in the absence of management changes, how management changes can alter that future, how that will influence the goods and services valued by humans, and who the humans affected are. Steps 5 and 6 draw primarily on economic methodologies to estimate values for the changes in services: this may involve primary valuation studies, though in most cases benefits transfer will be used. Discounted costs and benefits are calculated for each service category; the values may also be summed across categories, but it is important to bear in mind three key considerations:

- Uncertainties about physical/ecological relationships, leading to uncertainty about service changes;
- Uncertainties about ecosystem service change valuation, or errors in benefits transfer, leading to uncertainty about the value of service changes; and
- The existence of non-monetised service changes, which are therefore not represented in the summed figure, but may be highly valuable nonetheless.

These factors are taken into account in Steps 7 and 8. The final reporting step, Step 9, needs to draw general conclusions and in particular to use the results of Steps 7 and 8 on an even footing with results of Step 6: that is, it is important not to be 'seduced' by the apparent solidity of the monetary estimates into overlooking either the underlying uncertainties – which may often be large – or those service changes for which monetary estimates have not been possible – which may nonetheless be important changes.

The toolkit looks at a wide range of ecosystem goods and services from upland areas, but the list is not exhaustive. In any particular case, there may be additional services that need to be considered. One example is the fire regulation service, which appears to be important in many areas, and is likely to become more so as climate change proceeds.

The toolkit is tested out in a set of six case studies (see Section 4). Some of the methods and assumptions used in the case studies are rather ad hoc. These could be refined, with considerable additional work, beyond the scope of this project. But it is mostly work of the sort that might be undertaken anyway when conducting more detailed assessment of the likely implications of different management options: designing economic valuation into option appraisal from the start will result in much more effective and cost-effective appraisals than retrofitting valuation to existing studies.

To a greater or lesser extent, there are uncertainties – physical, ecological and/or economic - in all the ecosystem services examined. In particular, we need more work looking at underlying soils and how this influences services (to some extent this work exists, but our naive (economists') interpretations of habitats in this report do not reflect the full range of information available).

The overall conclusion to be drawn from the case studies is that it is possible to use economic valuation methods within a simple, logical framework to give useful results regarding the benefits and costs of management changes in the uplands. There are generally substantial areas of uncertainty, both in the natural science and in the economics, and further physical, ecological and economic research will always be useful. Nevertheless, it is generally possible to derive indicative figures for the economic values of service changes, and in many cases these can be sufficiently robust to allow some conclusions on whether or not particular changes are likely to be beneficial in economic value terms. The level of precision that is possible using benefits transfer and existing knowledge is quite low, however, and only really supports broad-brush assessment. It is unlikely to help distinguish between similar competing management options, but can be useful in demonstrating the value of management compared to 'do nothing' or 'business as usual' scenarios, in contrasting very different management options, and in building a business case for interventions.

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Appendix 1: Conceptual framework for ecosystem service valuation

There are five key concepts underpinning the methods outlined in this report. They are in common use in the environmental economics literature. References are given where appropriate, but for greater readability where concepts are widely understood and commonly used without citations, these are omitted. The concepts are discussed in this section in the following order:

- **Ecosystem services framework(s)**: for assessing the goods and services provided by ecosystems;
- **Total Economic value**: considering that part of human values that is reflected through preferences of individuals, revealed through trade-off between money (as a representative index of other resources) and changes in the quality or quantity of resources (termed willingness to pay or willingness to accept);
- **Economic appraisal**: the measurement of changes in social welfare by aggregating indices of individual values;
- **Environmental valuation** techniques for estimating the economic values of changes in goods and services, and
- **Benefits transfer**: the use of economic value evidence from one site for application to appraisal in another site.

1.1 Ecosystem services framework

Definitions

Defra (2007) describes ecosystem services as "the wide range of valuable benefits that a healthy natural environment provides for people, either directly or indirectly. The benefits range from the essentials for life, including clean air and water, food and fuel, to things that improve our quality of life and wellbeing, such as recreation and beautiful landscapes. But they also include natural processes, such as climate and flood regulation…".

Ecosystem services, and economic valuation, are anthropocentric perspectives: an essential feature is that humans benefit. Thus ecological functions are not necessarily services: we also need some human population that uses the function, or its end products. Ecological functions exist and can be described independently of human use and values, but ecosystem services only exist in the context of human use. The fundamental proposition of the 'ecosystem services paradigm', is that there is a causal link between underlying ecological structures and processes, and specific, measurable benefits to humans (Haines-Young and others 2009). This report is concerned with economic valuation of changes in ecosystem services, and so is firmly in an anthropocentric mode. Hence we consider ecological functions only through their impacts on ecosystem services used (or potentially used) by humans.

The most commonly used categorisation of ecosystem services is based on the Millennium Ecosystem Assessment (MA) (2005), featuring provisioning, regulating, supporting and cultural services:

- Provisioning services – products obtained from ecosystems, including fresh water, food, fibre, genetic resources, biochemicals, natural medicines and pharmaceuticals;

- Regulating services – benefits from the regulation of natural processes, including air quality regulation, climate regulation, water/flood regulation, erosion regulation, water purification, disease and pest control, pollination, buffering pollution;

- Cultural services – benefits people obtain from ecosystems through recreation, aesthetic enjoyment, appreciation of heritage and tradition, learning, 'sense of wonder' and various other non-material benefits, and

- Supporting services – underpinning production of all other ecosystem services, including soil formation, photosynthesis, primary production, nutrient cycling and water cycling.

However this is not the only possible classification and other approaches are discussed in the literature. Boyd and Banzhaf (2007) consider that "services" should be defined only as the directly consumable end-points of ecosystem functioning. Fisher and others (2008) on the other hand suggest that ecosystem services can include ecosystem organization or structure as well as process and/or functions, provided there are humans that benefit from them: services may be consumed actively or passively, directly or indirectly. Haines-Young and others (2008) present a framework in which indirect drivers (such as demographic change) and direct drivers (such as land management) impact first on functions, then in turn on services and finally on benefits (see Figure 1).

Fisher and others (2008) describe a similar framework in terms of intermediate services, final services, and benefits. For example, water flow regulation and filtering can be seen as "ecological functions" or as "intermediate services"; clean water provision as an "ecosystem service" or "final service", and the domestic consumption of water as a "benefit".

Martin-Lopez and others (2009) distinguish among:

- Natural capital: the capacity of ecosystems to exert ecosystem functions and provide ecosystem services to society;

- Ecosystem functions: the capacity of ecological processes and structure to provide services that satisfy human well-being, and

- Ecosystem services: benefits provided by ecosystems "that contribute to making human life both possible and worth living".

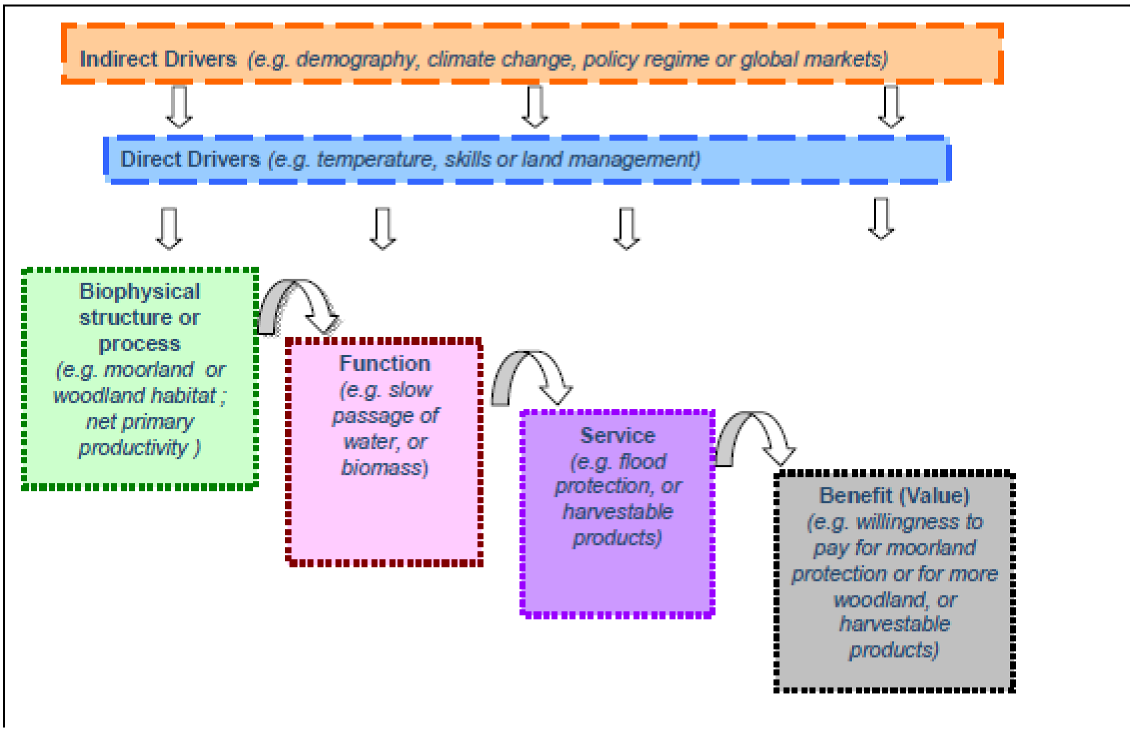

Figure 1: Ecosystem Services and Benefits (Haynes-Young and others, 2008).

Other authors suggest slightly different definitions within what is currently a rather lively scientific debate. But, pragmatically, for valuation and appraisal, it does not matter too much where exactly we put the boundaries of the "service" concept, provided we recognise four key facts:

- The ecosystem services framework is a model or tool created by humans to help recognition and assessment of the ways in which ecological systems and functions support human values;
- The concept of economic value can apply to any of the categories in the model, not just "final" benefits to humans;
- Values at different "levels" are not independent, but are rather derived from values at "higher" levels: the economic value of an ecological function or intermediate service, in these frameworks, is derived from the value of the final ecosystem services and consequent benefits to humans that it supports, and
- Any values that are interdependent cannot be added up together without double-counting.

Double counting

The main problem with the MA classification, in the cost-benefit and valuation context, is the risk of double-counting – for example nutrient cycling (supporting service) and water flow regulation (regulating service) lead to water supply (provisioning service). Each service could be valued in economic terms, but the values should not be added together, since (part of) the value of nutrient cycling and water flow regulation derive from their impact on water supply. This has led some authors to suggest valuation should be limited to final services only.

Double counting is much less of an issue when the objective is not valuation and appraisal, but rather education and communication regarding the ways in which ecosystems support human well-being. Omission is more of a problem in such contexts: we want to move from thinking of "water supply" as something that simply happens, to seeing it as a complex result of underlying functions including flow regulation and nutrient cycling, and so need to discuss all aspects.

An approach of valuing only the directly-used end points of ecosystem services – the "benefits to humans" above - can avoid this double-counting problem. However, it could mean very complex presentation of values in some cases, in particular where the end-uses are complex and/or distant in time or space (as for example with greenhouse gas regulation) or where the end-values are derived in complex ways from combinations with other environmental or man-made features (as for example in tourism). This can reduce the usefulness of the framework from a heuristic or communication perspective, and increase the difficulty of its application.

Similarly, the framework needs to take account of non-ecosystem inputs that are used in translating the service to benefit. We have already noted that a human beneficiary is an essential component of the "service" concept. Other aspects may also enter this ecosystem-human interface – for example various infrastructure requirements enabling recreational tourism. Careful treatment may be needed (depending on the context and purpose) to apportion benefits across natural and man-made features, or between different natural features.

The issue here is not one of fundamental categorisation of services, but rather of accounting consistency, and fitness for purpose. The same service could be both intermediate and final, depending on the benefit of interest, and the accounting boundaries or scale of assessment. The scale and purpose of analysis are important determinants of the appropriate level at which to apply valuation: at the UK level, for example, it may be most useful to value the final "water supply" service, whereas for consideration of specific land management changes in an upland area, it may be more useful to focus on valuing water flow regulation and filtering, via their contribution to water supply outside the local area.

Spatial classification

Fisher and others (2008) note that alternative classification frameworks might be appropriate for uplands management, in particular to take account of the spatial characteristics of services. They suggest that such a classification might include categories such as:

- In situ, for local services and benefits (for example, local environmental quality);
- Omni-directional, for local services benefiting the surrounding landscape without directional bias (for example, carbon storage);

- Directional, for services providing benefits in a specific location/direction (for example, downstream water quality and flood control), and
- Scale qualifiers (local, regional, global).

Such an approach could undoubtedly be useful, in particular for considering equity aspects and possible financing options, including payments for ecosystem services. It could also be useful at the valuation stage, where it can be necessary to determine the human population affected by changes in benefit levels. But note that the area in which the service is provided, the area in which the benefit is experienced, and the general location of the beneficiary are all different concepts – for example a tourist experiences locally produced service and benefit, but may travel long distances to do this. So the spatial categorisation mooted by Fisher and others (2008) is useful alongside, but not as a substitute for, other categorisation methods.

Conclusions

Ultimately, the objective is to take account of all the ways that changes in ecological systems impact on human values, and how that is best achieved will depend on the boundaries of the problem under consideration. Fisher and others (2008) call for a "fit for purpose" approach, arguing that no single categorisation will be suitable for all applications. This is an important observation, because, as noted in the introduction, ecosystem service valuation can aim to achieve multiple goals. Now we must realise that the best framework might vary according to the goal. The best framework for cost-benefit accounting might not be ideal for communication and awareness-raising; the best framework might vary with the geographical scale of the assessment; and so on.

We can consider this as steering a course between two extremes:

- A framework focused on valuing end benefits: this reduces risks of double counting, but the objects of valuation are removed from management changes by possibly long and complex chains of cause and effect, including interactions with other natural and man-made resources, and
- A framework focusing on changes in functions and services directly dependent on management changes: this helps clarify the link from management to service, but increases complexity of the valuation exercise, which may make double-counting harder to avoid.

These options are not really different in fundamentals, but rather in presentation: it's a matter of where between "management" and "end user" we choose to put the measuring device. In any given application, this could depend on the boundaries of the analysis, the characteristics of the value chain, the objectives, the data availability, the social and political context of the exercise, and the geographical scale.

An important consequence of this is that we need not make the same decision for each and every service: for some, it will be more appropriate, or more convenient, to value at the function stage (for example, greenhouse gas regulation) while for others we may need to focus on the end users (for example, recreation). The details of how this can be applied to upland services are set out in Section 2.2.

1.2 Total Economic Value

"Value" can have many meanings, so we need to be clear about exactly what we mean by Total Economic Value (TEV). The TEV conceptual framework is based on classifying the different sources of value to individual humans from the natural world. It splits value into "use" and "non-use" components.

- Use value
  - Direct use
    - Consumptive: personal use of resource in which the resource is used up, for example, food and fibre.
    - Non-consumptive: personal use of resource in which resource is conserved, for example, recreation. The boundaries may be blurred here by congestion or damage to the resource.
  - Indirect use: where the service leads to benefit by its impact on another production or consumption process, for example, role of watersheds in reducing flood risks, or flood protection expenditures, downstream.
- Option value
  - Option value: value of keeping open option to use resource in future over and above any current and planned future use. Only exists because of uncertainty about future preferences and/or availability of the good, and risk-averse preferences.
  - Quasi-option value: value of avoiding/delaying irreversible decisions where changed technology or knowledge could alter optimal management. Particularly relevant to conservation, where possible future uses or roles in ecosystem stability and service provision are not known perfectly, and where events such as extinction, invasive species introduction or habitat transformation can be irreversible
- Non-use value
  - Altruistic: value of knowing that others can use an ecosystem.
  - Bequest: value of knowing ecosystem preserved for future generations to use.
  - Existence: value of knowing ecosystem exists, not associated with any current or future human use. This is different from intrinsic value (see below) because it is a value to humans.

These are all parts of economic value because they are all reflections of different ways in which individual humans value environments and their goods and services. Changing the level of provision of an environmental good or service results in changes in the levels of these values, or components of welfare, and the sum of these changes gives a measure of the total economic value to the individual.

Other value concepts

The TEV measure does not cover all possible types of value. In particular, the natural environment, in whole and in parts, is often considered to have 'intrinsic value' (value in and of itself), over and above any human values for appreciation, use and enjoyment of environmental resources. Although this may be true, humans can have no way of assessing or measuring such values, and can take them into account only very imperfectly through moral arguments for restricting our interference with nature.

"Socio-cultural" values are also sometimes distinguished from TEV. These values are derived from moral, ethical and cultural principles "that differ from utilitarian criteria, and therefore, we do not express them in monetary terms" (Martin-Lopez and others 2009). However, though it is undoubtedly true that people do have moral, ethical and cultural principles relating to nature conservation, it is not obvious that these cannot be captured, at least partly, through TEV. Indeed it is these moral values that underpin the expression of non-use values in stated preference studies: why else would people express WTP for resources they don't use, including values for the 'mere' existence of the resource, except because of some ethical views that the resource 'ought' to exist, and/or that it should be preserved for the future, and/or that others should be able to enjoy it?

Willingness to Pay as an index of Total Economic Value

We can derive an index of economic values for any given change by looking at trade-offs that an individual is prepared to make. Considering some proposed improvement in environmental quality that would result in changes to the above components of TEV for an individual, we ask, what is the most of some other good or service the individual is prepared to give up in order to secure the improvement in environmental quality? The answer expresses, for that individual, the value of the environmental change in terms of the value of the other good or service.

The other good or service (the "numeraire") could be anything, but to be useful as an index, should be some easily understood quantity. For reasons of convenience and comparability, money is generally used. This has several clear advantages, in particular that people in modern societies are well used to using money in a very wide range of trade-offs (buying most of their daily necessities and luxuries, selling their labour, trading-off through time via borrowing and saving, donating to charitable causes).

To the extent that individuals attempt to use their financial resources to maximise their personal welfare (and this is not necessarily the same as personal material comfort, due in particular to the inclusion of altruistic non-use values) this makes monetary value, expressed as willingness to pay (trade-off) for different goods and services, a useful index of personal welfare[27].

1.3 Economic appraisal

Economic appraisal attempts to assess the social welfare impacts of the changes in resource allocations arising from a project or policy. Social welfare is not necessarily a simple additive function of individual welfares: it may also depend on the equity of distribution[28], and some individual values may be considered non-valid from a social perspective (for example preferences for illegal drug use).

Nevertheless, in our society we do rely on markets to allocate a large proportion of resources. We adjust allocations through tax and benefit policies, and public spending on services. We also use laws to limit permissible uses of money and resources. Beyond these readjustments and limitations, we accept that access to resources, and welfare, vary considerably among individual members of society. To the extent that we assume the overall policy mix is appropriate, using sums of individual WTP values to assess the social welfare impact of small changes to overall allocations is an acceptable approximation.

The most common approaches to economic appraisal, cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA), do exactly that, adding up net costs and benefits across individuals and across time. UK Government policy supports the use of these methods, and the HMT Green Book (HM Treasury, 2003) on appraisal states “Calculating the present value of the differences between the streams of costs and benefits provides the net present value (NPV) of an option. The NPV is the primary criterion for deciding whether government action can be justified.” Other methods are also used – for example MCA (multi-criteria appraisal) and LCA (life-cycle assessment) but these methods are not discussed in this report.

Schemes for “equity weighting” in appraisal are sometimes proposed, but rarely implemented. It is more common to have separate identification of winners and losers, alongside economic appraisal. A formal approach to this, the “Sugden approach”, is under consideration in the UK (Defra 2007d) but is not currently official policy.

Weighting across time, using discounting, is almost universally applied, both because it is theoretically strongly justified, and because using no discounting leads to counter-intuitive results. Discounting allows comparison of costs and benefits that

[27] Personal welfare here refers to the individual’s perception of his or her wellbeing. The TEV framework is individualistic, in the sense of not being paternalistic (it is the individual’s own perceptions/values that are counted), though not in the sense of being selfish (“personal welfare” can include altruistic and non-use motives).

[28] In addition a willingness to pay index is personal, since the welfare from one additional pound varies among individuals, for various reasons including differences in incomes and wealth. Simply aggregating monetary values across individuals ignores these points, and so is not necessarily the ‘best’ index of social welfare.

occur in different time periods, based on the principles of time preference (people prefer to receive goods and services now rather than later) and the opportunity cost of capital (resources invested now can give a profitable rate of return in the future).

The exact choice of discount rate is a source of perpetual debate, but we can avoid the details and defer to official UK policy on discounting (from Green Book), which states that the recommended discount rate is 3.5%. However for projects with long-term impact – over 30 years, which will be the case for uplands management projects – the guidance requires use of a declining discount rate, primarily as a way of accounting for uncertainty about the future. The rates are shown in Table 58.

Table 58 UK official discount rates

Period (years)	0–30	31–75	76–125	126–200	201–300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

Source: HM Treasury, 2003

Note that discounting is nothing to do with inflation. All costs or benefits in economic appraisal should be expressed in 'real terms' ('constant' prices), rather than 'nominal terms' (current prices). Generally the most convenient and intuitive base year is the year of the study. Published GDP deflators should be used to update values from earlier years (correcting for the impact of inflation), and any future price estimates that include inflation should have this removed.

The mathematical details of discounting are set out in the Green Book, but for application purposes it is sufficient to take the list of discount factors for each year, listed on page 100 of the Green Book: to calculate a present value, a cost or benefit "X years from now" needs to be multiplied by the discount factor listed for that number of years in the future. The calculation of *net* present values simply means summing together the discounted costs and benefits over all the years of the analysis – this can be done for the whole case, or for specific ecosystem services (for example, to calculate the net present value of a GHG regulation), or for specific groups (for example, to calculate the net present value of impacts on local farmers).

There are some key principles that should guide economic appraisal and the use of environmental valuation techniques:

- Appropriate effort for appraisal: the decision-making context, legal requirements, option characteristics, location, habitats affected, uses of the environment, scale of environmental effects and so on will determine the 'accuracy' that is needed from economic value evidence. This, in turn, determines the effort that is appropriate both for economic valuation and appraisal.

- Sensitivity analysis: limitations of data and uncertainty over environmental effects and monetary values can be partly addressed by sensitivity analysis. Analysis should be proportionate to the decision in-hand.

- Transparency of analysis and ensuring an ‘audit trail’: key assumptions, limitations, omissions and uncertainties should be explicitly reported.
- CBA and similar methods are approximations based on imperfect indices of social welfare. Other information will also often be relevant. Economic appraisal methods should always be considered as decision support tools: an aid to structuring certain types of information for decision making, not a replacement for deliberation or consideration of other evidence.

These points need to be kept in mind both through the development of the appraisal methodology, and in its application; in particular, in reaching decisions about appropriate levels of effort, including where to target scarce resources in resolving uncertainties or improving valuation data.

1.4 Environmental valuation techniques

Estimating the total economic value of changes in provision of goods and services, in the framework set out above, is a matter of estimating and aggregating individual willingness to pay for changes. This can be done in many ways, depending on the characteristics of the good or service and the ways in which it is allocated and used. The main techniques are surveyed briefly below – this is only an overview, and there are many nuances and complications not touched on here.

Measuring Willingness to Pay through markets

Where goods and services are traded in markets, market clearing prices act as indicators of marginal willingness to pay (marginal value). Prices act as signals guiding the allocation of scarce resources amongst competing ends, and if markets operate well, the resulting allocations are efficient in the economic (Pareto efficiency) sense that it’s not possible to find an alternative allocation in which nobody is worse off.

Under such conditions we can use the market values (prices) as good indicators of value to humans, for small (marginal) changes in quantities of goods or services. Where larger (non-marginal) changes are under assessment, we should not use simple prices, but should instead attempt to estimate demand curves, which explain how price (value) varies with the quantity of the good or service. Demand curves can be estimated econometrically from market data, and once this is done economic appraisal involving only goods and services traded in well-functioning markets is fairly straightforward.

Market failures

However there are many forms of “market failure” that create inefficiencies and prevent markets from reaching efficient allocations. Common failures include imperfect or asymmetric information, high transactions costs, monopoly power, distorting taxes and subsidies, and externalities. Where these failures exist, prices will not be accurate indicators of value.

Externalities are real side-effects of production or consumption of some good or service that are not fully taken into account by the producer or consumer and that cause loss of welfare to third parties[29]. Most common examples are environmental – an activity has an impact on the environment through pollution or resource depletion that is not taken into account by the actor.

Externalities can be considered as a problem of incomplete markets: no market exists for the environmental impact in question, generally because there are no clear property rights defining who owns the right to do specific things with a resource (though there are often restrictions on what uses are legal). This in turn is often because the environmental impacts or services have public goods characteristics, to a greater or lesser extent, being non-rival (consumption by one person does not reduce the opportunity for consumption by another) and/or non-excludable (it is not feasible to limit benefits to specific "customers"). Beyond compliance with legal limits and standards, actors have no incentive to take account of the externality, and may behave in ways that create too much of negative externalities (such as pollution) and not enough of positive externalities (such as carbon sequestration or flood protection).

Non-intervention solutions to externality

The existence of externality does not necessarily mean that policy is required to correct the problem. Cases in which policy may not be needed include, for example:

- Transactions costs: for minor externalities, or where the processes leading to externality are highly complex, the costs of policy to correct the problem may outweigh the potential benefits;
- Voluntary action: the potential creators of externalities may voluntarily take into account the impacts on others. This is quite common for some actors and some externalities: many people voluntarily recycle waste, for example; and,
- Coasian bargaining: externality creators and sufferers/beneficiaries can negotiate directly to seek a mutually beneficial outcome. This is most likely where there are few parties potentially involved in negotiations – that is, few externality creators and few sufferers/beneficiaries – because where many parties are involved, the costs of reaching agreement can be too great.

These points are relevant to the analysis of ecosystem services in UK uplands. Voluntary actions are common: for example farmers/landowners who view themselves as custodians of the countryside, making efforts to reduce their negative impacts on the environment, enhance conservation, and/or facilitate access for recreation. Initiatives such as SCaMP can be viewed as large-scale implementations of Coasian bargaining.

[29] An impact on the environment that does not affect someone's welfare is not an externality – but welfare covers both use and non-use values, so this is not unduly restrictive.

Where such “solutions” to market failure exist, legislative responses to perceived problems may have negative impacts, by interfering with processes that are in fact capable of dealing with the problem. This needs to be taken into account in determining policy for dealing with externalities. This report however is dealing primarily with economic appraisal, not environmental policy. The possible “institutional” solutions to market failure are of much less direct relevance to environmental valuation. They can be relevant to economic appraisal, to the extent that they influence baselines and the outcomes of different policy options.

Environmental valuation techniques

Environmental valuation techniques essentially seek to answer the question “what would the price be if there were a market for this?” – or more accurately, “what would the demand curve be?”, because price changes with quantity of a good or service, and often we are interested in the value of sizeable changes in quantity and/or quality. There are three main families of valuation techniques:

- Market-based techniques: using evidence from markets in which environmental goods and services are traded, markets in which they enter into the production function for traded goods and services, or markets for substitutes or alternative resources. These can be applied for example to food and fibre (direct markets), flood risk (for example, a production function relating the expected damage of flood risk to environmental conditions, rainfall, protection expenditures, and value of property exposed), and water quality (market for bottled water).

- Revealed preference (RP) techniques: based on interpreting actual behaviour with both environmental and market elements. Recreational values are often assessed using RP techniques, and aesthetic elements may also be valued this way.

- Stated preference (SP) techniques: based on stated behavioural intentions in hypothetical markets. Very widely applicable, used for example for biodiversity, and the only techniques capable of capturing non-use values.

The main variants of these techniques are described below.

Market values: can be calculated for traded ecosystem goods and services. Where markets exist, this method is relatively straightforward. The values do not account for any externalities associated with the production and use of marketed ecosystem goods and services. It may be necessary to adjust for taxation or for subsidy – in UK uplands, this is the case for agricultural production.

Proxy values including production function, avoided costs and replacement costs:

- **Production function**: an extension to market valuation, in which statistical analysis is used to determine how changes in some ecosystem function affect production of another good or service which is a traded resource. The primary difficulty in this method is the availability of scientific knowledge and/or data, necessary to allow estimation of the production function.

- **Avoided cost**: value certain services through the reduction in costs that would have been incurred in the absence of those services. In an uplands context, this is particularly relevant for downstream flood control, where reduced flood risk leads to avoided flood damages.

- **Replacement cost**: estimates a value based on the cost to replace an ecosystem function or service. In some cases, the method is applied to entire ecosystems – for example, the cost of providing new habitat to compensate for habitat losses. More generally the method refers to replacing ecological functions with human-engineered alternatives. For the uplands, examples include valuing downstream flood control at the cost of engineering alternatives (flood defences), or the costs of treating water to remove discolouration.

Travel Cost: assesses the demand for recreation in an area through econometric estimation of a demand function based on survey data relating to individual costs of travel and other expenditures to participate in recreation. This method is widely used and is a relatively inexpensive extension to simple collection of visitor data. It only accounts for the benefits of direct use for recreation.

Hedonic Pricing: determines a value for aesthetic or environmental quality aspects of an ecosystem by statistical analysis of property markets, assuming that the sale or rental values of properties can be explained as a function of a wide range of property “attributes”, including variables relating to environmental quality. The technique is often employed to assess nuisance from noise, traffic, or proximity to waste or quarry facilities, and to assess benefits of location near water bodies (rivers, lake shores, beaches). The technique only accounts for use values associated with occupation of the property. It may be difficult to separate out precise sources of value – for example, appreciation of landscape/view, proximity to recreation facilities, peace and quiet. Its applicability in uplands is likely to be limited due to low population densities: the method can only pick up use values of environmental quality associated with purchased composite goods, typically housing, whereas the bulk of use values of environmental quality in the uplands are more typically experienced by visitors, not residents.

Contingent valuation: surveys establish hypothetical markets in order to determine WTP for some specified change in a whole ecosystem or some subset of its components, goods and services. The technique can be used for valuing non-use benefits which are otherwise not possible to assess using market or RP techniques.

Choice experiments: or related techniques such as conjoint analysis and contingent ranking. CE methods are similar to CV : rather than directly posing a WTP question, CE derives WTP values from statistical analysis of observed choices from multiple hypothetical scenarios. Each scenario includes a small number of features, one of which is some measure of monetary payment (entrance fee, tax, …), and at least one other representing the ecosystem good(s) or service(s) under consideration.

Some common measures are not true economic value estimates, because they are not based on consumer demand but on costs of supply: for example, estimates based on costs of recreating a damaged resource, or replacing it with a substitute resource. Although these estimates can be useful in certain circumstances, in particular putting ceilings or floors on value estimates, great care is needed if using them for CBA purposes. Assuming the value of a resource is equal to the costs of replacing it makes costs equal to benefits by definition, making the CBA a meaningless exercise.

Measures are sometimes used that are not directly based on either demand or supply but rather on policy instruments – for example values based on subsidies available under Higher Level Stewardship. Under certain circumstances, using these values can be justified through arguments about the assumed optimality of policy, or consistency across related areas of policy. However they are clearly not direct estimates of value, and again are of no use in evaluating the policies from which they are derived.

Alternative methods outside the economics paradigm are sometimes used. Defra (2007) notes "non-economic valuation methods" for exploring preferences and opinions expressed in non-monetary formats. Such methods include individual preference indices through surveys and ranking exercises (without monetary components), and group-based prioritisation methods such as focus groups or citizens' juries. Discussion of such methods in the context of environmental valuation and decision making can be found, for example, in eftec and Environmental Futures (2006). "Biocentric" methods not reliant on human preferences are also sometimes used: for example embodied energy and "emergy" approaches. These methods represent additional tools for taking better account of environmental impacts, and can be used alongside economic valuation methods, but are outside the scope of this research.

Determining the objects of valuation

Some form of scientific analysis is generally used as a part of valuation, in order to translate some complex or higher-level impact into more easily understood goods and services. In upland valuation, for example, scientific analysis may be used to convert changes in management practices to changes in ecosystem functions such as water storage and filtration and then into changes in measurable ecosystem goods and services such as water supply and purity and downstream flood risk.

It is possible to conduct valuation without this stage. Revealed preference techniques look directly at behaviour, and so reveal preferences about whatever people think the case to be, rather than what the case actually is. Stated preference techniques can be applied directly to management changes, though a good study will require presenting respondents with information about the likely effects of the change. But for many goods and services scientific assessment is a necessary precursor to valuation.

Various forms of theoretical or statistical modelling may be used. 'Dose-response' methods, for example, are commonly used to construct functions relating measures of air pollution to estimates of health impacts and damage to vegetation and built environment, which can then be valued using valuation techniques. Bayesian Belief

Networks (BBNs) are a more recent method: Haines-Young and Potschin (2008, 2009) report application to UK uplands.

BBN models can be very versatile, for example incorporating modelling of management decisions within the BBN (for example, Aalders, 2008). This could be useful for the many cases in which the different likely behaviours of land managers under different scenarios is an important factor in estimating and valuing likely outcomes. For example, at 'X-Dale'[30], a key issue is what behaviour could be expected from estate managers if there were no agreement, and grazers gradually stopped exercising grazing rights.

Limitations in data availability and scientific understanding can restrict the usefulness of the framework to some extent. This is not unique to economic valuation: for example, Haines-Young and Potschin (2009) suggest that, rather than using their Bayesian Belief Network models "to build operational decision support systems", they could be considered "as a tool box that can help people represent complex problems, assess the likely consequences of decisions, and identify where judgements are based on empirical data." Barton and others. (2008) similarly show that while a BBN can help "integrated, inter-disciplinary evaluation of uncertainty" and may have advantages for risk communication with stakeholders, this can be offset by "the cost of obtaining reliable probabilistic data and meta-model validation procedures".

The economic valuation framework can be used as an extension to the BBN framework – though the valuation framework can also use many other forms of input – and similar comments can apply: the framework is ideally suited to decision support system, but in practice data limitations may prevent full cost benefit analysis; nevertheless, the framework can still be useful as a heuristic, a way of structuring information, a communication tool, and a guide for research effort.

Scale-related errors

There are several scale-related errors that need to be kept in check in environmental valuation applications. Double-counting of services has been noted above. Other errors can arise from issues such as:

- Failure to take account of diminishing marginal WTP for goods and services: substitution effects and part-whole bias. This can be a particular issue for recreation values, where the existence of substitute sites may limit the losses or gains at a site under consideration. It can also arise for conservation, where for example the value of the 1000th hectare conserved may be much less than the value of the 2nd, and the value of increasing populations of a species is similarly unlikely to be linear.

- Failure to take account of complementarity and embedding effects. In contrast with substitution effects, where goods are consumed jointly, this will tend to bias WTP estimates downwards.

[30] Anonymised for confidentiality – see case studies.

- Failure to take account of distance decay in WTP, or otherwise mis-specifying the population affected by a change. Use values should generally decrease with distance, because of the higher costs of travelling further and likely increasing availability of substitutes. Estimating the distance-decay effect is important in determining the populations affected by a change, for calculating aggregate WTP. When values are expressed per household, the size of the affected population, and the way in which WTP declines with distance from the affected area, are key issues. This applies in particular to use values; distance decay for non-use is much less pronounced, because there is no direct link from distance to non-use. Hanley and others (2003) report more rapid distance decay for use values than for non-use values (as expected) and no significant effect for a general class of environmental good, where a significant effect exists for a specific local example of the same class. They also report a substantial part–whole effect in aggregating non-use values.

1.5 Benefits transfer

Benefits transfer is the transposition of economic values estimated for one good (such as an improvement in environmental quality at a particular site) to value another good (a similar improvement at a different site). The typical benefits transfer terminology refers to the original study as providing the ‘study site’ or ‘study good’, and the context for which economic valuation evidence required as the ‘policy site’ or ‘policy good’.

The rationale for benefits transfer is that using previous research results in new valuation contexts saves time, effort and expenditure compared with undertaking original research. Accordingly, Defra (2007) states that “use of such transfers is seen as being essential to the more practical use of environmental values in policy-making.”

In practice, there are two main approaches to benefits transfer, which differ in the degree of complexity, data requirements and the reliability of the results:

(i) Unit value transfer

Study good value estimate [for example, £/hh/yr]

⇨ Policy good value estimate [£/hh/yr] = $£_{SS}$

Where $£_{SS}$ denotes the benefit estimate at the study site (SS).

The study good estimate may also be adjusted using the ratio of a factor (typically income) expected to influence differences in study and policy good values

⇨ Policy good value estimate [£/hh/yr] = $£_{SS} \times (a_{PS}/a_{SS})$

Here term the a_{PS}/a_{SS} is taken to be the ratio of policy site and study site average income and PS denotes the policy site and SS the study site.

(ii) Function transfer

Study good valuation function [for example, £/hh/yr = f (A_{SS})]

⇨ Policy good value estimate [£/hh/yr] = f (A_{PS})]

Where *A* is a set of factors that are found to statistically influence economic value.

The risk of obtaining misleading results may be controlled and reduced by integrating more explanatory variables into the function transfer. However, this also increases the data requirements and the complexity of the analysis. Recent tests show that the best benefits transfer results may be achieved if the variables included in the functions are those that are easily generalisable (e.g. income) rather then factors that are too specific to study site.

In addition, the possibilities of conducting a sound and reliable benefits transfer hinge on the number, quality and diversity of valuation studies available. The larger, the better, and the more diverse the existing set of studies is, the more likely will there be a primary study that is 'close enough' to the policy good for results to be transferable. Study quality is also an important criterion and should be addressed via the conventional approaches for assessing the validity of economic valuation studies (see for example Bateman and others., 2002). Other points of caution include treatment of distance decay relationships in the aggregation of benefit estimates (Willis and Scarpa 2006, Bateman and others., 2006a) and the issue of independent valuation and summation (eftec, 2007a).

Although benefits transfer is used extensively in practice and is certainly a valuable input to CBA, its limitations should be recognised. The robustness of the process depends on the success of the 'matching' of the policy good circumstances to an appropriate study good as well as on the quality of the original economic valuation study. A number of criteria have been identified in the literature for benefits transfer to result in reliable estimates (for example, Desvousges and others., 1992; Loomis and others., 1995). These are summarised in Brouwer (2000):

- Sufficient good quality data;
- Similar populations of beneficiaries;
- Similar environmental goods and services;
- Similar sites where these goods and services are found;
- Similar market constructs;
- Similar market size (number of beneficiaries), and
- Similar number and quality of substitute sites where the environmental goods and services are found.

Above all, the local circumstances in the policy good need to be close enough to the ones prevailing with respect to the study good(s). Not explicitly stated in the criteria, but clearly implied, are judgements as to the vintage of studies and the transferability of WTP estimates over time (see for example Brouwer and Bateman, 2005), and also the transferability of WTP estimates across countries (see for example Navrud and Ready, 2007).

Several studies seek to assess the validity of benefits transfer, by comparing values derived from benefits transfer to a site, with values derived from a primary valuation study at the site. For example, Lindhjem and Navrud (2008) report mean (47%) and median (37%) transfer errors for a meta-analysis value-function transfer of contingent valuation results for non-timber forest benefits in Scandinavian studies. The transfer error is lower than that resulting from simple mean unit value transfer from studies within a single country (86%, 41%), and lower still than for mean unit value transfer from the whole data set (166%, 85%). Brander and others (2008) note that this provides support for meta-analysis value transfer, but at the same time illustrates systematic differences in values between even rather similar countries.

Randall and others (2008) note that, while useful meta-analysis functions can be derived, this is hampered by shortcomings in the data sets: too many studies "fail to meet minimal standards for inclusion in meta analysis and, among those that do, there is too little consistency in methodological details and the specification of environmental descriptors – these are serious impediments to empirical generalization."

eftec is currently developing benefits transfer guidelines for Defra that are based on the above principles and illustrating applications of different approaches through case studies. The guidelines are expected to be available in summer 2009.

1.6 Conclusions

The framework outlined above for the economic valuation of ecosystem goods and services, using estimates of Total Economic Value, based on individual willingness to pay, for aggregation within a cost-benefit analysis, is fundamentally anthropocentric. Further, it only focuses on human values expressible through preferences about outcomes, and willingness to pay. Thus it is only a partial approach – though we would argue that it does cover a large part of what most people and decision makers would consider to be important, and moreover those elements that can be meaningfully quantified for the purposes of decision-making, including equity considerations. But to the extent that other factors – moral obligations, intrinsic values - are considered relevant to decision making, they must be taken into account in other ways, alongside the cost-benefit analysis.

Appendix 2: Review of valuation studies

The following tables review the valuation evidence available for the different ecosystem services. Unless otherwise stated, the values are derived from UK studies. Further information is noted about the specific good under valuation, the location, and whether the value is total or for a marginal change. The potential suitability for benefits transfer to UK uplands is indicated in the last column. All values have been converted to £ in 2008 values.

Table 59 Actual values and benefits transfer for Food and Fibre (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Yousefpour and Hanewinkel (2009)	Computer modelling using TreeGrOSS	Global utility of forests for timber havesting, carbon sequestration, and biodiversity.	Timber value avg. £11,437.72/ha (53% of total) Carbon value £2,691.60 (12%) Biodiversity £602.69 (3%) Standing volume £6,923.85 (32%)	Very broad approach.	Not applicable here.
Penning-Rowsell and others (2005)	Avoided housing and feed costs from grazing	Value of grazing day per livestock unit (dairy cow = 1lu; beef cow=0.8; 24 month beef=0.7; sheep plus lamb = 0.14)	£1.22/lu spring £0.87/lu autumn £0.41/lu winter	Covers changes in drainage: good to bad = 14-21 days reduction in spring, autumn. Good to very bad, 28-42 days reduction spring, 28 autumn, no stock out winter	Perhaps, but uplands-specific estimates should be feasible.
Penning-Rowsell and others (2005)	Production function / market prices	Estimates of returns and costs per head and per ha	Sheep per ha: gross margin £251/ha, after full fixed costs £-394/ha. Beef cattle, £369/ha, after full fixed cost £-256/ha		Perhaps, but uplands-specific estimates should be feasible.

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Penning-Rowsell and others (2005)	Market prices	Value of land "lost to agriculture"	65% of prevailing land price	The 65% correction takes account of agricultural subsidies.	Yes – an appropriate rule of thumb.
Forestry Commission	Market prices	Coniferous Standing Sales Price Index (CSSPI) of avg. price per cubic metre overbark standing achieved for Forestry Commission standing sales.	£10.68 avg. price/m^3 overbark		Varies with changes in the size mix
MLURI and others (1999)	Market prices / production function	Values of Scottish forestry	See Table 60 below.		Out of date, but could be updated
SAC (2005)	Market prices / production function	Scottish upland grazing	Upland breeding red deer - £251/ha £2656/100 hinds. Beef upland suckler - Silage feeding/ha (cow) Feb-April £363 (£189) May-June £432 (£242) Aug-Oct £430 (£275) Straw feeding Feb-April 261 (£107) May-June £268 (£102) Aug- Oct £350(£140) Black face ewes - £295/ha £2890/100 ewes		Only as first approximation if local estimates not available.

Table 60 Costs, incomes, and net profits or loss in various types of woodlands in Scottish Forestry (£, 2008)

Value: note that these are costs/benefits per rotation, and have been rounded off.	**Existing Native Woodland**	**New-Planted Native Woodland**	**Commercial Conifer Plantations**	**Farm Woodlands**
Approximate rotation length	-	70	50	50
Average costs per ha (£)	300	1250	1600	2270
Grant income per ha (£)	270	620	270	1820
Average value of Output per ha (£)	160	520	2010	1380
Profit or loss (£)	130	-120	680	930

Source : Scottish Forestry: An Input-Output Analysis (MLURI and others, 1999)

Table 61 Actual values and benefits transfer for Renewable Energy Provision (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
DECC (2008)	Market data/proxy	The marginal cost of delivering renewables from other sources	£125.15/MWh		Official value
Bergmann and others (2006)	CE	External impacts of renewables in Scotland	£8.97 high landscape impact to zero £4.69 slight wildlife damage to zero £13.26 slight wildlife damage to improvement £15.64 slight increase air pollution to zero		Difficult: imprecise specification of impacts.
EC (2003)	Summary of external cost estimates	External costs in pence per kWh Does not include risk or decommissioning costs for nuclear.	Wind: 0.1 Coal and lignite 3.5–5.7 Biomass 0.8 Oil 2.3-4 Gas 0.8-1.6 Nuclear 0.2	Climate change impacts, public health, occupational health and material damage	Yes
Ek (2002)	CE	Wind power in Sweden	18p/kWh compensation for location in mountainous region 13p/kWh compensation for large wind park 27p/kWh premium accepted for offshore		Not directly. But supporting evidence for visual intrusion disbenefit in mountainous areas, contrast with offshore.
Alvarez Farizo and Hanley (2002)	CE and CR	Quantifying public preference over the environmental impacts of wind farms in Spain	Cliffs: £19.20/yr Flora & Fauna: £33.73/yr Landscape: £33.04/yr		Yes.
Hanley and Nevin (1999)	CV	Values of residents to secure renewable projects	Wind farm: £66.82 Biomass: £30.42 Small-scale hydro: £64.57	Unusual case because schemes would generate profit for local community. Net values not reported	No.

Table 62 Actual values and benefits transfer for Water Supply (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Moran and Dann (2008)	Various	Economic value of water use in Scotland Paper recognises oversimplifications in methods, especially for agriculture. Hydropower values depend on cost of electricity displaced. Lower values for coal (but note carbon impact)	£0.71/Ml (CV) £0.68/Ml (demand function) £0.58 to 0.91/Ml (cost of supply) £3-167/Ml for industry £244-£1463/Ml for agriculture £0.52-£8.67/Ml for hydropower		To the rest of the UK, however only as rough estimate, based on quite simplified methods.
NERA and Accent (2007)	CV	Value placed by households on improvements to water environment brought about by WFD (England and Wales)	£45 to £170 per hh per year, for 95% to High Quality status by 2015	Not really about water supply, but rather environmental benefits associated with WFD	Yes, but not for water supply – more about general environmental quality associated with water environment. Hence limited applicability to uplands.
Johnson and Markandya (2006)	TCM	Use value of rivers in England for angling, included analysis of the uplands, specifically linking the travel cost method to a participation model.	WTP per trip for a 10% improvement in river water quality between £0.05 and £1.33 for individual factors.	Coverage of lowland and chalk streams although the results reported here are for uplands only.	Yes, but the link to uplands management may be limited.
Hynes and Hanley (2006)	TCM	Value of whitewater rafting in Ireland	£50-98 consumer surplus per trip.		Yes for rafting, but the link to upland management will be too tenuous for valuation.

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Pretty and others. (2003)	Damage cost	England and Wales costs of eutrophication.	£75.79-114.03 million per year	Value made up of: reduced value of waterside property, drinking water treatment costs, reduced recreational and amenity values, reduced value of non polluted environment, negative impacts on biota, reduced tourism revenues.	Mainly downstream impacts, not related directly to upland management.
Willis (2002)	Short run marginal cost / long run marginal cost	For overall value of water quantity for the provision of drinking water abstraction	See Table 63 below	Cost only.	Yes: value depends upon water company and area but is provided for each
Spurgeon and others (2001)	CV	Improve size and number of fish in nearest waterbody	£4.38 per household per year		No: probably too difficult to make clear link from flow levels to fish populations
Willis and Garrod (1999)	CV and CE	Forestry impacts on water flow. Angling and general amenity values (CV). Restoration to environmentally acceptable flow regime (CE, CV)	Recreation £4.60 per day for anglers to improve low flow (aggregates to £6,047 - £38,707 per river per year). EAFR 5.7 pence per household per km		Only for areas “severely affected” by low flow – values too high for less affected areas.

Table 63 Long Run Marginal Cost Estimates in £/m3 (Values from Willis 2002, converted to £, 2008)

Water company	**Resources**	**Treatment**	**Bulk Transport**	**Local Distribution**	**Total LRMC**
Anglian					
Anglian	19	14	17	1	51
Hartlepool	n/a	n/a	n/a	n/a	15-31
Dwr Cymru	n/a	n/a	n/a	n/a	54
United Utilities	23	6	13	14	56
Northumbrian					
Northumbrian	13	6	33	15	66
Essex	n/a	n/a	n/a	n/a	51
Suffolk	76	0	0	13	89
Severn Trent	16	15	17	16	65
South West	24	24	n/a	8	57
Southern					
Kent Medway	n/a	n/a	n/a	n/a	97
Kent Thanet	n/a	n/a	n/a	n/a	87
Sussex Hastings	n/a	n/a	n/a	n/a	45
Sussex Coast	n/a	n/a	n/a	n/a	31
Sussex North	n/a	n/a	n/a	n/a	26
Hampshire South	n/a	n/a	n/a	n/a	24
Thames	49	6	2	1	57
Wessex	14	14	29	86	145

Water company	Resources	Treatment	Bulk Transport	Local Distribution	Total LRMC
Yorkshire					
Yorkshire	29	0	0	2	31
York	0	12	15	5	31
Bournemouth & West Hants	20	10	0	30	61
Bristol	16	2	0	0.00	19
Cambridge	47	5	0	10	62
Dee Valley	12	21	0	29	62
Folkstone & Dover	42	4	21	0.00	66
Mid Kent	0	110	0	29	139
Portsmouth	4	0	1	6	10
South East					
Northern	19	10	13	27	69
Southern	28	52	35	27	141
S Staffordshire	9	7	17	13	48
Sutton & E Surrey	44	0	n/a	29	73
Tendering Hundered	37	7	0	10	56
Three Valleys					
Three Valleys	9	16	15	0	41
North Surrey	40	33	28	5	n/a

Notes: Prices from September 2000, converted to 2008 GBP and rounded up to whole £s.

Table 64 Actual values and benefits transfer for Impacts on Downstream Flood Events (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Pope (2008)	Hedonic		4% lower house prices in flood zones		Not ideal. From US (N. Carolina)
Werrity and others (2007)	Direct economic loss to households	Social impacts of floods on Scotland	£34,720 for damage to buildings, £14,318 for damage to contents.	Does not cover wider welfare effects, costs of temporary relocation, losses to industry	
Penning-Rowsell and others (2005)	Market values for losses to households	Economic loss of damages to properties	Standard values for property type, age, size etc. by depth of flooding		Yes – used in appraisal of flood and coastal erosion risk management schemes
RPA (2005)		Benefits of reduced health risk	£224 per household per year in high risk area		
Werrity and Chatterton (2004)		Economic cost of inland flooding in Scotland	Average £35.8 million per year		Location specific – not generally transferable

Table 65 Actual values and benefits transfer for Outdoors Recreation (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Hill and Courtney (2008)	Trip generating function (TCM method but no monetary value)	Countryside woodland areas in Britain	n/a - but implications for benefits transfer of TCMs.		Report that data issues, in particular the quality of available visit data, severely limit transferability.
Zandersen and Tol (2008)	Meta-analysis of TCM: 26 studies in 9 countries (7 from UK)	Consumer surplus for forest trips	£0.57 /trip to £97.52/trip; Mean £15.06, median £3.94		
Hynes and others (2007)	TCM	Farm commonage site in Connemara, Ireland	£25.60 /trip	Substitution effects not considered: could overstate WTP. Beach access, machair grassland.	
Phillip and Macmillan (2006)	CV	WTP for car parking in Cairngorms	Mean WTP £2.77; £4.04 if hypothecated	Indicative of difference between use and non-use, but not reliably	Strong anchoring effect (to actual car park charge)
Euromontana (2005)	CV	Enjoyment of public benefits associated with the uplands	£52.74 per UK household	Participants mostly users of uplands but may contain non-use values.	Only 190 participants in two locations. Postal survey.

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Kaval (2006)	Meta-analysis drawing on studies from several countries.	All activities (values per person day)	£41.01 (sd £65.19)	1229 studies (global)	
		Backpacking	£89.06 (sd £38.91)	6 studies.	
		Birdwatching	£81.36 (sd £86.15)	8	
		Camping	£25.73 (sd £27.66)	48	
		Cross-country skiing	£21.71 (sd £8.16)	12	
		Downhill skiing	£23.18 (sd £13.13)	5	
		Fishing	£35.81 (sd £66.72)	173	
		General recreation	£57.12 (sd £121.23)	52	
		Hiking	£21.34 (sd £24.72)	68	
		Horse Riding	£12.53 (sd 0)	1	
		Hunting	£32.50 (sd £25.48)	274	
		Mountain biking	£117.91 (sd £203.32)	32	
		Picnicking	£48.43 (sd £73.97)	13	
		Rock-climbing	£74.58 (sd £51.82)	27	
		Sightseeing	£36.33 (sd £52.89)	39	
		Viewing wildlife	£30.66 (sd £30.54)	240	
		National parks	£86.77		
		National forests	£37.28		
		State parks and forests	£35.93		
Fitzpatrick and Associates / Coillte (2005)	CV	Recreation in Irish Forests	£4.44 average per visit		
Willis and others (2003)	Public surveys. The specific valuation techniques are not described.	Average amenity value of UK woodlands	£172.77/ha/yr		

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Grijalva and others (2002)	Contingent Behaviour (combines elements of SP and TCM)	Restriction to access for rock climbing. Users surveyed for changes to visitation rate – value derived from travel costs incurred.	£510 seasonal loss per climber for closure to two of four areas and £954.41 for closure of three areas.		US study.
Hanley and others (2002a)	TC RUM	Rationing of open access upland areas – costs of policies to restrict access	-£14.57 to -£16.90 seasonal change in compensating variation (variation between sites and policy)		Looks at implications of parking costs and increase walk on visitation rates for mountaineering. Identify over crowding of resources and implications for utility and environmental stress.
Hanley and others (2002b)	CE	Valuing demand for recreation – using rock climbing as an example	Extra metre: £0.13 One hour reduction in approach time: £13.53 Crowded to not: £21.23. “Very scenic”: £29.21. “Three stars” climbs: £35.89		Sets out study design for valuation of recreational demand.
Brouwer and Bateman (2005)	CV	Recreational Benefits Norfolk Broads	£363.36/hh/yr	Flood protection and water quality included in value.	Not specific to the uplands. Relevant as shows valuing the same resource with similar samples five years apart can give different values.

Study (name/date)	**Method**	**Notes**	**Value**	**Other services?**	**Benefits transfer?**
Christie and others (2000)		Improvements to recreational facilities in the Grampian region. Values per household per year:	£4.98 for path maintenance £2.80 for upgrading paths £3.34 for new short paths £1.87 for new long paths £4.60 basic facilities £2.00 user facilities		
Scarpa and others (2000)	CV	Forests in Ireland	£0.82-£2.35 WTP at the gate; avg. 35p higher if nature reserve		
Liston-Heyes and Heyes (1999)	TC	Consumer surplus of a trip to Dartmoor National Park	£13.06 and £16.72/day for day visitors and £4.17 and £30.43/ day for overnight visitors.		Range depends on time value: lower if excluded, upper if 43% of wage.
Scarpa (1999)	TC	Forests in Northern Ireland	£1.39-£8.47	Values for trips where main purpose is forest visit.	
Bullock and Kay (1996)	CV	Southern uplands	£89.34 visitors; £107.46 general public		Odd result that public WTP more than visitors. Likely reflection of part-whole bias.
Gourlay (1996)	CV	Loch Lomond Stewartry	£26.67 residents; £2.56 per visit. £16.83 residents, £3.28 per visit		Tax vehicle for residents; entrance fees for visitors.
Bateman and others (1993)	CV	Mean visitor WTP for the Yorkshire Dales	£34.70		
Garrod and Willis (1992)	TC	Open access forest resources	£5.04, £3.03, £1.09, £0.86, £3.32 and £2.79 for the New Forest, Brecon, Buchan, Cheshire, Lorne and Ruthin respectively.		High variation in values highlights the issues of using travel cost for benefits transfer

Study (name/date)	**Method**	**Notes**	**Value**	**Other services?**	**Benefits transfer?**
Willis and Garrod (1992)	Hedonic Pricing	Amenity value of forests in Great Britain and its impact on the internal rate of return from forestry	Broadleaves increase property values; sitka spruce reduced.		
Benson and Willis (1991)	CV	New Forest visits	Consumer Surplus: Over £607/ha/yr Values per visit from £1.91 - £3.81		

Notes: CE = Choice Experiment; CV = Contingent Valuation; RUM = Random Utility Model; SP = Stated Preference; TCM = Travel Cost Method.

Table 66 Actual values and benefits transfer for Field Sports (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
www.britishmoorlands.com	Market price	Grouse – walked up, August, Speyside (September – same, plus hares) Pigeons over decoys, August, Speyside Rabbits walked up / bolted, Speyside Ducks flighting, September October-January, add pheasants etc	£125/day up to 3 birds; +£85/day extra brace £100/day £60/half day £50/evening £110/day		Scottish walked up values likely to be less than North England driven
Gunsonpegs.com	Market price	Grouse shoot: 50 brace, N. Yorks. Stag stalking near Oban	£995 £400		
IEEP and others (2004)	Market price	Grouse shooting	£57/bird £9,098-11,374 per party day		
Curtis (2002)	TC	Salmon fishing in Ireland	Approx. £111/day		
Fraser of Allander Institute (2001)		Prices of shooting on Scottish moors	Driven shooting £47 - £279 per brace (average £115.2); Walked up £17 - £118 per day (average £63.5); Over dogs £47 to £83 per day (average £63.5).	Costs not values	Scotland
Phillips and others (2001)	Market prices	Value of grouse shooting	£105/brace		South Scotland.
Radford and others (2001)	Implicit price models	Explaining values of fisheries as function of characteristics	Values for different types of fishery	Not WTP estimates	Perhaps, if link from water quality to fishery characteristics possible

Study (name/date)	**Method**	**Notes**	**Value**	**Other services?**	**Benefits transfer?**
Spurgeon and others (2001)	CV	Consumer surplus for angling trips	£2.47/trip for coarse £3.17/trip game		Only if possible to show link to trips
Swift (2001)	Damage costs	Damage caused by deer to forestry	£4.7m/year	External benefit of culling deer is to keep this damage down	Not directly
Bullock and others (1998)	Market prices	Previously paid by respondents in study	£213/day average. £308/day for stags.		
Bullock and others (1998)	CE	Values are for changes from “normal” Scottish conditions. Here quoted for UK stalkers – results also available for Europeans, and for stalkers who prefer roe deer.	Examples: Open range—abundant deer/poor quality, £125 Open range, better quality, £85; Mixed hill/forest with other game, £134; Full Caledonian pine forest, £-250		Perhaps, for valuing changes from initial conditions.

Notes: CE = Choice Experiment; CV = Contingent Valuation; TCM = Travel Cost Method.

Table 67 Actual values and benefits transfer for Cultural and historic non-use values (£, 2008)

Study (name/date)	**Method**	**Notes**	**Value**	**Other services?**	**Benefits transfer?**
Randall and others (2008)	Meta-analysis	Open space in agricultural landscapes: value in £value/acre/year, with 90% confidence interval	Viewing (scenic), only 50.43 (11.67 – 222.73) Open space, only 64.93 (7.42 – 637.42) Habitat, only 76.51 (23.33 – 254.55) All 3 services, at mean values 207.76 (98.64 – 444.39)	Combination of use and non-use values.	
eftec (2006)	CE	Cultural heritage in severely disadvantaged areas. Note that values for ‘small’ change not statistically significant. Ranges cover mid-point estimates for different GOR regions in England	‘Small’ change (‘rapid decline’ to ‘no change’): £0 - £8.86 per household per year ‘Large’ change (‘rapid decline’ to ‘much better conservation’): £4.43 - 24.36 per household per year	Combines use and non-use. Potential overlap with visual amenity	Not beyond ballpark – cultural heritage is broadly defined to include aspects such as traditional farm buildings, presence of animals on the hill, traditional breeds and/or traditional farming practices.
IREM/SAC 1999, 2001, Oglethorpe (2005)	CV / meta analysis	ELF model: landscape features throughout England	See table 68		
Hanley and others (2003)	CV	Biodiversity value of forests	Average value £444.60/ha/yr, based on household values Replanted area (£0.40/hh/yr) New broadleaves (£0.58/hh/yr) Ancient semi-natural forest (£1.15/hh/yr).		

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Hanley and others (2002)	CV	Absolute WTP values per household for an increase in 12,000 ha. Surveys in Birmingham, Bridgend, Croydon, Manchester and Newcastle.	Upland Conifer Forest - £0.29 Lowland conifer forest - £0.38 Lowland ancient semi-natural broad leaved - £1.32 Lowland New Broadleaved Native Forest - £0.98 Upland Native - £1.05 Upland New native - £0.71		
Hanley and others (2001)	CV	WTP per household per annum for increases in field margins and for protection of hedgerows from losses	Field margins: Cambridgeshire: £13.95 to £20.20 East Yorkshire: £15.60 to £22.26 Hedgerows: Devon: £17.78 to £31.93 Hereford: £12.94 to £31.57	Part of ELF study	
White and Lovett (1999)	CV	To conserve National Parks	Mean value of £3.75 per individual per year for Levisham estate within Moors National Park. For all UK parks, £144		

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
MacMillan and Duff (1998)	CV	Regeneration of native woodlands in the proposed Cairngorms National Park. Favoured by 67% of respondents surveyed, and opposed by 24%.	£29.56 per household per year (including compensation for those against; £65.27 otherwise). Net benefits of pinewood restoration: £47/ha/yr in Affric and £266/ha/yr Strathspey	Plan that featured a large-scale deer-culling programme	Likely to contain non-use and use values. Park iconic: indicative/ballpark, but not direct BT.
Hanley and others (1998)	CV	Breadalbane ESA	DC results: £51.73 (public mailshot); £70.20 (face to face) £89.90 (visitors); residents not enough “no” responses to calculate. Open ended WTP £38.	Combines use and non-use	Not beyond ballpark. DC results are after correcting for part-whole bias, but probably still high.
Hanley and others (1998)	CE	Breadalbane ESA	£62.14 (woods) £8.19 (archaeology) £28.26 (heather moors) £25.68 (wet grassland) £13.92 (drystone walls). Total £133.01/hh/yr	Combines use and non-use	Not beyond “ballpark”: likely part-whole bias, and imprecise improvements (“less” to “more”)
Garrod and Willis (1997)	CR	1% (3000ha) increase in remote upland coniferous forest	Mean WTP per household per year : £0.38 to £0.44		
Taylor and others (1997)	CV/CE	Mean WTP to pay per household per year	Selective felling: £16.26 / £3.84 Organic forest shape: £17.54 / £6.09 Diverse species mix: £14.33 / £4.18 Ideal forest: £48.13/£36.79		

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Garrod and Willis (1994)	CV	Local nature conservation, Northumberland	£14.22 for one extra reserve of each habitat type		
Willis and Garrod (1993)	CV	Landscapes in Yorkshire Dales	WTP £34/ha/yr for "today's landscape" Visitors: £36.77 Residents: £31.25 General Public: £31-38.1		
Cobbing and Slee (1992)	CV	Protect Mar Lodge Estate	£20-41 per household		
Hanley and Craig (1991)		Prevent commercial afforestation of the flow country with non-native species	£455/ha		
Dixon (2002)		Preferences for native woodlands and heather moorland landscapes			

Notes: CE = Choice Experiment; CV = Contingent Valuation

Table 68 Values from the ELF study (Oglethorpe 2005) (£,2008)

English Region		NE	NW	Y&H	EM	WM	E	SE	SW
Hay Meadow	Lower	22.16	22.69	29.70	26.75	21.31	73.67	32.49	9.11
	Upper	36.75	38.15	49.30	45.41	35.49	125.96	53.80	15.11
	Average	29.45	30.42	39.51	36.08	28.40	99.82	43.15	12.12
Heather Moorland or Heathland	Lower	1.04	3.10	1.36	6.91	11.02	35.51	11.12	3.30
	Upper	2.67	7.90	3.47	17.56	28.05	89.93	28.08	8.43
	Average	1.86	5.50	2.41	12.24	19.53	62.72	19.60	5.87
Rough Grazing	Lower	2.35	3.27	3.03	3.94	6.00	5.74	7.02	3.70
	Upper	4.39	6.10	5.66	7.37	11.22	10.75	13.17	6.91
	Average	3.37	4.69	4.34	5.66	8.62	8.25	10.10	5.31
Woodland	Lower	5.79	7.74	5.02	4.99	5.07	4.63	2.98	2.28
	Upper	8.72	11.65	7.55	7.52	7.62	6.98	4.50	3.42
	Average	7.26	9.69	6.28	6.26	6.35	5.81	3.75	2.85
Headlands	Lower	6.29	40.57	6.45	4.23	7.39	8.17	5.22	5.11
	Upper	9.16	58.98	9.38	6.15	10.75	11.87	7.57	7.43
	Average	7.73	49.78	7.92	5.19	9.08	10.02	6.40	6.27
Hedgerows	Lower	7.36	20.51	6.68	4.62	5.88	7.70	5.16	2.68
	Upper	10.38	28.91	9.40	6.52	8.29	10.85	7.27	3.78
	Average	8.88	24.72	8.04	5.58	7.09	9.28	6.22	3.23
Wetland	Lower	107.89	101.30	148.26	87.25	134.45	126.77	149.54	140.57
	Upper	142.33	133.62	195.50	115.22	177.44	167.51	197.71	185.48
	Average	125.12	117.46	171.88	101.24	155.94	147.14	173.62	163.02

Source: Oglethorpe 2005. Values are normalised using relative regional consumer price levels.

Table 69 WTP results (£ per household per year per 1% improvement for the first three attributes, £ per 1 metre increase in the case of field boundaries) derived from the choice experiment for each region (except the South East)

English Region	North West	Yorkshire and Humberside	West Midlands	East Midlands	South West	South East
Heather moor land and bog	0.78 (0.45-1.11)	0.30 (-0.06-0.65)	0.80 (0.42-1.18)	1.04 (-0.03-2.31)	0.92 (0.37-1.54)	0.81 (0.36-1.25)
Rough grassland	0.74 (0.45-1.05)	0.31 (0.01-0.60)	0.25 (-0.05-0.53)	0.08 (-0.99-0.91)	-0.06 (-0.56-0.39)	0.50 (0.14-0.86)
Broadleaf and mixed woodland	0.61 (0.30-0.91)	0.15 (-0.16-0.48)	0.43 (0.07-0.81)	0.97 (0.03-2.46)	0.39 (-0.01-0.78)	1.21 (0.81-1.66)
Field boundaries	0.00 (-0.03-0.04)	0.04 (0.01-0.08)	0.02 (-0.02-0.05)	0.06 (-0.06-0.18)	-0.04 (-0.11-0.02)	0.06 (0.02-0.11)
Cultural heritage (small[1])	1.03 (-1.84-4.14)	3.08 (-0.24-6.71)	-0.40 (-4.27-3.03)	7.92 (-1.96-22.62)	5.48 (-0.11-11.59)	0.81 (-3.22-4.96)
Cultural heritage (big[2])	4.89 (1.52-8.43)	11.93 (8.47-15.44)	6.56 (2.49-10.73)	22.51 (11.84-37.24)	7.68 (1.24-15.03)	15.79 (11.47-20.64)

Figures in brackets are the 95% confidence interval. Note that if the confidence interval spans zero then the WTP is not significantly different from zero.
HMB = heather moorland and bog, RG = rough grassland, BMW = mixed and broadleaf woodland, FB = field boundaries, CH = cultural heritage.
[1]*from "rapid decline" to "no change"*
[2]*from "rapid decline" to "much better conservation"*
Note that the South East figures are not really comparable, since in the eftec study the values expressed were for improvements in SDAs in all other regions, whereas the ELF values are for the South East region itself.

Table 70 Comparison of the 95% confidence intervals for £ per household WTP found by eftec 2006 and the ELF model (£, 2008)

Region	**NW**	**Y&H**	**WM**	**EM**	**SW**	**SE**
Heather moorland and bog						
SDA	0.50 - 1.23	-0.07 - 0.72	0.47 - 1.31	-0.03 - 2.56	0.41 - 1.71	0.40 - 1.38
ELF	0.02 - 0.06	0.02 - 0.04	0.02 - 0.06	0.02 - 0.06	0.02 - 0.06	0.02 - 0.06
Rough grassland						
SDA	0.50 - 1.16	0.01 - 0.66	-0.06 - 0.59	-1.10 – 1.01	-0.62 - 0.43	0.16 - 0.95
ELF	0.04 - 0.11	0.04 - 0.11	0.04 - 0.11	0.04 - 0.11	0.04 - 0.11	0.04 - 0.11
Broadleaf and mixed woodland						
SDA	0.33 - 1.01	-0.18 - 0.53	0.08 - 0.90	0.03 - 2.72	-0.01 - 0.86	0.90 - 1.84
ELF	0.07 - 0.09	0.06 - 0.09	0.07 - 0.09	0.07 - 0.09	0.07 - 0.09	0.06 - 0.09
Field boundaries						
SDA	-0.03 - 0.04	0.01 - 0.09	-0.02 - 0.06	-0.07 - 0.20	-0.12 - 0.02	0.02 - 0.12
ELF	0.03 - 0.04	0.03 - 0.04	0.03 - 0.04	0.03 - 0.04	0.03 - 0.04	0.03 - 0.04

Key: SDA = 95% confidence intervals for WTP for a 1% change in the attribute found by this study.
ELF = estimated mean range given in the ELF model for WTP for the whole attribute, divided by 200. Note that this is not a 95% confidence interval.

Table 71 Actual values and benefits transfer for regulation of greenhouse gas emissions

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
DECC (2008)	Marginal abatement cost	Alternative method – consistent with cost-efficient attainment of a pre-determined carbon target	Up to £250/tonne by 2050		
Defra (2007b)	Shadow price of carbon	Cover estimated damage costs from emissions of greenhouse gases	Price schedule increases over time at 2% p.a. 2009 value: £26.50	Carbon only	Yes – at present, official Government guidance

Notes: Prices not converted to 2008 values.

Table 72 Actual values and benefits transfer for Biodiversity and Wildlife (£, 2008)

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Lopez and others (2008)	Meta analysis	60 surveys assessed WTP for species conservation – mainly US studies	Higher values for larger animals (log of eye size), mammals and birds		Function could be used
Juutinen (2008)	Meta-analysis of CV	Biodiversity value of old-growth boreal forests in Finland	£198.90/ha/yr	Puts forest in the range between thresholds for delaying harvesting (£84/ha/yr) and permanent conservation (£398/ha/yr)	
Nijkamp and others (2008)	Meta analysis	75 distinct empirical case studies – European case studies drawn from RIVM so no recent values.	£22.71 – biodiversity preservation, £1.43 wildlife preservation		See comment above
Lindhjem (2007)	Meta-analysis	Mean WTP for forest protection / multiple use forestry	£119.20/hh/y (s.d. £137.60/hh/y) NOK/Euro in 2005 = 0.12491		Scale insensitive – so very difficult to justify per ha measures.
Christie and others (2006)	CE	Improvements from “continued decline” to various options: Stop decline in rare, familiar species Stop decline rare and common fam. Spp. Slow decline rare: Reverse decline rare Restore habitat Create new habitat Recover eco. services used by humans Recover all eco. Services	First figure for Northumberland, second for Cambs. £100.30, £39.47 £108.18, £103.51 n.s., -£51.68 £209.31, £127.47 £78.77, £38.09 £81.83, £67.93 £116.49, £59.37 n.s., £46.73	Shows diversity of values, and also illogical valuations in some cases – for example, “all services” valued less than just services used by humans.	

Study (name/date)	**Method**	**Notes**	**Value**	**Other services?**	**Benefits transfer?**
Christie and others (2006)	CV	Agri-environment schemes Habitat creation scheme Avoid development loss Pooled	n.a., £82.23 £52.58, £60.86 £40.79, £50.15 £47.02, £65.18	Pooled values	
eftec (2006)	CE	Habitat types (plus field boundaries) in severely disadvantaged areas. Ranges cover mid-point estimates for different GOR regions in England (for some regions WTP is not statistically significant)	WTP (£ per household per year per 1% improvement) Heather moorland and bog: £0.33 - £1.11 Rough grassland: £0 - £0.82 Mixed and broadleaf woodland: £0.17 - £1.33 Field boundaries: £0 (not statistically significant across all regions)	Combines use and non-use. Potential overlap with visual amenity	Likely ballpark estimates for specific attributes of upland areas, due to need to consider appropriate baseline for change.
Hanley and others (2006)	CV	WTP for improvement fair to good in Clyde and Wear rivers	River ecology: approx £22.14 Aesthetics: approx £17.71 Banksides: approx £22.14	Lower for Wear than for Clyde. Authors suggest controlling for heterogeneous preferences in studies	Perhaps, though non-specific impact.
Macmillan and others (2001)a	CE	Nature conservation of wild geese three options no shooting, prevent 10% increase in endangered species, obtain 10% increase in endangered species.	Mean wtp/hh/yr: £9.68-19.35 Trimmed mean wtp: £8.47-10.89 Median wtp: £3.63-£6.05		Two sites with large variation in value. Note difference in mean and median value.

Study (name/date)	Method	Notes	Value	Other services?	Benefits transfer?
Macmillan and others (2001)b		Restoration of 80,000 ha of native forest in Scotland and reintroduction of native species	£-15.72 to £122.17 for (negative values associated with reintroduction of the wolf) Strathspey: Forest only: £64.11 (WTP), £29.03 (WTP and WTA) Beaver: £120.96, £110.07 Wolf: £73.78, £49.59 Glen Affric: Forest only: £42.34 , £44.75 Beaver: £122.17, £81.04 Wolf: £37.50, £12.10	Unusual in identifying WTA compensation values – there are winners and losers from the reintroductions	Find functional form of importance and find some inter-site variation in value.
White and others (2001)	CV	Value of otter water vole, red squirrel and brown hare biodiversity action plans (25-50% increase)	Red squirrel: £2.94 Brown Hare: £0 Otter: £13.97 Water vole: £8.82		
University of Newcastle and ERM, (1996)	CV CR		Median WTP £2.83-£7.06/yr for improved biodiversity. Mean £26.84-£40.97. WTP for 1% increase in proportion of 300000ha managed to "basic" standard (42-48p), "desired" (73-79p) and "native woodland" (27-30p)		

Appendix 3: Errors and uncertainty in benefits transfer[31]

3.1 Uncertainty and transfer errors

The extent to which economic valuation methods are subject to uncertainties and produce estimation errors has not been subject to systematic analysis. In general, a distinction is made in the economic valuation literature between validity and reliability. Validity refers to the question to what extent a method measures what it is intended to measure. This is often called the 'true' economic value of the environmental goods or services involved. Since this true economic value is unknown (the reason why it is being measured through different valuation methods), the validity of economic valuation research is tested in practice by looking at the consistency of research findings compared to the theoretical starting points. In contrast, reliability concerns the extent to which the method is able to produce the same outcomes at different sites across different groups of people at different points in time.

According to Bateman and Turner (1993), reliability is related to two potential sources of variance: variance introduced by the sample and variance introduced by the method. The usual solution to the former is to use large samples in stated preference methods or larger data sets in others. The general approach in the literature for examining reliability has been to assess the consistency of stated preference estimates over time in so-called 'test-retest' studies (for example, Loomis, 1989; McConnell and others., 1998). Other methods are not usually subjected to this test. To date test-retest studies have only considered relatively short periods, ranging from two weeks (Kealy and others., 1988 and 1990) to two years (Carson and others., 1997). These have supported the replicability of findings and stability of values across such modest periods[32]. In a test-retest study covering a time period which is more than double that considered in previous test-retest analyses (Brouwer and Bateman, 2005), average WTP values and WTP functions appear to be significantly different across this longer time period for a number of reasons, including those expected from standard economic theory (changes in preferences and incomes).

Although benefits transfer is applied extensively, very little published evidence exists about its validity and reliability. Table 73 gives an overview of water related studies, which tested the reliability of the transfer of WTP values. The estimated benefits in these studies are related to different types of water use, such as recreational fishing, boating or other recreational water use (also the study by Bergland and others. (1995) and Parsons and Kealy (1994) look at water quality improvements for recreational use). The last column presents the range of transfer errors found in these studies, that is the difference between the WTP estimated for the new valuation context via benefits transfer and that estimated for the original valuation context. So, a transfer error of 50% means that the value from the previous study

[31] Note that the content of Annex 2 is an extract from eftec (2007b).

[32] An overview of studies investigating the reliability of contingent valuation estimates is found in McConnell and others. (1998).

used in the new policy context is 50% higher or lower than the 'true' value in the new policy context. A range of transfer errors is presented as the reliability of benefits transfer was tested for at least two sites (transferring a WTP value from say site A to site B and the other way around) and for both WTP values and WTP value functions (see Brouwer (2000) for more details).

It is difficult to say how large the errors can be expected to be on average when using existing economic value estimates in new decision-making contexts. In some cases they can be very low, in other cases they can be as high as almost five times the value, which would have been found if original valuation research was carried out. Similarly, no distinct differences can be found based on Table 73 when comparing transfer errors for contingent valuation and travel cost studies. This shows the importance of sensitivity analysis in aggregating from transferred values and their use in CBA.

Table 73 Transfer errors found in water related economic valuation studies

Study	**Valuation method**	**Estimated benefits**	**Transfer errors (%)**
Loomis (1992)	Travel cost	Sport fishing benefits	5 – 40
Parsons and Kealy (1994)	Travel cost	Water quality improvements	1 – 75
Loomis and others. (1995)	Travel cost	Water based recreation	1 – 475
Bergland and others. (1995)	Contingent valuation	Water quality improvements	18 – 45
Downing and Ozuna (1996)	Contingent valuation	Saltwater fishing benefits	1 – 34
Kirchhoff and others. (1997)	Contingent valuation	White water rafting benefits	6 – 228
Brouwer and Bateman (2005)	Contingent valuation	Flood control benefits	4 – 51

Source: Adapted from Brouwer (2000).

The extent to which transfer errors reported in Table 73 are considered a problem depends upon the acceptability of these errors by the user of the results. In some cases the user may find a transfer error of 50% too high, in other cases such an error may be acceptable. User acceptability of these errors will depend upon subjective judgement by the user, but also on the purpose and nature of the cost benefit analysis and the phase of the policy or decision-making cycle in which the evaluation is carried out. The reliability (and corresponding errors) of pre-feasibility studies carried out in an early stage of policy formulation to aid policy development is usually much lower (and errors larger) than the reliability of detailed cost benefit studies which are looking at the practical implementation of concrete policy measures on the ground. In general, the further the decision-making process has moved forward towards practical implementation, the higher the reliability of the evaluations will be given that better and more information is likely to be available. Large errors and low reliability as a result of unresolved uncertainties and lack of information will become less and less acceptable the closer the project moves towards the practical implementation of policy measures on the ground.

3.2 Non-transferability and large transfer errors

A number of reasons have been suggested in the literature why the test results found so far, as to the validity and reliability of benefits transfer, are ambiguous (Brouwer, 2000):

What constitutes an economic value (in terms of use and/or non-use values) may not always be clear leading to problems of aggregation. Moreover, even when studies are clear about distinct estimates of use(r) and non-use(r) values, they are not always clear about defining the non-user population which, again, causes problems when aggregating unit non-user value estimates at the policy site.

Economic value estimates are a snap-shot of individuals' preferences at the time of the study (perhaps more so for stated preference studies than revealed preference studies which can use time series data of consumer behaviour). Therefore, changes over time may affect the accuracy of transfers from study to policy sites – favouring studies that were undertaken in the near past against those which were undertaken in the distant past.

The explanatory power of most WTP functions are rather low[33] which means that the variability in the WTP across the sample cannot be fully explained and that a generally applicable WTP function cannot be found. Low R-square and hence high unexplained variation in WTP estimate are likely to lead to larger transfer errors since, if the full set of factors explaining WTP is not known, the necessary adjustments between the study and policy sites cannot be made.

Finally, even if WTP functions are statistically adequate, at least some of the variables are bound to be attitude and opinion related. The difficulty with this is that attitudinal data that may be needed for any adjustments do not exist readily at the policy site. And the expense of collecting such data (for example, through policy-site surveys) defeats the very purpose of benefits transfer, that is its relatively low cost.

While the first bullet point above acknowledges that some uncertainty may surround the precise nature of value estimates from some studies (particularly using stated preference studies), a relevant consideration for benefits transfer is whether such values are expected to remain more or less the same across social groups and environmental domains. If more or less constant, these values would be easily transferable without a need to look at motivations underlying such WTP values. However, values often do differ substantially in practice from case to case.

Moving on from the issue of transfer error in unit values, there are then implications for aggregation of values across different stakeholder groups. In particular, the

[33] For example, the R-square statistic which shows the proportion of variation in data which is explained by the estimated model/WTP function

inclusion of non-use values seems to aggravate rather than help solve the difficulties of solving the problem of aggregation, that is the number of stakeholders and the values they hold to be included in the analysis. Studies show that non-users may also attach a value to the environmental goods and services involved, but typically do not identify the boundaries of this specific ‘market segment’, that is the scale of the non-user population. On the other hand, values elicited in a very specific local context based on a sample of local residents or visitors may also reflect more than simply current and future use values. The historical-cultural context in which these values have come about may be a significant determinant of the elicited WTP values. Also in those cases where stated values seem to reflect upon well-defined local issues, it is important to carefully investigate the broader applicability of these values which may be embedded in specific local conditions when aiming to transpose these values across sites.