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NATURAL ENGLAND

Developing place-based approaches for Payments for Ecosystem Services

including a case study on developing the market for carbon storage and sequestration by peatlands

Final Technical Report

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GLOSSARY

Abbreviation	Definition	Notes and links
ANC	Acid Neutralising Capacity	
BAP	Biodiversity Action Plan	Current term is “priority” habitats and species as defined by S41 of NERC Act
BAU	Business As Usual	
CEH	Centre for Ecology and Hydrology’s	http://www.ceh.ac.uk/
CFMP	Calder Catchment Flood Management Plan	http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/gene0110brlh-e-e.pdf
CH_4	Methane	Naturally occurring methane is mainly produced by the process of methanogenesis. This multistep process is used by microorganisms as an energy source. The net reaction is: $CO_2 + 8\ H^+ + 8\ e^- \rightarrow CH_4 + 2\ H_2O$ The final step in the process is catalysed by the enzyme methyl-coenzyme M reductase. Methanogenesis is a form of anaerobic respiration.
CO_2	Carbon dioxide	
CSR	Corporate Social Responsibility	
DECC	Department of Energy & Climate Change	https://www.gov.uk/government/organisations/department-of-energy-climate-change
Defra	Department for Environment, Food and Rural Affairs	www.Defra.gov.uk/
DOC	Dissolved Organic Carbon	
ELS	Entry Level Stewardship	
ES	Environmental Stewardship	
FEP	Farm Environment Plan	
GEP	Good Ecological Potential	
GES	Good Ecological Status	
GEST	Greenhouse Gas Site Types	
GHG	Greenhouse Gas	
HLS	Higher Level Stewardship	

Abbreviation	Definition	Notes and links
IPCC	The Intergovernmental Panel on Climate Change	The leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. http://www.ipcc.ch/
LNPs	Local Nature Partnerships	In its Natural Environment White Paper, Government recognised that partnership working was key to delivering its ambitions for the natural environment at a local level and set out its vision for Local Nature Partnerships http://www.Defra.gov.uk/environment/natural/whitepaper/local-nature-partnerships/
MoorLIFE	In 2010, the European Union LIFE+ programme awarded the Moors for the Future team funds for MoorLIFE, a £5.5 million project.	MoorLIFE is one of the biggest moorland conservation programmes in Europe - protecting Active Blanket Bog by restoring bare and eroding peat in the South Pennines Special Area of Conservation (SAC) and Special Protection Area (SPA). http://www.moorsforthefuture.org.uk/moorlife
NO_3^-	Nitrate	
NH_4^+	Ammonium ion	The ammonium ion is generated when ammonia, a weak base, reacts with Brønsted acids (proton donors): $H^+ + NH_3 \rightarrow NH_4^+$
NGO	Non-Governmental Organisation	
NVC	National Vegetation Classification	The National Vegetation Classification (NVC) is one of the key common standards developed for the country nature conservation agencies. The original project aimed to produce a comprehensive classification and description of the plant communities of Britain, each systematically named and arranged and with standardised descriptions for each. http://jncc.Defra.gov.uk/page-4259
Ofwat	The Water Services Regulation Authority	The economic regulator of the water and sewerage sectors in England and Wales. Aims to make sure that the companies provide household and business consumers with a good quality service and value for money http://www.ofwat.gov.uk/
PES	Payment for Ecosystem Services	
POC	Particulate Organic Carbon	

Abbreviation	Definition	Notes and links
NCA	National Character Area	National Character Areas (NCAs) divide England into 159 distinct natural areas. Each is defined by a unique combination of landscape, biodiversity, geodiversity and cultural and economic activity. Their boundaries follow natural lines in the landscape rather than administrative boundaries http://www.naturalengland.org.uk/publications/nca/default.aspx
NIA	Nature Improvement Area	Established under the Natural Environment White Paper to facilitate ecological restoration at landscape scales across England and Wales http://www.Defra.gov.uk/environment/natural/whitepaper/nia/
SAC	Special Area of Conservation	
SCaMP	Sustainable Catchment Management Plan	http://stakeholder.unitedutilities.com/content/Environment/Naturalresourceprotectionandenhancement/SustainableCatchmentManagement.aspx
SPA	Special Protection Areas	
SPESP	South Pennines Ecosystem Services Pilot Project	Natural England has published a report on the experiences from the first phase of its three upland pilot projects to show how an ecosystems approach is applied 'on the ground'. The pilots were conducted in Bassenthwaite (Lake District), South Pennines of England and the uplands of South West England. NERR046 - Delivering the ecosystem approach on the ground – an evaluation of the upland ecosystem service pilots
SSSI	Site of Special Scientific Interest	
SO_4^{2-} (SO_4)	Sulphate	
SO_2	Sulphur dioxide	
UKNEA	UK National Ecosystem Assessment	http://uknea.unep-wcmc.org/
VCS	Verified Carbon Standard	http://v-c-s.org/
VPS	Visitor Payback Scheme	Visitor Payback is the process of asking visitors to voluntarily support conservation activities in the area they are visiting by donating a very small amount of money via their bill or fees (e.g. a voluntary donation to a bed and breakfast, which is then pooled with other donations and used to fund conservation activities)

Abbreviation	Definition	Notes and links
WFD	Water Framework Directive	http://www.defra.gov.uk/environment/quality/water/legislation/water-framework-directive/

1. EXECUTIVE SUMMARY

1.1.1 This project has considered how to develop place-based approaches for Payments for Ecosystem Services (PES) in the English uplands, using the South Pennines as a case study. Throughout this report, the phrase 'South Pennines' is used to refer to the South Pennines Ecosystem Service Pilot area. The aim was to provide a practical, market-based application of the ecosystems approach introduced in the Government's recent Natural Environment White Paper. It has built on the evidence base generated through Natural England's Ecosystem Service Pilots to identify, quantify, value and enhance packages of ecosystem services, working collaboratively with partners. Specifically, this project has:

- Reviewed the current baseline and trend in ecosystem service provision in an English upland context;
- Assessed the opportunity to improve a range of key ecosystem services in the area through land management actions;
- Identified potential beneficiaries of these ecosystem services;
- Developed metrics for measuring and modelling key ecosystem services;
- Reviewed the institutional context and mechanisms to enable PES; and
- Evaluated the overall feasibility of setting up a place-based PES scheme delivering either a layered or bundled PES scheme in an English upland context.

1.1.2 Place-based PES schemes deliver improvements in multiple ecosystem services in the same location through a voluntary transaction where a known quantity of ecosystem services is purchased by one or more buyers, leading to an overall increase in the provision of the service that would not have otherwise occurred. A place-based PES scheme may take place when a "premium" is charged for a core ecosystem service (such as climate mitigation or water quality) being "bundled" with a range of additional ecosystem services that are provided by the same management intervention. Alternatively, multiple ecosystem services may be marketed separately but in parallel with one another (or "**layered**") to different buyers who are only interested in a single service, rather than a broader bundle of services. It is also possible that a bundled scheme selling a combination of services (e.g. linked to carbon and biodiversity) together may operate in parallel to a layered scheme that markets single services to specific buyers (e.g. water quality benefits being sold to water companies, in parallel with recreational benefits being marketed to visitors via a Visitor Payback scheme). See section 9.2 for a more detailed explanation of different types of multiple-benefit PES scheme.

1.1.3 Interest in place-based PES schemes has grown rapidly in recent years, partly given impetus by the emphasis on PES in the 2011 Natural Environment White Paper, with a PES Best Practice Guide and PES Action Plan published May 2013. Such schemes offer the potential of additional funding to help meet existing local goals e.g. conservation and water quality. At the same time, a number of potential buyers (in particular those whose brands have a strong local identity) are interested in creating value for their brands and (in the case of water companies in particular), reducing operational costs by investing in such schemes. Market research suggests that there is considerable demand for place-based PES schemes, with carbon and climate change mitigation the key driver, but with interest in co-benefits (in particular water quality and biodiversity, and to an extent recreation benefits too). There is evidence from published literature to suggest that, by considering the effects of proposed management interventions on multiple ecosystem services and trying to capture and market those multiple benefits, place-based PES schemes may promote synergies and minimise

trade-offs between ecosystem services e.g. food production or conservation, compared to schemes that focus on a single ecosystem service alone.

1.1.4 In the South Pennines Ecosystem Service Pilot area (ESP) there is considerable interest from land owners and other stakeholders in developing a place-based PES scheme, potentially under the auspices of the Local Nature Partnership, which is chaired by Pennine Prospects and has broad stakeholder representation.

The ecosystem services

1.1.5 Previous research undertaken by and on behalf of Natural England has illustrated the range of ecosystem services that are co-produced in the South Pennines. These include provisioning services (food and fibre); supporting services (soil formation, nutrient cycling and biodiversity); regulating services (flood risk regulation, water quality, climate regulation, and erosion control) and cultural services (recreation and cultural heritage). Historically, the fact that provisioning services have had a market price while other ecosystem services have not, has led to a bias in favour of provisioning services, often at the expense of other ecosystem services, some of which have been significantly degraded. Placed-based PES schemes offer one opportunity for correcting this bias by generating private and public revenue which is targeted at improving non-provisioning services, such as water quality and biodiversity.

1.1.6 The ecosystem services considered most 'marketable' and therefore most able to generate private revenue to support their enhancement, were water quality, climate regulation, biodiversity, flood risk regulation and recreation. Taking into consideration the spatial scale at which these ecosystem services could be improved, the likely demand for the ecosystem services, the revenue that might be raised and the ease of monitoring improvements, water quality, climate regulation and biodiversity were deemed the most attractive. The conclusion was that there was potential for these services to generate revenue from the private sector over the short and medium term to complement existing agri-environment payments.

The beneficiaries

1.1.7 There are a number of potential buyers for ecosystem service improvements in the South Pennines. These vary from service to service, and a full beneficiary analysis is presented in the report for each service. These include: water utilities (i.e. Yorkshire Water & United Utilities); corporate entities interested in financing climate regulation as part of their Corporate Social Responsibility portfolio; corporations and developers interested in purchasing conservation/biodiversity credits to offset impacts generated elsewhere; Government via agri-environment schemes; and members of the public paying for ecosystem service projects via Visitor Payback Schemes.

The land management changes

1.1.8 A number of these ecosystem services can be co-produced in space/time and the evidence suggests that they can be promoted through a similar suite of land management changes in the South Pennines. These land management changes include:

- Revegetating bare peat and grip blocking in blanket bogs not exposed to significant historic grazing and burning, with *Sphagnum* re-introduction & reductions in grazing/burning where necessary;
- Appropriate tree planting on upland valleys and flood plains.

1.1.9 Grip blocking/re-vegetation of blanket bog, the predominant vegetation type in the area, is likely to have a positive impact on climate regulation (reduced GHG emissions and improved carbon sequestration); peatland biodiversity (including birds of conservation significance); water quality (water colour and sediment); and aesthetics (re-vegetation

of bare sites). The impact on recreational services and provisioning services will vary, and there may be some areas where some peatland restoration techniques could have a short term negative impact on grouse shooting and food production.

1.1.10 Any trade-offs that do occur (e.g food production or recreation) can be managed (although not completely mitigated) in order to reduce impacts and secure the best overall outcomes.

How much might be raised?

1.1.11 The South Pennines are capable of sequestering carbon, and a carbon market is developing. Using conservative figures based on a combination of restoration techniques developed for comparable areas of the Pennines, and combining these with the figures developed in the Technical Appendix, it is estimated that around 36,000 tonnes of carbon dioxide equivalent (CO_2e) per year could be sequestered or safeguarded if all 30,000 ha of blanket bog in the South Pennines were managed to improve carbon storage and sequestration. Of this, 6,000 ha would require restoration of grips, hags and changes to burning; and 24,000 ha could be restored by reducing grazing.

1.1.12 Careful management of intact or moderately degraded bogs (on which grazing/burning had been reduced) could sequester an additional 1-2 tonnes CO_2e per ha per year, and at today's carbon prices[1] might be worth around £5-10 per hectare per year (more for some sites, and les for others, depending on the condition of the bog). However, if carbon prices increased to £20 per tonne of CO_2e, this could lead to annual management payments to landowners of around £20 (for degraded bogs) to £40 (for mossy bogs) per hectare per year. For more capital intensive restoration projects involving grip blocking or revegetation, costs and values are substantially higher. These figures are given as indicators of the financial 'value' of managing peatland carbon and show that 'carbon farming' could soon make economic sense on peatlands.

1.1.13 Stopping peatlands from emitting greenhouse gases is even more valuable. If the 551 hectares of bare peat in the South Pennines were re-vegetated, this could save an estimated 17,000 tCO_2e per year in greenhouse gas emissions. At a carbon price of £20 per tCO_2e, revegetating severely degraded peatland (and restoring it to a moderately degraded state) could provide a carbon revenue of around £600 per hectare per year. At present, transactions based on climate benefits are likely to be via Corporate Social Responsibility funding, and are therefore based on paying the full costs of restoration (including ongoing maintenance and other associated costs). Re-vegetating bare peat can be expensive; so in future, restoration might be best achieved by forward selling the carbon (via carbon credits and a Peatland Carbon Code), which, if it entailed a 30 year agreement, a 25% buffer and an assumption that the eroding area would double in size during the next 30 years if no action was taken, might raise a lump sum of around £10,000 per hectare available to spend as capital towards planting new peat-forming vegetation on the bare peat (a useful contribution towards total costs). Because bare peat emits so much greenhouse gas, revegetation should be considered a priority.[2]

[1] Because of the range of carbon prices and the uncertainty over which prices might apply to each peatland carbon restoration schemes, this report uses two figures – a) £5 per tonne CO2eq as a reminder of present day voluntary carbon prices, for comparing with present-day peatland restoration and management costs, and b) £20 per tonne CO2eq as an estimate of a possible carbon price during the period 2013-2020. See note 80, page 50, for more information.

[2] These carbon figures are all rounded and based on a series of assumptions as detailed in the Technical Appendix, but are useful for indicative purposes. In practice, simple ecological and economic modelling would need to be undertaken for each restoration project, as is proposed in the Technical Appendix, and as is being taken forward as part of developing a UK Peatland Carbon Code.

1.1.14 Payments based on improvements in water quality derived from changes to peatland management have historically been modest, but by combining these payments with funding from agri-environment schemes, United Utilities were able to pay up to £3,800 per km^2 (£38 per hectare) per year as part of SCaMP 2. United Utilities financed capital works and HLS payments were used to cover some of the on-going costs of the scheme. Given the role water utilities have already played in funding peatland restoration, water quality should be considered as part of any future PES scheme.

1.1.15 In contrast to funding based on the value of climate regulation or water quality benefits, biodiversity credits may, theoretically, offer financial rewards an order of magnitude greater (up to £250 per hectare per year). However, it is uncertain what the demand for blanket bog biodiversity credits would be. Given the relatively low development pressure on this habitat type (with the possible exception of wind farms) demand from developers can be expected to be weak. Demand from corporations, who are interested in purchasing biodiversity credits, is unproven. As such it is considered that biodiversity, on its own, is unlikely to generate significant revenue at present. However, this may change as biodiversity credits and off-setting mature.

1.1.16 Tree planting is already underway across the South Pennine in upland valleys (known as “gills” and “cloughs”) and on flood plains, potentially providing climate regulation, biodiversity, recreation and flood risk alleviation benefits. There is potential to use already well-established PES markets to fund this work, e.g. via the UK Woodland Carbon Code. Alternatively, biodiversity credits may also be sold in the future to finance woodland creation projects.

Combining private and public funding

1.1.17 It is possible that agri-environment funding and private funding via a PES scheme could run jointly or in parallel, potentially providing a dual financial return from land in the scheme. This is the approach taken under the Woodland Carbon Code and, providing that ‘additionality’ criteria are met (see Box 6), is an attractive option to pursue. This issue is currently being explored in detail as part of the development of a UK Peatland Carbon Code. With the Code due to be launched later in 2013, there is the potential for the South Pennines to market the climate and other benefits of peatland restoration to local businesses as part of the pilot phase of Code implementation, either through existing intermediaries or with local institutions acting as intermediaries between land owners/managers and buyers.

The PES Scheme

1.1.18 PES is voluntary, and as such any uptake will depend on whether it is attractive to farmers and land managers. Land managers have the option to enter a scheme to be paid for providing ecosystem services that would not otherwise have been provided in the absence of payment. There may be a need to prioritise support for certain ecosystem services, and this should be based on stakeholder engagement and may require local fine-tuning, with care on setting payment rates. This approach could help to reduce unnecessary trade-offs, identify synergies, and make any residual impact(s) more acceptable.

1.1.19 Challenges to establishing a successful place-based PES scheme in the South Pennines, which are likely to also apply to other upland areas include:

- Complex and fragmented land ownership;
- The need to work across property boundaries to deliver some ecosystem services at relevant scales;
- Variable quality of data on ecosystem service levels, which will make it more difficult to monitor changes in ecosystem services over time;

- Transaction costs associated with managing ecosystem services at broad spatial scales, due to the need to co-ordinate multiple sellers in group schemes; and

- Perceived incompatibility of some PES scheme and land owner/manager objectives.

1.1.20 "Bundled" PES schemes are better able to take into account the complexity and inter-connectedness of ecosystems than "layered" schemes and are therefore less likely to contravene the principle of 'additionality'. However with effective co-ordination between layered schemes, it is possible to avoid the worst trade-offs between ecosystem services and promote synergies between services. Where there are multiple buyers with very different interests, layered schemes may be able to tailor marketing to specific buyers more effectively than bundled schemes, and obtain more funding per unit of area. However, care must be taken to demonstrate that funding streams are leading to additional improvements to ecosystem services that would not have occurred in the absence of the funding.

1.1.21 Potential buyers of ecosystem services in the South Pennines have quite differentiated interests, in particular for climate regulation versus water quality (both potentially bundled with biodiversity). In future, there may also be another type of high-value buyer focussed primarily on biodiversity offsets. For this reason, during a workshop with stakeholders (Technical Appendix, Annex 2), a preference was expressed for developing a layered scheme to market as many services as possible to different potential buyers over as broad an area as would be feasible, to optimise revenues to any future scheme. However, this solution might not be appropriate for other locations, or for all buyers. For example, some locations do not have an experienced local partnership to take forward a layered project. Care also needs to be taken in the context of similar land management actions: some buyers (such as those seeking carbon credits) require strict additionality; whereas others (such as those buying water catchment control) do not, but need to be aware that carbon cannot be sold as a 'free rider'[3].

1.1.22 Specifically, the layered place-based PES scheme that was favoured by local stakeholders would separately target: developers and corporations (for carbon and biodiversity); water utilities (for water quality benefits); visitors and tourists (for recreation benefits); downstream agencies (for flood risk alleviation); and Government (for a wide range of ecosystem services) (see Table 15, Chapter 8 for full details).

1.1.23 While there is a clear attraction to pursuing a layered PES scheme that offers the potential of raising money from multiple buyers who are interested in multiple ecosystem services, there are a number of challenges that should be considered. This includes the issue that some of these ecosystem services, in particular water quality and flood risk regulation, can only be secured if land management changes are made across a large spatial area. A layered PES scheme that offers flood risk regulation must therefore combine multiple landowners (sellers) in order that in can offer a probable improvement to flood risk regulation[4] Water quality also requires changes over relatively large land areas, although these can be targeted at strategic catchments and sub-catchments where water quality deterioration is a particular issue.

1.1.24 A practical approach would be to initiate a PES scheme at a smaller spatial scale, concentrating on those services that can be improved at that scale (e.g. carbon

[3] Under existing emissions trading schemes, offsets (emissions reductions from sources or removals by sinks) are only saleable if the project from which they are derived is Additional, i.e. if the project would not have occurred without the targeted financing. Carbon as a co-benefit from an existing water quality project would not be saleable; however carbon within a new project, a project that would only be viable if funded by both carbon and water markets, should be saleable.

[4] There are also many uncertainties in flood response to land management changes: the science is still developing, and each catchment needs specific modelling.

sequestration and storage and biodiversity) and, assuming sufficient demand, gradually expand the spatial scale of the PES scheme and the ecosystem services that it offers and delivers.

Greenhouse gas emission estimates for peatlands

1.1.25 Within a Payment for Ecosystem Services approach, this report answers a series of research questions focusing on whether we can use proxies and develop evidence based carbon metrics that would be a key underpinning element of a voluntary code for peatland restoration.

1.1.26 Crichton Carbon Centre's Technical Appendix to this report presents a set of first order estimates for standard values for greenhouse gas fluxes from intact and degraded blanket bog ecosystems in the UK. These values are intended for use in carbon balance calculations primarily associated with blanket bog restoration projects. They are based on an analysis of relevant scientific data but it must be recognised these data are very limited. The standard values must therefore be considered as first approximations and should be used accordingly. Whilst it is believed that they are reasonable approximations in terms of the relative orders of magnitude in greenhouse gas fluxes between the different ecosystem states, the values are not absolute, and should not be used as such. These standard values remain uncertain, and more research needs to be done to quantify and reduce this uncertainty.

1.1.27 These Greenhouse gas Emissions Estimates for Peatland (GEEP) are based on restoration ecology and an ecosystem functionality conceptual framework. Five ecosystem states are identified as being commonly associated with UK blanket bogs: Intact, Moderately Degraded, Highly Degraded, Eroded, and Artificially Drained. Quantitative plant functional types are developed using Ellenberg moisture values to describe these states. Available published measurements of greenhouse gas fluxes over peatlands are grouped together in relation to these plant functional types and statistically analysed. While it is recognised that the dataset is currently limited, it is shown that there are consistent and statistically significant differences between the ecosystem states. This allows standard values for carbon fluxes to be developed for each of the 5 blanket bog ecosystem states. This approach, because it focuses on vegetation and ecosystem functionality, can be used to quantify changes in service provision from specific interventions.

1.1.28 The GEEP metric could soon be used to underpin a marketing platform to help pay for peatland restoration. However, the underlying data are probably not yet extensive enough for the metric to be defensible in existing carbon trading schemes (for example, there is still insufficient data on methane fluxes), so we advise that the metric first be used in the context of financing peatland restoration as part of a Payment for Ecosystem Services approach. We recommend that additional data be incorporated as it becomes available, and that field protocols (for example, in assessing erosion and mapping areas of bare peat) are developed.

1.1.29 This project benefitted from and builds upon Natural England's South Pennines Ecosystem Services Pilot Project evidence base, and exchanged knowledge with the South Pennines peatland experts.

2. BACKGROUND

2.1 Introduction

2.1.1 The term 'ecosystem services' refers to the diverse range of benefits that we derive from the natural environment. Examples of these services include the supply of food, water and timber (provisioning services); the regulation of climate, water quality and flood risk (regulating services); opportunities for recreation, tourism and education (cultural services); and essential underlying functions such as soil formation and habitat for wildlife (supporting services).

2.1.2 The UK National Ecosystem Assessment (NEA), published in 2011, concluded that, of the range of services provided by eight broad terrestrial and aquatic habitat types in the UK, about 30% are declining with many others in a reduced or degraded state, often as a consequence of long-term declines in habitat extent or condition[5]. In recognition of this, the Government's 2011 Natural Environment White Paper[6], proposes various measures to mainstream the value of nature across society. The White Paper emphasises the "*real opportunities for land managers to gain by protecting nature's services, and trading nature's benefits with businesses, civil society and the wider public sector*".

2.1.3 The White Paper also recognises the Government's role in (and commitment to) enabling schemes to emerge in which the beneficiaries, or users, of ecosystem services provide payment to the stewards, or providers, of these services. Such schemes are termed Payments for Ecosystem Services (or 'PES'); these are usually voluntary agreements that involve a continuing series of payments to land or other natural resource managers in return for a guaranteed flow of ecosystem services, or at least management actions likely to enhance their provision. State-backed agri-environment schemes are a form of PES. Essentially, PES provides a market-based tool to help address the widely accepted market inefficiency in which the goods and services that nature provides society are frequently undervalued, often to the detriment of the environment, and the beneficiaries in society at large.

2.1.4 The principal challenge in managing ecosystem services, and indeed setting up a PES scheme, is that the services are not independent of each other and so attempts to optimise a single service can lead both to a reduction or loss of other services (a trade-off) or an improvement to other services (a co-benefit or synergy). Understanding the causal relationships between ecosystem services is necessary for making sound decisions about how to manage natural systems for the public good[7]. Another challenge relates to the fact that ecosystem services operate at a range of scales, and are subject to location-specific conditions and pressures. To understand the baseline (i.e. existing) ecosystem service provision in any one location, requires considerable data and, once established, monitoring remains a crucial element to a successful PES arrangement.

2.1.5 Under the strictest definition of PES, any scheme must satisfy the following criteria[8]:

- a voluntary transaction where;
- a well-defined ecosystem service (or a land-use likely to secure that service);

[5] For further details of the UK NEA, see: http://uknea.unep-wcmc.org/
[6] The Natural Choice: Securing the Value of Nature. Available online: http://www.Defra.gov.uk/environment/natural/whitepaper/
[7] Rodríguez, J. P., T. D. Beard, Jr., E. M. Bennett, G. S. Cumming, S. Cork, J. Agard, A. P. Dobson, and G. D. Peterson. 2006. Trade-offs across space, time, and ecosystem services. Ecology and Society 11(1): 28 (online) available at: http://www.ecologyandsociety.org/vol11/iss1/art28/
[8] Wunder, S. (2005). *Payments for environmental services: Some nuts and bolts*. Center for International Forestry Research Occasional Paper No. 42 [online] available at: www.cifor.org/publications/pdf_files/OccPapers/OP-42.pdf.

- is being 'bought' by a (minimum of one) ecosystem service buyer;
- from a (minimum of one) ecosystem service provider;
- if, and only if, the ecosystem service provider secures ecosystem service provision ('conditionality').

2.1.6 In addition to these criteria, the concept of 'additionality' is important, such that payments are made only for actions over-and-above what would usually be anticipated from land managers, i.e. providers should not be compensated for satisfying existing regulatory requirements, including those formulated under the 'polluter-pays principle'.

2.1.7 In reality, few PES schemes have been implemented in the UK that completely satisfy the criteria listed above, however many existing projects fulfil the principles of PES and provide useful lessons.

2.1.8 Ecosystem services pilot projects have been coordinated by Natural England (NE) in three English upland regions with the aim of implementing an ecosystems approach in practice. This project builds on experience from that work and is part of that process. In particular this project evaluates the ecosystem services that are provided at different scales within the South Pennines Ecosystem Service Pilot area (which was originally based on the National Character Area (NCA)) and explores the potential for setting up a 'place-based' PES scheme to support their on-going future provision. Throughout this report, the phrase 'South Pennines' is used to refer to the South Pennines Ecosystem Service Pilot area.

2.2 Description of the area

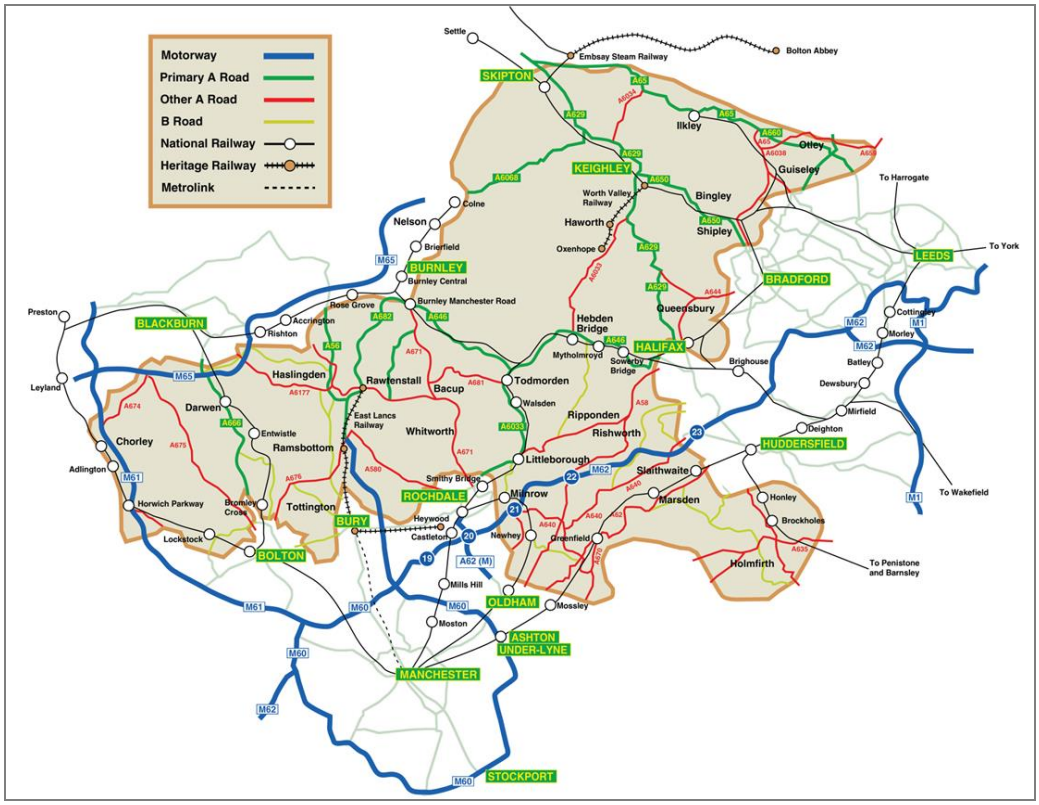
The South Pennines

2.2.1 The South Pennines Ecosystem Service Pilot area is based on the South Pennines National Character Area (NCA)[9] , which is located in the north of England close to the large urban centres of Leeds to the east and Greater Manchester to the south and west (Figure 1). The Pennine ridge of hills runs through the NCA continuing from the Peak District National Park in the south, and into the Yorkshire Dales National Park to the north. The proximity of the area to large population centres makes it a popular destination for visitors, to enjoy both the natural environment and the cultural heritage.

2.2.2 The South Pennines ESP area is home to a considerable variety of habitats and landscapes, comprising large areas of open moorland and blanket bog, broken up by wooded valleys (or 'cloughs'), pastures enclosed by dry stone walls, and small settlements concentrated in valley bottoms. The dominant land use is extensive sheep farming and agreements under agri-environment schemes are common (ELS, Upland ELS, HLS and some Classic Scheme agreements).

[9] Natural England (2012) National Character Area profile: 36 South Pennines (NE323). Available online: http://publications.naturalengland.org.uk/publication/511867

Figure 1: The South Pennines National Character Area (NCA) and Ecosystem Services Pilot area (ESP) – area within orange boundary



2.2.3 The area provides several important ecosystem services. Many of the catchments within the ESP area are important for **drinking water** supply for the nearby urban conurbations. The area receives some of the highest rainfall rates in Europe and there are many reservoirs in the area, supplying the neighbouring urban centres with drinking water. The South Pennines form the watershed between rivers running to the North Sea to the east and to the Irish Sea to the west; the main water utility company drawing on water supplies in the ESP area is Yorkshire Water, while United Utilities controls areas in the western part of the ESP area.

2.2.4 **Flood regulation** is also of particular importance, and while the rivers and streams are regulated to a certain extent by the many reservoirs in the area, many are still prone to flash floods, due to the high rainfall rates, underlying geology and topography and land management practices influencing run-off in the catchment. Due to the large expanse of deep peat soils and blanket bog, **carbon sequestration and storage** is also a significant service provided by the ESP area.

2.2.5 The upland habitats of moorland and blanket bog provide important **habitat for species** such as red grouse, curlew, merlin, golden plover, dunlin and short-eared owl. In terms of nature conservation sites, 17% of the ESP area is designated as a Special Area of Conservation (SAC) and the same area as a Special Protection Area (SPA), as part of the South Pennines Moors site (20,843 ha), both European level designations (Natura 2000 sites). At a national level, 15 Sites of Special Scientific Interest (SSSI) exist wholly or partially within the ESP area boundaries, accounting for 18% of the ESP area. There are also 257 local sites of nature conservation.

2.2.6 **Recreation and tourism** is a key feature of the ESP area's economy and use, and seven million people live within a one-hour drive of the ESP area. While there is a lack of data for the specific area, statistics for tourism in the neighbouring Yorkshire Dales and Peak District national parks indicates that the area provides a popular destination for both day visitors and longer stays. Features include the extensive network of open

access areas and public rights of way (including the Pennine Way long distance footpath), outdoor activities such as climbing on the various craggy outcrops, **cultural heritage** (e.g. historic mills, packhorse routes, 'Bronte country') and providing an open landscape in contrast to the nearby urbanised areas.

2.2.7 Within the ESP area, five specific catchments have been selected as the focus of the ecosystem services pilot, namely, Ilkley Moor, Keighley and Watersheddles, Marsden Moor, Rivington, and Worthstone. Table 1 provides a brief overview of these five sites. Environmental data collection is more established in these catchments compared to the rest of the ESP area, and they therefore provide a logical starting point for understanding and mapping ecosystem services and for linking them to beneficiaries.

Table 1: The five focal catchments of the South Pennies Ecosystem Services Pilot

Ecosystem Service Pilot Focus Area	Location	Characteristics
Ilkley Moor	North eastern limit of ESP area, close to town of Ilkley and north of Bradford. Near to Yorkshire Dales NP	Notable for the area's millstone grit, which is exposed in rocky outcrops and quarries, and underlies the acidic soils and moorland habitat. Popular destination for visitors with extensive views towards the Yorkshire Dales to the north. Designated SSSI.
Keighley and Watersheddles	Between Worsthorne and Ilkley catchments, to the west of Keighley town	Rural (only 8% urban); population of 16,200; dominated by blanket bog and upland heaths interspersed with steep wooded valleys with small settlements in valley bottoms; extensive sheep farming main land use.
Worsthorne	Centre of the ESP area, to the east of Burnley	One of the most important water supply areas in the South Pennines (feeding Hurstwood and Cant Clough reservoirs which partly supply Burnley); under United utilities' Watershed Landscape project to stabilise peat soils and prevent erosion.
Marsden Moor	Southern limits of ESP area – crosses into Peak District NP	Open moorland and blanket bog surrounding the village of Marsden, which sits along an important transport route across the Pennines between the conurbations of Manchester and Leeds. Further details in section below
Rivington	At far western end of ESP area between Bolton to the south and Blackburn to the north	Separated from the main Pennine Ridge by the valley of the River Irwell, and lower altitude than the other focal areas; contains chain of eight reservoirs which feed Liverpool and Wigan. Rivington Pike tower attracts visitors to the area along with the reservoirs and various options for outdoor activities.

2.3 Spatial focus of this report

2.3.1 Natural processes vary over time and space in response to a wide range of overlapping (and sometimes interacting) drivers of change. The ecosystem services these natural processes provide are therefore also highly dynamic. Some ecosystem services can be improved by changing land management approaches in a small geographical area, while others require a much broader catchment or landscape approach.

2.3.2 It is therefore appropriate to assess ecosystem services and approaches to improve them at different spatial scales. For the purposes of this report, the spatial boundary is the South Pennines ESP area (although it is acknowledged that this is artificial and

ecosystem services operate beyond this boundary); however where the data allows and where appropriate the analysis has drilled down into specific geographical areas. The five focal areas are used where possible because using these natural catchment units as boundaries better reflects the hydrological and biological pathways and processes at work.

2.4 The existing evidence base

2.4.1 A key aim of the ecosystem services pilot is to apply the ecosystem approach to help describe land management within the ESP area. An important element of the pilot is therefore to collect data and evaluate existing information available for the area, which describe the various goods and services provided in the ESP area and the focus catchments, with a view to mapping, valuing and linking them to the beneficiaries. A 'Narrative and Baseline Assessment' for the South Pennines Ecosystem Services Pilot was produced by Natural England and the pilot partnership (currently in draft form).[10] This provides a description for the ESP area and the focal areas (upon which this report draws) and summarises information on the current ecosystem service provision (including mapping) for the ESP area and in more detail for the five focal areas. The assessment draws on relevant sections of Natural England's uplands ecosystem services atlas (*Mapping Values: the vital nature of our uplands*)[11] as well as local data sources specific to the ESP area and focal catchments.

2.4.2 The current level of ecosystem services provided in the South Pennines ESP area is discussed in the baseline assessment for the following topics (the quality of the evidence available to this study for each of these is varied):

- Supporting services
  - Soil formation
  - Biodiversity
- Provisioning services
  - Agriculture and food provision (and take up of agri-environment schemes)
  - Woodfuel
  - Drinking water supply
  - Power from wind energy resource
- Regulating services
  - Air quality (nitrogen load)
  - Soil carbon (management of deep peat)
  - Flood regulation
  - Water quality
- Cultural services
  - Landscape character and tranquillity
  - Cultural heritage
  - Tourism and recreation

[10] Natural England (forthcoming) South Pennines Ecosystem Services Pilot Draft Narrative and Baseline Assessment.
[11] Natural England (2009) *Mapping Values: the vital nature of our uplands*. Available online: http://publications.naturalengland.org.uk/publication/47001?category=38019

2.4.3 Ongoing monitoring of particular ecosystem services is underway in the specific focus areas, for example, data are being collected on carbon storage and sequestration on Marsden Moor. Also for Marsden Moor, an analysis identifying priorities for restoring degraded and exposed peat soils in the catchment has been carried out by the Moors for the Future Partnership[12] as part of the NE ecosystem services pilot project. This analysis draws on available data to map the extent of bare peat in the catchment (based on aerial photographs taken in 2009), and applies information on biodiversity and water quality to inform a prioritisation process for restoration.

2.4.4 In the Keighley and Watersheddles catchment, Natural England has assessed land use and management scenarios with a focus on valuing ecosystem services under particular scenarios, in line with the best practice Value Transfer Guidelines produced by eftec in 2010. The results of this assessment are captured in Natural England Research Report NERR044.[13]

2.4.5 The 'South Pennines Ecosystem Services Pilot Project (SPESP) - Delivery Plan 2011', sets out actions for the next 25 years that could maximise the potential of land to deliver ecosystem services within the South Pennines. It identifies the following eight land management actions that could improve ecosystem service delivery:

- Reduction of burning to restore blanket bog
- Favourable management of upland heath
- Restore hydrological integrity
- Achieve sustainable grazing levels
- Increase woodland cover in defined locations
- Reinstate linear features
- Communication and engagement
- Interpretation and learning

2.5 The opportunity for place-based PES

2.5.1 It is apparent that the South Pennines ESP area and the focal catchments within this area provide a range of ecosystem services to local, regional and even global beneficiaries. Trends in many of these ecosystem services have however been declining (see discussion that follows). In order to reverse these trends, a reasonably well understood set of land management changes could be undertaken. The opportunity for place-based PES relates to using a payment for ecosystem services approach to fund those land management changes and consequently enhance the provision of ecosystem services.

2.6 Aims of the project

2.6.1 The aim of the project is to build on the evidence base generated through Natural England's Ecosystem Service Pilots to identify, quantify, value and enhance packages of ecosystem services, working collaboratively with partners, farmers and other land managers.

[12] Moors for the Future Partnership (2011) Mapping bare peat distribution and restoration priority within Marsden catchment. Draft report to Natural England.
[13] Harlow, Clarke, Phillips, & Scott (2012) Valuing land-use and management changes in the Keighley and Watersheddles catchment. Natural England Research Reports, Number 044.

2.6.2 Specifically, the aims are to:

- Review the current baseline and trend in ecosystem service provision;
- Assess the opportunity to improve a range of key ecosystem services through land management changes;
- Identify potential beneficiaries of these ecosystem services;
- Develop metrics for measuring and modelling key ecosystem services; and
- Evaluate the overall feasibility of setting up a place-based PES scheme delivering either a layered or a bundled PES scheme in an English upland context.

2.6.3 A secondary aim of the project is to develop and test metrics for measuring and monitoring carbon storage and sequestration in peatlands. This work is presented in the Technical Appendix to this report.

2.7 Structure of the report

- A scoping exercise is undertaken in **Section 3** to establish which ecosystem services provided by the ESP are likely to be best suited to a PES scheme;
- **Sections 4 to 8** consider the five ecosystem services taken forward for more detailed investigation. It presents an analysis of the current state and trend of the ecosystem service, a beneficiary analysis, an assessment of the appropriateness of existing monitoring data and an assessment of required land management changes;
- **Section 9** considers the feasibility of establishing a PES scheme based on multiple ecosystem services and evaluates the barriers and opportunities of different ways of tying multiple ecosystem services together;
- **Section 10** provides conclusions and recommendations.

3. ECOSYSTEM SERVICE SCOPING

3.1.1 This section explores the attributes of the ecosystem services that are provided by the South Pennines ESP and their suitability for inclusion in a PES scheme.

3.1.2 The South Pennines ESP currently supports a range of ecosystem functions and services.[14] The fact that provisioning services have had more market support from the Common Agricultural Policy (CAP) than non-provisioning services has led to the degradation of non-provisioning services such as climate regulation and water quality. To re-balance the supply of ecosystem services, it is necessary to find ways of addressing this market failure for non-market goods, and incentivise the activities required to deliver them. PES is one mechanism that has this potential.

3.1.3 The decision as to which ecosystem service(s) to include in a PES scheme depends on stakeholder preferences, the value and/or marketability of the relevant ecosystem services, and the capacity of the land to sustain the provision of those services under appropriate management. Where values are high yet marketability is poor, new mechanisms may be required.

3.2 Stakeholder preferences for ecosystem service(s)

3.2.1 Ecosystem services are interrelated and therefore any attempt to maximise the provision of a single ecosystem service could have a negative, positive or neutral impact on other ecosystem services[15]. As such, the choice of the ecosystem service(s) to support and the extent to which they are prioritised over other ecosystem services is a judgment that should be agreed with relevant stakeholders, including the beneficiaries of the affected ecosystem services.

3.2.2 The Ecosystem Service Pilot undertook extensive engagement with relevant stakeholders. The stated ambition of the Pilot was to '*... work in partnership to deliver an optimal range of ecosystem services on a defined spatial area in a cost effective way and link these services to the beneficiaries'* and '*agree and* implement' a vision for a place[16].

3.2.3 The Local Nature Partnership[17], which is coordinated and led by Pennine Prospects and represents a cross-sector partnership of local authorities, water utilities, rail operators, Natural England, the NFU and voluntary sector umbrella organisations, states that:

3.2.4 "*Pennine Prospects will continue to develop projects and identify resources for the sustainable management of the South Pennine uplands and will work to promote the full range of ecosystem services provided to the residents of* the *area and "exported" to the 7 million residents of the neighbouring conurbations"*[18]*.*

3.2.5 The implied preference here is to 'optimise' the delivery of multiple ecosystem services. This can be understood as integrating provisioning services such as food and fibre, along with the delivery of other ecosystem services for multiple benefits.

3.2.6 This report focuses on the main ecosystem services provided from the uplands. However, there may in some regions be local demands for specific services. Demands could come from the food and drinks sector (for example, peaty water for whisky); via the tourism sector (for example, for specific cultural landscapes, via books and songs –

[14] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment
[15] Bennett E, Peterson G D and Gordon L J 2009 Understanding relationships among multiple ecosystem services Ecology Letters 12 1394–404
[16] Waters and Clarke. Delivering Nature's Services: the Upland Ecosystem Services Pilots (online) available at: http://www.naturalengland.org.uk/Images/delivering-natures-services2_tcm6-17171.pdf
[17] South Pennines Local Nature Partnership Application
[18] Pennine Prospects Business Plan 2012-2013 (online) available at: http://www.pennineprospects.co.uk/about/business-plan

Bronte moors; Ilkley Moor), and via local authorities and the Environment Agency (for example, on invest-to-save projects)

3.2.7 A 'market' can only occur if a buyer and seller agree on a price. Some services cannot readily be ascribed a market value (and perhaps some values are purely intrinsic), some can have a spread of values (carbon) and some are explicitly linked to other markets (commodities).

3.3 The marketability of the ecosystem service(s)

3.3.1 Re-balancing the provision of ecosystem services from the uplands can be facilitated via a range of different mechanisms. The high proportion of upland farms that are part of agri-environment schemes reflects how one particular PES-like mechanism is being used to support this process. Agri-environment schemes[19] can purchase (on behalf of the public) a broad range of ecosystem services by specifying management actions likely to secure their delivery (e.g. maintenance of stone walls, sowing of pollinator-friendly seed mixes, reduced management intensity). The ecosystem services they deliver will depend on the type of agri-environment scheme and the management practices specified. The current agri-environment scheme in England, Environmental Stewardship, offers two broad tiers or levels of management, with landscape scale outcomes resulting from mass uptake (currently over 50% of the utilizable agricultural area). There are thematic sub-strands focussed at the uplands and organic farms. The Higher Level supports more site specific and demanding environmental outcomes, targeted at the best locations to deliver them. All levels of Environmental Stewardship seek to deliver value for money through contracts that deliver multiple benefits and optimising synergy across objectives. In contrast, examples of private sector PES schemes tend to focus on a narrow range of outcomes such as water colour (quality) that offer clear benefits to the private purchaser e.g. a Utility Company. However there is scope to link private and state funded PES schemes with mutual complementarity and a number of examples of this already exist in England. To be effective, a number of pre-requisites need to be met. These are set out below:

i) The opportunity to protect/enhance the ecosystem service

3.3.2 There should be a clear opportunity to alter land management practices to enhance the level of ecosystem service provided to a beneficiary. For example, there is little point trying to set up a PES scheme to improve water quality if it is already of good quality or if the changes in land management practices make no discernible difference to the intended beneficiaries.

ii) A well-defined ecosystem service or bundle of ecosystem services

3.3.3 The service or bundle of services offered for sale needs to be well-defined and well-evidenced, so that buyers can be confident that their purchase will deliver the benefits they require in a cost-effective way. For example, what is sold can be a directly measureable service (e.g. additional tonnes of carbon sequestered) or a land use or other resource management intervention likely to promote service provision (e.g. wetland restoration to enhance water storage). A clear relationship between resource management intervention (cause) and service provision (effect) is therefore important. While some resource management activities have well-documented links with service provision (e.g. in-field buffer strips can reduce diffuse pollution and promote water quality through slowing run-off and intercepting sediment), others may require further research to establish their effects in practice (e.g. research on the links between woodland creation and flood risk regulation).

[19] Agri-environment schemes are voluntary, and depend upon the options chosen by the farmers and negotiated with the Natural England advisor

3.3.4 Although further research may, in some instances, be a necessary precondition for scheme development, in others, buyers may be content to tolerate a degree of uncertainty around cause-and-effect if the weight of evidence suggests that benefits are likely to emerge. This 'leap of faith' is apparent in several existing PES schemes (particularly input-based schemes such as agri-environment schemes). Having said this, the less robust the scientific basis for a PES scheme, the more exposed it is to the risk of buyers questioning its rationale, potentially leading to weak demand. Where a bundle of ecosystem services is bought, this risk may be lower because, by purchasing a bundle of services, the buyer should be more confident about value added overall even if a single ecosystem service is not improved to the extent expected. Alternatively, buffers are often built into schemes, with the size of the buffer proportional to the perceived risk of delivering the required ecosystem services. For high uncertainty or risky projects, a large proportion (e.g. up to half) of the ecosystem service benefits are not sold, and kept in reserve in case of non-delivery or non-permanence of delivery.

iii) A service of value to one or more buyers

3.3.5 Without a willing and able buyer, there is no prospect of a PES deal. Beneficiaries are most likely to consider entering into a PES agreement if they are experiencing problems with the supply of a particular ecosystem service (e.g. clean water, habitat for wildlife or greenspace for recreation). Ultimately, there must be a clear demand for the service being proffered for sale, and its provision must be financially valuable to one or more buyers. Furthermore, the buyer(s) must be in a position to at least cover the opportunity costs incurred by the seller(s) in providing the service as well as any ongoing maintenance/management costs that would not otherwise have been incurred.

3.3.6 This, of course, presupposes that beneficiaries are aware of their dependency on particular ecosystem services. If beneficiaries do not recognise the value of these services, it is unlikely that a market will arise. As such, clearly articulating the reliance of beneficiaries on ecosystem services through outreach and awareness-raising activities may be an important precursor to scheme development.

iv) A service over which potential sellers have clear influence

3.3.7 The complex nature of ecosystem service provision means that it can be difficult to identify which land uses and/or managers are able to influence the provision of a particular service(s). As such, identifying who should be paid can be potentially problematic. For example, determining which land management practices in particular contribute to water purification may necessitate monitoring over an extended period of time, which could, in turn, significantly increase scheme transaction costs. In the case of biodiversity, the impacts of individual actions can be hard to separate from those undertaken on neighbouring landholdings (especially for mobile populations e.g. birds). However, in some instances single landowners can clearly influence biodiversity (e.g. restoration of hay meadows under agri-environment schemes).

3.3.8 Ecosystem services can be influenced at different scales. While it is possible for an individual landowner to undertake measures to increase rates of carbon sequestration, a single landowner is unlikely to be able to influence water quality or flood risk regulation appreciably. Protecting and enhancing some ecosystem services therefore requires greater coordination between land managers than others and may consequently result in higher transaction costs[20].

v) A service whose improvement does not lead to unacceptable levels of trade-offs in other ecosystem services, and where possible leads to synergies

3.3.9 Given the inter-relatedness of ecosystem services, there is the potential that improvements to one ecosystem service will adversely impact one or more others.

[20] Prager K, Reed MS, Scott A (2012) Encouraging collaboration for the provision of ecosystem services across multiple scales: rethinking agri-environmental payments. Land Use Policy 29: 244-249

Equally, synergies between ecosystem services exist. In the case of the English Uplands, synergies between carbon sequestration, biodiversity, water quality and flood regulation appear to be strong.[21, 22] As discussed, an informed value judgement is required concerning which ecosystem services to support. It is important to highlight potential trade-offs and synergies between ecosystem services in order that measures to reduce trade-offs and promote synergies are identified early in the PES design process.

3.4 Ecosystem services scoping table

3.4.1 Given the large number of ecosystem services provided by the English Uplands and the ESP it is necessary to scope out services that are unlikely to lend themselves to PES schemes, to highlight those services with greatest potential and to demonstrate their relative strengths and weaknesses. Table 2 below considers a limited[23] set of ecosystem services in relation to the key requirements discussed above.

[21] Natural England (forthcoming) South Pennines Ecosystem Services Pilot Project (SPESP) - Delivery Plan 2011

[22] Reed MS, Hubacek K, Bonn A, Burt TP, Holden J, Stringer LC, Beharry-Borg N, Buckmaster S, Chapman D, Chapman P, Clay GD, Cornell S, Dougill AJ, Evely A, Fraser EDG, Jin N, Irvine B, Kirkby M, Kunin W, Prell C, Quinn CH, Slee W, Stagl S, Termansen M, Thorp S, Worrall F (2013) Anticipating and managing future trade-offs and complementarities between ecosystem services. *Ecology & Society* 18(1): 5 http://dx.doi.org/10.5751/ES-04924-180105

[23] The limited number of ecosystem services was agreed by the project team and was based on knowledge of existing and emerging PES schemes and understanding of the South Pennines ESP area.

Table 2: Ecosystem services scoping table

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Supporting – Biodiversity	Yes, there is a clear opportunity to improve peatland biodiversity. For example, there are around 21,000 ha of SSSI habitat within the ESP area, 99% of which is currently in unfavourable condition.	Yes, however, different management regimes favour different aspects of biodiversity (i.e. different assemblages of species populations and habitats), so a normative decision has to be made about what species and habitat it is important for the scheme to improve.	Yes, conservation credits may provide a market for biodiversity improvements. Buyers may include developers or corporations. SSSIs are not eligible for biodiversity offsetting, but would be eligible for carbon offsets, and could be attractive to CSR buyers.	Partially, improvements on small parcels of land can improve biodiversity. However, the impact will be greater if large parcels of land are managed for biodiversity (particularly for more mobile species with more extensive ranges).	Yes, managing for biodiversity may require less intensive agricultural systems, changing burning patterns, and restoring damaged blanket bog. There are likely to be trade-offs between different species, depending on the form of management.	Yes

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Provisioning – Agriculture and food production	Yes, food and wool/fibre production in the area could be enhanced through more intensive agriculture. There is also the opportunity to enhance food quality through local premium produces and supply chains for local food. However, intensification may not be sustainable, and the trade-offs may not be acceptable to all stakeholders.	Yes, management techniques for promoting food production are well established	Yes, there is a well established existing market for food produced from this environment	Yes, through changes in land/agricultural management	Yes, to increase productivity, it may be necessary to drain moorland and to increase fertilizer use etc. This would have negative impacts on carbon sequestration and storage, flood risk, water quality and cultural services[24]. However, producing local premium produce on the moorland (e.g. a switch from sheep grazing to cattle) can be compatible with promoting other ecosystem services (e.g. water quality).	No, there are already well-established markets for agricultural outputs.
Provisioning - Fibre	Yes, there is an opportunity to create woodlands and manage existing woodlands for timber production and woodfuel.	Yes, management techniques to harvest timber and woodfuel are well established	Yes, there is a well established existing market for timber and woodfuel	Yes, through plating woodlands and increasing management of existing woodlands	Potentially, planting on peat soils can have negative impacts in terms of other ecosystem services (e.g. carbon storage). However, planting along cloughs/gills could have beneficial impacts on services such as flood risk regulation and biodiversity.	No, although the criteria are met, PES is not considered the appropriate mechanism. Conventional markets support this ecosystem service

[24] Reed MS, Hubacek K, Bonn A, Burt TP, Holden J, Stringer LC, Beharry-Borg N, Buckmaster S, Chapman D, Chapman P, Clay GD, Cornell S, Dougill AJ, Evely A, Fraser EDG, Jin N, Irvine B, Kirkby M, Kunin W, Prell C, Quinn CH, Slee W, Stagl S, Termansen M, Thorp S, Worrall F (2013) Anticipating and managing future trade-offs and complementarities between ecosystem services. *Ecology & Society* 18(1): 5 http://dx.doi.org/10.5751/ES-04924-180105

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Regulating– Erosion control	Yes, substantial areas of the bog surface are eroding, there are extensive areas of bare peat[25], some river habitats can be damaged by sediment, and some reservoirs are filling with sediment. However, some erosion features can be considered natural phenomena of intrinsic interest[26].	Yes, measures such as grip blocking and re-vegetating bare peat can reduce the risk of erosion, and can help to re-habilitate towards a fully functioning system.	Potentially, from those wishing to avoid dredging reservoirs and rivers, and from visitors interested in paying for restoration of bare peat.	Yes, on a local scale, land managers can reduce soil erosion.	Yes, to prevent soil erosion changes to grazing and burning management may be required.	Indirectly yes, although there are no direct buyers of erosion control, there are buyers for climate mitigation, water quality and recreation, which are all enhanced via erosion control
Regulating – Climate – Carbon Sequestration and Storage	Yes, substantial areas of the peatland are bare, eroding and losing stored carbon. None of the peatland is at maximum sequestration capacity.	Yes, there is increasingly good data on the science and correlation between peatland condition and carbon flux. Peatland in poor condition loses stored carbon, and loses its long term ability to sequester additional carbon	Yes, commercial organisations are interested in buying carbon, either voluntarily as part of corporate social responsibility, or in the hopes of being able to offset against their previous carbon emissions	Yes, land managers can restore blanket bog to lock in carbon?	Potentially, restoring blanket bog to enhance carbon storage could impact on provisioning services (grazing) and recreation services (some paths may need re-routing or improving).	Yes

[25] JNCC (2012) South Pennine Moors: site details (online) available at: http://jncc.Defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0030280
[26] ibid

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Regulating - Water Quality	Yes, bringing moorland into favourable condition will help reduce erosion and the deterioration of water colour.	Partially, given the fact that water quality is impacted by a range of pressures (such as diffuse pollution from agriculture), it is difficult to separate improvement to the blanket bog with other changes in the catchment. However, the condition of blanket bog is particularly associated with levels of DOC and water colour deterioration.	Yes, water companies are already involved in projects that are seeking to incentivise upstream changes in land management to improve water quality.	Partially, however the extent is difficult to determine and depends on the scale of the improvement and diffuse pollution downstream	Yes, restoration of blanket bog could impact on provisioning services, and recreation services.	Yes
Regulating - Flood risk regulation	Yes, flood risk is deemed a risk in the catchment and the associated costs are significant.	Potentially, flood risk is geographically specific and research needs to be undertaken to better define the land management activities that would reduce flood risk for this area and further downstream.	Potentially, but buyers may have to be aggregated, which could increase transactions costs	Potentially, but modelling is required to ascertain whether reductions in flood risk would be significant.	Yes, managing the moorland to provide flood risk regulation could impact on provisioning services, and recreation services (grouse shooting).	Yes

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Cultural - Recreation (walking)	Potentially, the area is deemed important for recreational opportunities and especially for walking (The Pennine Way runs through the ESP area). However, the impact of improving walking trails etc. on visitor numbers and the visitor experience is less certain, and displacement is likely: walkers may be attracted from other areas.	Partially, it is difficult to isolate the value that walkers would get from improvements to walking trails and restoration of the environment they are walking through etc from the range of other factors that might contribute to the visitor experience (e.g. landscape and cultural heritage).	Yes, payments are already made to fund improvements to recreation infrastructure that should enhance cultural services via Visitor Payback schemes. However these schemes rarely quantify the benefits so are not technically PES schemes. Some Visitor Payback PES schemes do exist however and Defra are exploring the potential to expand such payments e.g. via smart phone apps[27]	Potentially, land managers can improve the quality of paths and the wider landscape (e.g. stonewalls). However, given the linear nature of this form of recreation, it would often require aggregating landowners in order to realise the cumulative benefits. Furthermore, other factors may lead to deterioration of the service (e.g. increase in number of users leading to a loss of tranquillity) .	Yes, however, access can be managed to protect habitats/species	Yes, given the successful implementation of visitor payback schemes it is worth exploring this opportunity further.
Cultural - Recreation (grouse shooting)	Yes, mosaics of blanket bog and heath of different heights can provide grouse habitat benefits.	Yes, management regimes to support grouse populations are well known.	Yes, there is proven demand for grouse shooting.	Yes, owners can change land management to support grouse populations.	Yes, some moor burning regimes can have negative trade-offs on other ecosystem services (carbon sequestration, water quality, erosion).	Yes, it is important to consider this ecosystem service due to its role in shaping the landscape and the potential for it to be impacted by improvements to other ecosystem services.

[27] Defra Payment for Ecosystem Service Pilot research project led by Mark Reed from Birmingham City University

Ecosystem Service	Is there an opportunity to improve the ecosystem service?	Is there a strong cause and effect pathway between land management and ecosystem services?	Is there a potential buyer for the ecosystem service?	Does the seller have influence over the ecosystem service?	Are there potential trade-offs associated with promoting this ecosystem service?	Does the ecosystem service merit further consideration?
Cultural – Recreation (angling)	Potentially, improvements to water quality may support fish stocks	Yes, increasingly, there is evidence that high DOC and POC can damage fish and water habitats	Yes, recreational anglers may be interested in purchasing improved water quality for fish stocks. Angling Schemes have demonstrated the potential of this type of mechanism.	Partially, the landowner may be able to improve water quality for fish close to the upland habitat but will not be able to make improvements further downstream.	Yes, restoring blanket bog could impact on provisioning services, and recreation services (shooting).	Yes, this service is given further consideration in the following discussion.
Cultural – Cultural heritage	Yes, 260 scheduled monuments are considered at risk within the ESP area.	Partially, improving the landscape around the cultural heritage and access to it can improve this service.	Unknown	Partially, In some instances landowners can manage their land differently to improve the setting of cultural heritage or to improve access.	Unknown	No , for the purposes of this study, the value of cultural heritage is considered to be largely captured by other recreational services.

3.5 Which services lend themselves to marketing and why?

3.5.1 It is evident from Table 2 above that none of the ecosystem services provided by the area can immediately be packaged into a PES scheme. Further work is needed to understand what land management activities are required, where and how effective they would be in delivering the ecosystem services of interest, and in generating demand for them amongst beneficiaries. On balance, our initial analysis demonstrates that there is greatest potential for initiating a place-based PES scheme around five ecosystem services. These are:

- Carbon sequestration and storage;
- Water quality;
- Flood risk regulation;
- Biodiversity; and
- Recreation (walking, angling and grouse shooting)

3.5.2 These ecosystem services meet enough of the defined pre-requisites (section 3.3) to warrant further exploration.

4. WATER QUALITY

Box 1: Water quality summary

Existing condition and trend of water quality in the ESP area

At present only 8% of waterbodies (either partly or wholly in the ESP area) are achieving good ecological status (GES) or good ecological potential (GEP) under the Water Framework Directive.[28] The Environment Agency predicts that by 2015 10% of waterbodies will achieve GES/GEP with 90% achieving it by 2027.

Trends in water quality in the sub-catchments differ. In some it is stable or improving, while in others, such as the Keighley and Watersheddles catchment, it has deteriorated and is continuing to deteriorate. This downward trend is partly linked to the microbial breakdown of peat within the upland catchments as a result of peatland degradation. Without intervention in the catchment, significant increases in raw water colour concentrations are projected to continue and will result in the need for additional treatment to ensure that customers receive high quality drinking water.

Beneficiary Analysis

The beneficiary analysis suggests that water utilities are the most likely beneficiary to pay for improved water quality on behalf of local residents. Both Yorkshire Water and United Utilities are engaged, understand the links between peatland degradation and deterioration of raw water quality and have the financial capital to incentivise land management changes. However, water utilities are required to demonstrate to Ofwat that incentivising land management changes is a cost-effective way of reducing treatment costs (in comparison to reasonable alternatives) and will not lead to unnecessary increases in costs for customers. Ofwat has supported £52 million worth of catchment management work by 2012, with approximately half of this being spent on peatland restoration.[29] There is now an expectation of a business case for catchment management schemes, as suggested in Ofwat's PR14 guidance.[30]

Measuring changes and improvements in water quality

The Water Framework Directive (WFD) requires the competent authority to use proxies (e.g. abundance and age structure of fish fauna) as an indicator of the ecological status of a waterbody. It also requires direct measurement of nutrient levels, oxygenation conditions etc. In addition water utilities collect data on water quality. Water quality is therefore being monitored in the ESP area, but this does not necessarily translate into information that is useful for a PES scheme.

Suitability of information for a place-based PES scheme

Frequent monitoring of water quality at close proximity to the peatland restoration initiatives is required to detect any change in water quality and its extent. Neither the monitoring framework under the WFD nor the current water quality monitoring regime carried out by the water utilities is well suited to detecting changes in water quality as a result of peatland restoration initiatives. In response to this, water utilities involved in peatland restoration schemes have initiated more rigorous systems to monitor and evaluate changes in water quality (For example, the SCaMP project).

The cause and effect pathway is well understood, and the evidence-base is improving. Ofwat is supporting restoration while at the same time taking a cautious approach: "there is not yet enough evidence overall to show that catchment management schemes deliver better water quality and lower treatment costs...More work is needed to ensure that the benefits of this approach are demonstrated clearly."[31]

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[28] http://ec.europa.eu/environment/water/water-framework/objectives/status_en.htm
[29] Martin Furness, Ofwat presentation 12 May 2012: http://www.slideshare.net/RebeccaSlack/martin-furness
[30] *www.ofwat.gov.uk › Price Review*
[31] Ofwat (2011) From catchment to customer: can upstream catchment management deliver a better deal for water customers and the environment? http://www.ofwat.gov.uk/sustainability/prs_inf_catchment.pdf

4.1 Introduction

4.1.1 The uplands habitat mosaic, which is made up of blanket bogs, heathlands, grasslands, woodlands and rivers, is a significant source of drinking water in the UK, notably in Northern England. The high levels of rainfall in the uplands and the low levels of evapotranspiration mean that these areas supply large volumes of raw water to surrounding conurbations. The quality of this raw water can be impacted by the extent and condition of the peatlands. Peatlands can impact on the concentration of dissolved organic carbon (DOC), particulate organic carbon (POC), sulphate (SO_4), and nitrate (NO_3) in the water and its acidity. In some locations that have experienced high levels of former pollution, degraded peatlands can also release heavy metals into stream water. As described below, the condition of the peatlands can have both positive and negative impacts on water quality:

- Damaged peatlands can produce large amounts of DOC, which could be considered an ecosystem 'dis-service' due to its contribution to water discoloration and impact of water treatment costs[32]. There is evidence that the level of DOC in the water in the South Pennines has increased significantly over the last three decades with a 91% increase in DOC observed from drainage water from upland peat catchments across the UK over the period 1988 - 2003[33].

- Water draining from peat soils is naturally more acidic than water draining from other soil types. Atmospheric pollution from local industry and transport has also added to the acidity of water supply from peatlands. Functioning peats with high water tables however can reduce this acidity by retaining atmospheric pollutants, such as SO_4, and reducing them to non-harmful forms. The practice of draining peatlands appears to have reduced their natural capacity to retain deposited atmospheric pollutants possibly due to reduced residence times[34].

- Functioning peats are also effective at retaining atmospheric nitrogen. As nutrient-poor systems, most or all incoming nitrogen is incorporated in plant and microbial biomass, and ultimately transferred to long-term storage in the peat. High water tables also favour NO_3 reduction to less mobile ammonium ion NH4+. Loss of *Sphagnum* species is linked to a reduced capacity in peats to retain nitrogen, which has led to leaching and eutrophication downstream. The loss of *Sphagnum* from the South Pennines peatlands during the 20th Century was attributed to high atmospheric SO_2 pollution probably accentuated by moorland burning and erosion.[35]

- In peatlands close to industrial cities that have been exposed to long-term pollution, the peat may be storing heavy metals, which can be released into streamwater through erosion in degraded sites. There is strong evidence that

[32] Bonn, Holden, Parnell, Worrall, Chapman, Evans. Termansen, Beharry-Borg, Acreman, Rowe, Emmett, Tsuchiya (2010) Ecosystem services of peat – Phase 1 (online) available at: http://randd.Defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15990

[33] Yallop, Clutterbuck, Thacker (2010) Increases in humic dissolved organic carbon export from upland peat catchments: the role of temperature, declining sulphur deposition and changes in land management (online) available at:http://www.int-res.com/articles/cr_oa/special/BUppp2.pdf

[34] Bonn, Holden, Parnell, Worrall, Chapman, Evans. Termansen, Beharry-Borg, Acreman, Rowe, Emmett, Tsuchiya (2010) Ecosystem services of peat – Phase 1 (online) available at: http://randd.Defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15990

[35] ibid

re-vegetation and gully-blocking lead to significant reductions in heavy metal export from degraded peatlands.[36,37,38]

4.1.2 The evidence presented above strongly suggests that water quality from functioning peatlands is of higher quality than that from degraded peatlands. A high water table and the presence of *Sphagnum* species are associated with lower levels of DOC, SO_4, and NO_3 levels in water run-off. Vegetation cover and the absence of drainage ditches or gullies are also associated with lower levels of heavy metal export.[39]

4.1.3 A number of estimates of the impact of land management changes on water quality have been made. There is strong evidence that re-vegetation and gully-blocking lead to significant reductions in sediment (and associated heavy metal export) from degraded peatland within peatland-dominated catchments[40,41,42], leading to improved stream biodiversity[31,43,44]. There is also increasing evidence that gully blocking reduces DOC over the long-term, despite an initial DOC spike[45]. For the Peak District, it has been estimated that water table restoration could generate a 50% reduction in SO_4 leaching, based on a comparison of gullied and intact catchments on Bleaklow[46] and a 25% reduction in DOC[47]. A separate study estimated that re-vegetating peatlands with *Sphagnum* species and the cessation of burning practices could lead to an average 40% reduction in surface water DOC concentrations. These estimates are variable but give an indication of the magnitude of change that can be achieved through peatland restoration.

4.1.4 Estimates of the impact of the 'Sustainable Catchment Management Plan' (ScaMP)[48] project on a range of study sub-catchments also demonstrate that blocking grips, re-

[36] Holden, J. Shotbolt, L., Bonn, A., Burt, T.P., Chapman, P.J., Dougill, A.D., Fraser, E.D.G., Hubacek, K., Irvine, B. Kirkby, M.J., Reed, M.S., Prell, C., Stagl, S., Stringer, L.C., Turner, A., Worrall, F. (2007) Environmental change in moorland landscapes. Earth Science Reviews 82: 75-10

[37] Wilson, L., Wilson, J., Holden, J., Johnstone, I., Armstrong, A. & Morris, M. (2011) Ditch blocking, water chemistry and organic carbon flux: Evidence that blanket bog restoration reduces erosion and fluvial carbon loss. *Science of The Total Environment* 409: 2010-2018

[38] Rothwell, J.J., Taylor, K.G., Evans, M.G. & Allott, T.E.H. (2011) Contrasting controls on arsenic and lead budgets for a degraded peatland catchment in Northern England. *Environmental Pollution* 159: 3129-3133.

[39] Wilson, L., Wilson, J., Holden, J., Johnstone, I., Armstrong, A. & Morris, M. (2011) Ditch blocking, water chemistry and organic carbon flux: Evidence that blanket bog restoration reduces erosion and fluvial carbon loss. *Science of The Total Environment* 409: 2010-2018

[40] Holden, J. Shotbolt, L., Bonn, A., Burt, T.P., Chapman, P.J., Dougill, A.D., Fraser, E.D.G., Hubacek, K., Irvine, B. Kirkby, M.J., Reed, M.S., Prell, C., Stagl, S., Stringer, L.C., Turner, A., Worrall, F. (2007) Environmental change in moorland landscapes. Earth Science Reviews 82: 75-10

[41] Wilson, L., Wilson, J., Holden, J., Johnstone, I., Armstrong, A. & Morris, M. (2011) Ditch blocking, water chemistry and organic carbon flux: Evidence that blanket bog restoration reduces erosion and fluvial carbon loss. *Science of The Total Environment* 409: 2010-2018

[42] Rothwell, J.J., Taylor, K.G., Evans, M.G. & Allott, T.E.H. (2011) Contrasting controls on arsenic and lead budgets for a degraded peatland catchment in Northern England. *Environmental Pollution* 159: 3129-3133.

[43] Ramchunder, S.J., Brown, L.E. & Holden, J. 2012. Catchment-scale peatland restoration benefits stream ecosystem biodiversity. *Journal of Applied Ecology* 49: 182-191.

[44] Armstrong A., Holden J., Kay P., Foulger M., Gledhill S., McDonald A., Walker A. (2009) Drain- blocking techniques on blanket peat: A framework for best practice. *Journal of Environmental Management* 90: 3512–3519

[45] Wallage Z, Holden J, McDonald AT. 2006. Drain blocking: an effective treatment for reducing dissolved organic carbon loss and water discolouration in a drained peatland. *Science of The Total Environment* 367: 811–821.

[46] Daniels, Evans, Agnew and Allot (2008) Sulphur leaching from headwater catchments in an eroded peatland, South Pennines, U.K (online) available at: http://www.ncbi.nlm.nih.gov/pubmed/18817950

[47] Wallage, Holden, McDonald (2006) Drain blocking: an effective method for reducing dissolved organic carbon loss and waster discoloration in a drained peatland (online) available at: http://www.hydrology.org.uk/Publications/durham/bhs_17.pdf

[48] United Utilities developed SCaMP (in association with RSPB) with the aim of applying an integrated approach to catchment management across all of the water catchment land. In this way they sought to improve the quality of water entering their reservoirs through changing land management both on their land and, more recently, on private land.

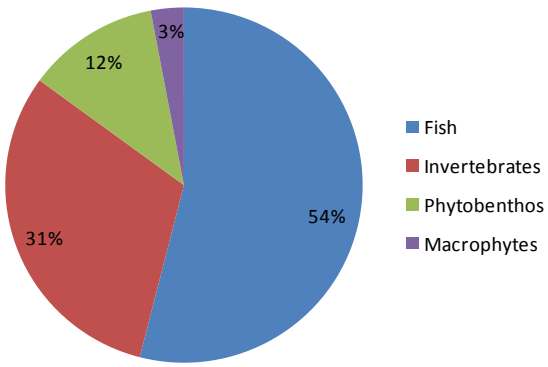
vegetating bare peat and reducing or stopping burning practices can improve water colour.[49]

4.2 Ecosystem Service Provision

4.2.1 Evidence for water quality across the catchments of the ESP area is patchy. There is evidence of the overall status of the waterbodies as categorised under the Water Framework Directive.[50] There is also more detailed evidence for Marsden Moor and Keighley and Watersheddles focal areas. This evidence is considered in turn.

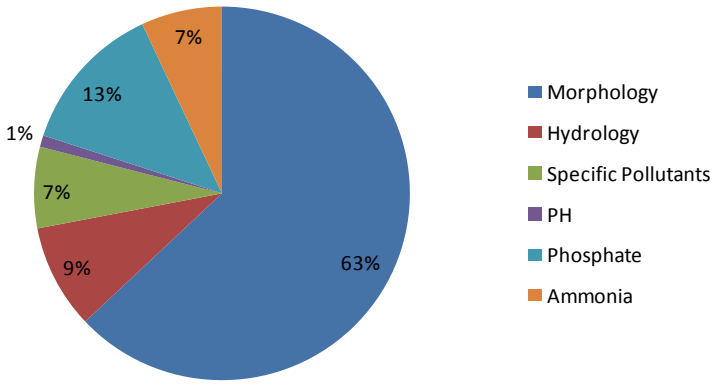
4.2.2 The ecological status of the waterbodies within the South Pennines ESP area are reported in River Basin Management Plans; a requirement of the Water Framework Directive (WFD). At present only 8% of waterbodies (either partly or wholly in the ESP area)) are currently achieving good ecological status (GES) or good ecological potential (GEP)[51]. The Environment Agency predicts that by 2015 10% of waterbodies will achieve GES/GEP with 90% achieving it by 2027.

Figure 2: Biological elements which fail the Good Ecological Status/Good Ecological Potential of the WFD



[49] Penny Anderson Associates (2012) SCaMP Water Quality Monitoring.
[50] The Water Framework Directive (WFD) is designed to improve and integrate the way water bodies are managed throughout Europe. Member States must aim to reach good chemical and ecological status in inland and coastal waters by 2015 subject to certain limited exceptions.
[51] Whilst good ecological status is defined as a slight variation from undisturbed natural conditions in natural water bodies, artificial and heavily modified water bodies are unable to achieve natural conditions. Instead, artificial and heavily modified water bodies have a target to achieve Good Ecological Potential, which recognises their important uses, whilst making sure ecology is protected as far as possible. For Natura 2000 (N2K) sites (e.g. the SPA and SAC sites), the targets for improving water quality must be in line with the N2K site objectives

Figure 3: Supporting elements which fail the Good Ecological Status/Good Ecological Potential of the WFD



4.2.3 The large number of waterbodies that fail due to morphology means that characteristics such as the depth and flow rate significantly diverge from what would be expected in undisturbed systems. Similarly, the failure due to the fish and invertebrate elements suggests that the age and structure of the fish communities in the waterbodies and the composition and abundance of benthic invertebrate fauna diverge significantly from undisturbed systems.

Marsden Moor

4.2.4 The seven Water Framework Directive (WFD) waterbodies contained wholly or partially within the Marsden Moor area are failing to achieve good ecological status/potential (currently at moderate status). The waterbodies are failing the WFD status due to several conditions: pressures underlying these include demands/impacts from urbanisation, flood protection, water storage and water supply. In addition, diffuse pollution from urban and/or agricultural sources (e.g. phosphate) has been identified as an issue.

Keighley Moor and Watersheddles Catchment

4.2.5 *"Over the past two decades, raw water quality has shown demonstrable deterioration in the Keighley Moor and Watersheddles catchments mainly due to the increased concentrations of colour. A substantial programme of research has been carried out to determine the causes of the colour increase. The colour is generated by the microbial breakdown of peat within the upland catchments and this breakdown is affected by land management practises which change peat hydrology"*[52]

4.2.6 The same study valued this downward trend in water quality. Based on 'cost avoided', the study estimated that a 'decline scenario', which caused a 30% increase in DOC levels, could cost circa £2.5 million in additional treatment costs to the water company over 25 years.[53] It is evident that water quality is an issue throughout the South Pennines ESP area.

[52] Natural England (2012) Valuing land-use and management changes in the Keighley and Watersheddles catchment (online) available at: http://publications.naturalengland.org.uk/publication/1287625
[53] Natural England (2012) Valuing land-use and management changes in the Keighley and Watersheddles catchment (online) available at: http://publications.naturalengland.org.uk/publication/1287625

Ilkely

4.2.7 There are four WFD waterbodies (sub-catchments) partially covered by the Ilkley focal catchment. All four waterbodies are classified as heavily modified and are failing to achieve their ecological potential (GEP); 3 are at moderate status and 1 is at poor status.[54] Pressures on the waterbodies include pollution from both agricultural and urban sources.

4.3 Trends in ecosystem service provision and the Business As Usual (BAU) scenario

4.3.1 Trends in water quality in the sub-catchments differ. In some it is stable or improving, while in others, such as the Keighley and Watersheddles catchment, it has deteriorated and is continuing to deteriorate. This downward trend has been linked to the microbial breakdown of peat within the upland catchments as a result of peatland degradation. Without intervention in the catchment, significant increases in raw water colour concentrations are projected to continue and will require additional treatment to ensure that customers receive high quality drinking water. The process for treating higher colour levels involves increasing the chemical dosing and, where colour concentrations reach a certain limit, as a last resort, new and expensive treatment solutions must be built.[55]

4.3.2 Various projects have been initiated to restore peatlands in the uplands. MoorLIFE is a £5.5million project aimed at restoring bare and eroded peat in the South Pennines Special Area of Conservation (SAC) and Special Protection Areas (SPA). The projects on Rishworth Common and Turley Holes fall within the ESP area. Under the business as usual (BAU) scenario, it can be assumed that the peatlands in these two areas will be improved and the levels of water discoloration and leaching from these peatlands reduced.

4.3.3 Beyond this, it can be assumed that there will be further degradation to some peatlands in the ESP area and the long-term trend of water discolouration will continue. It is likely that these trends will be exacerbated by increases in intense precipitation and periods of drought, which are predicted under climate change scenarios[56].

4.4 Beneficiary analysis

4.4.1 Improved water quality benefits a number of individuals and organisations both directly and indirectly. These include:

- Local users of surface water (water for farming/fisheries)
- Downstream residents;
- Participants in water-based recreation; and
- Water companies and their customers.

4.4.2 A number of factors are likely to determine the likelihood of turning these beneficiaries into buyers. Table 3 explores key factors that are likely to influence whether a beneficiary can be turned into a buyer.

[54] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment
[55] Natural England (2012) Valuing land-use and management changes in the Keighley and Watersheddles catchment (online) available at: http://publications.naturalengland.org.uk/publication/1287625
[56] NERC QUEST, climate change and upland peat loss: implications for policy (online) available at: http://quest.bris.ac.uk/research/wkg-gps/soil/briefingnote.pdf (accessed December, 2012)

Table 3: Water quality beneficiary analysis

	Farmers	Drinking Water Recipients	Water-based recreation participants	Water Utilities
Number and connectivity of buyers	A small number of disaggregated beneficiaries with some connectivity to each other	A large number of disaggregated beneficiaries that are poorly connected	A small number of aggregated beneficiaries	A single beneficiary; but requires regulatory approval from Ofwat
Availability of capital to incentivise land management changes	Upland farmers often receive subsidies. Levels of available capital can be assumed to be low	If aggregated they are likely to have sufficient capital	Likely to have some capital	High levels of capital and access to increased capital through customers
Engagement on issues	Engaged through agri-environment schemes but unlikely to see it as their role to pay	Largely non-engaged	Likely to be concerned about water quality and impacts on fish populations	Fully engaged
Level of reliance on water quality	Livestock grazing is the predominant type of farming in the South Pennines. Discoloured water is unlikely to have a negative impact on the health of sheep and cattle	Residents are reliant on water quality for drinking but their reliance is indirect	Anglers are reliant on water quality for fish stock.	Water Utilities have a statutory obligation to provide drinking-quality water. To attain those standards they treat the water. Better quality water is likely to lower treatment costs.

4.4.3 The beneficiary analysis suggests that water utilities are the most likely beneficiary to pay for improved water quality on behalf of local residents. Both Yorkshire Water and United Utilities are engaged in the issue, understand the links between peatland degradation and deterioration of raw water quality and have the financial capital to incentivise land management changes. Furthermore, they have both funded peat restoration programmes as part of their catchment management plans for the purposes of improving water quality.

4.4.4 Although delegates at the Halifax workshop (see Technical Appendix Annex 2) did not include representatives from United Utilities or Yorkshire Water, at the meeting held to exchange knowledge about this project with the South Pennines Ecosystem Services Pilot group, Yorkshire Water indicated interest in the potential for using carbon funds to help to pay for water quality restoration projects in the South Pennines.[57]

For a water utility, the rationale for paying for land management changes upstream needs to make economic sense and they are required to demonstrate to Ofwat that the proposed approach is a cost-effective way of reducing treatment costs (in comparison to reasonable alternatives) and will not lead to unnecessary cost increases to customers. There is some anecdotal evidence to suggest that upstream land

[57] Pers. Comm. made during the Ecosystem Pilot Group meeting to discuss this project, Leeds, 12.11.2012

management activities are cost-effective in comparison to increasing water treatment.[58] However, the business case will need to be strengthened through careful monitoring and more rigorous cost-benefit analysis.

4.5 Is there sufficient information available, upon which to base a PES scheme?

4.5.1 The evidence collected so far builds a strong case for undertaking land management changes to support the improvement of water quality, particularly POC and water colour. Although some studies suggest that improvements to water quality following peatland restoration are very slow,[59] other studies suggest that improvements are measurable within 7 years, [60] although it may take up to 20 years before water colour is sufficiently reduced.[61]

4.5.2 In theory a 'payment by results' system could be put in place, whereby land managers are paid based on observed improvements to raw water quality. However, previous water-quality PES schemes have not taken this approach due to the diverse range of pressures on water quality in a catchment and the impracticability of trying to differentiate water quality improvements relating to peatland restoration from other changes (e.g. a reduction in diffuse pollution from agriculture). Furthermore, the long time horizons involved before any results become evident also make this approach less attractive to land owners/managers. Payments have therefore been based on land management 'inputs' - measures that the landholders have undertaken to improve water quality.

4.5.3 Despite this, monitoring and reporting of changes in water quality should still be undertaken, preferably both at the treatment plant and further upstream close to the area of peatland restoration.

4.5.4 The available information is not sufficiently detailed to suggest where land management changes might best be targeted in the ESP area. No data on the quality of water draining from upland catchments and sub-catchments into reservoirs have been identified. [62] This would be the best basis for judging where improvements might best be sought.

4.6 Is the ecosystem service well defined?

4.6.1 The pressures on the peatlands that contribute to poor water quality are relatively well understood. These include drainage and burning of peatlands, intensive grazing, erosion caused by recreational walkers and vehicles, atmospheric pollution from local industry and climate change. However, the relative contribution of each of these natural and anthropogenic pressures to poor water quality is not certain.

4.6.2 Evidence suggests that blocking grips, managing moorland burning, and re-vegetating bare peat are likely to lead to improved raw water quality; although the extent of the improvement will vary from site to site. The exact improvements may be measured and monitored over time, as they are likely to vary from site to site.

4.6.3 Currently, both water companies and the Environment Agency measure water quality, though improvements in the location and density of sampling points would be desirable from the perspective of a PES scheme.

4.6.4 The WFD requires the 'competent authority', which for England and Wales is the Environment Agency (EA), to develop River Basin Management Plans (RBMPs) every

[58] Pers. Comm. made during the Ecosystem Pilot Group meeting to discuss this project, Leeds, 12.11.2012
[59] Holden, J, Wallage, Z.E., Lane, S.N and McDonald, A.T. 2011. Water table dynamics in drained and restored blanket peat. Journal of Hydrology 402, 103-114
[60] SCaMP (2012) corporate.unitedutilities.com/scamp-monitoring-reports.aspx
[61] Pers. Comm. made during the Ecosystem Pilot Group meeting to discuss this project, Leeds, 12.11.2012
[62] However, it is possible that the water utilities hold more detailed information

six years. These are required to report water quality using a range of indicators of the chemical and ecological status of the waterbodies. These include the abundance of aquatic flora, abundance and age structure of fish fauna, oxygenation conditions, salinity, acidification, nutrient conditions, and presence of polluting substances[63].

4.6.5 A framework for measuring water quality is therefore already in place. However, this does not necessarily translate into information that is useful from a PES perspective or for ecosystem services management more generally. From a PES perspective, it is the impact on the beneficiary that is important, rather than general improvements that accrue to the wider population, and the data that is required is often quite specific (e.g. levels of DOC).

4.6.6 Given their statutory obligation to collect and test water samples, water companies also collect data on water quality. They are therefore in a good position to detect changes in water quality as a result of land management changes upstream. The difficulty, however, is the diffuse nature of water pollution. It is difficult for water companies to separate the impact of land management change in one area from other changes and pollution events in the catchment. The smaller the scale of land management change, the weaker the improved water quality signal and the more difficult to detect.

4.6.7 Neither the monitoring framework under the WFD nor the current water monitoring regime carried out by the water utilities is adequate for the purposes of a PES scheme. More frequent monitoring at a closer proximity to the peatland restoration initiatives would be required to detect any change and the extent of those changes. However, a business case for water catchment management is now close; and one investor has taken a 'leap of faith' and invested in capital works, land management changes and monitoring systems. The SCaMP project is testament to the water utilities' leadership in this area.

4.6.8 The cause and effect pathway is reasonably well understood, and although Ofwat note that "there is not yet enough evidence overall to show that catchment management schemes deliver better water quality and lower treatment costs – that is, benefits that will hold down the bills that customers would otherwise have to pay. More work is needed to ensure that the benefits of this approach are demonstrated clearly"[64], the evidence base is improving year by year, and the business case for some catchments is becoming stronger, as suggested in Ofwat's PR14 guidance[65].

4.7 Is it possible to develop simple metrics for stocks and flows that could underpin a marketing platform?

4.7.1 In terms of water quality, it is easier to measure the flow of the ecosystem service than it is to measure the 'natural capital stock'. The flow of the ecosystem service can be measured by recording water quality over time. This may be in terms of nitrate/phosphate concentration or oxygenation conditions. The flow can be measured at a particular location (e.g. in close proximity to the moorland or at an abstraction point) or it can be measured at multiple locations. It can also be measured over short or long time durations.

4.7.2 The moorland is part of the natural capital stock through which water passes and which can either negatively or positively impact on water quality. The management of peat and organo-mineral soils, which support a range of vegetation such as blanket bog and

[63] See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF
[64] Ofwat (2011) From catchment to customer Can upstream catchment management deliver a better deal for water customers and the environment? (online) available at: http://www.ofwat.gov.uk/sustainability/prs_inf_catchment.pdf
[65] *www.ofwat.gov.uk › Price Review*

dwarf shrub, impact on stream water chemistry.[66] Currently, the impact of slight variations in the quality of this natural stock on water quality is not known.

4.7.3 Yorkshire Water is in the process of developing a Water Calculator, relating water quality to rainfall, peat depth and colour.[67]

4.8 Recommendations for improving the potential of using water quality as part of a place-based PES

4.8.1 A number of actions could be undertaken to increase the viability of including water quality as part of a PES scheme. These include:

- Before initiating a place-based approach to PES across the ESP area, it would be useful to undertake research to understand how variations in peat condition and land management contribute to water quality across the area, so that land management initiatives can be effectively targeted;
- Where water quality services are being included in a place-based approach to PES, it will be necessary for the sellers or co-ordinators of such a scheme to establish water quality monitoring in much closer proximity to peatlands than is currently performed by water companies in the ESP area;
- Local partnerships could engage local recreation water users and communicate the impact of poor water quality on fish stocks, to garner greater local support for place-based PES in the ESP area and help highlight these co-benefits to potential buyers;
- Water companies could continue to develop the evidence on costs and benefits of catchment solutions compared to end-of-pipe solutions for water quality;
- Those developing a future place-based PES scheme would benefit from conducting a wider beneficiary analysis so that partnership funding can be developed alongside water company investment; and
- The development of a place-based approach to PES that includes water services may usefully link to and build upon other catchment-based initiatives e.g. if the area is a Demonstration Test Catchment or one of the pilot catchments where the Environment Agency and other partners are exploring the potential to work more closely with land managers and other stakeholders around the implementation of RBMPs to meet targets under the WFD.

[66] Reed et al (20009) The future of the uplands (online) available at: http://www.sciencedirect.com/science/article/pii/S0264837709001380

[67] Pers. Comm. made during the Ecosystem Pilot Group meeting to discuss this project, Leeds, 12.11.2012

5. CLIMATE REGULATION: CARBON STORAGE AND SEQUESTRATION

Box 2: Carbon storage and sequestration summary

Existing condition and trend of carbon storage and sequestration in the ESP area

Carbon **storage** is significant in the deep peats of the moorlands of the ESP area. A small minority of carbon stores are safe, protected by a healthy peatland vegetation of damp *Sphagnum* moss. The majority of carbon stores are at risk of oxidation as a result of desiccation and changed vegetation cover – the loss of peat forming vegetation, and the increase in heath and grasses. Certain carbon stores are at particularly high risk due to vegetation loss and the onset of peat erosion. Carbon **sequestration** is variable. Peatlands vegetated with grasses and mosses continue to sequester carbon, but those dominated by heather and bare peat have ceased to do so. Changing climate, and especially any increase in spring and summer droughts, will exacerbate negative trends.

Beneficiary Analysis

The analysis suggests that the global population (and especially those most vulnerable to a changing climate) will be the main beneficiary of improving carbon storage and sequestration in the ESP area, because of the ameliorative effect on climate change. There are no direct ways for the global population to pay for these benefits. However, as a result of global and national climate change targets and carbon offset programmes, UK companies are increasingly prepared to pay for this global benefit.

Monitoring improvements to carbon storage and sequestration regulation

It is not sensible to directly measure improvements in carbon storage and sequestration in the context of a PES scheme, because of the high costs of doing so. However, it is possible to use proxies to determine improved carbon storage and sequestration, and this project has demonstrated such a proxy, based on peatland ecosystem functionality, in the Technical Appendix. Proxies that can be used include vegetation type and cover, hardness of the peatland surface, and area of bare peat (see Technical Appendix).

Suitability of information for a place-based PES scheme

Information on carbon storage and sequestration by blanket bogs is at the point of being suitable for a place-based PES scheme. The metrics developed here (in the Technical Appendix) can be linked with the developing UK Peatland Carbon Code to form a pilot version of a place-based PES scheme for peatland carbon. Further research coupled with evidence from previous restoration projects will be required to fine tune the metrics and develop the scheme. In parallel with this, a transparent trading system will be required, and local restoration partnerships may be necessary.

5.1 Summary of ecosystem service provision

5.1.1 The carbon services currently being provided by peatland are the:

- Storage of peat carbon in the catotelm (deep peat), for hundreds or thousands of years
- Storage of carbon in the acrotelm (surface layer of *Sphagnum* mosses) for tens of years
- Carbon sequestration by the peatland vegetation (via photosynthesis by *Sphagnum* mosses, grasses, sedges and shrubs)

- Greenhouse gas flux from the peat ecosystem. Greenhouse gases, including carbon dioxide (CO_2) and methane (CH_4), can be lost from a damaged bog via a number of routes – from oxidizing, desiccating peat, from DOC and POC in run-off, and from vegetation responding to management change (see Technical Appendix); however, restoring a blanket bog leads to reductions in greenhouse gas emissions

5.1.2 The quality, quantity and flows of these marketable services depends upon the condition of the peatland. Healthy peat is better at storing and long-term sequestering of carbon than unhealthy peat. Conversely, degraded peat is likely to be emitting greenhouse gases.

Table 4: Impact of peat condition on Greenhouse Gas emissions[68]

Peatland condition	Type of ecosystem service	Quality of ecosystem service	Flow of ecosystem service	Effect on climate
Healthy peatland	Carbon sequestration and carbon storage	Very good	Improving	Positive
Grazed peatland	Carbon storage	Adequate	Steady or deteriorating	Variable
Burnt peatland	Carbon storage	Adequate	Steady or deteriorating	Variable
Degraded peatland	Carbon storage	Poor	Deteriorating	Negative
Eroding peatland	Carbon storage	Very poor	Deteriorating	Negative

5.2 Trends in ecosystem service provision and the business as usual scenario

5.2.1 In the South Pennines, the provision of upland carbon ecosystem services is deteriorating[69,70]. Damaged peatlands lead to a deterioration of ecosystem service provision: carbon emissions from damaged peatlands exacerbate climate change, rapid run-off from damaged peatlands exacerbates flooding, and run-off from damaged peatland exacerbates drinking water treatment costs. The business as usual scenario for the South Pennines is one where damaged peatlands are causing ecosystem dis-benefits at present, and where future climate forecasts suggest that service provision is likely to decline further, with the potential loss of much of the peat from drained, damaged, desiccated and eroding peatlands. However, restored peatlands would potentially provide positive ecosystem services – new *Sphagnum* moss growth could help sequester additional carbon from the atmosphere; and peatland restoration could

[68] this table is based on data summarised and discussed in the Technical Appendix of this report.
[69] Natural England (2009) *Mapping Values: the vital nature of our uplands*. Available online: http://publications.naturalengland.org.uk/publication/47001?category=38019
[70] Reed MS, Hubacek K, Bonn A, Burt TP, Holden J, Stringer LC, Beharry-Borg N, Buckmaster S, Chapman D, Chapman P, Clay GD, Cornell S, Dougill AJ, Evely A, Fraser EDG, Jin N, Irvine B, Kirkby M, Kunin W, Prell C, Quinn CH, Slee W, Stagl S, Termansen M, Thorp S, Worrall F (2013) Anticipating and managing future trade-offs and complementarities between ecosystem services. *Ecology & Society* 18(1): 5 http://dx.doi.org/10.5751/ES-04924-180105

reduce carbon emissions by preventing loss of the peatland store, and could also lead to reduced flooding and reduced water treatment costs[71].

5.2.2 The most instantly accurate way to measure greenhouse gas flux in a peatland ecosystem is to measure CO_2 and CH_4 fluxes using gas chambers, and to measure DOC and POC in run-off. Ideally, one would also need to measure carbon lost through wind erosion. Such greenhouse gas flux measurements create a snapshot that doesn't fully articulate the driving forces (the 10-year vegetation and climate trends), thresholds, or permanence of upland carbon storage and sequestration. Instead, the best way to forecast trends in upland carbon sequestration and storage is by measuring peatland condition – by measuring the vegetation, surface hardness and extent of bare peat – and assessing whether or not the peatland ecosystem is close to major biotic (e.g. loss of peat-forming *Sphagnum* species) or abiotic (e.g. physical breakdown and erosion of peat mass) thresholds[72]. [*This is discussed more comprehensively in the Technical Appendix*]. A hard, compacted peat surface (i.e. a peatland with no acrotelm) is likely to be eroding or on the verge of erosion: areas of thin vegetation and bare peat are susceptible to rain and trampling damage, and, in a wet climate, areas of unvegetated, bare peat on slopes eventually develop into gullies, as in Marsden Moor. Coupled with climate trends[73] (which forecast more droughts as well as more heavy rainstorms, and which place the South Pennines at the southern limit for peat formation), a peatland that has already stopped growing and is already eroding or on the brink of eroding can be expected to lose much of its stored carbon over the next 100 years. Securing such peat, by restoring the surface vegetation, is a key to safeguarding the carbon.

5.2.3 It is unknown whether or not climate change in the South Pennines will be so great as to disable the peat-forming processes on restored and healthy peatlands. Extreme climate models suggest that the area may eventually become too dry in summer to support a fully functioning peat forming system[74,75]; even so, the area could still store peat (with a heath vegetation) if the erosion was controlled by restoring gullies and revegetating. Investment in peatland would only fail to deliver results if the climate change was so extreme that delivery of the other ecosystem services, particularly drinking water supplies, was also threatened. On the other hand, restoration and conservation of the peatlands would help maintain the water supplies. It therefore remains important to secure the peat that is presently stored in the peatland, and minimise the likelihood of such extreme future climate scenarios.

5.3 Is there sufficient information available, upon which to base a PES scheme?

5.3.1 The carbon value, and carbon fluxes, of upland peatland depend upon peatland condition, and particularly on peatland vegetation and peatland compaction (see Technical Appendix). There are a number of different sources of evidence for peatland condition – peatland condition maps and data, SSSI maps and data, priority habitat data, vegetation data, British Geological Survey and James Hutton Institute maps and reports of peat soils, and agri-environment scheme data (see Technical Appendix for more detailed description and discussion of these). No single one of these data sources is ideal for supporting the development of a PES scheme because they were not designed for a PES scheme, which requires cost-effective monitoring of GHG fluxes.

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[71] United Utilities 'SCaMP' programme applies an integrated approach to catchment management: *http://corporate.unitedutilities.com/scamp-monitoring-reports.aspx.*

[72] Example of a peatland threshold: an event (such as a flash flood following a drought) or slow accumulation of pressure (such as overgrazing, trampling and pollution) that triggers major ecosystem change, such as widespread erosion or loss of peat

[73] NERC QUEST, climate change and upland peat loss: implications for policy (online) available at: http://quest.bris.ac.uk/research/wkg-gps/soil/briefingnote.pdf (accessed December, 2012)

[74] Artz, R.R.E.; Chapman, S.J.; Towers, W.; Lilly, A.; Matthews, R.**, (2012)** JHI Climate change research relevant to organic soils and peatlands., *Briefing Note to IPCC Working Group, 25 January 2012.*

[75] Worrall F, Burt TB, Adamson J, Reed MS, Warburton J, Armstrong A, Evans M (2007) Predicting the future carbon budget of an upland peat catchment. *Climatic Change* 85: 139-158

5.3.2 When developing a biodiversity metric, Defra (2012) considered using the SSSI site condition categories, but eventually decided to use the Higher Level Agri-Environment Scheme (HLS) condition assessment tool. The HLS tool includes a handbook that clearly describes the method, and divides habitat condition into one of three categories: good, moderate or poor. However, the HLS scoring is based on Farm Environment Plans, which are not necessarily comparable across the UK.

5.3.3 The SSSI condition monitoring and the HLS scheme monitoring have now been combined into Integrated Site Assessment Monitoring. This scheme provides benefits such as increased data on site vegetation under the HLS schemes on non-SSSI sites. However, it still lacks sufficient detail for it to be used as an indicator of peatland condition for carbon purposes (it was not designed with this aim in mind). For example, there is no specific category to provide information on peat-forming *Sphagnum* species (although the surveyor may list six indicator species for blanket bogs, there is not necessarily any indication of whether or not *Sphagnum* is present), and the category for "peat erosion" is only triggered when more than 10% of the area is bare ground (which provides no details on whether this is 11% or 100%, and hence insufficient information on the extent of peat erosion). If such categories could be added to the assessment sheets, the Integrated Site Assessment tool for Upland Vegetation Conditions could be a useful tool for PES; however, without such categories there is insufficient data for use in estimating carbon fluxes.

5.3.4 Detailed peat condition survey work (such as the work carried out by the Yorkshire Peat Partnership) is required in order to prioritise and cost restoration projects. Development of PES requires that data are available on an area basis. Knowing the number of kilometres of grips or gullies is less useful than knowing the area affected by gripping or gullying, and the condition of those grips/gullies. (However, it is necessary to know the number of kilometres of both grips and gullies in order to calculate likely restoration costs).

5.3.5 The area then needs to be mapped into parcels of 'like' character, according to the 'quality' of that habitat. Assessing the 'quality' is a subject in its own right (see Technical Appendix).

5.3.6 Development of a clear and straightforward PES baseline using, for example, Defra's Biodiversity Metric, requires that sites be clumped simply into three categories according to the quality of their biodiversity. For peatland carbon, however, more quantification of the different site types is possible and will probably be required by potential funders (because they will be interested in a fairly accurate estimate of how much carbon they are saving), so we therefore recommend five categories in order to properly represent the range of carbon emissions and sequestration possible from peatlands of different conditions (see Technical Appendix).

5.4 Beneficiary analysis

5.4.1 A number of factors are likely to determine the likelihood of turning carbon/climate beneficiaries into carbon buyers. The following table outlines the principal beneficiaries of carbon management, and explores factors that are likely to influence whether or not a beneficiary can be turned into a buyer.

Table 4: Carbon management beneficiary analysis

	Farmers/managers	Regional population, regional businesses	Global population
Number and connectivity of beneficiaries	Unlikely to benefit directly from climate change mitigation in the short term. However, could benefit from future carbon trading schemes.	Unlikely to benefit directly from climate change mitigation in the short term.	Will benefit over a long timescale if climate change can be mitigated. Unconnected, except by global carbon trading schemes
Availability of capital to incentivise land management changes	Upland farming subsidies can, and have been used to, incentivise change. Levels of available capital can be assumed to be low.	Potentially.	Global and national trading schemes, and local partnership projects can provide finance and capital
Engagement with issues	Likely to have little understanding of their impact on climate change, but becoming more engaged.	May not have good knowledge of the relationship between land management climate change.	Aware of climate change, but likely to have little understanding that peatlands can impact on this.
Level of reliance on carbon storage/ sequestration	Low, although very high reliance on soil quality, soil erosion and vegetation quality	Low	High; per hectare carbon storage by blanket bogs is almost as important as the rainforests

5.4.2 The beneficiary analysis indicates that carbon storage and sequestration is at present a 'public good' for which there are no local beneficiaries: carbon management is an ecosystem regulating service that benefits the global population in the long term, but does not in itself benefit local people in the short term[76]. None of the direct beneficiaries are likely to pay for the service unless they join conservation charities. However, the development of international/national and compliance/voluntary carbon trading schemes can help to create indirect beneficiaries and hence buyers for the service.

5.4.3 There is, however, concern over the phrase "carbon offsetting". Following media reports that businesses were buying forest carbon offsets of uncertain quality in the first decade of the 21st century in order to claim green credentials, some key environmental NGOs and environmentally-aware individuals have criticised offset schemes as a "licence to pollute" instead of considering them as part of a "polluter pays" approach[77]. This has discouraged funding for ecosystem restoration. Recently, increased focus on the mitigation hierarchy (whereby offset buyers should first seek to avoid impacts, then to minimise them, then take on-site measures to rehabilitate or restore, before finally offsetting residual, unavoidable impacts) has encouraged those who genuinely seek to offset their carbon emissions to be able to do so (e.g. see DECC carbon offsetting guidelines[78] and Defra Greenhouse Gas Accounting Guidelines[79]). However, some

[76] It is, however, recognised that the co-benefits of peatland restoration – improved water quality and flood risk – can be short/ medium term.
[77] This is linked to the ethical argument of the 'intrinsic value' of nature, and to practical concerns over the integrity and effectiveness of emissions trading schemes, including the previous over-supply of permits.
[78] DECC and Defra (2010) Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting: Methodology Paper for Emission Factors (online) available at: http://archive.defra.gov.uk/environment/business/reporting/pdf/101006-guidelines-ghg-conversion-factors-method-paper.pdf

organisations may continue to favour the principal of funding peatland restoration as part of a philanthropic Corporate Social Responsibility project without formally measuring or accounting for the carbon benefits, while others, although keen to fund ecosystem restoration and account for the carbon, may prefer to avoid using the term "carbon offset". In the latter instance, 'project financing' is a preferred term.

5.4.4 There are existing buyers for carbon from upland ecosystems. One scheme is known to have been paid for by a London-based buyer from the financial services sector. Other potential carbon purchasers include up-market fast food retailers, heavy plant manufacturers, and transport companies; however these potential purchasers are awaiting clarification on likely climate legislation and targets before making a purchase (details are commercially confidential). Such companies seem interested in the potential of a voluntary carbon purchase prior to the expected UK mandatory carbon accounting, due to start April 2013. They are voluntarily funding peatland restoration projects on the basis that such projects save carbon, and are interested in the possibility in future of using the carbon credits so generated to help offset their previous year's commercial carbon footprint. To date, each buyer has funded a specific area of peatland restoration (in the order of hundreds of hectares); however, buyers could be aggregated for funding larger areas of restoration[80].

5.4.5 Market research by Rabinowitz and d'Este-Hoare in 2010[81] and ongoing market research by Defra[82] has shown that a range of companies is interested in investing in peatland restoration projects. They are particularly attracted by the opportunity to invest in UK-based projects, which they perceive to be more accountable than overseas projects and hence less likely to turn into "toxic" investments. They are interested in sites that are accessible and attractive, that they can photograph for public relations material and potentially use for corporate team-building activities. They are interested in co-benefits, in particular biodiversity (and to a lesser extent water quality), though they are less concerned about quantifying these co-benefits in great detail. There is also strong demand for an appropriate regulatory environment in which peatland restoration

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[79] Defra and DECC (2009) Guidance on how to measure and report your greenhouse gas emissions (online) available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69282/pb13309-ghg-guidance-0909011.pdf

[80] **A note on carbon prices**. It is difficult to value the price of carbon in peatland restoration. UK government policy appraisal recommended using the cost of mitigation https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41793/3136-guide-carbon-valuation-methodology.pdf, and values carbon in the non ETS traded sector at £57 for 2013. However, this was updated in 2012, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/41794/6667-update-short-term-traded-carbon-values-for-uk-publ.pdf. Defra (https://www.gov.uk/**carbon**-valuation) now suggests that UK policy appraisals and valuations use the market price of carbon whenever possible. In the compliance market, January 2012, the price of a permit to emit a tonne of carbon dioxide was at an all time low of £2 as a result of oversupply of permits in the European Emissions Trading Scheme. By February 2013, the carbon price was around £5 per tonne carbon dioxide. Voluntary carbon offset prices are affected by the compliance market, and can be higher or lower, depending on the buyer. Woodland carbon credtis trade at around £10 (http://www.woodlandtrust.org.uk), and early peat carbon trades have been less than this. Market research suggests that UK-based corporations are prepared to pay more for UK-based carbon sequestration projects with additional co-benefits, but less than the shadow price of carbon. The shadow price of carbon is based on estimates of the lifetime damage costs associated with greenhouse gas emissions, known as the "social cost of carbon"; it is measured as tonnes carbon dioxide equivalent. Because of the range of carbon prices and the uncertainty over which prices might apply to peatland carbon restoration schemes, this report uses two figures – a) £5 per tonne CO2eq as a reminder of present day voluntary carbon prices, for comparing with present-day peatland restoration and management costs, and b) £20 per tonne CO2eq as an estimate of a possible carbon price during the period 2013-2020. The £20 figure represents a conservative mid range value (range £6 (2013) to £75 (2030)) from the central scenario in the updated Defra "Updated short term traded carbon values for UK public policy appraisal" (2013) guidance for the period 2013-2030, but there can be no guarantee of what actual carbon prices will be in the future. By comparison, in the compliance sector, Defra are expected to introduce a carbon floor price of £16 in April 2013, with a target price of £30 by 2020. The UK's Centre for Climate Change expects a figure of £30 per tonne of carbon dioxide equivalent in 2030.

[81] Rabinowitz, R. & d'Este-Hoare, J. (2010) *The Feasibility of Creating a Funding Mechanism for UK Carbon Reduction Projects*. http://www.ukcarbonreporting.org/filelibrary/IP17_10.pdf.

[82] Defra Payment for Ecosystem Service Pilot project led by Mark Reed at Birmingham City University

projects are covered by a Government-led regulatory framework to assure standards in restoration practice, monitoring and reporting, additionality and permanence. To address these issues, a draft UK Peatland Carbon Code is currently being developed as part of a Defra research project[57]. This follows the precedent of the Woodland Carbon Code, a Government-led code which provided equivalent, and necessary, assurances for woodland carbon schemes.

5.5 Is there an opportunity to improve the service through changes in land management?

5.5.1 Upland carbon sequestration and storage is strongly affected by changes in land management.

5.5.2 Carbon **sequestration** is enhanced by changing land management to favour the growth of bog mosses (*Sphagnum*). This can be achieved by changing grazing, burning, water levels and trampling to encourage *Sphagnum* growth, and (if necessary) re-seeding with *Sphagnum*. Carbon sequestration rates may be temporarily enhanced by planting fast-growing plants (trees) on peat, but for peatlands, this sequestration spike is entirely transient, resulting in widespread oxidation of the deep peat and loss of much greater quantities of carbon from long-term carbon stores in the following years. To understand carbon sequestration rates on peatlands and all organic soils it is necessary to consider the peat/soil carbon flux as well as the vegetative greenhouse gas flux. This point is now clear in the literature published by the Intergovernmental Panel on Climate Change (IPCC) and Voluntary Carbon Standard (VCS) (see Technical Appendix).

5.5.3 Carbon **storage** can be safeguarded and enhanced by changing land management to reduce erosion and oxidation of deep peat. This can be achieved by changing land management, rewetting, blocking gullies, blocking grips, and (if necessary) “re-seeding” with *Sphagnum*.

5.5.4 Improvement in long term carbon sequestration and storage can occur at any scale, so the actual size of an individual moor is not relevant – the key thing is to work at the hydrological unit of each peatland, so that re-wetting and restoration can be effective. This means identifying hydrologically-independent peatland catchments: peatland basins. However, for most restoration projects, the integrity and continuity of peatland management is critical, so farm and estate boundaries become important. In such cases, individual farms become the practical scale for peatland carbon management, and several may need to work together in order to undertake peatland restoration over a catchment. Furthermore, unfenced common lands are often situated on the moor tops between the settlements, straddling the watershed. In these cases, the whole moor may need to be managed as a single unit, and the case for a local partnership approach to peatland restoration becomes clear.

5.5.5 The seller of the ecosystem service (peat carbon sequestration and storage) needs to have influence over the management of the moorland, in order to influence the provision of the services. For example, if the manager of the moorland were to increase the sheep grazing and muirburn, this could result in loss of carbon, so loss of potential carbon income. The only people/organizations able to sell the carbon from the moor would be the people/organizations with property rights for the moor and/or its peat. This may involve several people, for example where there are many commoners, or where there are grazing rights, shooting rights, and/or peat-cutting rights, and is another indication of the benefits of working via a local partnership.

5.5.6 There are also opportunities to create woodland in upland valleys (in the non-peat areas) to provide habitat for wildlife, to sequester carbon and potentially to improve opportunities for recreation[83]. Buyers for the carbon generated from the new woods

[83] http://www.pennineprospects.co.uk/projects-programmes/south-pennines-woodlands

could come via the established Woodland Carbon Code[84], run by the Forestry Commission.

5.6 Is the ecosystem service well defined, i.e. is there a strong cause and effect pathway and can buyers be confident they are getting what they pay for?

- What data can be used as proxies for services and how accurate and suitable is this information?
- Is it possible to standardise the proxies so they can be used on other sites?
- What are the buyers' requirements? What level of uncertainty are buyers likely to tolerate?
- Is it possible to develop simple metrics for stocks and flows that could underpin a marketing platform?

5.6.1 The Technical Appendix outlines the proxies for carbon sequestration/emission (flows) and carbon storage safeguard (stocks), compares possible proxies, and identifies best proxies, both in terms of accuracy and ability to measure cost-effectively. The proxies are developed in a European context, and have been translated into a UK context (c.f. the Centre for Ecology and Hydrology's (CEH) work on Ellenberg moisture values). Standardisation to sites throughout the UK is probable because the model is generic (based on plant functional types) and was derived from UK and European data on blanket peat (using plants as indicators of key environmental characteristics, including peat formation), so should be easily transferrable to other sites. Statistics are presented to measure ranges, degree of variability, and confidence limits.

5.7 Are there potential trade-offs and synergies between improving this ecosystem service and the supply of other ecosystem services?

5.7.1 There are many trade-offs and synergies between improving carbon sequestration and storage and the supply of other ecosystem services.

5.7.2 **Trade-offs:** improved long term carbon sequestration and reduced greenhouse gas emissions can lead to softer bogs, with more bog-mosses. This can lead to loss of trafficability on a peatland: it may become more difficult to walk across some areas of peatland, or to drive vehicles across the peatland. However, these newly softened areas are likely to occur in areas which previously (historically) had always been boggy. Furthermore, the ridges and shoulders of the peatland are likely to remain comparatively dry, and are likely to be the places followed by traditional footpaths and pony tracks. The softer peatland may therefore encourage moorland users to remain on the old routes. Bog restoration may also involve reduced grazing/trampling, (i.e. reduced stocking levels, or seasonal grazing), and, depending on the site, changes to burning regimes (cessation/reduction of any burning which damages the peatland or mosses).

5.7.3 **Synergies:** The presence of an active functioning *Sphagnum* layer is indicative of a functioning ecosystem and good quality habitat. Management that improves carbon sequestration and storage by enhancing the *Sphagnum* can lead to enhanced peatland biodiversity (SSSI, HLS and priority habitat condition scoring all value the presence of *Sphagnum* as being good for biodiversity). Improved carbon sequestration and storage can lead to enhanced water quality. Water companies have become aware that a healthy peatland provides better water quality than an eroded or oxidizing peatland.

5.7.4 Improved carbon sequestration and storage can lead to improved flood risk regulation, i.e. lower flood peaks (see section 6).

[84] *www.forestry.gov.uk/**carboncode***

5.8 What institutional set-up is required to coordinate and deliver the protection/enhancement of the ecosystem service?

5.8.1 Improved carbon sequestration and storage needs to be delivered by the moorland manager. This is easiest where there is only one land manager, but in some cases in the Pennines, there may be grazing managers[85], sports managers, recreation/access managers, water supply managers and flood control/river managers, each with their own impact on carbon sequestration and storage. In cases where such people need to work together, and in cases where significant capital works need to be undertaken (e.g. grip blocking, gulley blocking), the works may need to be co-ordinated. In practice, local partnerships (such as Moors for the Future and the Yorkshire Peat Partnership) have proven successful at initiating and coordinating peatland restoration projects.

5.8.2 Furthermore, international emissions trading systems are expected to rollout incrementally[86]; national and regional initiatives will need to fit within these.

5.9 Recommendations for improving the potential of using the ecosystem service as part of a place-based PES

5.9.1 Carbon sequestration and carbon storage may be layered with other ecosystem services as part of a place-based PES. Carbon sequestration and carbon storage has good potential as a foundation-layer for place-based PES, upon which other (less easily valued) ecosystem services may be offered[87]; however carbon as a tradable commodity cannot easily be added as a layer to existing schemes because of the need to prove additionality. In practice, because of the win-win situation with similar land management providing both carbon and water quality benefits, and because of the increasingly strong business case[88] for some catchment management schemes, it should be possible to design new peatland restoration schemes that can layer both water and carbon.

5.9.2 Realising the potential of carbon sequestration and carbon storage as part of a place-baed PES scheme requires:

- Establishment and acceptance of a government assured peatland carbon metric (see the Technical Appendix for a pilot version) and Peatland Carbon Code;
- Positive coverage (to the public and to companies) of the benefits of well-functioning peatlands, explaining clearly how restoration benefits the climate;
- Commitment to a transition to a low carbon society that involves accounting for negative externalities and a robust accounting regime, providing the stability necessary for both supply and demand side innovation to occur. This requires clear government commitment to carbon footprinting and GHG accounting for companies; clear goalposts and timelines, so that companies can better plan for carbon reduction strategies and carbon offset programmes; and government commitment to carbon accounting for landuse change, including rewetting/restoration of wetlands and peatlands.

[85] In areas where commons are grazed, agreements may be needed from all commoners to change management; and all graziers need to sign up to agri-environment on the common as a whole.
[86] See Emerging Carbon Markets: Experiences, Trends & Challenges. Climate Strategies, 2013, for example
[87] 'piggybacking', as in the woodland carbon code
[88] Some water companies have already begun catchment management, others are undertaking Cost Benefit Analyses to compare the costs of catchment management with more conventional water treatment methods .

6. FLOOD RISK

Box 3: Flood risk summary

Existing condition and trend of flood risk regulation in the ESP area

Flood risk is significant both within the upper catchment and further downstream and has adverse economic and social consequences. Evidence on the link between moorland condition and flood risk suggests artificial drainage, livestock grazing and lack of surface roughness can increase flood risk, although uncertainty remains. Under a business as usual scenario flood risk is likely to increase due to the impacts of climate change. Recent widespread flood events are pushing concerns about flooding higher up the social and political agenda.

Beneficiary Analysis

The analysis suggests that none of the direct beneficiaries are currently likely to pay for improvements to land management across a sufficient scale to improve flood risk regulation. Downstream residents are unlikely to be aware of the link between moorland management and flood risk, and unlikely to view flood risk protection as their responsibility. However, key organisations such as the Environment Agency and Insurance companies are interested in increasing their understanding of the contribution land management changes can make to local flood risk.

Monitoring improvements to flood risk regulation

It is not possible to measure a reduction in flood risk directly as it relates both to the *likelihood* of an event and the *magnitude* of its impact. However, it is possible to use proxies to demonstrate improved flood regulation. Proxies that can be used include synchronicity of flows, peak flow rates and levels, and response time to rainfall events. However, given the geographical specificity of flooding, flood risk modelling would have to be undertaken to understand where land management changes (e.g. planting of trees or blocking of grips) would be best targeted.

Suitability of information for a place-based PES scheme

For this catchment, the cause and effect pathway is not yet sufficiently understood to assess the likely impact of land management changes on flood risk. It is likely that changes across a large land area would be required and the benefits may not be substantial or readily visible (taking into account the impact of climate change). Further research is required before flood risk can be incorporated into a place-based PES scheme.

6.1 Ecosystem Service Provision

6.1.1 Flood risk is significant both within the catchment and further downstream. This is due to the topography and relatively high levels of precipitation in the area. The upper reaches of the Calder run through steep and relatively narrow gullies, which mean they react quickly to rainfall. The condition of flood defences in the towns and villages in these areas are assessed as poor and the protection they afford low. Flooding has significant economic and social impacts on settlements within the ESP area, such as Hebden Bridge, and outside of the ESP area, further downstream.

6.1.2 The Environment Agency published the Upper Calder Improvements Strategy in 2004. This recommended that flood defence schemes were put in place in Todmorden, Hebden Bridge[89], Mytholmroyd and Sowerby Bridge; all of which are within the South

[89] Hebden Bridge, a town deep in the Pennines, is well known as the location where BBC film crews await the floods. In winter 2013, the new river flood defences were sufficient to protect the high street, although shops and other properties still put out sand bags to protect their premises from flooding.

Pennines ESP area. A number of defence schemes, such as the Todmorden Flood Alleviation Scheme, have since been built[90].

6.1.3 The Calder Catchment Flood Management Plan (CFMP) (2010) indicates that 2000-5000 properties are at risk of flooding in Todmorden during 1:100 year river flood (assuming no flood defences are in place). Some 500 to 1000 properties are at risk of flooding in Hebden Bridge and in Mytholmroyd[91]. The CFMP includes a catchment sensitivity analysis, which assesses the relative importance of future drivers in changing the impact of flood events in the catchment. The analysis demonstrated that large scale changes in agricultural land management, especially in the Uplands, had the potential to decrease river flows by 25% and reduce run-off[92].

6.1.4 Implicit in the sensitivity analysis is the link between upstream land management practices and downstream flood risk. The evidence for the impact of different land management practices on flood risk is detailed below:

- The practice of moorland draining has changed the pathways through which water flows through and over moorland soil[93]. The impact on flood risk is equivocal however and both increases and decreases in flood peaks have been observed[94]. This is because moorland draining has both positive and negative impacts on levels of attenuation. Moorlands with a low water table buffer a rainfall event by providing extra soil storage capacity for rainwater. In contrast rainwater run-off from saturated moorlands is higher and more immediate. Ditches in drained moorlands and the greater number of soil pipes speed up the flow of water into streams and can therefore increase flood peaks[95]. Compacted bare peat surfaces provide the fastest run-off and highest peaks. Although early reports[96] raised concern that during the first few years following rewetting and ditch blocking there was more overland flow and higher flood spikes, later reports[97,98,99] show that once the peatland surface has regained its health and surface roughness (in particular *Sphagnum* cover), the flood response is flattened. Holden et al. (2004) showed that 11 out of 16 studies of the effects of peatland drainage since 1957 showed increases in flood peaks after drainage (compared to 3 studies that showed a decrease in flood peaks and one that showed both increases and decreases)[100]. One of these studies used data from the 1950s in the Moorhouse Nature Reserve in the North Pennines to show that drainage led to increased peak flows, increased annual water yield and decreased low

[90] Environment Agency (2012) Todmorden Flood Alleviation Scheme (online) available at: http://www.environment-agency.gov.uk/homeandleisure/floods/117980.aspx
[91] Environment Agency (2010) Calder Catchment Flood Management Plan Summary Report December 2010 (online) available at: http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/gene0110brlh-e-e.pdf
[92] ibid
[93] Holden et al (2007) Environmental change in moorland landscapes (online) available at: http://gislearn.org/people/a.turner/publications/papers/journal/HoldenEtAL2007.pdf
[94] Holden (2005) Controls of soil pipe frequency in upland blanket peat. *Journal of Geophysical Research*
[95] Holden et al (2007) Environmental change in moorland landscapes (online) available at: http://gislearn.org/people/a.turner/publications/papers/journal/HoldenEtAL2007.pdf
[96] Holden et al (2007) Environmental change in moorland landscapes (online) available at: http://gislearn.org/people/a.turner/publications/papers/journal/HoldenEtAL2007.pdf
[97] United Utilities 'SCaMP' programme *http://corporate.unitedutilities.com/scamp-monitoring-reports.aspx.*
[98] Holden J; Kirkby MJ; Lane SN; Milledge DG; Brookes CJ; Holden V; McDonald AT (2008) Overland flow velocity and roughness properties in peatlands *Water Resources Research* 44 doi: 10.1029/2007WR006052
[99] Grayson R; Holden J; Rose R (2010) Long-term change in storm hydrographs in response to peatland vegetation change *Journal of Hydrology* 389: 336-343 doi: 10.1016/j.jhydrol.2010.06.012
[100] Holden J; Chapman PJ; Labadz JC (2004) Artificial drainage of peatlands: hydrological and hydrochemical processes and wetland restoration, *Progress in Physical Geography* 28: 95-123. doi: 10.1191/0309133304pp403ra

flows[101]. Holden et al. (2006) compared their data with new data collected in 2002-4 in exactly the same catchments and found that peak flows had reduced, although annual yields were significantly higher, suggesting that short-term studies of the effects of drainage may be misleading[102]. In an attempt to take these long-term effects into account, modelling studies have been conducted, and have shown that drain blocking can reduce peak flows downstream[103], although this may depend on the angle of the drains with respect to the slope[104]. In summary, although drainage increases flood risk downstream, drain blocking only sometimes reduces this flood risk (and in some cases, depending on the pattern of dams in relation to rainfall patterns, can exacerbate flooding), and the effect depends on a number of factors. Re-vegetating bare peat however shows a clear benefit for downstream flood risk.

- There is stronger evidence for a link between cattle and sheep densities and downstream flood risk.[105] Sheep in particular cause soil compaction and reduce rainwater infiltration, which leads to faster run-off.
- There is some evidence that the presence of trees and other vegetation along streams may increase the 'roughness' of the terrain and may help attenuate rainwater during intense precipitation[106].

6.1.5 The current provision of the ecosystem service (flood regulation) is low. While there is evidence to suggest that reducing the number of sheep in the South Pennines ESP area, restoring moorlands and planting trees and vegetation along strategic waterways may reduce downstream flood risk, the magnitude of this impact is uncertain.

6.2 Trend in ecosystem service provision and the BAU scenario

6.2.1 The CFMP assessed the impact of a number of future drivers on flood risk in the catchment. It found that the impact of future urbanisation on flood risk was low. This was because the total area of urban development is expected to be small and appropriate drainage systems are likely to be a prerequisite of any development. However, it found that the impact of climate change on flood risk was significant. More frequent and intense storms and increased winter rainfall are likely to cause more frequent flooding and increased depth and flow of flood waters in the existing at-risk communities[107].

6.2.2 Under a business as usual scenario, which assumes that the moorlands in the South Pennines ESP area remain in their current state of degradation, flood risk can be expected to increase due to the effects of climate change.

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[101] Conway, V.M. and Millar, A. 1960: The hydrology of some small peat-covered catchments in the northern Pennines. *Journal of the Institute of Water Engineers* 14, 415-424.
[102] Holden J; Evans MG; Burt TP; Horton M (2006) Impact of land drainage on peatland hydrology, *Journal of Environmental Quality* 35: 1764-1778. doi: 10.2134/jeq2005.0477
[103] Ballard CE, McIntyre N, Wheater HS (2012) Effects of peatland drainage management on peak flows *Hydrology and Earth System Sciences* 16: 2299-2310
[104] Lane and Milledge (in press) cited by Joe Holden, http://www.slideshare.net/AberdeenCES/peatland-management-impacts-on-flood-regulation
[105] Lane (2010) Slowing the floods in the U.K. Pennine uplands…a case of Waiting for Godot? (online) available at: http://knowledge-controversies.ouce.ox.ac.uk/Ryedale2/documents/usefuldocuments/Lane.pdf
[106] Slowing the flow at Pickering. See: http://www.forestry.gov.uk/fr/INFD-7YML5R
[107] Environment Agency (2010) Calder Catchment Flood Management Plan Summary Report December 2010 (online) available at: http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/gene0110brlh-e-e.pdf

6.3 Beneficiary Analysis

6.3.1 Enhanced flood regulation benefits a number of individuals and organisations both directly and indirectly. These include:

- Farmers;
- Downstream residents; businesses and travellers;
- Insurance companies; and
- The agencies and authorities responsible for flood risk mitigation in the UK

6.3.2 There is a comprehensive system in the UK for addressing flooding[108]. Defra is the lead Government Department responsible for planning for and responding to flooding emergencies in England. Local authorities generally lead when the emergency response shifts into the recovery phase. The Environment Agency leads on assessing flood risk, communicating flood awareness, maintaining warning systems, and preparing operational plans for managing EA flood management systems and flood defences (including barriers and sluices). The Met Office and Environment Agency provide flood forecasting under one roof (the Flood Forecasting Centre), and together with the Extreme Rainfall Alert Service provide guidance and alerts to the emergency services, local authorities and other organisations where relevant (Health and Safety Executive, transport and utility companies). The Regional Resilience Fora support local planning authorities[109].

6.3.3 A number of factors are likely to determine the likelihood of turning these beneficiaries into buyers. The following table explores a number of key factors.

Table 5: Flood risk regulation beneficiary analysis

	Farmers	Downstream residents	Local Authorities, Environment Agency	Insurance companies
Number and connectivity of buyers	A small number of disaggregated beneficiaries with some connectivity to each other.	A large number of disaggregated beneficiaries that are poorly connected	Small number, well connected.	A limited number of large insurance companies.
Availability of capital to incentivise land management changes	Upland farmers often receive subsidies. Levels of available capital can be assumed to be low.	If aggregated they are likely to have sufficient capital	Access to sufficient capital, but may lack time/resources to prioritise	Insurance companies have access to sufficient capital.

[108] Defra (2012) Flooding in England: Lead Government Department Plan (online) available at: http://archive.defra.gov.uk/environment/flooding/documents/planning/ldp.pdf

[109] local Resilience Fora lead emergency planning across all Civil Contingenies Act 2004 responders

	Farmers	Downstream residents	Local Authorities, Environment Agency	Insurance companies
Engagement with issues	Likely to be engaged in relation to flood risk. Likely to have an understanding of the relationship between land management changes and flood risk.	Likely to be engaged in relation to flood risk. May be unaware of the relationship between land management changes and flood risk.	Engaged in flood prediction, flood management, flood response and engineered flood protection to minimise flooding of roads and towns. Recently becoming more engaged in land management issues	Engaged. They factor flood risk into estimating insurance premiums for homeowners. Their knowledge of mitigation measures, such as land management, is uncertain.
Level of vulnerability to flood risk	Farm infrastructure may be vulnerable to flooding	Downstream residents in urban centres such as Hebden Bridge are highly vulnerable to flooding.	Site-specific vulnerability to flooding; towns in deep valleys (e.g. Hebden Bridge); main roads, railways and commuting routes along valleys are all vulnerable to flooding	Insurers face increasing insurance claims after flood events, and increasing flood risk due to climate change. They can mitigate this risk by raising premiums and refusing to offer insurance, but lack certainty as to the predicted changes in flood risk.

6.3.4 The beneficiary analysis suggests that none of the direct downstream beneficiaries are very likely to pay for land management changes that may reduce flood risk. However, significant barriers remain:

- Their disaggregation and poor connectivity. Aggregating home owners is likely to increase transaction costs;
- A view that it is not their responsibility to pay for flood protection; and
- Poor understanding of the effects of upstream land management on flood risk.

However, there is scope for engagement of insurance companies and, via the Regional Resilience Fora, further engagement with local authorities and the Environment Agency, especially in those towns and areas already partly defended from flooding.

6.4 Is the ecosystem service well defined?

6.4.1 It is not possible to measure a reduction in flood risk directly as it relates both to the *likelihood* of an event and the *magnitude* of its impact. However, it is possible to use proxies to demonstrate improved flood regulation. Proxies that can be used include:

- Synchronicity of flows;
- Peak flow rates and levels; and
- Response time to rainfall events.

6.4.2 The Slowing the Flow at Pickering pilot study is investigating the link between land management changes and flood risk. The impact of measures, such as creation of riparian woodlands and construction of bunds, has been modelled. At the same time, the flow rate is being monitored to give an indication of the impact of the measures[110]. See Thomas and Nisbet (2007)[111] for a review of evidence for floodplain woodland reducing flood flows.

6.4.3 However, given the fact that flood risk is spatially specific, the degrees to which synchronisation of flows, flow rates and response rates contribute to downstream flood risk will vary and measures cannot simply be transferred from one location to another.[112] There is therefore a need for flood modelling to demonstrate where land management changes might be most effective and to give an indication of the magnitude of impact.

6.4.4 It may be that beneficiaries will pay land-owners based on observable improvements in these proxies. However, the uncertainty surrounding the marginal improvement landowners can have on flood risk through particular actions is unknown. The CFMP suggests that an appreciable difference to flood risk could only be achieved through land management changes across the entire landscape.

6.4.5 Rather than 'paying by result', it may be preferable to pay for inputs, which best-available evidence suggests can help to ameliorate flood risk. These measures may include:

- Increasing the physical "roughness" of habitats;
- Increasing vegetation cover;
- Grip blocking;
- Increased woodland planting;
- More appropriate grazing management;
- Bare peat restoration; and
- Increasing the interval between burning management cycles.

6.4.6 The difficulty remains that the cause and effect pathway is not sufficiently understood for potential beneficiaries to be confident they are getting what they pay for. To add to this problem, is the likely impact of climate change that will make flood risk reduction more difficult to achieve.

6.5 Recommendations for improving the potential of incorporating flood regulation into a place-based PES scheme

6.5.1 There is no evidence-based case for setting up a PES scheme around flood regulation in the South Pennines ESP area; however, there is increasing demand for one[113]. For

[110] Forest Research (2012) Slowing the flow at Pickering. See: http://www.forestry.gov.uk/fr/INFD-7ZUCL6
[111] Thomas, H., Nisbet, T.R. (2007) An assessment of the impact of floodplain woodland on flood flows. *Water and Environment Journal* 21: 114-126.
[112] Morris & Camino (2011) Economic Assessment of Freshwater, Wetland and Floodplain (FWF) Ecosystem Services (online) available at: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=IVLEq%2BxAI%2BQ%3D&tabid=82
[113] For example, pers comm made during the Halifax meeting 15.1.2013, see Annex 2 of the Technical Appendix; an urgent meeting had just been requested by the Regional Resilence Forum between the Local Authority and the Environment Agency over the recent flooding of the Pennines dales and main roads. In September 2012, the A1, east coast railway line and many other routes and towns were flooded for two days following heavy rain. Although a cause and effect (beyond rainfall) is hard to establish for flood events, the social and political pressure for action to reduce flood disruption is high.

flood risk regulation to be included in future as part of a place-based PES scheme, the following work would be required:

- Improving the understanding of the cause and effect pathway between changes in land management and changes in downstream flood risk – including undertaking flood risk modelling;
- Understanding changes in the collaboration between government agencies and insurers, and the strategic approach to funding both flood defences and catchment flood management planning.
- Undertaking a grey-green analysis of the costs and benefits of investing in natural solutions and land management changes rather than conventional flood defences; and
- Engaging beneficiaries, particularly regional and local authorities, downstream residents and insurance companies, and raising awareness around the potential of land management changes to reduce flood risk. Work on this has already begun in the South Pennines ESP area, following the 2012 flooding. Similar work is also being undertaken as part of the Environment Agency's pilot catchments and DEFRA's Demonstration Test Catchments.

7. BIODIVERSITY

Box 4: Biodiversity summary

Existing condition and trend of biodiversity in the ESP area

The South Pennines ESP area is an important area for biodiversity, attested to by the large number of nature designations (18% SSSI and 31% UK Priority Habitat). The majority of the SSSI habitat (94.5%) is in 'unfavourable recovering' condition. Outside of these areas information on biodiversity is absent. However, some artificial draining, grazing and moorland burning have had an adverse impact on biodiversity; especially in the blanket bog habitats. Management is already in place to improve the condition of SSSIs and there are targets to improve priority habitats. Outside of these areas however, biodiversity may continue to be adversely impacted.

Beneficiary Analysis

The beneficiary analysis suggests that local developers and corporations may be willing to invest in improving biodiversity through purchasing 'biodiversity offset credits' either to comply with Local Planning Authorities or for the purposes of Corporate Social Responsibility (CSR). Wildlife organisations, such as the RSPB, may also be willing to pay or provide technical assistance to improve biodiversity and particularly habitat for bird species.

Measuring biodiversity improvements

Restoring priority habitats improves biodiversity for the priority species. Management interventions to improve biodiversity are reasonably well known; although there are inevitable trade-offs between improving habitat for one species at the expense of another. The best quality data on the condition of habitats and on biodiversity in the ESP area is collected through SSSI condition monitoring against favourable condition tables for SSSI designations. Outside SSSI designations, some information is collected on the condition of different habitats through Farm Environment Plans (FEP) that are a one-off requirement of entering HLS. However, the quality of the data collected under FEPs is variable and is not available in the public domain.

Suitability of information for a place-based PES scheme

The existing evidence is sufficient for use in voluntary/CSR projects to improve biodiversity (for example, to benefit specific habitats or species), and is being used as a biodiversity metric, but is not ideal as the basis of a biodiversity credit scheme. The 'favourable condition tables' relating to the SSSI designations do not collect the information in a way that is suitable for biodiversity credits. The framework for collecting information for the FEPs is suitable, however the quality of information collected can be inconsistent. Primary research may be required for specific habitats.

7.1 Introduction

7.1.1 Biodiversity both underpins a range of ecosystem services (as a supporting service), and can help enhance other service provision, for example by improving water quality, food productivity, and opportunities for recreation (as a cultural service). Biodiversity provides an array of benefits as varied as *"recognising the environment's capacity to retain greenhouse gases in habitats such as blanket bogs", through to a habitat's ability to support invertebrates which then go on to pollinate food crops."* [114] This report looks at biodiversity both as a 'supporting service' and as 'cultural heritage'.

[114] Natural England (2011) Mapping values: the vital nature of our uplands – an atlas linking environment and people (NE209) (online) available at: http://publications.naturalengland.org.uk/publication/47001

7.1.2 The South Pennines supports extensive areas of valuable habitat, with 18% of the ESP area designated at international or national level for its biodiversity value.[115] The South Pennines is the largest area of unenclosed moorland within West Yorkshire and contains the most diverse and extensive examples of upland plant communities in the county. The mosaic of habitats supports moorland breeding bird assemblages of regional and national importance. [116]

7.1.3 The South Pennines Moors contain Special Protection Areas (SPA) and Special Area of Conservation (SAC). These international designations reflect the highest level of environmental protection afforded through legislation and are indicative of the international significance of the ecosystems and wildlife within the ESP area. Any land use changes that may alter the ecological integrity of these sites would therefore need to be compliant with the Habitats Regulations 1994[117] .

7.1.4 The South Pennines Moors are designated as a Site of Special Scientific Interest (SSSI) for their ecological and geological significance. Extensive areas of blanket bog occur on the upland plateau, interspersed with species-rich acidic flushes and mires. There are also wet and dry heaths and acid grasslands. The moorland supports breeding populations of merlin, golden plover and twite.

7.1.5 Peatlands are notable contributors to biodiversity in England and internationally. The English uplands contain a significant proportion of the global resource of blanket bog and upland heath[118]*:*

7.2 Ecosystem Service Provision

7.2.1 The status of biodiversity is measured through both the presence of priority species and habitats (as mapped by the national UK BAP Habitat inventory March 2011) and the condition of SSSIs (as designated under the Wildlife and Countryside Act 1981). The study area contains 35,971 ha of UK Priority Habitats covering over 31% of the ESP area and 20,939 ha of SSSI designated habitat covering 18% of the ESP area.[119]

7.2.2 Table 6 sets out the proportions of land area in the ESP area that are covered by priority habitats.

Table 6: Area and percentage of priority habitats in the Southern Pennines ESP area.

Habitat	Area (ha)	% of ESP area
Blanket Bog	28,702	24%
Broadleaved Woodland (National Inventory of Woodland & Trees)	3,142	3%
Upland Heathland	1,419	1%
Lowland Dry Acid Grassland	721	1%
Lowland Meadows	773	1%
Purple Moor-grass & Rush Pastures	613	1%
Floodplain Grazing Marsh	99	<1%
Lowland Calcareous Grassland	15	<1%

[115] SSSI designation covers 18% of the ESP area, and the SPA and SAC cover 17% (the international sites are within the SSSI)
[116] ibid
[117] However, these do allow for over-riding public interest.
[118] Natural England (2011) Mapping values: the vital nature of our uplands – an atlas linking environment and people (NE209) (online) available at: http://publications.naturalengland.org.uk/publication/47001
[119] It is likely that the majority of SSSIs are also BAP Priority Habitats, but the exact overlap of the two landscape designations for the ESP area is not known.

Habitat	Area (ha)	% of ESP area
Upland Calcareous Grassland[1]	88	<1%
Upland Hay Meadows[2]	15	<1%
Fens	348	<1%
Lowland Heath[3]	18	<1%
Lowland Raised Bog	18	<1%
Total	**35,971**	**> 31%**

Notes:

Natural England's expert opinion is that is this likely to be: [1] Lowland Calcareous Grassland UK Priority Habitat; [2] Lowland Meadow UK Priority Habitat; [3] degraded Blanket Bog/Upland Heathland UK Priority Habitat

Figure 4: Condition of the SSSIs within the South Pennines ESP area

7.2.3 The South Pennine Moors SSSI (note that this area is also designated as an SPA and SAC) is 20,939 ha in area. 94.57% of this total area was, as of 1st December 2012, in 'unfavourable recovering' condition, with 1.13% in 'favourable' condition. This meets the Natural England target of 95.70% in unfavourable recovering condition.[120] There are a number of reasons for the unfavourable condition status.

7.2.4 For blanket bog these include[121]:

- Insufficient cover of key indicator species for blanket bog;
- More than 10% of the ground cover is disturbed bare ground;

7.2.5 The targets set out in the Government's Biodiversity 2020 strategy[122] are to increase the proportion of SSSI in favourable condition to 50% or more and to maintain the combined measure of favourable and unfavourable recovering sites above 95%.[123]

7.2.6 The majority of the SSSI is blanket bog habitat (20.89% of SP ESP area). Although much of this habitat is recovering, the timescales for recovery stretch into decades. The

[120] 'Unfavourable Recovering' status indicates that although the habitat condition is unfavourable, appropriate management is in place to enable its recovery to favourable condition. Natural England (2011) Site of Special Scientific Interest (online) available from: http://www.sssi.naturalengland.org.uk/Special/sssi/sssi_details.cfm?sssi_id=1007196

[121] Upland Vegetation Condition Assessment

[122] Defra (2011) Biodiversity 2020: A strategy for England's wildlife and ecosystem services (online) available at: http://www.defra.gov.uk/publications/files/pb13583-biodiversity-strategy-2020-111111.pdf

[123] Natural England (2012) Spotlight on SSSIs Working towards the goals of Biodiversity 2020 (online) available at: http://publications.naturalengland.org.uk/publication/3004475

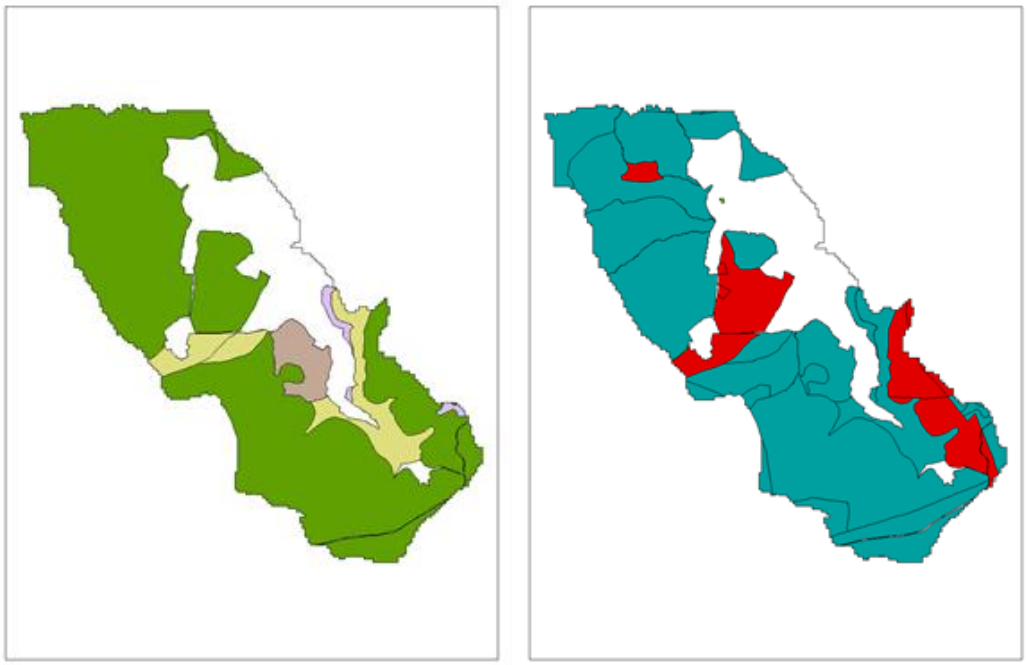
poor condition is largely due to atmospheric pollution, overgrazing and inappropriate burning.[124]

7.2.7 There is no available data on the condition of other priority habitats, only their extent.

Marsden Moor

7.2.8 Figure 5 shows the key priority habitats classified within the area: largely blanket bog, with areas of heath and purple moor grass typically where the moors have been degraded over time. The majority of the Marsden focus area is designated as a SSSI, as part of the South Pennine Moors site in the north and the Dark Peak site in the south. The majority of SSSI units within the Marsden area are in 'unfavourable recovering' condition.[125] It also falls within the South Pennine Moors SPA and candidate SAC. The area is home to bird species such as golden plover, red grouse, twite and curlew.

Figure 5: BAP habitat map of Marsden Moor



Key: (Left): BAP Habitat map (BAP habitats: green = blanket bog; purple = upland heathland; yellow = purple moor grass; brown = overlap between upland heathland and purple moor grass). Figure (Right): SSSI Condition map (blue = unfavourable recovering; red = unfavourable no change) ***[126]***

Keighley and Watersheddles Focal Area

7.2.9 A high percentage (37.5% or 1631ha) of the catchment is designated as SSSI. The international significance of this wildlife resource is reflected in the same area also

[124] Peak District National Park Authority(2012) Peak District Habitats (online) available at: http://www.peakdistrict.gov.uk/looking-after/biodiversity/peak-district-biodiversity/peak-district-habitats
[125] Natural England www.sssi.naturalengland.org.uk and Nature on the Map www.natureonthemap.naturalengland.org.uk
[126] Moors for the Future Partnership (2011) *Mapping bare peat distribution and restoration priority within Marsden catchment*. Draft report to Natural England. [Figure 3]

being designated as both a SAC, and a SPA under the EU Habitats and Birds Directives respectively.[127]

7.2.10 Natural England summarises the condition of the focal area as:[128]

"At present large areas of the blanket bog are degraded through inappropriate drainage, grazing and burning. This management has resulted in a blanket bog habitat which is functionally impacted and has an impoverished flora and fauna. Overall the blanket bog is currently too dry and homogenous lacking the characteristic mosaic of different habitat types. Much of the moorland is therefore dominated by heather which is favoured by the dry conditions and burning practices. In addition, currently there are areas of bare peat which support no vegetation and have little value for invertebrates or other fauna"

7.3 Trends in ecosystem service provision and the business as usual (BAU) scenario

7.3.1 Uplands have been subject to extensive change through management for human use and many are now maintained in their condition by continued management. However, it is evident that biodiversity has been, and continues to be, significantly impacted by land management. *"Habitat change and loss from the uplands has been a feature of the last 50 to 100 years. Some habitats have been affected more than others."*[129]

7.3.2 The high proportion of SSSIs in unfavourable condition (albeit improving) is a concern for the services the habitats underpin. However, the fact that they are designated as 'recovering' suggests that all the relevant management procedures are in place for them to improve.

7.3.3 The Government has committed to a target to bring 50% of the total area of SSSIs into favourable condition by 2020.[130]

7.3.4 It could be assumed that under a business as usual scenario, an improvement in SSSI condition to favourable would be achieved in due course - although whether this would be achieved by 2020 is uncertain given the long time scales involved in improving these types of habitat. There is also uncertainty over Common Agricultural Policy funding post 2014 which could lead to greater uncertainty and therefore place increased importance on identifying alternative funding sources. It could be argued that the non-designated priority habitats would perform relatively poorly compared to their designated comparators and therefore these may remain in a poorer condition. This is a simplistic prediction as the effects of climate change, management, food production and other activities are unknown and may affect SSSI conditions as well as that of the non-designated habitats.

7.4 Is there a buyer for the ecosystem service?

7.4.1 Due to the range of services that biodiversity supports and underpins, there is a wide range of potential buyers. The beneficiaries are also likely to change over time, depending on the nature of access and management. Historically, the habitats may "*be enjoyed by a wider range of people than those who physically craft the landscape, including tourists, walkers and bird watchers, many of whom may have benefitted from improved access arrangements and the increase in leisure time the last 30 years has*

[127] Natural England (2012) Valuing land-use and management changes in the Keighley and Watersheddles catchment. Natural England
[128] Ibid
[129] Natural England (2011) Mapping values: the vital nature of our uplands – an atlas linking environment and people (NE209) (online) available at: http://publications.naturalengland.org.uk/publication/47001
[130] Defra (2011) Biodiversity 2020: A strategy for England's wildlife and ecosystem service (online) available at: http://www.Defra.gov.uk/publications/files/pb13583-biodiversity-strategy-2020-111111.pdf.

afforded." [131] There is a large potential for visitors to use the South Pennines with seven million people living within one hour's drive from the South Pennines.[132]

7.4.2 Improved biodiversity benefits a range of beneficiaries from individuals to organisations both directly and indirectly. A characteristic of biodiversity as both an underpinning and a cultural ecosystem service is that the scope of beneficiaries includes locals as well as the wider population. These include:

- Walkers and informal visitors to the South Pennines;
- Bird watchers, wildlife enthusiasts and environmental NGO members, including those who do not actually visit the moors but value the service nonetheless;
- Farmers and food producers – pollination services and soil formation (as an underpinning supporting service); and
- Local residents (those living within the ESP area) and the wider population (through existence values and shared social values).

Potential biodiversity buyers also include

- Developers - this could include local housing developers to more strategic infrastructure providers such as the Highways Agency or HS2 Ltd. that are looking to offset biodiversity elsewhere;
- Local Authorities – Local Authorities could gain through conservation credits for planned development; and
- Corporations – those that might benefit from purchasing conservation credits for CSR purposes.

7.4.3 A number of factors are likely to determine the likelihood of turning these beneficiaries into buyers. The following table explores key factors that are likely to influence whether a beneficiary can be turned into a buyer.

[131] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment
[132] ibid

Table 7: Biodiversity beneficiary analysis

	Visitors	Environmental NGOs	Farmers	Local residents	Developers	Local Planning Authorities	Corporations
Number and connectivity of buyers	A significant number of disaggregated beneficiaries that are potentiality connected through associations (e.g. Saturday Walkers Club, South Pennines Walk and Ride Festival).	A significant number of disaggregated beneficiaries that are potentiality connected through associations (e.g. Huddersfield Birdwatchers Club; RSPB).	Farmers and tenant farmers make up a large proportion of landowners in the ESP area. Likely to have some connectivity to one another.	A small number of disaggregated beneficiaries that are likely to be poorly connected.	Uncertain number of developers who may be interested in/required to offset their impact through purchasing biodiversity offsets. Key local developers could include Peel Holdings, house builders, windfarm developers and airport developers.	A limited number of beneficiaries (if it is assumed that there is a local catchment for biodiversity offsets). The key beneficiaries could include Bradford, Calderdale, Kirklees, Lancashire, Oldham & Rochdale councils.	A potentially large number of beneficiaries for conservation credits for CSR or offsetting depending on the sector and size of the company.
Availability of capital to incentivise land management changes	Local rambling association or clubs likely to have low levels of available capital.	Large organisations such as the RSPB are willing to help deliver biodiversity. Smaller clubs and organisation are likely to have a lower availability of capital.	Upland farmers often receive subsidies and many of them are considered to be on disadvantaged or seriously disadvantaged land. Levels of available capital to improve biodiversity are therefore likely to be low. However, they do have access to agri-environment schemes and are required to undertake measures that will have a positive impact on biodiversity.	Levels of available capital can be assumed to be low.	High levels of capital - potential land banks could increase liquidity.	More likely to act as intermediaries, although they are large land owners and may develop their own sites. High levels of capital and access to increased capital though Council Tax or s106 / CIL arrangements – Central Government funds likely to be squeezed.	Availability of capital depends on company size, but as a group they have significant levels of capital available and are increasingly investing for the purposes of Corporate Responsibility.

	Visitors	Environmental NGOs	Farmers	Local residents	Developers	Local Planning Authorities	Corporations
Engagement with issues	Larger organisations such as the Ramblers Association are fully engaged. Smaller organisations may not be engaged to the same extent.	Larger organisations such as the RSPB are fully engaged. The level of engagement of smaller organisations is unknown however it may be that some are very engaged.	Engaged through agri-environment schemes but unlikely to see it as their role to pay.	Engagement likely to be variable.	Developers have been required to offset impacts on biodiversity in the past and the biodiversity offsetting pilots are continuing to raise awareness.	Local Authorities are involved in ensuring developers offset their impact on biodiversity. They are engaged in the Pennine Prospects project.	Some engagement on the issues from large companies such as Puma and companies in the extractive industries sector.
Level of reliance on biodiversity.	Walkers are reliant on good provision of access. However, enjoyment of biodiversity is likely to be one of the reasons for visiting the South Pennines.	High – the South Pennines is an area notable for its breeding birds and rare habitats, reflected in the level of designations on the ESP area.	Livestock grazing is the predominant type of farming in the South Pennines and over-grazing can have a negative impact on biodiversity. Habitat biodiversity is an important component of grazing, and wildlife/landscape is used to market farm products (food and accommodation)	Local residents are likely to value the South Pennines landscape and the biodiversity that is part of that. They are not likely to be reliant on biodiversity in terms of livelihoods given the relatively small amount of spend by visitors (about £2.06 per person on average)[133].	Private developers or providers of large infrastructure projects that are required to offset biodiversity losses require appropriate habitats in which to do so.	LPAs will have targets with regard to BAP habitats and species and SSSI condition	Local businesses may rely on the biodiversity of the South Pennines to bring in business. Larger corporations are unlikely to be directly reliant. However, a growing number of companies are seeking reputational advantage through Corporate Responsibility investments and conservation credits are one potential mechanism through which to invest.

[133] South Pennines Ecosystem Services Pilot

7.4.4 The beneficiary analysis suggests that the most likely new mechanism for enhancing biodiversity may be through biodiversity offsets.[134] There is significant potential in the North West for high levels of public and private development and as such there may be significant demand to offset the impacts of these developments on biodiversity. Large private developers such as the Peel Group are not necessarily engaged but given the potential development on land owned by them, there is an advantage to engaging them pro-actively.[135] Furthermore, port development in the Mersey estuary; airport expansion at Manchester, and windfarm development on the Pennines could provide a significant source of land take to support a biodiversity offsetting scheme. For example, delegates to the Halifax stakeholder workshop[136] commented that the recent restoration of Ovenden Moor, was partly financed by EoN to offset the impacts of windfarm development.

7.4.5 Private corporations are also a potential buyer of biodiversity improvements in the ESP area. There is the potential for them to fund conservation (through CSR) and purchase Conservation Credits (generated through the same mechanism as biodiversity offsets) from landowners in the South Pennines ESP area and to report the improvements they have funded for the purposes of Corporate Responsibility. There is evidence to suggest that companies increasingly value being able to fund tangible and local improvements rather than improvements in other countries.[137] The success of the Woodland Carbon Code attests to this trend. Companies may therefore be willing to invest in improving biodiversity for the purposes of improving brand image and gaining a reputational advantage. The magnitude of this opportunity is currently uncertain.

7.4.6 Birdwatchers, environmentalists and environmental NGOs such as the RSPB are also potential funders. The RSPB were involved in the SCaMP Project with United Utilities and provided assistance to farmers in preparing compliant farm management plans for accessing Higher Level Stewardship funding. The National Trust organises conservation on the 2500 hectare Marsden Moor estate, which they own and manage. Individuals and NGOs are more likely to support philanthropic funding of conservation through CSR than through offsets. However, because NGOs can help mobilise funds to pay for habitat management, there is scope for their further involvement in a place-based PES scheme in the South Pennines.

7.5 Does the evidence articulate the information in the way required for the development of PES?

7.5.1 *"Biodiversity, and natural features such as rivers and mountains, underpin other ecosystem services. They also provide many direct benefits to people in the form of recreation and aesthetic values."*[138] Therefore when considering biodiversity and the potential for a PES mechanism, a broad reading of biodiversity as an ecosystem service should be considered.

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[134] Biodiversity offsets, reflected in the Natural Environment White Paper provide a system whereby developers may offset biodiversity losses through providing biodiversity (through restoration, enhancement or creation) elsewhere in lieu of biodiversity loss on a development site. Conservation (or biodiversity) Credits provide a system for developers to offset for biodiversity loss but they are not exclusive to that type of impact (e.g. companies could purchase Conservation Credits for the purposes of Corporate Responsibility). Biodiversity offsetting, and Conservation Credits, are not strictly considered a PES scheme. This is because rather than a system where the provider of the ecosystem services is paid, biodiversity offsets operate along a system where the polluter pays for their impacts.

[135] http://www.peel.co.uk/

[136] A meeting organised by this project and chaired by Pennines Prospects, Halifax January 2013

[137] Ecosystem Marketplace (2012) Developing Dimension: State of the Voluntary Carbon Markets 2012. Forest Trends and Bloomberg New Energy Finance. Available online http://www.forest-trends.org/publication_details.php?publicationID=3164 [accessed 15.10.12].

[138] Natural England (2011) Biodiversity and natural features – underpinning our ecosystem services (online) available at: http://publications.naturalengland.org.uk/publication/47001

7.5.2 As previously stated, comprehensive data on biodiversity is restricted to the SSSI areas. For SSSI sites within the South Pennines ESP area, data is collected by qualified ecologists through Upland Vegetation Condition Assessments. These tables contain information on vegetation composition, cover of indicator species, cover of other species, vegetation structure, indicators of disturbance, physical structure, peat erosion and indicators of ground disturbance due to herbivore and human activity. Depending on whether or not the habitat meets the requirements under each of these criteria, the area is categorised as either favourable or unfavourable.

7.5.3 When developing a biodiversity offsetting metric, Defra considered the information collected through the previous SSSI monitoring system but found that the categories were "*not evenly spread, and there can be a very wide range within the favourable recovering category*".[139] Furthermore, SSSI monitoring data is only available for SSSIs.

7.5.4 Instead the Defra metric focussed on the biodiversity evidence that is gathered as part of the Higher Level Stewardship (HLS) process. In putting together a Farm Environment Plan (FEP), applicants are required to undertake an assessment of habitat condition. The habitat is then assigned to one of three categories (good, moderate or poor).[140] However, the quality of information collected can be inconsistent and this data is only available on land holdings covered by HLS agreements.

7.5.5 Given the fact that the current biodiversity offsetting approach is built on the HLS condition assessments, we recommend that this remains the basis for creating conservation credits. However, in order to create conservation credits primary evidence gathering is required, and for some specific buyers, such as bird watchers, this may not be deemed an appropriate metric. Instead, the abundance or distribution of a particular indicator species, or its habitat, may be chosen as the basis for a potential PES scheme. Should the Defra metric be redeveloped, it may be appropriate to consider using the new Integrated Site Assessment process, which combines SSSI and HLS monitoring.

7.5.6 The evidence suggests that effort may best be focussed on improving those blanket bog habitats that are currently described as in a poor condition.

7.6 Is the ecosystem service well defined?

7.6.1 The pressures on biodiversity in the uplands are relatively well understood. However, given the range of habitats, the effects of these pressures result in different outcomes.

7.6.2 Currently, Natural England monitors the condition of the SSSIs on the site in a six year cycle and fills in the criteria set out in the Upland Vegetation Condition Assessment tables. It is evident that there is a deficiency in monitoring the long-term development of non-designated habitats in the study area.

7.6.3 The ScaMP project has implemented a programme running from 2005–2014 to undertake comprehensive monitoring of the effects of land management changes at selected sites and sub-catchment areas including moorlands, blanket bog, upland vegetation, upland woodlands and grassland. Improvements in condition were measured as a result of a range of management measures including stock changes and additional restoration.[141] It is evident that the link between land use management and improvement in condition is sound. However, this is in relation only to condition as measured by Integrated Site Assessment Monitoring and in regard to SSSI units. For non-designated sites, monitored evidence is scarcer.

[139] Defra (2012) Biodiversity Offsetting Pilots - Technical Paper: the metric for the biodiversity offsetting pilot in England (online) available at: http://www.Defra.gov.uk/publications/files/pb13745-bio-technical-paper.pdf
[140] ibid
[141] United Utilities (2011) Sustainable Catchment Management Programme, Volume 3, The restoration of Highly Degraded Blanket Bog (online) available at: http://corporate.unitedutilities.com/documents/Vol_3_The_Restoration_of_Highly_Degraded_Blanket_Bog.pdf

7.7 What data can be used as proxies for services and how accurate and suitable is this information?

7.7.1 Defra published an updated Technical Paper in March 2012 setting out its views on the measurements to be used for biodiversity offsetting pilots.[142] The metric proposed by Defra is that of Habitat Bands. Habitat Bands are based on the distinctiveness of habitat types which can include species richness, diversity, rarity and the degree habitats support species. Habitat condition is a further consideration in assessing biodiversity compensation.

7.7.2 The development of the Habitat Band provides a metric that can be applied to measure and classify biodiversity on a range of sites. However, whilst the approach is transferable, some sites would require a bespoke approach to classifying habitats, based on a local geographical scale.

7.8 Is it possible to develop simple metrics for stocks and flows that could underpin a marketing platform?

7.8.1 Although there is a range of tools to measure condition, there is no standard approach recognised. Defra suggest that the Common Standards Monitoring (CSM) tool is the most well known. However, the categories are not *"evenly spread, and there can be a very wide range* [of SSSI units] *within the favourable recovering category. In addition, they may describe the management of the site, rather than the actual condition of the habitat."*[143]

7.8.2 In the case of biodiversity offsetting, Defra uses Farm Environment Plans (FEPs), which are put together as part of Higher Level Stewardship (HLS) instead of the CSM to assess habitat condition for the biodiversity metric as it is based on habitat condition rather than management and has evenly spread categories which fit with the offsetting metric. Furthermore, it provides a *"clear and transparent"* methodology for most habitats. However, while the methodology may be suitable, the quality of information collected thus far through the HLS FEPs is inconsistent and may not be of sufficient quality. Ideally, therefore, biodiversity metric data should not be taken from existing HLS FEPs.

7.8.3 A major issue with biodiversity offsetting is that of permanence. For the majority of habitats within the ESP area, long timescales are required to improve the habitat. Peat is irreplaceable within a generation[144] and dry heaths are very difficult to re-create. To overcome the issue of permanence, contracts with landowners should ideally extend for 100 years. There is however, some resistance to such long-term commitments and the cost to the buyer is likely to increase substantially.[145]

7.8.4 For biodiversity projects funded by CSR, no specific metrics are required, and it is much simpler to provide evidence, through long-term surveys, of the benefits of specific environmental and habitat improvements.

7.9 Recommendations for improving the potential of using biodiversity as part of a place-based PES

7.9.1 A number of actions could be undertaken to increase the viability of including biodiversity as part of a PES scheme. These include:

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[142] Defra (2012) *Biodiversity Offsetting Pilots Technical Paper: the metric for the biodiversity offsetting pilot in England*. Available from: http://www.Defra.gov.uk/publications/files/pb13745-bio-technical-paper.pdf. Accessed 05/11/2012.
[143] Ibid
[144] IMASCAP
[145] Personal Communication from Tom Tew.

- Undertake research / monitor the condition of biodiversity priority habitats in the study area and their likely trajectory vis-à-vis future condition;
- Research or implementation of an effective monitoring programme for non-designated habitats (specifically the condition of Priority Habitats);
- Engage with developers and local authorities in the area to encourage take up of PES schemes and build links.
- Explore the potential for the generation of regional Conservation Credits[146] under the Government's Pilot Biodiversity Offset Scheme[147]. For example, it should be possible to develop a regional map showing areas for which funding for restoration/environmental enhancement is being sought, areas which have already been restored, and (for conservation/ restored areas) a link to the project co-ordinator and project funders. Organisations with a sequence of planned projects, such as the National Trust, might wish to list their projects on a regional website (and on other websites, such as the Environment Bank), in the hope of attracting funding for conservation. The planning departments of local authorities could be made aware of the conservation credit list, and asked to consider its use when developing planning policy. This would be the first step in the establishment of a conservation 'bank' in the South Pennines.

[146] According to the Environment Bank, the Government's Biodiversity Offsets scheme generates conservation credits

[147] offsets and credits are different; offsets only have value if they are admissible by a regime in lieu of (compliance or voluntary) obligations

8. RECREATION

Box 5: Recreation summary

Existing condition of and trends in recreation services in the ESP area

The ESP area is an important recreational resource for the local and wider population; it is within easy reach of the densely populated areas of Lancashire, Greater Manchester and West Yorkshire. The uplands provide a range of recreational opportunities including walking, angling and grouse shooting. Recreation depends on other ecosystem services, such as biodiversity, water quality and cultural heritage and is difficult to consider in isolation. However, the large number of footpaths and visitors, rod licences and game-bag numbers suggest recreation services are well provided.

Walking opportunities may be adversely impacted by increasing visitor pressure and angling may be impacted where water quality is deteriorating in the ESP area. However, these trends are uncertain and unlikely to be significant. Grouse shooting opportunities have been increasing over recent years with growing numbers of landowners viewing it as the most profitable use of the land. However, managed burning associated with grouse moor management can adversely impact other ecosystem services, such as carbon storage and water quality.

Beneficiary Analysis

Anglers and walkers are the most likely beneficiaries to pay for enhanced recreation opportunities. The most likely mechanism through which they can invest in ecosystem services is a Visitor Payback Scheme (VPS), or through membership of organisations (such as rivers trusts) and support of projects to enhance habitats and fisheries (including upstream improvements).

Measuring improvements to recreation services

The value of walking and angling to individuals is difficult to define. The openness of the moors, the presence of reservoirs, the literary and gritstone cultural heritage and the biodiversity are all considered important attributes. However, rather than supporting projects that enhance the 'wider landscape' it may be better to fund specific projects, such as the improvement of walking trails or fisheries, that offer tangible benefits to visitors and a direct link between payments and improvements to ecosystem services.

Suitability of information for a place-based PES scheme

General information on the number of trails, visitors, rod licences and game bag numbers demonstrates the importance of the resource. However, the value of these services to users and their appetite for improving them is difficult to determine. It is likely that a Visitor Payback Scheme or an Angling Passport Scheme would generate revenue to support specific improvements to recreation opportunities, but whether this will be sufficient to cover the transaction costs of initiating and maintaining the scheme is uncertain.

8.1 Outdoor Recreation

8.1.1 Outdoor recreation is a major leisure activity in Great Britain with about 2.73 billion visits made in 2011/2012 and about £20 billion spent during these visits.[148] 52% of these visits were to the countryside. The moors and uplands provide a range of recreational opportunities (climbing, mountaineering, rock scrambling, walking, fell

[148] Natural England (2012) Monitor of Engagement with the Natural Environment: The national survey on people and the natural environment - Annual Report from the 2011-12 survey (NECR094) (online) available at: http://publications.naturalengland.org.uk/publication/1712385?category=47018

running, skiing, orienteering, riding and mountain biking) many of which are informal and non-commercial.[149]

8.1.2 The South Pennines Pilot study states that the *"South Pennines is easily reached from the densely populated urban areas of Lancashire, Greater Manchester and West Yorkshire; most visitors to the South Pennines are almost exclusively regular day visitors travelling from the surrounding urban areas, with 96.8% of visitors coming direct from home and 81.1% of visitors originating from urban areas."*[150] It is evident that local tourism is an important element of the local economy.[151]

8.1.3 Evidence on the more specialist forms of recreation in the study area (such as mountain biking) is lacking. The focus of this assessment is on walking, angling and grouse shooting.

Walking

8.1.4 Approximately 80.5% of visitors to the South Pennines specifically visited the countryside, with 39.9% visiting for a walk without a dog and 32.5% walking with a dog. Visitors are attracted to the South Pennines by a variety of characteristics and because it is easily accessible.[152] However, some of the main impacts to peatland areas have been caused by increases in the range of outdoor activities and the number of people participating in these. Peatlands, especially those which are already degraded as a result of desiccation, compaction, erosion and loss of vegetation, can be damaged by recreational trampling. Walking can impact on habitat quality and extent with footpaths and summits attracting the most severe impacts. This activity also has an impact on birds, particularly breeding birds that can be disturbed by recreation activities.[153]

Angling

8.1.5 Angling is a major pastime for over 1 million licensed anglers in England and Wales with sales of EA Rod Licenses increasing by 35% between 2000/01 and 2011.[154] In 2010, it was estimated that 4.2 million people had been fishing in the previous year.[155] Licensed anglers fished about a total of 30 million days during 2005.[156]

8.1.6 Angling is one of the core activities in the ESP area: *"it is estimated that there may be as many as 24,734 Environment Agency Angling Licence holders (it is likely that there will also be a number of anglers who illegally fish without a licence)."*[157] The Environment Agency estimates that the ESP area contains about 3,858 km of river.[158] It

[149] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
[150] Natural England (forthcoming) South Pennines Ecosystem Services Pilot Draft Narrative and Baseline Assessment.
[151] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme
[152] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment
[153] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme
[154] Brown, A., Djohari N and Stolk, P (2012) Fishing For Answers The Final Report of the Social and Community Benefits of Angling Project (online) available at: http://resources.anglingresearch.org.uk/sites/resources.anglingresearch.org.uk/files/Final%20report.pdf
[155] Environment Agency (2010) Public Attitudes to Angling 2010 - A survey of attitudes and participation in England & Wales (online) available at: http://resources.anglingresearch.org.uk/sites/resources.anglingresearch.org.uk/files/EA_Public_Attitudes_to_Angling_2010.pdf
[156] Sen, A., Darnell, A., Crowe, A., Bateman, I., Munday, P and Foden, J (2011) Economic Assessment of the Recreational Value of Ecosystems in Great Britain (online) available at: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=zzHJEl1HCM0%3D&tabid=82&bcsi_scan_AB11CAA0E2721250=1swF/97ttuRdOut+wAQ2kk2CrKyZAAAARmEqew==&bcsi_scan_filename=LinkClick.aspx
[157] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment
[158] Natural England (forthcoming) South Pennines Ecosystem Services Pilot: Narrative and Baseline Assessment

therefore provides significant opportunities for a range of water-based recreation activities.

Shooting

8.1.7 Grouse shooting has a long history of shaping the landscape in the uplands and large parts of the South Pennines are managed for grouse shooting. The management of moors for grouse shooting has been very influential in shaping the appearance of parts of the UK uplands, and in determining the flow of a range of ecosystem services. Heather burning is particularly important. It is evident that whilst moorlands have been managed since the early 19th century there has been a *"long term decline in grouse abundance and bag density since the 1930s".* [159] Despite this decline, the number of estates making a profit has increased by 43% since 2001. However, the majority run at a loss.[160]

8.2 Summary of Ecosystem Service Provision

8.2.1 A large proportion of the ESP area is Open Access land (38%)[161]. The site is characterised by a high density of access and rights of way:

- There are 4,190 km of public rights of way, of which:
  - 455 km is bridleway;
  - 15 km is byway open to all traffic;
  - 3,691 km is footpaths; and
  - 27 km is roads used as public paths.
- a high density of 3.50 km of footpaths per km^2 ; one of the highest in the country;
- two national trails running through the site.

8.2.2 The moorlands and moorland fringes provide the greatest tranquility in the ESP area, whilst the valley bottoms, which contain the majority of the roads and other infrastructure, are less tranquil.[162]

8.2.3 The recreation services provided in the South Pennines are closely linked to the landscape and biodiversity of the area.

Landscape

8.2.4 The South Pennines ESP area is characterised by dramatic landforms including hills and narrow valleys. The landscape is formed of a mosaic of semi-natural and man-made landforms and structures. This, in combination with the cultural heritage contained within the area has created a strong sense of place. The expansive views and sense of isolation and wilderness are valued elements of the moorland landscape and valued by those who visit for recreation. [163]

8.2.5 Land management, including for grouse shooting, has played a role in shaping the landscape and it resonates with those who enjoy the countryside. Early agriculture and

[159] See: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=kZXZ3VE088U%3D&tabid=82
[160] See: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=kZXZ3VE088U%3D&tabid=82
[161] Natural England (2012) National Character Area profile: 36 South Pennines (NE323). Available online: http://publications.naturalengland.org.uk/publication/511867
[162] ibid
[163] Natural England (2012) National Character Area profile: 36 South Pennines (NE323). Available online: http://publications.naturalengland.org.uk/publication/511867

industry on the moorland fringes and large-scale industrial activity with the accompanying infrastructure *"robustly built in local stone"*[164] provide an insight into the cultural heritage of the landscape.

Recreational Biodiversity

8.2.6 *"Biodiversity, and natural features such as rivers and mountains…provide many direct benefits to people in the form of recreation and aesthetic values."*[165] The South Pennine Moors are important due to the extensive open access areas and footpaths and the opportunity they offer for 'escapism'. Part of the attraction is also the quality and extent of the habitats they offer. As discussed in the biodiversity chapter, the importance of the habitat in the ESP area is evidenced by the large number of internationally and nationally protected sites (28% of the area) and the presence of priority species.

8.2.7 For bird watchers, bird species such as golden plover, red grouse, twite, curlew and birds of prey are a significant attraction. The area is deemed important for supporting merlin *Falco columbarius* and golden plover *Pluvialis apricaria.* The density of breeding golden plover is high compared to other regional populations in northern England and Scotland. The area is also important for supporting a nationally important breeding population of migratory species which include curlew.[166]

8.2.8 The recreational benefits people enjoy in relation to the South Pennines ESP area are therefore varied. Walking, grouse shooting and bird watching are all popular activities and are supported by the broader quality of the landscape and the cultural heritage that is contained within the landscape.

8.3 Trends in ecosystem service provision and the business as usual (BAU) scenario

8.3.1 The Uplands have been subject to extensive change through management for human use and are now maintained in their condition by continued management. Indeed, *"habitat change and loss from the uplands has been a feature of the last 50 to 100 years."*[167] These changes have impacted, and continue to impact, on the level of recreation as an ecosystem service.

Walking

8.3.2 It is notable that the economy of the uplands has altered since the 19th century, with a shift from an economy based largely on farming to one with an increased emphasis on recreation and tourism.[168] Recreational pressure on the moors is likely to increase due to two factors. Firstly, household projections indicate that numbers of households in the North West will increase from 3,098 thousand in 2012 to 3,617 thousand in 2033, primarily driven by population increases.[169] Secondly, an increasing trend towards 'stay-cations' means that holiday goers are more likely to use local attractions. It is therefore likely that more people are likely to enjoy the countryside and the ecosystem services provided, but that this increased pressure, if not managed, may compromise the qualities of the moors they value (e.g. tranquillity).

8.3.3 It is notable that much of the recreation takes place along linear routes which keeps the impacts confined to small areas. Furthermore, it has been shown that this settled

[164] ibid
[165] ibid
[166] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme
[167] Natural England (2011) Mapping values: the vital nature of our uplands – an atlas linking environment and people (NE209) (online) available at: http://publications.naturalengland.org.uk/publication/47001
[168] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
[169] See: http://www.communities.gov.uk/publications/corporate/statistics/2033household1110

pattern of recreation increases bird populations.[170] Nevertheless, there is a risk of habitat fragmentation.

8.3.4 A report for the South Pennines ecosystem services pilot project[171] identified three factors influencing cultural services in the South Pennines: openness, existence of reservoirs as features and the built gritstone features. It is likely that both the existence of reservoirs (with the associated calming stretches of water, wildlife and sports) and the built features (stone walls, local buildings and farming heritage) would not change under the business as usual scenario. However, it may be that increasing use of the moors reduces the tranquillity and perception of 'emptiness' that is valued.

8.4 Shooting

8.4.1 Due to the history of land management described, the UK contains the majority of the world's heather-dominated landscapes.[172] Parts of these are managed for red grouse shooting. Indeed, *"with the recent decline in income for stocking sheep, some estates are viewing shooting as the most profitable use of the land."* [173] The UK National Ecosystem Assessment (UKNEA)[174] states that grouse shooting activity in the English uplands increased between 2001 and 2009.

8.4.2 The management of the moors for grouse have a strong influence on biodiversity.[175] This impact can be both negative and positive. It has been suggested that many of the management actions identified by the literature have positive effects on bird populations, including grouse.[176] However, there is also evidence that certain burning regimes reduce the abundance and distribution of certain key indicator species, such as *Sphagnum* moss.[177]

8.4.3 The UKNEA also identified that there are growing concerns over the visual impact of burning.[178] Grouse moor management, and particularly over-burning, has been identified as one of the most important recent pressures for changes in moor habitats.[179]

8.4.4 There is evidence to suggest that demand for grouse shooting is increasing.[180] Any over-burning associated with this is likely to lead to substantial trade-offs with other ecosystem services (e.g. climate regulation and water quality – see section 9).

8.5 Angling

8.5.1 Fish communities are reliant on good quality water and the availability of migratory routes. As shown in the water quality section, trends in water quality in the sub-catchments differ. In some it is stable or improving, while in other, such as the Keighley

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[170] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme
[171] The Research Box (2011) Assessing and evaluating the cultural services of the South Pennines Ecosystem Services Pilot. Draft report.
[172] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
[173] ibid
[174] ibid
[175] ibid
[176] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme
[177] Clutterbuck, B. & Yallop, A.R., 2010, Land management as a factor controlling DOC release from upland peat soils 2: Changes in DOC productivity over four decades, Journal of Science of the Total Environment, 407, p.3803-3813.
[178] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
[179] See: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=kZXZ3VE088U%3D&tabid=82
[180] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

and Watersheddles catchment, it has deteriorated and is continuing to decline. Without intervention in the catchment, significant increases in particulate and dilute organic carbon (POC and DOC) are projected to continue. This may impact on fish communities and, in turn, on angling opportunities.

8.6 Is there a buyer for the ecosystem service?

8.6.1 It is evident that land near major urban areas, such as Liverpool and Manchester is under demand for informal recreation such as walking, running, riding, and cycling.

8.6.2 Improved recreation benefits a number of individuals and organisations. These include:

- Informal, individual users (walkers, cyclists, horse-riders, anglers)
- Informal group users and club members (including groups of the above)
- Businesses and specialist users (grouse shooters, specialist wildlife businesses, specialist literary/cultural tour groups)

8.6.3 The following table explores the likelihood of turning these beneficiaries into buyers.

Table 8: Recreation beneficiary analysis

	Walkers	Grouse shooters	Anglers
Number and connectivity of buyers	A significant number of disaggregated beneficiaries that are potentiality connected through associations (e.g. Saturday Walkers Club, South Pennines Walk and Ride Festival).	A small number of beneficiaries that are potentiality connected through associations (e.g. South Pennine Shooting School)	A small number of disaggregated beneficiaries that are poorly connected unless they are members of a club or Rivers Trust.
Availability of capital to incentivise land management changes	Ramblers Association likely to have modest available capital. Local rambling association or clubs likely to have low levels of available capital. Individual walkers may be willing to participate in a Visitor Payback Scheme and make small payments via local businesses to support maintenance and improvement of paths and the wider landscape.	Some individuals and businesses have capital to invest and spend on land management for grouse shooting (grouse shooting is at the high end of sport shooting).	Levels of available capital can be assumed to be low. However, individuals may be willing to make small payments to landowners to improve fish spawning and nursery areas. They may be willing to participate in an Angling Passport Scheme.
Engagement on issues	Larger organisations such as the Ramblers Association are fully engaged. Smaller organisations may also be engaged.	Engagement with the wider ecosystem services provided by the South Pennines ESP area assumed to be relatively low.	Levels of engagement likely to be variable.
Level of reliance on recreation	Individuals are reliant on the provision of public access, both open access land and access routes, and the maintenance of the broader landscape and cultural heritage.	Grouse shooters are heavily reliant on the land management in the South Pennines ESP area to provide grouse shooting opportunities.	Anglers are reliant on the reservoirs and rivers in the ESP area and the fish communities they support.

8.6.4 The UKNEA suggests that there are growing concerns around the impact of moorland burning on peat structure and carbon storage and on certain species (e.g. dunlin and hen harrier).[181] Given these trade-offs, a PES scheme that improves grouse shooting opportunities at the expense of other ecosystem services is not deemed appropriate. In addition, grouse shooting interests already pay for ecosystem management on grouse moors. Therefore anglers and walkers are the next most likely beneficiaries to pay for enhanced recreation opportunities. The most likely mechanism through which they could invest is a Visitor Payback Scheme (VPS), or an Angling Passport Scheme or though membership of a club or trust (for example, Rivers Trust or National Trust).

8.6.5 Visitor Payback Schemes[182], whereby visitors voluntarily support particular projects in the area by making a small payment, have been set up successfully in the past. VPS has the potential to generate revenue to help fund the management of the natural environment; improving infrastructure for visitors to the countryside whilst enhancing the provision of vital ecosystem services for UK society.[183] Although there is a large potential to generate revenue from visitor payback[184], this is rarely realised. Considerations of administration, effective partnerships and lack of clearly identified projects and objectives remain key barriers to further uptake. Nevertheless, there is a growing number of visitor payback schemes, which may take a variety of forms (e.g. opt in, opt out, donations, merchandising, participation, membership).

8.6.6 The Nurture Lakeland VPS in Cumbria is the most successful in the UK; it has raised almost £2m in donations from visitors and tourists over a 17 year period. The scheme has been used to restore footpaths, support conservation of nesting ospreys, and improve water quality. A similar scheme for the South Pennines ESP area warrants further investigation.

8.7 Is the ecosystem service well defined?

8.7.1 Because walking is undertaken both formally and informally, it is difficult to quantify the exact change in activity that would result from an improvement in ecosystem services. It has been suggested that improvements to blanket bog, heathland and broadleaf woodlands may improve recreation value but that this is likely to be marginal.[185] More specific projects, such as constructing better quality paths and picnic areas are likely to have a more tangible benefit.

8.7.2 The relationship between peat habitats and angling is complex as the latter is largely dependent on the water quality of these habitats. The predicted acid neutralising capacity (ANC) of the rivers could be used as a metric as different ANC concentrations support different fish populations. It is acknowledged that whilst ANC is not the only factor influencing fish populations,[186] it provides a starting point and importantly, can *"provide a basis for valuing the recreational and actual market values of fisheries in rivers that benefit from peat restoration."*[187] Furthermore, the Environment Agency holds angling license data and as such any changes in water quality may be reflected in the number of licenses in the catchments of the ESP area. Despite this, the land management changes that would need to be undertaken to improve water quality are substantial and the subsequent impact on fish population and angling opportunities

[181] UKNEA (2012) Mountains, Moors and Heaths (online) available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
[182] Visitor payback has been defined as "...the process of visitors choosing to give money (or other help) to assist the conservation or management of places they visit" (Scott *et al*, 2003).
[183] Scott, A., Christie, M. and Tench, H. (2003) Visitor Payback: Panacea or Pandora's Box for Conservation in the UK? *Journal of Environmental Planning and Management*, 46(4), 583–604.
[184] Denman & Ashcroft (1997) estimated that if every tourist in Europe donated six pence per night's stay, this would raise over £112 million per annum
[185] Natural England (2012) *Valuing land-use and management changes in the Keighley and Watersheddles catchment*. Natural England
[186] Habitat availability for spawning, nursery grounds, and river/stream morphology, are also important.
[187] Defra *Ecosystems services of peat - Phase 1*

likely to be relatively minor. Projects that improve fish spawning and nursery areas are likely to have a more tangible benefit.

8.8 Does the evidence articulate the information in the way required for the development of PES?

8.8.1 The evidence demonstrates that the South Pennines ESP area is extensively used for recreation. This information can be quantified in terms of the number of visitors, game bag numbers (for grouse shooting) and rod licences (angling). However, there is no evidence relating to the quality of these services or the demand for improving them.

8.8.2 The large number of visitors that come to walk and fish in the South Pennines ESP area suggests that visitors might be willing to support projects that improve fishing, walking trails and biodiversity. Visitor Payback Schemes and Angling Passport Schemes offer one mechanism for facilitating this. However, experience of these schemes to date, suggests that the funds raised will be relatively modest and the costs involved in initiating and running the scheme might be substantial.

8.9 Recommendations for improving the potential of using recreation as part of a place-based PES

8.9.1 A number of actions could be undertaken to increase the viability of including recreation as part of a place-based PES scheme. These include:

- Identify specific projects and opportunities for improving walking and angling;
- Engage local businesses as intermediaries to collect payments from visitors; and
- Put in place mechanisms for communicating the impact of funding to visitors.

9. PLACE-BASED PES

9.1.1 The previous sections assessed the existing evidence base around the five ecosystem services provided by the South Pennines ESP area that were considered most 'marketable': water quality, climate regulation, flood risk regulation, biodiversity and recreation.

9.1.2 There is scope for improving each of these ecosystem services and evidence to suggest that they would all respond to a similar suite of land management changes. It has been suggested that Payment for Ecosystem Service (PES) schemes offer the opportunity to raise revenue to incentivise these land management changes. Indeed, the potential to integrate funding from diverse sources as part of multiple-benefit PES schemes was identified in a recent evaluation of Natural England's upland pilots as a key innovation that could enhance the provision of ecosystem services.[188] There is a growing number of examples of multiple-benefit, place-based PES schemes emerging in areas comparable to the South Pennines ESP area. These include the Pumlumon Project in Wales, a new carbon-based element to South West Water's Upstream Thinking project, and the Westcountry Angling Passport scheme, all of which demonstrate how single service PES can be developed in the context of place-based thinking.

9.1.3 The Westcountry scheme markets improved recreational opportunities for anglers by paying for actions that improve water quality and wildlife. They are investigating links with other PES schemes (via the Forestry Commission and South West Water's Upstream Thinking project) to pay for the creation of wet woodlands that could further enhance the recreational experience of anglers. The Pumlumon Project in Wales layers payments for climate mitigation from charities with Government payments for biodiversity to facilitate peatland restoration. Similarly, South West Water (SWW) is interested in developing a scheme that would use money from companies interested in 'offsetting' their carbon emissions and enhancing biodiversity to pay for peatland restoration in Exmoor National Park. This scheme would become part of their Upstream Thinking project, an initiative funded by SWW to invest in farm infrastructure that can reduce water treatment costs by reducing the level of diffuse pollution entering watercourses from the farm environment.

9.1.4 Moreover, the characteristics of peatlands in the South Pennines ESP area, in common with most upland peatlands in the UK, make them particularly compatible with a place-based PES approach: many of the benefits associated with sustainable peatland management and woodland creation are public goods that do not currently provide sufficient income to land owners and managers. While the cost of providing peatland ecosystem services will vary between providers and locations[189], service providers generally have secure land tenure[190] and adequate information and skills to manage the land for the ecosystem services that are being purchased[191].

9.1.5 Given these characteristics, the range of ecosystem services provided in the South Pennines ESP area, and the similarities between this area and other emerging place-based schemes in the UK, this chapter explores the opportunities and barriers to initiating such a place-based PES scheme.

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[188] Waters and Clarke. Delivering Nature's Services: the Upland Ecosystem Services Pilots (online) available at: http://www.naturalengland.org.uk/Images/delivering-natures-services2_tcm6-17171.pdf

[189] Jack, B.K., Kousky, C., Sims, K.R.E., 2008. Designing payments for ecosystem services: lessons from previous experience with incentives-based mechanisms. *PNAS* 105: 9465–9470.

[190] Quinn CH, Fraser EDG, Hubacek K, Reed MS (2010) Property rights in UK uplands and the implications for policy and management. *Ecological Economics* 69: 1355-1363

[191] Bulte, E., and Engel, S., 2006. Conservation of tropical forests: Addressing market failure. In R. López, J. Stiglitz, and M. Toman (Editors), *Sustainable Development: New Options and Policies*. Oxford University Press, New York.

9.1.6 Table 9 below details the land management changes that would be likely to optimise delivery of each of the ecosystem services and Table 10 demonstrates the trade-offs and synergies arising from these interventions. These are based on a combination of evidence from peer-reviewed literature, and model outputs and interviews conducted as part of the Sustainable Uplands project[192].

Table 9: Land management changes to optimise place-based ecosystem services in the uplands of the South Pennines ESP area

Ecosystem Service	Assumed land management changes to optimise ecosystem service provision
Water Quality	• Clean-up water colour and turbidity by keeping peatland intact healthy and moist • Avoid damaging the peatland surface: reduce trampling, avoid erosion, avoid surface desiccation/baking/crusting/cracking, maintain/enhance vegetation and sphagnum moss cover, so manage/reduce/cease (as appropriate to site) grazing and burning • Avoid introducing new peatland drainage, avoid deepening existing drains, and avoid exacerbating peatland sub-surface cracks and drainage, so restore/enhance/rewet blanket bog, see above. • Re-vegetate bare peat, ideally with sphagnum moss • Block some moorland grips and re-profile eroding gullies • Nutrient management, livestock control, riparian management
Climate Regulation	• Restore functioning blanket bog by restoring Sphagnum mosses • Avoid damaging the peatland surface: reduce trampling, avoid erosion, avoid surface desiccation/baking/crusting/cracking, maintain/enhance vegetation and sphagnum moss cover, so manage/reduce/cease (as appropriate to site) grazing and burning; ; consider seasonal grazing • Re-vegetate bare peat, ideally with sphagnum moss • Block all active moorland grips and re-profile eroding gullies • Avoid introducing new peatland drainage, avoid deepening existing drains, and avoid exacerbating peatland sub-surface cracks and drainage (so restore/enhance/rewet blanket bog, see above) • Woodland creation on non-peaty soils (e.g. along Gills)
Local Flood Risk Reduction	• Manage vegetation to increase surface roughness, interception, infiltration and evapo-transpiration; re-vegetate bare peat • Avoid introducing new peatland drainage, avoid deepening existing drains, and avoid exacerbating peatland sub-surface cracks and drainage; so restore/enhance/rewet blanket bog • Woodland and scrubland planting along rivers to increase 'roughness' of habitats, slow down flood flows and increase flood storage

[192] Reed MS, Hubacek K, Bonn A, Burt TP, Holden J, Stringer LC, Beharry-Borg N, Buckmaster S, Chapman D, Chapman P, Clay GD, Cornell S, Dougill AJ, Evely A, Fraser EDG, Jin N, Irvine B, Kirkby M, Kunin W, Prell C, Quinn CH, Slee W, Stagl S, Termansen M, Thorp S, Worrall F (2013) Anticipating and managing future trade-offs and complementarities between ecosystem services. *Ecology & Society* 18(1): 5 http://dx.doi.org/10.5751/ES-04924-180105

Ecosystem Service	Assumed land management changes to optimise ecosystem service provision
Biodiversity	• On moorland blanket bog, re-vegetate bare peat, restore functioning blanket bog, block some grips, manage grazing and burning to restore appropriate habitats • Sustainable grazing • Creation/restoration/re-connection of other habitats, for example wetlands, riparian zones, woodlands on appropriate non-peaty soils (e.g. along gills)
Recreation (walking)	• Increased provision and maintenance of footpaths and other access routes / points; sensitively routed to avoid damage to other ecosystem services
Recreation (angling)	• See measures for water quality; • Removal of barriers for migratory fish;

Key to table 10:

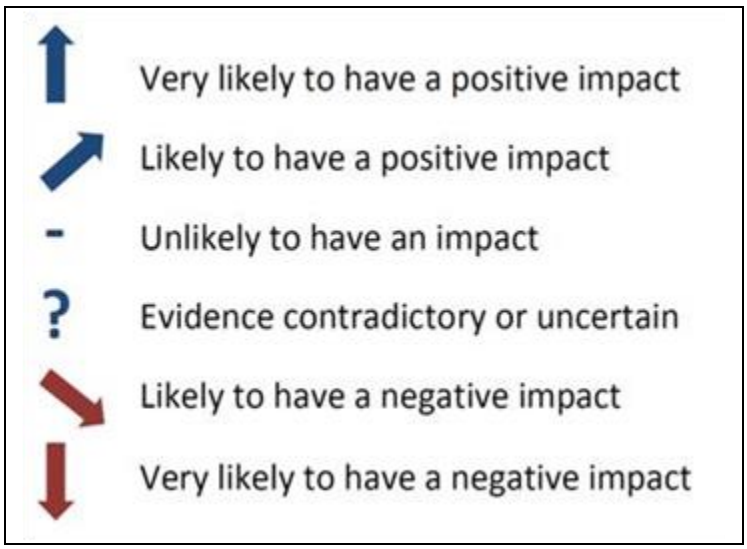

Table 10: How land management options affect ecosystem service provision (provisional: evidence still under review)

Land Management Actions	Soil Formation and Reduced Erosion	Biodiversity	Agriculture and food production	Fibre	Climate regulation	Water Quality	Flood Protection	Recreation (walking)	Recreation (grouse shooting)	Recreation (angling)	Landscape (sense of place)	Cultural Heritage & Archaeology
Reduce burning on blanket bog	↑	↑	-	-	↑	↑	?	?	?	-	?	?
Reduce frequency/intensity of burning on moorland	↑	?	-	-	↑	↑	?	?	↓	-	?	?
Re-vegetate bare peat	↑	↑	-	-	↑	↑	↗	↗	↗	↗	↗	↗
Block all active moorland grips and re-profile eroding gullies	↑	↑	-	-	↑	↑	?	↗	-	↗	↗	↗
Less intensive grazing, seasonal grazing and sustainable stocking levels	↑	↗	↘	-	↗	↗	↗	-	-	↗	-	-
Native woodland creation along Gills (not on peaty soils)	↑	↑	-	↑	↑	?	↗	?	?	-	↗	?

9.1.7 It is clear from the evidence available that the relationships between the five ecosystem services considered here are broadly synergistic and can be promoted through a similar suite of interventions and improvements to the upland environment.

9.1.8 Making plans for ecosystem restoration involves comparing different scenarios; for example, comparing the present situation with what would happen to the ecosystem if the Pennines were managed differently. Figure 6 shows how the carbon budget would be likely to change in response to different forms of peatland restoration in the Peak District National Park which is adjacent to the South Pennines ESP area and part of the same South Pennines SPA and SAC designated under the EU Habitats Directive.[193] Most notably, Figure 6 shows that in the Peak District, a combination of reducing grazing and burning, re-vegetating bare peat and blocking drainage ditches could greatly improve the carbon budget for the area.[194] By actively managing for carbon, the area could sequester well over an extra tonne of carbon dioxide equivalent per hectare per year.

9.1.9 This report uses a different method, but provides similar figures for the South Pennines (see Technical Appendix), with various different restoration measures providing additional carbon sequestration of 0.8 to 1.9 tCO_2e per hectare per year (80-190 tonnes tCO_2e per km^2 per year), and restoration of bare peat providing 31 tCO_2e per hectare per year (3100 tonnes tCO_2e per km^2 per year). It is concluded that there is the potential to sequester around 5000 tCO_2e per year from restoring the 6000 hectares of degraded (gripped, burned and hagged) blanket bog in the South Pennines ESP area. If the remaining 24,000 hectares of blanket bog were managed for carbon, it could sequester an additional 24,000 tCO_2e per year. If the 551 hectares of bare peat were re-vegetated, this would save an estimated 17,000 tCO_2e per year. In total, up to 36,000 tCO_2e per year could be sequestered or safeguarded if all the 30,000 ha of blanket bog in the South Pennines were managed for carbon.

9.1.10 The carbon price fluctuates, and some projects would be more risky than others (in terms of non-permanence, uncertainty, and the size of the buffer). At a £5 carbon prices[195], carbon sequestration by intact or moderately degraded bogs (on which grazing/burning had been reduced) could sequester an additional 1-2 tonnes CO2e per hectare per year[196], and so be worth around £5-10 per hectare. However, if carbon prices increased to £20 per tonne of CO_2e, a carbon market could provide annual management payments to landowners of around £20 (for degraded bogs) to £40 (for mossy bogs) per hectare per year (which is comparable with but lower than English agri-environment schemes payment rates)[197].

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[193] Council Directive 92/43/EEC of 21 May 1992

[194] Compared to the current carbon budget in the Peak District National Park (-62 tonnes of CO_2e per km2 per year), the carbon budget in 2030 with cessation of grazing and burning would be -117 tonnes of CO_2e per km2 per year, and the carbon budget in 2030 under active management for carbon, including various combinations of cessation of grazing and burning, blocking drainage ditches and gullies, and re-vegetation bare and eroding peat soils would be -160 tonnes of CO_2e per km^2 per year (Reed et al., 2013). For the Peak District, there is the potential to sequester >100tonnes CO_2e per km2 year.

[195] Because of the range of carbon prices and the uncertainty over which prices might apply to each peatland carbon restoration schemes, this report uses two figures – a) £5 per tonne CO2eq as a reminder of present day voluntary carbon prices, for comparing with present-day peatland restoration and management costs, and b) £20 per tonne CO2eq as an estimate of a possible carbon price during the period 2013-2020. See note 80, page 50, for more details and references.

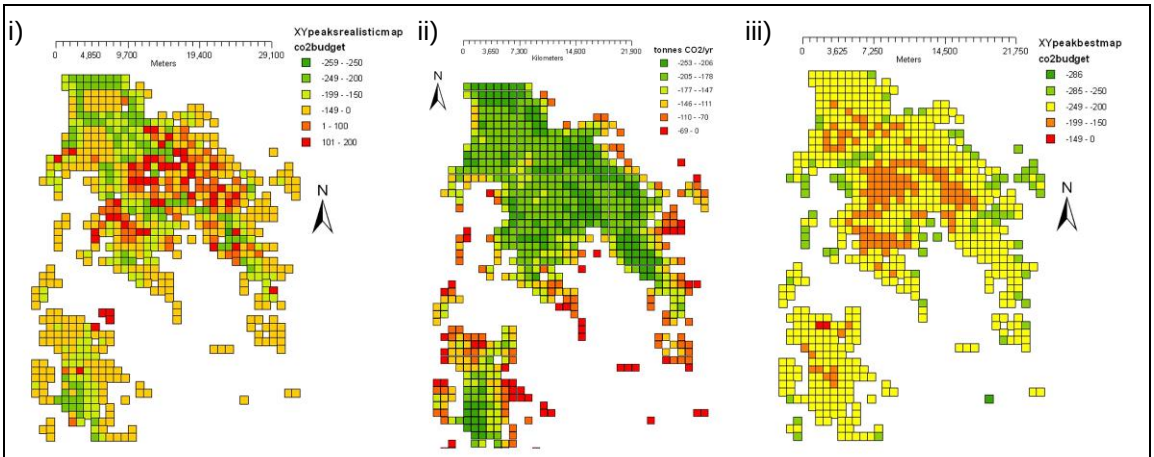
[196] The quantity of carbon depends on the condition of the bog, and can range from eroding bogs which are net emitters, to mossy bogs which can sequester 3 tCO2e per ha per year. The Tech Appendix provides a mid range example of a peatland being enhanced from 'highly degraded' to 'moderately degraded' over 10 years, which would generate 0.5tCo2e per ha per year; and one changing from 'moderately degraded' to 'intact', generating 1.82 tCo2e per ha per year. The mossiest bogs can sequester 3 tCo2e per ha per year.

[197] Environmental Stewardship starts at £58 per hectare for moorland restoration for HLS moorland restoration underpinned by UELS in Severely Disadvantaged Areas, above the moorland line on parcels of land larger than 15 ha. Payments are greater below the moorland line and on parcels less than 15ha.

9.1.11 To be successful, re-vegetation of bare peat and gully/grip blocking are usually associated with a reduction in the intensity of grazing and managed burning. On blanket bog habitats, there are few major trade-offs if this course of action is followed, because healthy blanket bogs are not particularly productive for sheep, and are probably beneficial for grouse chicks[198]. Many areas of deep peat (over 0.5 m) which must have once been blanket bogs (in order to lay down the peat) now have far lower water tables than would normally be expected on such deep peats, and are now dominated by dwarf shrubs. Some of these areas could be restored as functioning blanket bogs.

9.1.12 Changes in moorland management would enhance the SSSIs and while it might create temporary changes in vegetation height and structure, the rewetting, resulting in additional *Sphagnum* mosses and healthy blanket bogs, should benefit peatland birds and other wildlife (including threatened invertebrates and frogs). There are opportunities to create woodland in some upland valleys to provide habitat for wildlife, to sequester carbon and potentially to improve opportunities for recreation. Furthermore, there is potential to consider restoring wetlands and wet woodlands along riparian zones and floodplains where these could help attenuate flood waters and mitigate flood risk.[199] Evidence for a link between woodland creation along gills and flood risk is lacking, however, a similar opportunity may exist. There is the potential to build on the well-established market for woodland carbon with multiple benefits via the Woodland Carbon Code.

Figure 6: Carbon budget in Peak District National Park



Carbon budget in Peak District National Park, South Pennines, showing i) current carbon budget (-62 CO_2/yr); ii) carbon budget in 2030 under active management for carbon, including various combinations of cessation of grazing and burning, blocking drainage ditches and gullies, and re-vegetation bare and eroding peat soils (-160 CO_2/yr); and iii) carbon budget in 2030 with cessation of grazing and burning (-117 CO_2/yr).[149] Red colours indicate carbon losses; greens and yellows indicate carbon gains/sequestration.

9.1.13 There are a number of other trade-offs that should be noted; these relate to:

- **Provisioning services (food production)** - Upland hill farming is the most common agricultural enterprise within the pilot area, with 1,204 farm businesses supporting >300,000 sheep and lambs in 2008 (Agriculture Census Data 2008). The management interventions considered here involve reducing levels of livestock grazing and managed burning in the

[198] red grouse chicks feed on the insects found in wet bogs http://www.moorlandassociation.org/red_grouse.asp

[199] Thomas, H., Nisbet, T.R. (2007) An assessment of the impact of floodplain woodland on flood flows. *Water and Environment Journal* 21: 114-126.

ESP area. While cessation of grazing is necessary to restore severely degraded blanket bog, and reductions in grazing may be helpful in other areas, each area is different, and moorland vegetation management needs to be site specific[200]. Any reduction in grazing intensity will impact on sheep stocking density, however, the magnitude of the trade-off (in terms of food production) is unclear, especially when livestock can be off-wintered. There is evidence that livestock grazing numbers, particularly of sheep, have been declining over the last decade in the South Pennines and are likely to continue along that trajectory[201]. Hill sheep production is highly dependant upon agricultural payments, which are expected to decline in future years in response to Common Agriculture Policy reform. Although agri-environment schemes tailored to uplands are likely to persist in future, income from managing other ecosystem services may help offset those expected future reductions.

- **Recreation (grouse shooting)** – Changes to managed burning on blanket bog may be necessary in order to get some South Pennine protected habitats into 'favourable' condition, reduce carbon loss, enhance carbon sequestration and storage[202] and enhance water quality.[203] [204] The extent to which a reduction in the occurrence or location of burning would affect grouse numbers is unclear.

- **Recreation (walking):** Based on interviews with recreationalists in the South Pennines, Reed *et al*.[149,205] reported that those who visit uplands for recreation tend to value their uninterrupted views and unique habitats and wildlife. This assertion is also supported by Bullock and Kay (1996)[206] and the Mountains, Moorlands and Heathlands chapter of the National Ecosystem Assessment.[207]

- **Landscape (sense of place)** – There is limited evidence on the contribution of managed burning to local residents' 'sense of place', and many surveys confuse peatlands with heaths. However, one study suggests that land managed for grouse-shooting has shaped the local landscape, which is valued by the local population.[208] Bullock and Kay (1996)[161] found a preference for open versus forested upland landscapes amongst visitors to UK uplands. In contrast to this, interviewing visitors to

[200] South Pennines Ecosystem Services Pilot – Delivery Plan 2011.
[201] Tinch, D., Hanley, N and Beharry-Borg, N (2010) UK National Ecosystems Assessment 2nd Draft Economics group report - Mountains, Moorlands and Heaths (online) available at: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=kZXZ3VE088U%3D&tabid=82
[202] Yallop, A.R. & Clutterbuck, B., 2009, Land management as a factor controlling DOC release from upland peat soils 1: spatial variation in DOC productivity. *Journal of Science of the Total Environment*, 407, p.3803-3813.
[203] Clay, G.D., Worrall, F., Clark, E. & Fraser, E.D.G., 2009, Hydrological responses to managed burning and grazing in an upland blanket bog, *Journal of Hydrology*, 376, p.486-495
[204] Worrall, F., Armstrong, A. & Adamson, J.K., 2007, The effects of burning and sheep grazing on water table depth and soil water quality in upland peat, *Journal of Hydrology*, 339, p.1-14.
[205] Reed, MS, Hubacek K & Prell C (2005) *Sustainable Upland Management for Multiple Benefits: a multi-stakeholder response to the Heather & Grass Burning Code Consultation*. Project report submitted to DEFRA's consultation on the review of the Heather and Grass Etc. (Burning) Regulations 1986 and the Heather and Grass Burning Code 1994.
[206] Bullock C.H. and Kay J. (1997). Preservation and change in the upland landscape: the public benefits of grazing management. *Journal of Environmental Planning and Management* 40: 315-334.
[207] van der Wal, R., A. Bonn, D. Monteith, M.S. Reed, K. Blackstock, N. Hanley, D. Thompson, M. Evans, I. Alonso, with T. Allot, H. Armitage, N. Beharry-Borg, J. Glass, J. McMorrow, L. Ross, R. Pakeman, S. Perry, D. Tinch. (2011) Mountains, Moorlands and Heathlands. In *UK National Ecosystem Assessment*, UNEP, WCMC and DEFRA
[208] Natural England, 2009, Environmental impacts of land management, Natural England, Research Report NERR030.

North Pennines moorlands and blanket bogs, Black et al. (2010)[209] found a preference for "nature reserve" style management with reduced levels of grazing and burning and an increase in woodland cover, compared to the status quo. However, this scenario was not favoured by visitors who were most interested in seeing wildlife.

9.1.14 In summary, there are a number of synergies and trade-offs associated with peatland restoration in the South Pennines Pilot area, which need to be considered in the design of any place-based PES scheme. Restoration based on the re-vegetation of bare and eroding peats has most synergies and least trade-offs: restoration improves climate, water quality, peatland biodiversity and recreation; probably reduces flooding, and probably doesn't negatively impact farming or grouse management. In these more heavily degraded areas, more intensive restoration approaches, including *Sphagnum* propagation, are likely to be required to achieve the full range of potential co-benefits. More widespread restoration of degraded blanket bog (grip blocking, gully re-profiling and re-wetting) would provide significant climate, water and biodiversity synergies, but might involve reducing grazing or managed burning until the blanket bog was functioning again.

9.1.15 The principal co-benefits that may be exploited in a place-based PES scheme in the South Pennines Pilot area are as follows:

- Revegetation of bare and eroding peats and gully blocking in eroding blanket bogs, combined with *Sphagnum* re-introduction and reductions in, or the prevention of, grazing and managed burning where necessary, to restore functioning blanket bog and/or safeguard the stored peat:
    - Improved long-term carbon budgets via reduced loss of carbon (as DOC or POC in stream water and carbon dioxide from the oxidation of peat) and increased sequestration and storage of carbon in actively building, restored peat bogs (with long-term sequestration of carbon dioxide outweighing short-term increases in methane production immediately post-restoration);
    - Biodiversity benefits, including improvements in floral diversity and the abundance of blanket bog indicator species such as *Sphagnum* mosses and cotton grass, and increases in the abundance of a number of peatland bird species that are of conservation concern;
    - Reduction in levels of DOC and sediment entering upland streams and reservoirs;
    - Local/short term changes to accessibility, followed by improved recreational access across bare-peat/eroded sites previously dissected by gullies (once the restoration is complete); and
    - Improved aesthetics, particularly in formerly bare and eroding areas.
- Gully re-profiling and grip blocking in degraded blanket bogs, combined with careful vegetation management to help restore functioning blanket bog, reduce erosion and/or safeguard the peat.
    - Improved long-term carbon budgets (as above);
    - Peatland biodiversity benefits;

[209] Black, J., Milner-Gulland, E.J., Sotherton, N. and Mourato, S., 2010. Valuing complex environmental goods: landscape and biodiversity in the North Pennines. *Environmental Conservation* 37: 136-146.

- Reduction in levels of DOC and sediment entering upland streams and reservoirs

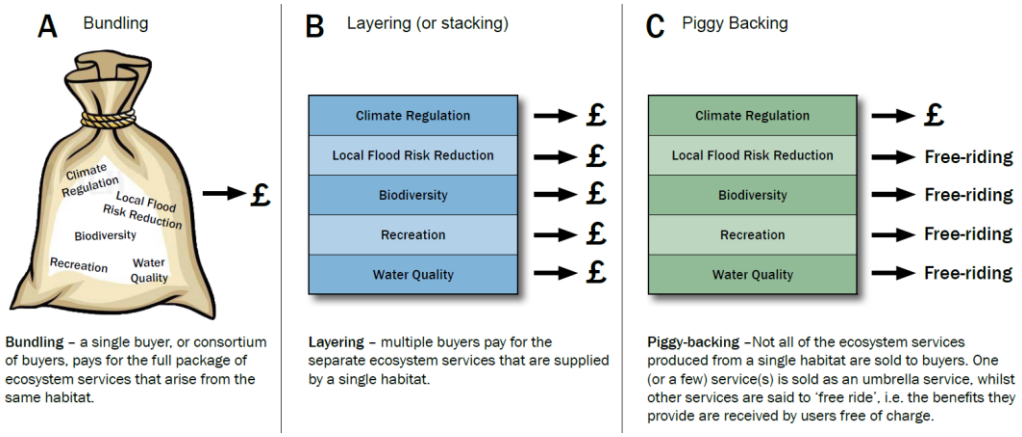
9.1.16 A number of changes may occur when peatlands are rewetted and where levels of grazing and/or managed burning are reduced. These are very site specific, but may include:

- An initial flush of flowering grasses (cotton grasses) or temporary increase in vegetation height.
- A gradual change, for example, a shift from bare peat, dry heath and tussocks to lusher, diverse vegetation with pillows of sphagnum moss and small pools.

9.2 Packaging ecosystem services

9.2.1 Ecosystem Services can be packaged and sold in different ways. Figure 7 below illustrates different types of multi-service PES.

Figure 7: Different types of multi-service PES (adapted from DEFRA PES Best Practice Guide)



9.2.2 Bundling in PES is defined as grouping multiple ecosystem services together in a single package to be bought by individual or multiple buyers.[210] For example, carbon, water quality, biodiversity, visitor benefits and wildfire risk benefits could be bundled together in a single scheme designed to pay for peatland restoration. "Layering" (also called "stacking") refers to schemes where payments are made for different ecosystem services separately from the same system. For example, the same peatland restoration project could run a carbon offset scheme in parallel with a scheme targeting water companies to pay for water quality benefits, whilst taking in money from a visitor payback scheme. Sometimes it is not possible to capture payments for all the co-benefits of a PES scheme. This is often referred to as "piggy-backing", where payments for one ecosystem service lead to the production of

[210] Lau, W.W.Y. (in press). Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem services. *Ocean and Coastal Management*

additional services for free.[211] Those who then benefit from these additional services without paying for them are referred to as "free riders".[212]

9.2.3 Bundling is the easiest type of scheme to manage. Where bundling is not deemed suitable or feasible, or where no buyer or consortium of buyers can be found for a bundle of services, then layering (with careful quantification) may provide the co-ordination necessary to provide win-wins and minimise trade-offs between ecosystem services.[168]

9.2.4 Layering is the obvious mechanism to provide extra funding for restoration projects, especially if one project to restore peatland provides many different ecosystem benefits, and therefore might attract many layers of funding. However, layered projects could result in overpayment (for example, paying for the peatland restoration many times over on the basis of different benefits). Proper valuation of a layered project assumes that services are produced independently, and that each service can be clearly delineated and quantified separately; however, in practice this is not the case as the ecosystems are interlinked, the benefits are correlated, and the layers become blended. Some buyers (such as for the carbon market) have clear rules on additionality[213], and would not fund projects where carbon was over-paid and became the 'free-rider'. For that reason, it may be sensible to design future projects so that the aims of each part of the restoration are clear, and so that each service can be clearly delineated and quantified separately[214], (perhaps using sub-areas within the main restoration project, or specifying additional management needs for particular ecosystem service provision) and so that the layer with most requirement for additionality is designed into the project as its foundation. This may be a particular requirement of future water/carbon restoration projects.

9.2.5 There are therefore likely to be higher costs associated with setting up and "layering" multiple PES schemes in parallel. Where existing PES schemes are already operating (e.g. a water company paying land managers to produce clean water), it may be possible, but difficult, to introduce additional schemes for additional services over time in response to market demand (e.g. introducing a carbon scheme to get new investors to pay for the carbon benefits of managing additional land for clean water, thereby sharing the costs of changing land management between multiple buyers, who benefit from multiple services). It would be better to design a restoration project where some parts of the moor were managed primarily for water, and others primarily for carbon.

9.2.6 In theory, bundling may offer a number of important benefits to PES schemes, compared to layering schemes that market single ecosystem services:

- It reduces the likelihood that a payment for one ecosystem service may lead to trade-offs with other services.[215,216] Where bundling includes a wide range of services, it is more likely to preserve intact ecosystems;[217]

[211] Wertz-Konounnikoff, S., Locatelli, B., Wunder. S., Brockhaus, M., (2011). Ecosystem-based adaptation to climate change: what scope for payments for environmental services? *Climate and Development* 3(2) S. 143-158.
[212] Wunder S, Wertz-Kanounnikoff S. (2009). Payments for ecosystem services: a new way of conserving biodiversity in forests. Journal of Sustainable *Forestry* 28: 576–596.
[213] Under existing carbon trading schemes, carbon is only saleable if it is Additional, i.e. if the project would not have occurred without the carbon payments. Carbon as a co-benefit from an existing water quality project would not be saleable; however carbon within a new project, a project that would only be viable if funded by both carbon and water markets, should be saleable.
[214] Kosoy, N., Corbera, E., (2010). Payments for ecosystem services as commodity fetishism. *Ecological Economics* 69: 1228–1236.
[215] Kemkes R.J., Farley J., Koliba C.J., (2010). Determining when payments are an effective policy approach to ecosystem service provision. *Ecological Economics* 69: 2069-2074.

- Bundling ecosystem services with "coincidental" or co-benefits can allow sellers to charge a premium for the ecosystem services they are providing, as long as those co-benefits can be clearly identified and quantified.[218,219] It is therefore more likely that bundled PES schemes will deliver benefits for biodiversity and for ecosystem services that are hard to monetise, as those with no premium would 'piggyback';

- It may be possible to attract new buyers who are interested in investing in services that have been included in the bundle, who might otherwise not have been interested in the project. Similarly, by including additional services that operate at a wider spatial scale in a bundle, it may be possible to access a wider range of buyers, who are interested in investing in the wider surrounding area;[220]

- Bundling makes payments more resilient over time, as payments are likely to come from a more diverse range of buyers, and allows both buyers and sellers to aggregate in order to create sufficient demand/supply. Therefore, if a particular source of funding becomes unsustainable, it is likely that other sources will continue to invest;[221,222]

- Bundling can increase political and public support for a scheme, and improve benefits for investors motivated by Corporate Social Responsibility concerns, by increasing the range of benefits and beneficiaries, and making more of the benefits explicit and tangible;[223]

- Although intermediaries are likely to be needed, compared to establishing individual markets for many different ecosystem services, bundling ecosystem services can reduce the transaction costs associated with establishing a market for multiple ecosystem services.[224] Similarly, bundling makes it easier for multiple projects to work together to produce a complementary bundle of ecosystem services in a particular location and jointly market the services they produce, reducing the transaction costs of dealing with multiple sellers.[225]

- As in any service delivery, strategies and mechanisms will need to be in place for non-delivery risk mitigation; buffers or discounting (in the origination-to-issuance process); validation and verification

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[216] Deal, R.L. et al. (2012). Bundling of ecosystem services to increase forestland value and enhance sustainable forest management. *Forest Policy and Economics* 17: 69–76.
[217] Redford, K.H., and Adams, W.M. (2009). Payment for ecosystem services and the challenge of saving nature, *Conservation Biology* 23: 785-7.
[218] Turpie, J.K., Marais, C., and Blignaut, J.N. (2008). The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa, *Ecological Economics* 65: 788- 798.
[219] Venter, O., Meijaard E., Possingham H. *et al*. (2009). Carbon payments as a safeguard for threatened tropical mammals. *Conservation Letters* 2: 123–129.
[220] Kemkes R.J., Farley J., Koliba C.J., (2010). Determining when payments are an effective policy approach to ecosystem service provision. *Ecological Economics* 69: 2069-2074.

[221] Kemkes R.J., Farley J., Koliba C.J., (2010). Determining when payments are an effective policy approach to ecosystem service provision. *Ecological Economics* 69: 2069-2074.
[222] Deal, R.L. et al. (2012). Bundling of ecosystem services to increase forestland value and enhance sustainable forest management. *Forest Policy and Economics* 17: 69–76.
[223] Kemkes R.J., Farley J., Koliba C.J., (2010). Determining when payments are an effective policy approach to ecosystem service provision. *Ecological Economics* 69: 2069-2074.
[224] Deal, R.L. et al. (2012). Bundling of ecosystem services to increase forestland value and enhance sustainable forest management. *Forest Policy and Economics* 17: 69–76.
[225] Mayrand K. and M. Paquin (2004). *Payments for Environmental Services: A Survey and Assessment of Current Schemes*. Unisfera International Centre for the Commission of Environmental Cooperation of North America, Montreal, p.9

9.2.7 From a buyers' perspective, bundling can represent a means of securing a range of ecosystem services through a single mechanism. For example, a government with a mandate to provide several different services may employ bundled payments as a mechanism for securing multiple benefits through a single mechanism.[226] However, it is unlikely that many private sector buyers' would be dependent on multiple ecosystem services. Some water utilities may be an exception since they may be interested in water quality and carbon sequestration as well as biodiversity, landscape and amenity in their role as SSSI owners etc. Private companies may also be interested in bundling in terms of the co-benefits associated with a core service for corporate responsibility reasons.

9.2.8 Having said this, there are a number of challenges that need to be overcome for bundling to operate successfully. For example, pricing can become complicated when many interdependent services are produced together.[227] Pricing individual ecosystem services can be challenging when creating new markets, particularly for services that are hard to quantify (e.g. some cultural services), and this challenge is made worse when paying for a bundle of services, as this further obscures the value of the individual services. Broadly, two approaches have been proposed to overcome this challenge. First, a range of techniques has been developed to elicit values for changes in ecosystem services for which there is no market value e.g. contingent valuation, hedonic pricing, choice modelling, etc.[228] This approach was taken to assess water company expenditure in the South Pennine Upland Pilot. Second, sellers may compete with each other to deliver ecosystem services, with prices based on the cost of providing the service in a particular location e.g. as is being trialled currently in the South West Upland Pilot area.[229] This bidding approach leads to ecosystem services being bought from the locations where they can most efficiently be provided, with prices varying between locations for the same ecosystem service.[230] Although in theory, bidding should be economically efficient, there can be significant transaction costs associated with such schemes, and it becomes difficult to spatially target measures.[231]

9.2.9 As the number of ecosystem services in a bundle increases, the number of beneficiaries and other stakeholders (e.g. land owners) increases, which may increase transaction costs and raise challenges of co-ordinating actions to deliver the services. When schemes target ecosystem services that require management across property or tenure boundaries, this raises particular challenges. Prager *et al*. (2012)[232] and Reed *et al.* (in prep.)[233] however, suggest that many of these challenges may be overcome through effective scheme design and the co-ordination and facilitation of affected groups of land owners and other stakeholders (Box 6).

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[226] USAID (2012). Bundling and Stacking for Maximizing Social, Ecological, and Economic Benefits: A Framing Paper for Discussion at the "Bundling and Stacking Workshop", April 5-6, 2012

[227] Reed, M.S., Moxey, A., Prager, K., Hanley, N., Skates, J., Evans, C., Glenk, K., Scarpa, R., Thompson, K. (in prep.) Payment by potential results: paying for ecosystem services in agri-environment schemes in UK peatlands, *Ecosystem Services*

[228] Kroeger, T . and F . Casey (2007). An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics* 64: 321-332.

[229] Currently a single service provision from a place (clean water), but the Fowet auction is relevant as an example. http://www.valuing-nature.net/news/2012/payments-ecosystem-services-pilot-scheme-south-west-water

[230] Engel, S., Pagiola, S. and Wunder, S. (2008). Designing payments for environmental services in theory and practice – an overview of the issues, *Ecological Economics* 65: 663- 674.

[231] Reed, M.S., Moxey, A., Prager, K., Hanley, N., Skates, J., Evans, C., Glenk, K., Scarpa, R., Thompson, K. (in prep.) Payment by potential results: paying for ecosystem services in agri-environment schemes in UK peatlands, *Ecosystem Services*

[232] Prager K, Reed MS, Scott A (2012). Encouraging collaboration for the provision of ecosystem services across multiple scales: rethinking agri-environmental payments. *Land Use Policy* 29: 244-249

[233] Reed, M.S., Moxey, A., Prager, K., Hanley, N., Skates, J., Evans, C., Glenk, K., Scarpa, R., Thompson, K. (in prep.) Payment by potential results: paying for ecosystem services in agri-environment schemes in UK peatlands, *Ecosystem Services*

However, debates about whether land owners or land managers (where these differ) should be entitled to payments are likely to be less immediately tractable.[234]

Box 6: Co-ordinating stakeholders and encouraging collaboration

In place-based PES schemes, a number of the ecosystem services that are being paid for need to be managed at a catchment, habitat or landscape scale, e.g. flood risk management, freshwater provision, climate regulation, and habitats for species of both commercial and conservation value. The ecological systems that provide these services often operate at a scale (e.g. landscape, river catchment) and with network linkages (e.g. hydrological connectivity, habitat mosaics) that span individual management units. However, land ownership and management, is often highly fragmented, with many individual owners, managers and management units. Individual management units (e.g. farms, nature reserves) are typically managed in isolation from each other. Although land managers regularly cooperate in some contexts (e.g. labour and machinery sharing or as members of commodity cooperatives), there is much more limited evidence of collaboration around the provision of ecosystem services and the transaction costs of negotiating voluntary collective action agreements amongst many participants can be high.

Although financial incentives can be designed to encourage co-operation between land managers, achieving co-ordination across a landscape will typically require some level of independent facilitation, to bring different actors together across property boundaries. Deliberation between land-owners and managers over the uptake of collaborative PES schemes that cross property boundaries could help ensure that such collaborations are based as much as possible on the knowledge and expertise of land managers, in addition to scientific evidence about links between management prescriptions and the provision of ecosystem services. It may be possible to build on experience from initiatives such as the UK Environment Agency's "Common Ground" workshops (that focussed on Water Framework Directive implementation), the Environment Agency's pilot catchments and DEFRA's Demonstration Test Catchments, where land owners/managers and (in some cases) other stakeholders were brought together with agency advisors in independently facilitated workshops. To incentivise engagement in such fora, it may be necessary to include bonus payments in PES schemes to reward co-operation across property boundaries for the management of specific ecosystem services.

As part of this negotiation process, it may also be possible to co-ordinate between agri-environment PES schemes and private PES schemes e.g. for water services, carbon offsetting or visitor payback. At its most simple, this co-ordination could ensure the additionality of PES by avoiding duplication between private and public schemes.

Recommendations for the promotion of cross-boundary collaboration for ecosystem service management in place-based PES schemes include:

- Gauge land managers' problem perceptions, and if necessary invest in awareness-raising activities;
- Establish local ideas about the management of ecosystem services, and land managers' ability and willingness to cooperate. Collaboration may not always be needed or appropriate, and land managers may be resistant for good reason;
- Identify formal institutional barriers to a collaborative approach (administrative, political, legal) and create enabling institutional structures within PES schemes where possible;
- Provide an opportunity to trial the cooperation without too much commitment, to minimise associated risks; generally ensure that collaboration is seen to reduce rather than increase risk to land owners and managers;
- Arrange opportunities for communication, try out different modes of communication, and identify effective and low cost ways of communicating;
- Allow discussion of land tenure issues and property rights;

[234] The payment is made to support a particular land management activity. Payment therefore requires delivery. A cost model is therefore required and agreement on acceptable profit margins.

- Consider (initial) compensation for time investment and travel expenses, i.e. transaction costs arising from negotiating voluntary collective action agreements amongst many participants; and
- Ensure that there are demonstrable benefits of collaboration.
- Establish a variety of legal entities that can represent legal ownership

9.2.10 Currently, additional ecosystem service benefits in the majority of PES schemes can be considered as 'piggy backing' on the core services that are being marketed by the scheme. One buyer purchases the enhancement of a single ecosystem service, but in so doing, indirectly impacts (either positively or negatively) on the provision of other ecosystem services from which others may benefit. Where it is possible to market these additional ecosystem services to beneficiaries that do not currently pay for the benefits they receive as a result of the scheme, it may be possible to reduce the cost of paying for the core service or generate additional income from the scheme. However, there is nevertheless a risk that instead of 'piggy-backing' multiple benefits on the back of a core service, enhancing the provision of the core service may compromise the provision of other services; what is termed by economists as a "negative externality". Some of these negative effects may be off-site, for example when land use exacerbates flooding or sediment loss/accumulation in adjacent areas downstream; or there may be on-site impacts when a decision in one sector (e.g. conservation) affects another sector (e.g. agriculture)[235]. As such the design of multiple-benefit PES schemes must pay as much attention to understanding trade-offs as they do to capturing multiple benefits. By embedding PES schemes within an ecosystems approach however, it should be possible to explicitly consider system-wide co-benefits and trade-offs, through collaboration with local land owners/managers and beneficiaries.

9.2.11 It is therefore preferable to establish a PES scheme that explicitly considers (and ideally monitors) the impact of land management changes on a range of other ecosystem services, in addition to those that are being marketed via the scheme. The next section considers five design principles for multiple-benefit, place-based PES schemes that could help structure the design of a scheme for the South Pennines ESP area.

9.3 Designing a multiple-benefit, place-based PES scheme

9.3.1 There are five main considerations for selecting a preferred PES set up. These are:

- Spatial concurrence of ecosystem services;
- Number and type of ecosystem service buyers;
- Number and type of ecosystem service sellers;
- Potential costs of land management changes; and
- Potential revenue from selling ecosystem services.

9.3.2 These variables are considered in turn below.

9.4 Spatial concurrence of ecosystem services

"*Another important characteristic of ecosystems and the services they provide is that they are not homogenous across landscapes or seascapes, nor are they static*

[235] Agri-environment schemes recognise this through paying for agricultural income foregone

phenomena. They are heterogeneous in space and evolve through time".[236]

9.4.1 Sections 4-8 have made it clear that ecosystem services can be enhanced at different scales – this is summarised in Table 11 below.

Table 11: Scale at which ecosystem services can be influenced

Ecosystem Service	Scale at which it can be influenced	South Pennines ESP area
Climate Regulation	Sub-catchment and watershed (one hectare to one hundred hectare units).	Climate regulation is insensitive to location and therefore peatland re-wetting and rehabilitation can be undertaken anywhere. However peat restoration needs to occur across an entire peat hydrological unit (this might be a small moor-top, or a peat basin, or the sloping peatland above a reservoir). This may involve partnership working in sub-catchments and on watersheds. The greatest benefits are likely to accrue from rehabilitating bare, eroded and dried out peatland, as these areas are typically losing most carbon, so restoration can avoid significant carbon loss as well as sequestering and storing carbon in active, restored peat bogs.
Water Quality	Most effective at the catchment level, but appreciable differences can be made at the sub-catchment level.	Water quality could be improved through targeting land management changes in key catchments that are currently degraded and drain into sensitive reservoirs. For example, restoring the 1220 ha of degraded bog and 24 ha of severely burnt bog in the Keighley & Watersheddles Catchment is likely to slow (and possibly stop) water colour deterioration and particularly increasing levels of DOC.[237]
Flood Risk	Most necessary at the catchment level, but most evidence at field, hillslope and sub-catchment scale (e.g. Pont Bren)	The flood generating potential of the Aire, Calder and Irwell catchments are particularly sensitive to land management issues.[238] Land management changes, through habitat restoration across these catchments may improve flood risk regulation. Although there is good evidence that moorland re-vegetation can reduce overland flow, slow flood water and hence reduce peak flows, evidence for grip blocking is more equivocal, and local hydrology is key.

[236] Fisher, B., Turner, R. and Morling, P. (2008) *Defining and classifying ecosystem services for decision making*. Ecological Economics Vol 68. Elsevier
[237] Natural England (2012) *Valuing land-use and management changes in the Keighley and Watersheddles catchment*. Natural England
[238] Environment Agency (2010) Calder Catchment Flood Management Plan Summary Report December 2010 (online) available at: http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/gene0110brlh-e-e.pdf

Biodiversity	Depends on the species and habitat in which improvements are being sought. Improving habitat quality around SAC/SPAs and/or linking SPA/SACs has been identified as a cost-effective way of improving biodiversity and complementing existing Government funding to isolated sites.[239] Grazing units, hydrological units, and administrative/ ownership units are also key.	Re-vegetating bare peat and restoring previously drained moorland habitats in the ESP area will have a broadly positive impact on biodiversity (although inevitably some species will gain, while others will lose) and can be positive at any scale. Improving habitat around the two SPAs/SACs in the South Pennines ESP area and providing habitat corridors linking them may be particularly beneficial.
Recreation	Given the linear nature of many recreation opportunities (e.g. walking) and the scale at which landscape aesthetics are appreciated by recreationalists, improvements across large areas (catchment scale) tend to be required. For angling, improvements relate to water quality improvements impacting on fish species and removing any barriers to fish migration; catchment scale.	Improvements to paths and the immediate landscape around walking routes (e.g. the Pennine Way) would be beneficial, although this can result in displacement of activity from elsewhere in the Pennines. Improving angling opportunities would require catchment improvements to water quality and migration channels. The beneficial impact of both of these interventions is uncertain and unlikely to be substantial.

9.4.2 The provision of these five ecosystem services overlap substantially across space and time in the South Pennines ESP area. The majority of ecosystem services are likely to be delivered through interventions at hill-slope to catchment scales, and can be enhanced within an acceptable time span[240], although flood risk mitigation may be more difficult. Climate regulation benefits take place over much longer time horizons and are felt globally.

9.4.3 As summarised in Table 9, all of the proposed management options are likely to benefit climate regulation, biodiversity and water quality in some way. The fact that multiple management options can deliver improvements in climate regulation, biodiversity and water quality in the same location (albeit over different time-horizons) suggests that these three services may be able to form the basis for a bundled or layered place-based PES scheme, if the other design criteria (below) can also be met. Any trade-offs, including any impacts on sheep and grouse production, need to be understood. Recreation (walking) benefits are likely to be greatest from the re-vegetation of bare and eroding peat, but may also benefit from grip/gully blocking in heavily dissected sites.

9.4.4 With the exception of biodiversity, which can be manipulated at a field/hillslope scale, the majority of the ecosystem services identified operate at a catchment scale, suggesting that this is the most relevant scale at which to design a place-based scheme that is able to capture most co-benefits. The number of ecosystem services to be included in the PES scheme is a key decision and will be informed by the following four considerations.

[239] The Environment Bank, Biodiversity Offsetting: a general guide (online) available at: http://www.environmentbank.com/documents/BiodiversityOffsetting-Ageneralguide_000.pdf

[240] Increasing evidence from Moors for the Future, the Yorkshire Peat Partnership and SCaMP peatland restoration projects suggest improvements to water quality and vegetation within a decade.

9.5 Number and type of ecosystem service buyers

9.5.1 The number and type of potential ecosystem service buyer(s) is a key consideration in establishing any PES scheme. A PES scheme cannot be established in the absence of a willing buyer.

9.5.2 The simplest set up involves a single buyer purchasing a bundle of ecosystem services from a small number of sellers. More complex schemes aggregate multiple buyers to fund the PES scheme.

9.5.3 The beneficiary analysis presented in the previous sections demonstrates that there is a wide range of beneficiaries of ecosystem services provided by the South Pennines ESP area that might be persuaded to directly purchase ecosystem services. Overall, the most likely buyers were considered to be:

- Water companies (i.e. Yorkshire Water and United Utilities);
- Corporations interested in purchasing reduced emissions from peatland degradation and carbon sequestration;
- Corporations interested in purchasing conservation credits;
- Developers interested in purchasing voluntary biodiversity offsets;
- Tourists and visitors; and
- Local and national Government through agri-environment schemes (see Box 7)

9.5.4 In addition to this, Defra research is ongoing to investigate the potential to market ecosystem services to the public via Visitor Payback schemes. Working with Nurture Lakeland in the Lake District National Park, this project is developing a number of smart phone apps that can enable visitors to invest in projects that deliver ecosystem services. The project will offer a "visitor payback module" that can be added to existing or future apps in other locations. Existing research[241] shows that visitors are interested in investing in well-defined projects in which they can see their investment has delivered specific benefits. Given the significant number of visitors to the South Pennine Pilot area, the recreational benefits of the proposed management actions and the specific nature of the co-benefits that could be delivered from visitor investments, it may be worth considering layering a Visitor Payback scheme alongside schemes based around marketing benefits to the mainly corporate beneficiaries listed above.

9.5.5 The willingness of these beneficiaries to participate in a place-based PES scheme is not known. Further work is required to engage these beneficiaries and to understand their appetite for investing in improving ecosystem services. It will be important to establish:

- **Whether a single buyer is sufficient** – Comparing the costs of land management changes to the value of the ecosystem service to the buyer is a necessary step to establish whether or not a single buyer can pay for the required land management changes or whether revenue from multiple buyers needs to be combined (if necessary, this could be done via an auctioning system).

[241] Nurture Lakeland (2011) Vital Uplands - Visitor Payback Pilot Scheme (online) available at: http://www.nurturelakeland.org/images/stories/pdfs/vital%20uplands%20visitor%20payback%20pilot%20report.pdf

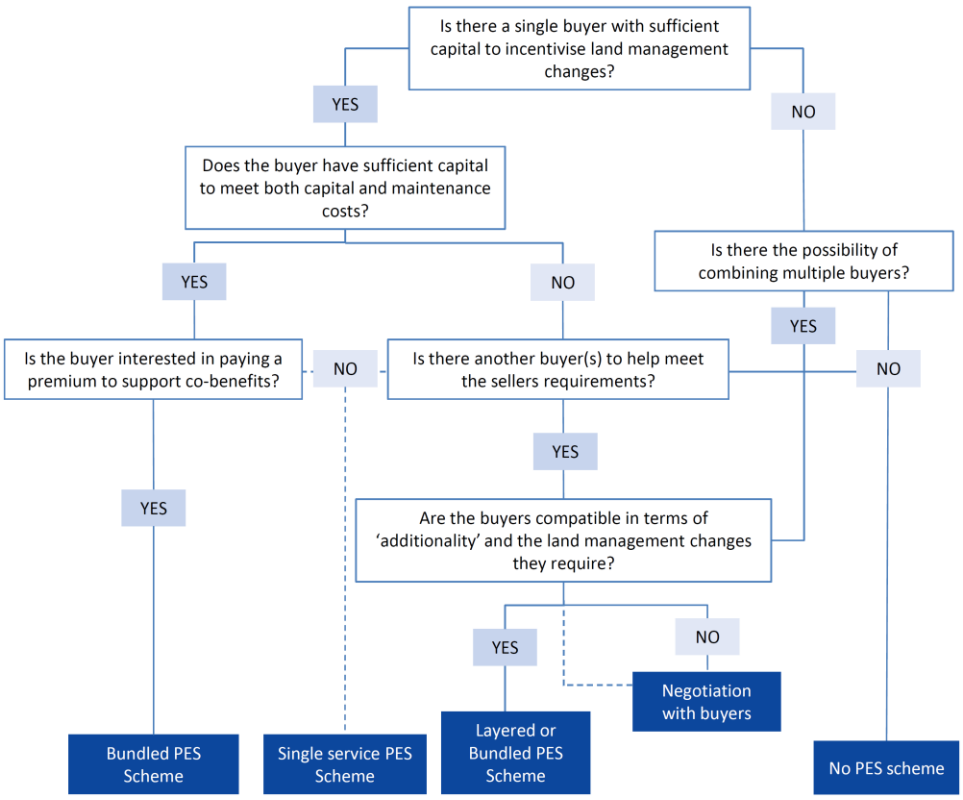
- **Constraints to funding** – private organisations may be constrained in terms of the types of finance they can invest in PES schemes. For example, some may be more able to provide upfront capital for particular improvements rather than providing ongoing finance for maintenance over long time periods; water companies need to adhere to Ofwat guidance for example.

- **How the buyer wishes to claim the ecosystem services benefits** – different buyers are likely to have different objectives and wish to claim the benefits in different ways. Organisations who invest in carbon credits may wish to trade them or report them as an asset in their Company Reports, while water utilities may wish to demonstrate improvements to Ofwat. In order to avoid 'double counting' it will be necessary to prove additionality (see box 7). Understanding buyers' objectives from the outset is therefore important and will influence how the PES scheme is set. Some may want a risk-sharing arrangement (perhaps through an off-take), they will all require discounting for early investment, they will certainly want to understand the process and the business plan, and the non-delivery risk mitigation strategy.

- **Buyers' concerns over free-riding** by **other beneficiaries**– Buyers may be concerned that other organisations are free-riding on the back of their investment. If this is the case, it may be necessary to engage other buyers in the PES scheme.

9.5.6 While, the specific requirements of the beneficiaries considered here are not known a number of general principles can be outlined. The decision tree below sets out how the number and type of buyer can influence the set up of a PES scheme:

Figure 8: PES Buyer decision tree



Box 7: Additionality and PES

The concept of 'additionality' is that all PES schemes should fundamentally seek to obtain an environmental benefit that would not have otherwise occurred, or to prevent an environmental harm that would have occurred in the absence of the payment (precisely what constitutes additionality will vary from case-to-case but the actions paid for must at the very least go beyond regulatory compliance). Providing payment to projects that are not additional is economically inefficient. With limited financial resources, programs should be designed to encourage activities that would not occur otherwise.[242]

A bundled PES scheme is at much lower risk of contravening the principle of additionality than a layered PES scheme.[243] This is because it is common for different ecosystem services in any one habitat to be connected and for management activities targeted at improving one service to improve one another. In a layered PES scheme, where different buyers are paying for different ecosystem services from the same parcel of land, the additionality of funding for one ecosystem service may be difficult to prove.

In the context of the South Pennines, payment for climate regulation necessitates a similar suite of land management changes as does improving water quality or biodiversity. Funding for one ecosystem service is therefore likely to lead to improvements in the others and the "additionality" provided by funding for the other ecosystem services is debatable.

One means of proving additionality, is to demonstrate that payments from one source (e.g. for carbon) are not sufficient to lead to land management changes on their own and that it is only when revenue from multiple sources are aggregated that land management changes become viable.

Box 8: Agri-environment schemes and privately financed PES schemes

An agri-environment scheme can be considered a bundled government-financed PES scheme, which encourages environmentally sensitive farming to deliver multiple ecosystem services. In England, Environmental Stewardship (ES) is the main agri-environment scheme for farmers. Entry Level Stewardship (ELS) is the basic scheme open to all farmers and it supports simple environmental management across the farm (e.g. ditch management). Higher Level Stewardship (HLS) targets specific environmental improvements in strategic locations and therefore seeks to actively enhance particular ecosystem services. In the South Pennines ESP area this includes funding for protecting and restoring degraded blanket bog.[244]

There is an opportunity to combine the finance available to farmers through agri-environment schemes with private finance for particular ecosystem service enhancements. There is a precedent for this both in the example of SCaMP and for woodland creation projects:

- For woodland creation projects, landowners are eligible to receive funding through HLS (for scrub creation), through the English Woodland Grant Scheme (EWGS) and through selling carbon credits through the Woodland Carbon Code (WCC). There are a number of conditions attached to this.[245] Firstly, the minimum contribution from carbon finance must exceed 15% of project costs in order to demonstrate 'additionality'. Secondly, the project cannot claim to be a carbon 'offsetting' project. Instead the project will contribute to the UK meeting its climate change commitments. Finally, it must be made clear to those investing in the project that the carbon savings have not yet been made. If these requirements are met private finance through the

[242] WRI (2002) Stacking Payments for Ecosystem Services (online) available at: http://pdf.wri.org/factsheets/factsheet_stacking_payments_for_ecosystem_services.pdf
[243] USAID (2012) Bundling and Stacking for Maximizing Social, Ecological, and Economic Benefits: A Framing Paper for Discussion at the "Bundling and Stacking Workshop", April 5-6, 2012
[244] Natural England (2008) HLS Target Area Statement YH06 South Pennines Target Area (online) available at: http://www.naturalengland.org.uk/Images/hlstargeting/South_Pennines.pdf
[245] Forestry Commission (2011) Co-funding of woodland creation through EWGS and carbon finance (online) available at: http://www.forestry.gov.uk/pdf/ON020-EWGS&CarbonFinance.pdf/$file/ON020-EWGS&CarbonFinance.pdf

WCC and public finance through the EWGS can be combined to support woodland creation projects.

- Private funding such as that provided by United Utilities can meet the gaps between scheme payment rates and real costs for capital works, pay upfront where agri-environment schemes can't, and pay for changes in tenancy agreements. SCaMP has successfully combined money from United Utilities with money from agri-environment schemes. In the first phase of the project United Utilities paid £8m for capital improvement works (grip blocking, restoring moorland, livestock fencing etc.) and the Government paid £2.5m through agri-environment support; mainly through HLS payments.

There is therefore an opportunity to combine private funding for peatland restoration with public funding. These two sources of funding can be well suited with private funding available to meet upfront capital costs, where public funding cannot[246] and with public funding meeting on-going maintenance costs, where private finance cannot.[247]

In theory public and private finance could be brought together in different ways to encourage the desired changes to land management:[248]

- Private finance could be used to introduce new options to HLS, or new management options in addition to HLS.
- Private finance could be used to make existing HLS options more financially attractive to farmers.
- Projects could seek funding both from agri-environment schemes (e.g. applying for HLS funding) and from selling carbon credits through a Peatland Carbon Code. The rules on Additionality would prevent double-funding.
- Projects could combine funding from agri-environment schemes with funding for other ecosystem services (e.g. water quality or biodiversity).

The most significant barrier to such schemes is that of **additionality** with the risk that the improvements would have occurred in the absence of the additional funding made available through combining private and public revenue sources. Given the fact that funding is already available for some of the measures necessary to improve ecosystem services (e.g. £4.30 per grip block under HLS), the case for private finance leading to additional benefits needs to be made. This could be done in the same manner as for the WCC and EWGS, where carbon finance (or finance from selling other ecosystem services) is required to make up at least 15% of the project costs. Care also needs to be taken to ensure that the public and private schemes do not have contradictory objectives.

9.6 Number and type of ecosystem service sellers

9.6.1 The number and type of ecosystem service sellers that might become involved in a PES scheme is also a key determinant of scheme design and the type of ecosystem services that are focused on.

9.6.2 An overriding issue is that the location and area of land that provides particular ecosystem services is not always owned by a single individual or organisation. To affect a change in the level of ecosystem service multiple sellers will often have to be aggregated with interventions coordinated across different land holdings. This can make the initiation of a PES scheme more difficult and costly to organise

[246] WTO and EU rules about the way money from the Common Agricultural Policy is distributed may limit the ability of public funds to pay for capital costs of projects. Private finance is not subject to EU/WTO rules and therefore private companies can provide more flexible capital grants.
[247] Private companies may not be willing or able to commit to pay for ongoing maintenance costs over long time periods (e.g. 20 years).
[248] Care needs to be taken that such schemes do not contravene EU or WTO rules on the distribution of funds.

9.6.3 A number of factors in particular that relate to land ownership and tenure can complicate the initiation of a PES scheme. These include:

- **Complex and/or fragmented land ownership and tenure** – In general the greater the number of landowners that need to be aggregated, the greater the transaction costs and the more difficult it may be to reach an agreement. Under these conditions, it may be beneficial to initially focus on improving ecosystem services that can be improved through interventions that can be applied at a smaller spatial scale (e.g. small habitat biodiversity). Where land ownership is simple and a small number of owners can make the necessary land management changes, multi-service PES may be possible. If a significant number of sellers need to be aggregated, trusted brokers may be an imperative. This may be even more pertinent if physical interventions themselves need to be coordinated across multiple land holdings (as opposed to interventions being of sufficiently small scale that they can be confined to individual land holdings).

- **Poor knowledge of land ownership and tenure** – Poor knowledge of who owns the necessary land can increase the transaction costs of initiating a PES scheme and can make it difficult to bring potential buyers and sellers together.

- **Constraints on particular landowners and tenants** – Some owners and tenants may face constraints on what type of changes they can make to the land. For example, tenant farmers may not be able to make particular changes under the conditions of their tenancies (e.g. woodland creation). In addition owners of land designated as SPAs/SACs/SSSIs cannot undertake measures that are likely to adversely impact the condition of the habitat and undermine the site's conservation objectives. Although in theory these constraints may limit the ability of landowners to engage in a PES scheme and enhance particular ecosystem services, in reality the range of management actions proposed for the South Pennines ESP area is unlikely to conflict with conservation objectives.

- **Incompatible land ownership/tenure objectives** – Payment for Ecosystem Services is voluntary, so each landowner/tenant will make their own decision as to whether or not it is worthwhile to enter into a PES agreement. For the majority of private owners it is likely that this will be based to some extent on how financially attractive the different options are. For other organisations (e.g. The National Trust) the decision will be based on how it fits with wider organisational priorities. Where different landowners have different objectives for their land, it may be more difficult to amalgamate them into a PES scheme.

Box 9: Land interests structure in the South Pennines ESP area

Detailed data on land ownership across the South Pennines ESP area is not publically available due to data protection. There are some limited data on land ownership within the SPA and within the wider ESP area. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme (IMSCAP) states that[249]:

"*Land ownership, tenure and management within the South Pennine Moors SPA is complex and often overlapping. As an historic upland water catchment area serving major conurbations to the east and west, large areas are owned by the two water companies. In addition to the reservoirs themselves significant areas of moorland are owned by the water companies and*

[249] Pennine Prospects. The South Pennines Moor Integrated Management Strategy and Conservation Action Programme

managed by tenant farmers. There are some large private estates still run as grouse moors with tenant graziers. Over 40 areas of common land occur within the SPA with rights of pasturage (grazing), turbary (peat cutting), estovers (firewood), sporting and minerals. The majority of land holdings however are small private traditional farms, which may provide only part of the income for the part-time farmer. Very little land belongs to public bodies; Bradford Council is unique in owning a grouse moor at Ilkley and the National Trust runs the Marsden Moor estate which extends beyond the project area into the Peak Park."

While these data are for the SPA only, The NCA profile[250] suggests that a similarly complex system of landownership exists throughout the NCA and therefore the ESP area. The NCA profile states that there is an even split between tenanted and owner-occupied farms and that in 2009 940 holdings were based on upland livestock while 123 were dairy farms. Small farms (below 20ha) represent 57% of all holdings but account for only 13% of the farmed area.[251] Amongst these farms are grouse estates, local authority land and common land.

The implication of this reasonably complex land ownership structure in the South Pennines ESP area is that PES schemes that operate over a smaller geographical area may be preferable, at least initially (until a mechanism can be found to help farmers work together). A scheme that aggregates a few key sellers based on ecosystem service mapping to identify 'hotspots' may be a good starting point.

9.7 Potential costs of land management changes

9.7.1 The costs of setting up the PES scheme include:

- Opportunity costs on the part of sellers;
- Transaction costs associated with scheme development and implementation;
- Initial capital costs associated with delivering interventions;
- On-going maintenance costs associated with maintaining capital works over the duration of the contract; and
- Monitoring and verification costs

9.7.2 The scale of these costs and the ability of a buyer to meet these costs influence the viability and structure of a PES scheme.

9.7.3 The **opportunity cost** of the PES scheme relates to the 'income foregone' from the alternative land management actions. For example, where a PES scheme requires a reduction in sheep stocking levels, the opportunity cost relates to the income foregone as a result of reducing the number of sheep on the farm.[252]

9.7.4 PES programmes entail significant transaction costs that stem from identifying and matching service providers and users, negotiating conditional contracts, monitoring compliance, and enforcing contract terms. Transaction costs are likely to increase 1) with the number of ecosystem services incorporated into the scheme; 2) where there are a large number of disparate buyers that need to be aggregated to facilitate scheme emergence, 3) landownership amongst the ecosystem services providers is complex and fragmented. This is usually taken care of by the market infrastructure: tradable securities, auction systems, projects database, registry (issuance system of

[250] Natural England (2012) National Character Area profile: 36 South Pennines (NE323). Available online: http://publications.naturalengland.org.uk/publication/511867

[251] ibid

[252] Just as in agri-environment schemes, individual sellers make decisions on trade-offs based on financial attractiveness and preference.

record), exchanges, etc. Given the length of this type of project, properly designed market infrastructure is essential.

9.7.5 Transaction costs are likely to be significantly higher for layered schemes, as each service needs to be quantified (which is why quantification methodologies need to be developed) and a greater number of stakeholder groups (especially buyers) will be involved. In a layered scheme, the effort and time to reach an agreement over management interventions, the type and amount of payments, and the monitoring of compliance is likely to lead to increasing transaction costs[253] (although these might be spread across different buyers). In terms of economic efficiency, it is preferable to only add additional layers to a PES scheme if the revenue from doing so exceeds the value of the costs incurred (including the transactions costs). As well as the impact of increasing the number of ecosystem services on transaction costs, increasing the number of sellers also increases transaction costs. Ecosystem services that are influenced at a broader spatial scale (e.g. flood risk regulation) require greater coordination of land managers and therefore higher transaction costs, to facilitate and encourage collaboration.

9.7.6 **Capital and maintenance costs** relate to the costs associated with making the required land management changes to improve particular ecosystem services. For example, capital costs may relate to gripping drained peatlands and re-vegetating bare peatland, while maintenance costs may involve maintaining low stocking densities.

9.7.7 Capital costs vary widely depending on the activities that need to be undertaken. Although they are typically calculated per meter for drain blocking, it is likely that these costs will need to be converted to an area basis for integration with payments for other ecosystem services. This requires a number of assumptions to be made e.g. about site boundaries, which may then affect cost calculations. The range of costs was illustrated in an analysis of 56 UK peat restoration and management projects[254], and was updated at a meeting in Halifax (January 2013; see Annex 2 of Technical Appendix). The cost of reseeding bare peat ranged from £95 per ha at Vyrnwy, Wales to £900 per ha on Bleaklow. The cost of grip blocking also varied widely and ranged from £1000 per km to £6500 per km depending on location and technique used. Vegetation removal (i.e. removing trees from peatlands) cost between £1000 and £10,000 per hectare. A more detailed analysis was recently undertaken by IUCN and others at a workshop in 2013 as part of this research project (see Technical Appendix, Annex 2, for the full details). This showed that for sites in the Pennines restored by Yorkshire Peat Partnership (which are most comparable to the South Pennine Pilot area) that included a mix of degradation severities and restoration techniques, the mean cost of restoration was £548 per hectare (ranging from £272-£948 per hectare). This workshop showed that restoration costs varied according to the following factors:

- Severity of degradation will determine the frequency and magnitude of blocks required, and whether re-profiling is needed
- Access for machinery – where specialist machinery and/or helicopters are required, this significantly increases costs
- Restoration technique:

[253] This detail constitutes Project Design Document, which is typically produced by the project proponent and is (a) the proponents estimate of value and (b) the sales brochure. The estimate is validated by a competent authority and adjusted as appropriate (budget) and the actuals are verified periodically (typically annually) for issuance into the primary market. If trading takes place this will happen in the secondary market.

[254] Moors for the Future (2008) A compendium of UK peat restoration and management projects (online) available at: http://www.peatlands.org.uk/

- Gully/grip blocking technique: for example, using peat dams on lightly damaged peatlands may cost as little as £0.40 per meter (Yorkshire Peat Partnership figures where 90% of grips were small – category 1-3), but may rise to as much as £54 per meter plus re-profiling costs of as much as £5.27 per meter to block more severe gullies (category 4+) using wooden dams (Yorkshire Peat Partnership figures)
- Revegetation averaged £104 per hectare for the Yorkshire Peat Partnership
- Forest removal cost between £250 and 2500 per hectare in Lake Vyrnwy and the Flow Country respectively, depending on factors including access and timber prices, with additional mulching costs of £500-1200 for felled trees and £1800-3000 for standing trees and regeneration control costing £80-£3000 per hectare in the Flow Country
- No estimates are available for the opportunity costs of reducing or ceasing burning in terms of grouse production

9.7.8 **Maintenance costs** will vary from site to site, and for peatland restoration will vary depending on the reduction in grazing and/or removal of winter grazing, and the restoration technique e.g. dams are more likely to fail in steep sites and need replacing, and wooden dams are more expensive to install than peat dams, but are likely to cost less to maintain over the long-term, as a higher proportion of the peat dams are likely to fail in the first few years. For woodland creation, establishment rates are likely to vary between sites, requiring more or less replanting in the initial years of a scheme.

9.7.9 **Monitoring and verification costs** will vary depending on the ecosystem services incorporated into the PES scheme. For some services, direct measurement of changes in the ecosystem service may be possible (e.g. water quality), while for others proxies can be used and developed (e.g. climate regulation, flood risk and recreation). Stricter monitoring is required for certain ecosystem services (e.g. for carbon sequestered through a Carbon Code) while for other ecosystem services buyers may be willing to tolerate less certainty and therefore reduce the rigour with which monitoring is required.

9.7.10 Multiple ecosystem service PES schemes require greater levels of monitoring and verification than single service PES schemes. These requirements are set out in Table 12 for the five services of interest:

Table 12: Monitoring and verification requirements of different ecosystem services

Ecosystem Service	Monitoring requirements	Verification requirements
Climate Regulation	Vegetation surveys pre and post-restoration and at regular intervals, using the Greenhouse Gas Emissions Site Types (GEST) approach. The sampling density and frequency and rigour with which monitoring is conducted is likely to differ depending on the needs of the market. The Verified Carbon Standard (VCS), which is one of the most rigorous verification standards, has approved a methodology based on vegetation proxies, which is being adapted to the UK context.	Verification is central to scheme governance. Verification will depend upon the type of market the carbon is being sold to – for the Corporate Social Responsibility market (the main near-term option), verification requirements are not as strict as they would be for voluntary carbon markets or company carbon accounting under the Greenhouse Gas Accounting Guidelines. VCS then requires projects to be validated by two independent assessors.
Water Quality	Continuous monitoring by water utility at the treatment plant and monitoring by the Environment Agency in accordance with the Water Framework Directive. Monitoring close to any land management changes may be implemented as part of the scheme (as is being undertaken as part of the SCaMP project).	A water company paying for its own catchment management is unlikely to require independent verification of changes in water quality. However, they would need to demonstrate the cost-effectiveness of the measures to Ofwat. Should another buyer pay for improvements in water quality, they would need to ensure that the project proponent (the water company in this case) is doing what it said it would with the finance,
Flood Risk	The Environment Agency currently monitors flow rates at certain locations in the ESP area. More detailed monitoring would be required to establish the impact on flood risk (e.g. synchronicity of flows and response times).	Verification requirements are likely to depend on the buyer, but generally the verification requirements are part of the scheme design mandated by the regime.
Biodiversity	The condition of the SSSIs and priority habitats are currently monitored through Natural England's Integrated Site Assessment. An approach is being developed for wider monitoring of priority habitats for Biodiversity 2020 reporting. Monitoring and verification would therefore have to be expanded for many sites. This could easily be combined with vegetation surveys using the GEST approach where carbon is also be monitored.	Verification requirements are likely to depend on the buyer but as a minimum Defra's biodiversity offset guidance should be followed. Under a voluntary biodiversity offsetting scheme, planning authorities may wish certainty as to the impact of the measures. If conservation credits are sold to corporations, their requirement for verification might be higher.
Recreation	Monitoring of improvements to recreational opportunities is likely to be restricted to proxies such as the area of improved paths or the number of visitors to the area.	Independent verification may not be required. Nurture Lakeland, who run the Visitor Payback Scheme in Cumbria, require the charities they fund to provide monitoring data so that they can report their impact.

9.7.11 The costs associated with initiating and maintaining a PES scheme are therefore likely to be significant, and would need to be incorporated into the pricing structure of the scheme. However, a lack of specific data on many of the costs associated with

other land management changes in the South Pennines ESP area makes it difficult to assess the viability of a 'place-based' PES scheme. Table 13 below, considers some of the likely costs for the South Pennines ESP area.

Table 13: Costs of land management changes in the South Pennines ESP area

Type of cost	South Pennines ESP area
Opportunity Costs	In the South Pennines ESP area, the opportunity cost associated with the land management changes set out in the Delivery Plan are likely to be greatest for grouse estates, where this leads to a reduction in managed burning. Opportunity costs for hill farmers will depend upon stocking densities, and upon individual farm circumstances
Transaction Costs	The relatively complex land ownership structure in the South Pennines ESP area and the lack of a single ecosystem buyer means that it is likely that a PES scheme would need to aggregate both buyers and sellers. This is likely to increase transaction costs. Concentrating on ecosystem services that can be delivered by improvements to small areas of land (e.g. blanket bog restoration) may help reduce these transaction costs.
Capital and Maintenance Costs	As has been noted, capital costs for restoring blanket bog vary significantly, depending on access, restoration technique and severity of degradation. However, assuming similar costs to the Yorkshire Peat Partnership, working elsewhere in the Pennines, it may be possible to assume a similar mean cost of £548 per hectare (ranging from £272-948 per hectare[255]).
Monitoring and verification costs	Monitoring and verification are key to the integrity of the scheme, needing to relate to the ecosystem service itself as well as to the buyers' requirements. For that reason, monitoring and verification are the core of scheme governance and determine the value associated with the asset classes produced by the scheme and the securities that are derived from them. It is likely that requirements for monitoring and verifying biodiversity and carbon storage and sequestration will be stricter than for other ecosystem services, but that initial markets for Corporate Social Responsibility are likely to be less demanding than possible future voluntary carbon markets or compliance with the GHG Accounting Guidelines.

9.8 Potential revenue generated from selling ecosystem services

9.8.1 The potential revenue that can be generated for providing different ecosystem services is an important part of assessing the viability of different PES schemes. Experience from previous PES schemes suggests that different ecosystem services can generate different levels of revenue. Table 14 provides an indication of the magnitude of revenue that could be generated. The applicability of these estimates to the South Pennines Pilot area is highly uncertain and *the figures should be treated as illustrative only.*

[255] for more details, see Technical Appendix

Table 14: Estimation of level of payments for different ecosystem services

Ecosystem Services	Potential Revenue	Justification for estimated potential revenue	Derivation of cost	Source
Climate Regulation	**£-£££**	Current prices on the voluntary carbon market are low and do not cover restoration costs, so currently these costs would be covered via the CSR market, which pay for the full costs of restoration and maintenance. Until a carbon market is launched, it will not be possible to tell what prices investors are willing to pay. However, experience from the Environment Bank suggest that prices can vary significantly, with buyers prepared to pay more for projects in particular geographical locations with specific co-benefits (see below). However, carbon prices on the voluntary carbon market are expected to rise. For the purposes of comparison with other services, if carbon were sold at £20 per tonne, peatland restoration projects could generate £20-40 per hectare per year for changing peatland management; and up to £600 per hectare per year for re-vegetation of bare peat (i.e. ceasing emissions from an eroding peatland – see Tech Appx[256])	Market based. Carbon value is different at every site.	Woodland Carbon Code and Technical Appendix of this report
Biodiversity	**£££**	It is estimated that voluntary biodiversity offsets could generate around £25,000 per hectare over 100 years.[257] This would equate to £250 per hectare per year. However, demand to date has been slow. Philanthropic funding has already generated funding for biodiversity projects, so CSR is a good potential.	Costs for biodiversity projects and corresponding prices for biodiversity offsets are set by the project proponent who may be the landowner but may be a project financier	Environment Bank

[256] The Tech Appendix provides a mid range example of a peatland being enhanced from highly degraded to moderately degraded over 10 years, which would generate 0.5tCo2e per ha per year; and one changing from moderate to intact generating 1.82 tCo2e per ha per year

[257] Tom Tew *Pers Comm*. Markit provides spot and futures prices.

Ecosystem Services	Potential Revenue	Justification for estimated potential revenue	Derivation of cost	Source
Water Quality	**££**	In SCaMP 1, combined funds of £10.5m were made available to improve 20,000ha of land. This equates to £525 per hectare for initial capital costs and ongoing support through agri-environment schemes. Spread over 10 years (the typical length of an HLS agreement), this equates to £52.50 per hectare per year. In SCaMP 2, 30,000 hectares of land is being improved at a cost of £11.3 million.[258] This equates to £376 per hectare for initial capital costs and ongoing support through agri-environment schemes. Spread over 10 years (the typical length of an HLS agreement), this equates to £37.60 per hectare per year.	Cost based	SCaMP1 and SCaMP2
Flood Risk	**£**	Combined funds of £1.3 million are being spent on the Slowing the Flow at Pickering Project.[259] This cannot be converted to a per hectare value.	Cost based	Slowing the Flow at Pickering
Recreation	**£**	The Nurture Lakeland Visitor Payback Scheme was established in 1993 and in 17 years has raised almost £2m in voluntary donations. Approximately 80% of funds raised by the scheme are generated from four large businesses, which operate voluntary levy schemes. Between 1999 and 2000, the total income from the VPS was £42,148.	Money raised through the VPS	Nurture Lakeland Visitor Payback Scheme

9.8.2 It is not possible to compare all the estimates of the revenue a PES scheme might generate. Comparing ecosystem services is complicated by the way they are measured and traded; it is not possible to compare tonnes with hectares.[260] The evidence presented here suggests that biodiversity and water quality may provide the greatest revenue streams to landowners and therefore these services may be the most appropriate to focus on initially.

9.8.3 Although revenues from voluntary carbon markets would not cover the costs of restoration for the most complex projects, Corporate Social Responsibility initiatives are already covering the costs of restoration and ongoing maintenance for some peatland restoration projects in the UK. As this type of activity expands and matures

[258] United Utilities (2012) The SCaMP story continues (online) available at: http://corporate.unitedutilities.com/2204.aspx

[259] Forestry Commission (2011) Appendix 12.1: Report on Match Funding Received from Partners during Period of Project to 31/03/11 (online) available at: http://www.forestry.gov.uk/pdf/stfap_final_report_appendix12_1_Apr2011.pdf/$FILE/stfap_final_report_appendix12_1_Apr2011.pdf

[260] USAID (2012) Bundling and Stacking for Maximizing Social, Ecological, and Economic Benefits: A Framing Paper for Discussion at the "Bundling and Stacking Workshop", April 5-6, 2012

over the coming years, it will be possible to see whether or not buyers are willing to pay more than the costs of restoration and maintenance to secure climate regulation benefits in this way, generating profits for land owners/managers. Initial market research by Rabinowitz and d'Este-Hoare (2010)[261] suggests that major corporations are willing to pay premium prices for UK land-based carbon sequestration projects that have multiple benefits, especially if they are associated with improvements in biodiversity. As such, it is not implausible to expect that a climate regulation scheme bundled with biodiversity and water quality benefits may attract significant investment in future.

9.9 Potential structure of a place-based PES scheme for the South Pennines ESP area

9.9.1 There are significant evidence gaps that prevent a detailed discussion of the optimal design of a place-based PES scheme for the South Pennines ESP area. These relate primarily to:

- Uncertainty over the demand from potential buyers for improving ecosystem services, their available capital and conditions attached to that capital;
- Uncertainty over the opportunity, transaction, capital and monitoring costs associated with protecting and enhancing the desired ecosystem services;
- Uncertainty over landowners' willingness to provide these ecosystem services and the ease with which sellers can be aggregated.
- Uncertainty about the future of agri-environment schemes and the potential for compatibility

9.9.2 Improved understanding of these four areas will inform the design of the place-based PES scheme.

9.9.3 In the absence of this detailed information however, it is possible to put forward a number of PES schemes that may be viable in the South Pennines ESP area. These are detailed in table 15 below:

[261] Rabinowitz, R. & d'Este-Hoare, J. (2010). The Feasibility of Creating a Funding Mechanism for UK Carbon Reduction Projects. http://www.ukcarbonreporting.org/filelibrary/IP17_10.pdf.

Table 15: Alternative PES structures for the South Pennines ESP area

Type of PES scheme	Buyer	Ecosystem Service (s)	Distribution of Finance	Capital or maintenance costs	Conditions of finance	Intermediaries	Spatial scale	Comments
Bundled PES scheme 1	Water utility	Water quality* Biodiversity Climate regulation Flood risk	Ultimately funded through customer water bills.	Capital costs.	Demonstrate to Ofwat that it is a cost-effective way of improving water quality.	Water utility can engage directly with landowners or establish an intermediary to do so on its behalf.	To make an appreciable difference to water quality, changes at the sub-catchment scale are desirable.	Water quality improvements are the focus of the PES scheme, but improvements to other ecosystem services are monitored and reported as part of the corporate strategy.
Bundled PES scheme 2	Corporations	Climate Regulation* Biodiversity Water Quality Etc.	Finance distributed via intermediaries working within a Peatland Carbon Code.	Capital and maintenance costs. Funding is 'ex-ante' (i.e. before the carbon has been sequestered).	Carbon sequestration must be additional; verification and monitoring are required, ideally to a standard consistent with the requirements of voluntary carbon markets and corporate carbon accounting.	Necessary for intermediaries to broker deals between multiple buyers and sellers, in keeping with monitoring and verification guidelines under the proposed Peatland Carbon Code.	Payments could be made per tonne of carbon (the area of land this would equate to would vary from site to site), or per project area (for a fixed amount of carbon and co-benefits).	Since the scheme already bundles climate regulation with biodiversity, it would not be possible to secure additional funding from Biodiversity Offsets, as this would be double counting the biodiversity.
Bundled PES scheme 3	Developers and Corporations	Biodiversity* Climate regulation Water quality	Funded through voluntary biodiversity offsets or conservation credits.	Capital and Maintenance costs. Funding is 'ex-ante'.	Biodiversity improvements must be additional; Monitoring and verification are required.	Intermediary to establish the metrics for measuring biodiversity improvements, putting in place the trading platform, and to monitor, verify and report the improvements.	1 credit is equal to 1 hectare. The value of the 1 hectare credit varies depending on habitat type.	Biodiversity offsetting and conservation credits are not likely to be in significant demand for sites such as those found in the South Pennines Pilot area, as there is not currently significant development pressure on peatland/moorland sites, and sites must replace "like for like".
Layered PES scheme 1	Water utility	Water quality	Funded through raising customer water bills.	Capital costs	Demonstrate to Ofwat that it is a cost-effective way of improving water	Water Utility can engage directly with landowners or establish an	To make an appreciable difference to water quality,	Private and public funds are combined. The Water Utility pays for capital improvements while

Type of PES scheme	Buyer	Ecosystem Service (s)	Distribution of Finance	Capital or maintenance costs	Conditions of finance	Intermediaries	Spatial scale	Comments
					quality.	intermediary to do so on its behalf.	changes at the sub-catchment scale are desirable.	Government pays for ongoing maintenance costs.
	Government	Broad range of ecosystem services (biodiversity, landscape, cultural heritage etc.).	Funded through Environmental Stewardship (UELS and/or HLS).	Some funding available for capital costs but mainly for maintenance costs.	Dependent on scheme.	Natural England administer Environmental Stewardship payments.	Environmental Stewardship is available across the South Pennines ESP area.	
Layered PES scheme 2	Corporations	Climate regulation and biodiversity (bundled).	Finance distributed via intermediaries working within a Peatland Carbon Code.	Capital and maintenance costs.	Carbon sequestration must be additional; verification and monitoring are required, ideally to a standard consistent with the requirements of voluntary carbon markets and corporate carbon accounting.	Necessary for intermediaries to broker deals between multiple buyers and sellers, in keeping with monitoring and verification guidelines under the proposed Peatland Carbon Code.	Payments could be made per tonne of carbon (the area of land this would equate to would vary from site to site), or per project area (for a fixed amount of carbon and co-benefits).	Market research suggests corporations are interested in paying premium prices for climate regulation that is bundled with biodiversity. If the scheme is focussed on peatland restoration, then it may still be able to consider this restoration work as "additional" because land owners did not previously take up this option from the agri-environment scheme. If restoration only became financially viable due to the private PES scheme, then it would not otherwise have happened and could be considered "additional".
	Government	Broad range of ecosystem services (biodiversity, landscape, cultural heritage etc.).	Funded through Environmental Stewardship (UELS and/or HLS).	Some funding available for capital costs but mainly for maintenance costs.	Dependent on scheme.	Natural England administer Environmental Stewardship payments.	Environmental Stewardship is available across the South Pennines ESP area, although funding may be tighter in future.	
Layered PES scheme 3	Corporation and Individuals.	Climate regulation.	Non-bundled carbon credit.	Capital and maintenance costs.	Payments need to be additional.	A single intermediary is required to aggregate the different buyers and funding streams, to	Payments could be made per tonne of carbon (the area of land this would equate to would vary	This layered PES scheme is complex and likely to significantly increase the transaction costs associated with the PES scheme. Proving the

Type of PES scheme	Buyer	Ecosystem Service (s)	Distribution of Finance	Capital or maintenance costs	Conditions of finance	Intermediaries	Spatial scale	Comments
						ensure funding from the different sources are additional, to cost-effectively monitor and verify improvements. The Local Nature Partnership, which has broad stakeholder engagement, may be in a good position to act as the intermediary.	from site to site), or per project area (for a fixed amount of carbon and co-benefits).	additionality of the funds is likely to be difficult. The scheme would require a strong intermediary with broad stakeholder support, who is able to aggregate both buyers and sellers and meet distinct demands. The alternative here is a South Pennines Trust Fund which everybody pays into on the basis of the benefits anticipated for each buyer and a management group is mandated to make spending decisions on service enhancements which meet as many expectations as possible, which looks like a bundled scheme, but with a layered shop front.
	Developers and Corporations	Biodiversity	Non-bundled biodiversity credit	Capital and maintenance costs	Payments need to be additional		1 credit is equal to 1 hectare. The value of the 1 hectare credit varies depending on habitat type	
	Water Utility Company	Water Quality	Funded through raising customer water bills	Capital costs	Payments need to be cost effective compared with other means on improving water quality		Sub-catchment level	
	Visitors and Tourists	Recreation	Visitor Payback Scheme	Capital and maintenance costs	n/a		Landscape level improvements	
	Agency on behalf of downstream residents	Flood Risk	Aggregated payments from downstream residents (eg via environment agency or local authority)	Capital and maintenance costs	Payments need to be cost effective compared with other means on reducing flood risk		Land management changes targeted at reducing flood risk in strategic waterways.	
	Government	Support for a broad range of ecosystem services	Funded through Environmental Stewardship (UELS and HLS)	Some funding for capital costs but mainly for maintenance costs	Dependent on scheme		Environmental Stewardship is available across the South Pennines ESP area	

* Lead ecosystem service

9.9.4 The above analysis suggests that some sort of intermediary facilitation body could be useful - perhaps a South Pennines Trust Fund into which everybody pays on the basis of the benefits anticipated for each buyer, and a management group is mandated to make spending decisions on service enhancements which meet as many expectations as possible. This would look like a bundled scheme, but with a layered shop front.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1.1 This project has considered how to develop place-based approaches for Payments for Ecosystem Services (PES) in the English uplands, using the South Pennines as a case study. The aim was to provide a practical, market-based application of the ecosystems approach introduced in the Government's recent Natural Environment White Paper. It has built on the evidence base generated through Natural England's Ecosystem Service Pilots to identify, quantify, value and enhance packages of ecosystem services, working collaboratively with partners, farmers and other land managers. Specifically, it has:

- Reviewed the current baseline and trend in ecosystem service provision in an English upland context;
- Assessed the opportunity to improve a range of key ecosystem services in the area through land management actions;
- Identified potential beneficiaries of these ecosystem services;
- Developed metrics for measuring and modelling key ecosystem services;
- Reviewed the institutional context and mechanisms to enable PES; and
- Evaluated the overall feasibility of setting up a place-based PES scheme delivering either a layered or bundled PES scheme in an English upland context.

10.1.2 Place-based PES schemes deliver improvements in multiple ecosystem services in the same location through a voluntary transaction where a known quantity of ecosystem services are purchased by one or more buyers, leading to an overall increase in the provision of the service that would not have otherwise occurred. A place-based PES scheme may take place when a 'premium' is charged for a core ecosystem service (such as climate mitigation or water quality) being "bundled" with a range of additional ecosystem services that are provided by the same management intervention. Alternatively, multiple ecosystem services may be marketed separately but in parallel with one another (or "**layered**") to different buyers who are only interested in a single service, rather than a broader bundle of services. It is also possible that a bundled scheme selling a combination of services (e.g. linked to carbon and biodiversity) together may operate in parallel to a layered scheme that markets single services to specific buyers (e.g. water quality benefits being sold to water companies, in parallel with recreational benefits being marketed to visitors via a Visitor Payback scheme). See section 9.2 for a more detailed explanation of different types of multiple-benefit PES scheme.

10.1.3 Interest in place-based PES schemes has grown rapidly in recent years, partly given impetus by the emphasis on PES in the 2011 Natural Environment White Paper, with the publication of a PES Best Practice Guide and PES Action Plan imminent. Such schemes offer the potential of additional funding to help meet existing local goals e.g. conservation and water quality. At the same time, a number of potential buyers (in particular those whose brands have a strong local identity) are interested in creating value for their brands and (in the case of water companies in particular), reducing operational costs by investing in such schemes. Market research suggests that there is considerable demand for place-based PES schemes, with carbon and climate mitigation the key driver, but with interest in co-benefits (in particular water quality and biodiversity, and to an extent recreation benefits too). There is evidence from published literature that by considering the effects of proposed management interventions on multiple ecosystem services and trying to capture and market those multiple benefits, place-based PES schemes may find synergies and minimise trade-offs between ecosystem services e.g. food production or conservation, compared to schemes that focus on a single ecosystem service alone.

10.1.4 In the South Pennines ESP area there is considerable interest from land owners and other stakeholders in developing a place-based PES scheme, potentially under the auspices of the Local Nature Partnership, which is chaired by Pennine Prospects and has broad stakeholder representation.

The ecosystem services

10.1.5 Previous research undertaken by, and on behalf of Natural England, has illustrated the range of ecosystem services that are co-produced in the South Pennines ESP area. These include provisioning services (food and fibre); supporting services (soil formation, nutrient cycling and biodiversity); regulating services (flood risk regulation, water quality, climate regulation, and erosion control) and cultural services (recreation and cultural heritage). Historically, the fact that provisioning services have had a market price while other ecosystem services have not, has led to a bias in favour of provisioning services, often at the expense of other ecosystem services, some of which have been significantly degraded. Placed-based PES schemes offer one opportunity for correcting this bias by generating private and public revenue which is targeted at improving non-provisioning services, such as water quality and biodiversity.

10.1.6 The ecosystem services considered most 'marketable' and therefore most able to generate private revenue to support their enhancement, were water quality, climate regulation, biodiversity, flood risk regulation and recreation. Taking into consideration the spatial scale at which these ecosystem services could be improved, the likely demand for the ecosystem services, the revenue that might be raised and the ease of monitoring improvements, water quality, climate regulation and biodiversity were deemed the most attractive. The conclusion was that there was potential for these services to generate revenue from the private sector over the short and medium term to complement existing agri-environment payments.

The beneficiaries

10.1.7 There are a number of potential buyers for the ecosystem service improvements in the South Pennines ESP area. These vary from service to service, and a full beneficiary analysis is presented in the report for each service. These include: water utilities (i.e. Yorkshire Water and United Utilities); corporations interested in financing climate regulation as part of their Corporate Social Responsibility portfolio; corporations and developers interested in purchasing conservation/biodiversity credits to offset impacts generated elsewhere; Government via agri-environment schemes; and members of the public paying for ecosystem service projects via Visitor Payback Schemes.

The land management changes

10.1.8 A number of these ecosystem services can be co-produced in space/time and the evidence suggests that they can be promoted through a similar suite of land management changes in the South Pennines ESP area. These land management changes include:

- Re-vegetating bare peat and grip blocking in blanket bogs not exposed to significant historic grazing and burning, with *Sphagnum* re-introduction and reductions in grazing/burning where necessary;
- Appropriate tree planting on upland valleys and flood plains.

10.1.9 Grip blocking/re-vegetation on blanket bog is likely to have a positive impact on climate regulation (reduced GHG emissions and improved carbon sequestration); peatland biodiversity (including birds of conservation significance); water quality (water colour and sediment); and aesthetics (re-vegetation of bare sites). The impact on recreational services and provisioning services will vary, and there may be some areas where some peatland restoration techniques could have a short term negative impact on grouse shooting and food production.

10.1.10 Any trade-offs that do occur (e.g food production or recreation) can be managed (although not completely mitigated) in order to reduce impacts and secure the best overall outcomes.

How much might be raised?

10.1.11 The South Pennines are capable of sequestering carbon, and a carbon market is developing. Using conservative figures based on a combination of restoration techniques developed for comparable areas of the South Pennines, and combining these with the figures developed in the Technical Appendix, it is estimated that around 36,000 tonnes of carbon dioxide equivalent (CO_2e) per year could be sequestered or safeguarded if all the 30,000 ha of blanket bog in the South Pennines were managed to improve carbon storage and sequestration. Of this, 6,000 hectares would require restoration of grips, hags and changes to burning; and 24,000 hectares could be restored by reducing grazing.

10.1.12 The carbon price fluctuates, and some projects would be more risky than others (in terms of non-permanence, uncertainty, and the size of the buffer). At a £5 carbon price[262], carbon sequestration by intact or moderately degraded bogs (on which grazing/burning had been reduced) could sequester an additional 1-2 tonnes CO2e per hectare per year[263], and so be worth around £5-10 per hectare. However, if carbon prices increased to £20 per tonne of CO_2e, a carbon market could provide annual management payments to landowners of around £20 (for degraded bogs) to £40 (for mossy bogs) per hectare per year (which is comparable with but lower than English agri-environment schemes payment rates)[264]. For more capital intensive restoration projects involving grip blocking or revegetation, costs and values are higher, and more variable.

10.1.13 Stopping peatlands from emitting greenhouse gases is even more valuable. If the 551 hectares of bare peat in the South Pennines were re-vegetated, this could save an estimated 17,000 tCO_2e per year in greenhouse gas emissions. At a carbon price of £20 per tCO_2e, this could provide a revenue of around £600 per hectare per year. Revegetating bare peat can be expensive; so in practice restoration would be best achieved by forward selling the carbon (via carbon credits and a Peatland Carbon Code), which, if it entailed a 30 year agreement, a 25% buffer and an assumption that the eroding area would double in size during the next 30 years if no action was taken, might raise a lump sum of around £10,000 per hectare available to spend as capital towards planting new peat-forming vegetation on the bare peat (a useful contribution towards total costs). Because bare peat emits so much greenhouse gas, revegetating it should be considered a priority.[265]

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[262] Because of the range of carbon prices and the uncertainty over which prices might apply to each peatland carbon restoration schemes, this report uses two figures – a) £5 per tonne CO2eq as a reminder of present day voluntary carbon prices, for comparing with present-day peatland restoration and management costs, and b) £20 per tonne CO2eq as an estimate of a possible carbon price during the period 2013-2020. See note 80, page 50, for more details and references.

[263] The quantity of carbon depends on the condition of the bog, and can range from eroding bogs which are net emitters, to mossy bogs which can sequester 3 tCO2e per ha per year. The Tech Appendix provides a mid range example of a peatland being enhanced from 'highly degraded' to 'moderately degraded' over 10 years, which would generate 0.5tCo2e per ha per year; and one changing from 'moderately degraded' to 'intact', generating 1.82 tCo2e per ha per year. The mossiest bogs can sequester 3 tCo2e per ha per year.

[264] Environmental Stewardship starts at £58 per hectare for moorland restoration for HLS moorland restoration underpinned by UELS in Severely Disadvantaged Areas, above the moorland line on parcels of land larger than 15 ha. Payments are greater below the moorland line and on parcels less than 15ha.

[265] These carbon figures are all rounded and based on a series of assumptions as detailed in the Technical Appendix, but are useful for indicative purposes. In practice, simple ecological and economic modelling would need to be undertaken for each restoration project, as is proposed in the Technical Appendix, and as is being taken forward as part of developing a UK Peatland Carbon Code.

10.1.14 Payments based on improvements in water quality derived from changes to peatland management have historically been more modest, but by combining these payments with funding from agri-environment schemes, United Utilities were able to pay up to £3800 per km^2 (£38 per hectare) per year as part of SCaMP 2. United Utilities financed capital works and HLS payments were used to cover some of the on-going costs of the scheme. Given the role water utilities have already played in funding peatland restoration, water quality should be considered as part of any future PES scheme.

10.1.15 In contrast to funding based on the value of climate regulation or water quality benefits, biodiversity credits may, theoretically, offer financial rewards an order of magnitude greater (up to £250 per hectare per year). However, it is uncertain what the demand for blanket bog biodiversity credits would be. Given the relatively low development pressure on this habitat type (with the possible exception of wind farms) demand from developers can be expected to be weak. Demand from corporations, who are interested in purchasing biodiversity credits, is unproven. As such it is considered that biodiversity, on its own, is unlikely to generate significant revenue at present. However, this may change as biodiversity credits and off-setting mature.

10.1.16 Tree planting is already underway across the South Pennine ESP area in upland valleys (known as “gills” and “cloughs” in the local area) and on flood plains, potentially providing climate regulation, biodiversity, recreation and flood risk alleviation benefits. There is potential to use already well-established PES markets to fund this work, e.g. via the UK Woodland Carbon Code. Alternatively, biodiversity credits may also be sold in the future to finance woodland creation projects in the ESP area.

Combining private and public funding

10.1.17 It is possible that agri-environment funding and private funding via a PES scheme could run jointly or in parallel, potentially providing a dual financial return from land in the scheme. This is the approach taken under the Woodland Carbon Code and providing ‘additionality’ criteria are met (see Box 6), is an attractive option to pursue. This issue is currently being explored in detail as part of the development of a UK Peatland Carbon Code. With the Code due to be launched later in 2013, there is the potential for the South Pennines ESP area to market the climate and other benefits of peatland restoration to local businesses as part of the pilot phase of Code implementation, either through existing intermediaries or with local institutions acting as intermediaries between land owners/managers and buyers.

The PES Scheme

10.1.18 PES is voluntary, and as such any uptake will depend on whether it is attractive to farmers and land managers. Land managers have the option to enter a scheme to be paid for providing ecosystem services. There may be a need to prioritise support for certain ecosystem services, and this should be based on stakeholder engagement and may require local fine-tuning, with care on setting payment rates. This approach could help to reduce unnecessary trade-offs, identify synergies, and make any residual impact(s) more acceptable.

10.1.19 Challenges to establishing a successful place-based PES scheme in the South Pennines ESP area, which are likely to also apply to other upland areas include:

- Complex and fragmented land ownership;
- The need to work across property boundaries to deliver some ecosystem services at relevant scales;
- Variable quality of data on ecosystem service levels, which will make it more difficult to monitor changes in ecosystem services over time;

- Transaction costs associated with managing ecosystem services at broad spatial scales, due to the need to co-ordinate multiple sellers in group schemes; and

- Perceived incompatibility of some PES scheme and land owner/manager objectives.

10.1.20 "Bundled" PES schemes are better able to take into account the complexity and inter-connectedness of ecosystems than "layered" schemes and are therefore less likely to contravene the principle of 'additionality'. However with effective co-ordination between layered schemes, it is possible to avoid the worst trade-offs between ecosystem services and promote synergies between services. Where there are multiple buyers with very different interests, layered schemes may be able to tailor marketing to specific buyers more effectively than bundled schemes, and obtain more funding per unit of area. However, care must be taken to demonstrate that funding streams are leading to additional improvements to ecosystem services that would not have occurred in the absence of the funding.

10.1.21 Potential buyers of ecosystem services in the South Pennines ESP area have quite differentiated interests, in particular for climate regulation versus water quality (both potentially bundled with biodiversity). In future, there may also be another type of high-value buyer focussed primarily on biodiversity offsets. For this reason, during a workshop with South Pennines ESP area stakeholders as part of this research project (Technical Appendix, Annex 2), a preference was expressed for developing a layered scheme to market as many services as possible to different potential buyers over as broad an area as would be feasible, to optimise revenues to any future scheme. However, this solution might not be appropriate for other locations, or for all buyers. For example, some locations do not have an experienced local partnership to take forward a layered project. Care also needs to be taken in the context of similar land management actions: some buyers (such as those seeking carbon credits) require strict additionality; whereas others (such as those buying water catchment control) do not, but need to be aware that carbon cannot be sold as a 'free rider'[266].

10.1.22 Specifically, the layered place-based PES scheme that was favoured by local stakeholders would separately target: developers and corporations (for carbon and biodiversity); water utilities (for water quality benefits); visitors and tourists (for recreation benefits); downstream agencies (for flood risk alleviation); and Government (for a wide range of ecosystem services) (see Table 15, Chapter 8 for full details).

10.1.23 While there is a clear attraction to pursuing a layered PES scheme that offers the potential of raising money from multiple buyers who are interested in multiple ecosystem services, there are a number of challenges that should be considered. This includes the issue that some of these ecosystem services, in particular water quality and flood risk regulation, can only be secured if land management changes are made across a large spatial area. A layered PES scheme that offers flood risk regulation must therefore combine multiple landowners (sellers) in order that it can offer a probable improvement to flood risk regulation[267] Water quality also requires changes over relatively large land areas, although these can be targeted at strategic catchments and sub-catchments where water quality deterioration is a particular issue.

10.1.24 A practical approach would be to initiate a PES scheme at a smaller spatial scale, concentrating on those services that can be improved at that scale (e.g. carbon

[266] Under existing emissions trading schemes, offsets (emissions reductions from sources or removals by sinks) are only saleable if the project from which they are derived is Additional, i.e. if the project would not have occurred without the targeted financing. Carbon as a co-benefit from an existing water quality project would not be saleable; however carbon within a new project, a project that would only be viable if funded by both carbon and water markets, should be saleable.

[267] There are also many uncertainties in flood response to land management changes: the science is still developing, and each catchment needs specific modelling.

sequestration and storage and biodiversity) and, assuming sufficient demand, gradually expand the spatial scale of the PES scheme and the ecosystem services that it offers and delivers.

10.2 Lessons Learnt

10.2.1 Place-based PES schemes offer an opportunity to access and co-ordinate between multiple sources of funding, to pay for the restoration of degraded land and the sustainable management of land that can provide a sufficiently wide range of ecosystem services. A number of lessons have been learnt, which could be usefully remembered by any organisation considering a PES:

10.2.2 Pilot projects such as the 'South Pennines Ecosystem Services Pilot Project' are helpful in developing underpinning data and evidence which can be used as building blocks for future work in payments for ecosystem services.

10.2.3 Data, proxies or metrics are necessary for measuring ecosystem service provision, especially when selling services to non CSR buyers.

10.2.4 Data on water quality are gathered by water utility companies and the Environment Agency. Improvements in the location and density of sampling points would be desirable from the perspective of a PES scheme.

10.2.5 It is possible to use proxies to demonstrate improved carbon storage and sequestration, and this project has demonstrated such a proxy, based on peatland ecosystem functionality, in the Technical Appendix.

10.2.6 Detailed habitat condition survey work (such as the work carried out by the Yorkshire Peat Partnership) is required in order to prioritise and cost restoration projects. Development of PES requires that data are available on an area basis. For peatland restoration, knowing the number of kilometres of grips, or gullies, is less useful than knowing the area affected by gripping or gullying, and the condition of those grips/gullies. (However, it is necessary to know the number of kilometres of both grips and gullies in order to calculate likely restoration costs)

10.2.7 Development of a clear and straightforward PES scheme, using Defra's Biodiversity Metric for example, requires that sites be clumped simply into three categories according to the quality of their biodiversity. For peatland carbon, however, more quantification of the different site types is possible and will probably be required by potential funders (because they will be interested in a fairly accurate estimate of how much carbon they are saving), so we therefore recommend five categories of peat condition in order to properly represent the range of carbon emissions and sequestration possible from peatlands of different conditions (see Technical Appendix)

10.2.8 Improvement in carbon sequestration and storage can occur at any scale, so the actual size of an individual moor is not relevant – the key thing is to work at the hydrological unit of each peatland, so that re-wetting can be effective. A frequent problem is that moorlands, as watersheds, are often administrative boundaries even when there are no fences along the watershed, and unfenced common lands are often situated on the moor tops between the settlements. In these cases, the whole moor may need to be managed as a single unit, and the case for a local partnership approach to peatland restoration becomes clear

10.2.9 Some sort of intermediary facilitation body could be useful - perhaps a South Pennines Trust Fund into which everybody pays on the basis of the benefits anticipated for each buyer, and a management group is mandated to make spending decisions on service enhancements which meet as many expectations as possible. This would look very like a bundled scheme, but with a layered shop front.

10.2.10 By running individual PES schemes focusing on the provision of single ecosystem services in parallel with one another (a "layered" PES scheme), it may be possible to

market those services more effectively to specific types of investor. By quantifying and marketing individual ecosystem service benefits in this way, it may be possible to capture more financial value than by bundling less clearly quantified co-benefits around a single core service for which there is particular demand (e.g. "premium" carbon schemes). However, careful co-ordination is necessary to ensure that the benefits each investor pays for are truly additional (to avoid double-counting). The transaction costs of establishing, managing and co-ordinating schemes that target many different ecosystem services are higher than for bundled schemes. These transaction costs may be largely hidden as they may be spread between many different intermediaries each managing schemes focused on different ecosystem services.

10.2.11 When designing layered schemes, it may be helpful to use the service with the strictest conditions of Additionality (e.g. carbon) as the foundation layer, and top up with services which, if the scheme is carefully designed can offer additional benefits (such as biodiversity).

10.2.12 It may prove attractive but difficult to layer water quality and carbon schemes, because of the difficulties in proving Additionality. It may instead be necessary to map out (on the ground) which parts of the restoration project are being done in order to improve water quality, and only use carbon funding for the areas which are being 'unnecessarily' or "additionality' restored. (For example, a water quality improvement project might want to re-vegetate the peatland with the cheapest practical vegetation, whereas a carbon scheme might be used to increase the funding and pay for re-vegetation with *Sphagnum* moss, the 'best' vegetation for carbon)

10.2.13 Whether ecosystem services are marketed in bundles or are marketed separately in a layered scheme, to be successful, place-based PES schemes must be able to identify management interventions that can simultaneously (in space and time) provide a range of ecosystem services, without leading to trade-offs that are problematic either financially (e.g. significantly reducing the productivity of valuable agricultural outputs) or ethically (e.g. compromising biodiversity). There is evidence in the South Pennines ESP area that peatland restoration can simultaneously provide a range of ecosystem service benefits (e.g. carbon, water quality and recreation, alongside benefits for certain species and habitats), whilst trade-offs for provisioning services (principally livestock grazing) and cultural ecosystem services (such as sporting interests, recreation and sense of place) are likely to be relatively minor on blanket bogs. Similarly, creating woodland in some upland valleys may provide habitat for wildlife, sequester carbon and improve opportunities for recreation, with few major trade-offs.

10.2.14 A number of factors relating to land ownership and tenure can complicate the initiation of a PES scheme. These include complex and/or fragmented land ownership and tenure, individual constraints; and incompatible land ownership/tenure objectives. Further work might address how to help land managers work together to deliver larger ecosystem restoration projects.

10.2.15 Further work is required to engage buyers and to understand their appetite for investing in improving ecosystem services; for example to establish the level of capital the buyer might invest; how the buyer wishes to claim the ecosystem services benefits; and buyers' concerns over other beneficiaries free-riding.

10.2.16 The lack of specific data on the costs associated with land management changes in the South Pennines ESP area makes it difficult to assess the viability of place-based PES schemes. The costs to run a PES programme would involve the development of methods and protocols, capital and operating costs, validation and verification costs, and legal costs. Comprehensive cost models will be required.

10.2.17 Market infrastructure will be required in developing and supporting the financing of place-based PES schemes - auction platforms, project database, registries (issuance system of record), marketplaces (Over the Counter (OTC), exchanges, etc.).

10.2.18 Any next steps in setting up a PES programme for the South Pennines would need to:

- agree methodologies and the use of metrics for specific ecosystem services, to estimate the environmental and financial returns, and include a cost model for project proponents. Project lifecycles need to be mapped for each stage of the process: project design documents, protocols and methodologies, pricing and discounting strategies.
- agree a Code of Practice, and ensure a focus on property rights and legal requirements.
- agree the type of Partnership approach required (whether a local nature partnership, a charity, or a project),
- agree a marketing strategy, develop value propositions (sales pitches) that are credible; estimate addressable and target market size, identify primary and secondary audiences (beneficiaries), identify relevant messaging to each audience to create 'buyers', assess competitive landscape, and
- adopt a sensible timescale for operation, perhaps capitalising on the goodwill and expertise of those involved in the PES pilot.