Paying for public goods from land management: How much will it cost and how might we pay?

Final Report

A report for the RSPB, the National Trust and The Wildlife Trusts

Matt Rayment

Rayment Consulting Services Ltd

40 Gifford Terrace Road

Plymouth, PL3 4JE

UK

Tel: +44 7827 946033

Email: matt.rayment@outlook.com

Date: 28 June 2019

Contents

Executive Summary

This report

An earlier (2017) study estimated the costs of meeting environmental land management priorities in the UK at between £2.2 billion and £2.3 billion per year. These estimates were made by building an MS Excel spreadsheet model, which defined the land management actions required to meet a range of defined environmental priorities (including for biodiversity/ ecosystems, soil, water, landscape and the historic environment), and estimated the costs of delivering these actions using appropriate unit cost estimates.

This report presents the results of a follow-up study in 2019 which built on and further developed the model to reflect recent changes in cost drivers and strengthened the analysis in key areas (notably advisory services, the costs of securing long term changes in land management, and the costs of maintaining land management on marginal high nature value farms). The study also examined the financial implications of moving from the current costs and income forgone approach to calculating land management payments, to consider alternative approaches such as payments based on natural capital values.

Updated cost estimates of meeting environmental land management priorities in the UK

The environmental land management costings model enables unit cost estimates of the costs and income forgone from environmental land management actions to be updated to take account of changes in cost drivers. The model was updated to include latest available data on output prices and input costs, including crop and livestock prices and yields, and the costs of labour, machinery, seeds, fertilisers and sprays. Increases in output prices and input costs since 2017 increase the previous estimates of the overall costs of meeting environmental land management priorities in the UK to £2,538 million annually.

Costs of advice to support environmental land management in the UK

The provision of advice plays a crucial role in supporting the effective delivery of environmental land management schemes. The costs of provision of advice have been estimated through a simple modelling approach, estimating the cost of each advisor and the number and area of land management businesses supported. The cost of advice is estimated to average £4.35 per hectare per year across the UK, but varies widely in different geographies and farming systems, particularly as a result of differences in average farm size. Applying the average cost per hectare to the area of land requiring environmental land management action gives a total estimate of £62 million per year of the cost of providing advice to support environmental land management action across the UK.

Costs of securing public goods in vulnerable high nature value farming systems

The 2017 cost estimates focused on the costs and income forgone of meeting defined land management actions. It was recognised that farming systems in some areas (particularly the uplands) are at risk of cessation or change in land use if direct payments are removed, and that the continued delivery of environmental public goods may involve extra costs in supporting the systems required to deliver them. These systemic costs were assessed by examining data on farm business income from the Farm Business Survey, and estimating the additional support required to support vulnerable farming systems delivering environmental public goods. It was estimated that additional support could be required over 1.7 million hectares of land at a cost of £247 million per year across the UK. These costs would be reduced if farms enhanced business management practices, especially through lower stocking and reducing input costs. Provision of farm business advice could help to achieve this, at an estimated cost of £5.4 million annually across the UK. Financial performance is also linked to farm size, with higher performing farms tending to be much larger than the lowest performing. Amalgamation of unprofitable farming enterprises could also therefore enhance profitability and reduce the costs of delivering environmental priorities.

Costs of securing long term environmental benefits

Some environmental land management priorities require long term changes in land use and management, such as through the creation and restoration of habitats and the planting of hedgerows. Typical five-year agri-environment agreements present potential problems in this respect, providing

limited certainty to taxpayers about the security of public benefits in the longer term, particularly since investments in creating or restoring habitats may take many years to deliver their potential benefits. Securing long term benefits could be achieved by very long term (e.g. 100 year) contracts, incentives for long term management, results-based payments, and/or legal mechanisms such as covenants. These measures are likely to require increased incentives to obtain long term commitments from land managers. The costs of these measures depend on the mechanism and level of incentive employed. A simple illustrative modelling exercise suggested that the net present value of costs over 100 years of expanding and restoring priority habitats and planting hedgerows could increase by up to 42% to secure these long-term commitments.

Overall implications for the costs of meeting environmental land management priorities

The combined effect of the additional cost elements is to increase the overall estimated annual cost of meeting environmental land management priorities in the UK to £2.9 billion per annum over the next 10 years (Table ES1).

Table ES1: Estimated overall costs of meeting environmental land management priorities in the UK (£m per annum over 10 years)

Land management costs	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	518	42	381	120	1,061
Boundary features	261	50	77	49	437
Historic environment	50	4	39	8	102
Arable land	486	18	47	5	556
Grassland	187	54	75	40	356
Organic	17	0	3	5	26
Total land management	***1,520***	***168***	***622***	***227***	***2,538***
Additional elements					
Environmental land management advice	34	3	21	4	62
Securing vulnerable high nature value farming	112	15	80	40	247
Business advice to vulnerable HNV farms	3	0	1	1	5
Securing long term changes in land use	6	1	4	1	12
Sub-total: Additional cost elements	***154***	***19***	***107***	***46***	***326***
Total	**1,674**	**188**	**729**	**273**	**2,864**
Proportion of total	60%	7%	25%	9%	100%

This figure represents an updated overall estimate of the costs of meeting environmental land management priorities in the UK, as defined in the 2017 report. The largest increases arise from the inclusion of estimates of the costs of maintaining vulnerable high nature farming systems, which were not included in the previous estimates.

As before, some care is needed in interpreting the figures presented. The exercise has highlighted that there is no single correct answer to the question, and that the cost estimates are sensitive to the assumptions and inputs used in the model. One major variable relates to the overall level of ambition applied in estimating land management needs, and the model was therefore designed to allow the policy choices and assumptions regarding the scale of need to be varied. While the work involved a detailed and wide-ranging assessment, and extensive consultations with experts and stakeholders, the previous report noted that the model would benefit from further development and refinement in several areas. These include the specification of needs for water quality, soil management and the historic environment.

As well as providing a broad assessment of the financial needs for achieving environmental land management priorities in the UK, the model can be used to make alternative estimates of financial

needs, based on different inputs, assumptions, and policy and economic scenarios. It is hoped that the assessment and the model can be further refined and developed, based on peer review, expert input and further targeted research, and that the model will be helpful in informing further discussion regarding financial needs for environmental land management after Brexit.

Potential alternative ELM payment methodologies

The UK's departure from the EU provides a major new opportunity to change the system of land management payments in each of the four countries, focusing payments on the delivery of public goods and potentially changing the way that these payments are calculated. The administrations in England and Wales have both signalled an intention to change the current methodology for calculating environmental land management payments, which offers payments for prescribed activities based on estimates of costs incurred and income forgone. The current system is criticised as being inflexible and bureaucratic, and doing too little to incentivise delivery of environmental outcomes.

An ELM payments methodology has many dimensions, but two important distinguishing features between the main options are the question of what is paid for (activities or outcomes) and how the payment is calculated (through estimates of costs and income forgone, the value of benefits, or individually determined payment rates, which may be set by negotiation or bidding processes such as reverse auctions).

Basing payments on land management activities is a well-understood approach that can work well where defined actions are known to be effective and there is a clear pathway between actions and results. It may be less effective where there is a need for locally targeted actions based on local conditions and knowledge. A major limitation is that this approach requires land managers only to follow the prescribed activities and does not incentivise them to deliver higher levels of environmental outcomes. Advice which engages and raises awareness land managers can play a role in helping to achieve this.

Outcome-based payments offer greater incentives for land managers to increase environmental outcomes over time, provided that suitable outcome indicators and related control and verification systems can be devised and effectively implemented. They may require greater investments in advice, particularly in the short term, to be effective.

Calculating payments based on costs and income forgone helps to limit payment rates and control the costs of schemes but may offer limited profit to the average land manager and – as applied at present - may be insufficient to achieve high rates of uptake. Nevertheless, there is potential to apply the approach in a flexible way, varying assumptions about costs and baseline practices, and to enhance uptake by varying the calculations to reflect the cost structures and practices of target farms. Variations on the costs and income forgone approach can be considered, offering geographical or performance related supplements or rewarding commitments to deliver long-term changes in practice.

Costs and income forgone may be used as the basis for calculating outcome-based payments, by making assumptions about the activities required to deliver the target outcomes, setting payment rates accordingly, and then giving land managers the flexibility to vary practices as they wish. This approach has been applied in the English results-based payment pilots – early results appear to be promising, though scalability may present a significant challenge.

Calculating payments based on estimates of the value of environmental benefits has the potential to incentivise actions that deliver the greatest benefits. However, major gaps in valuation evidence mean that it is not feasible to apply this approach to all ecosystems and their services, as illustrated in two case studies, which examine restoration and management of blanket bog, and management of arable land for biodiversity and pollinators. For reasons of value for money, where valuation evidence is available, it is likely to inform methods of calculating payment rates rather than be used to calculate them directly. If a values-based approach is applied, it is likely to rely on a combination of monetary and non-monetary evidence of ELM benefits to guide setting of payment rates.

Combinations of these approaches can also be considered. For example, ELM payments might supplement payments for activities with bonuses to reward the delivery of environmental outcomes. Payments could be based initially on estimates of costs and income forgone but varied to reflect differences in the value of benefits achieved by location and/or performance.

1 Introduction

1.1 Background and objectives

In 2017 the RSPB, the National Trust and The Wildlife Trusts commissioned Matt Rayment to provide an assessment of the costs of meeting environmental land management priorities in the UK. The work involved building an MS Excel spreadsheet model, which estimated the land management actions required to meet a range of defined environmental priorities (including for biodiversity/ ecosystems, soil, water, landscape and the historic environment), and estimating the costs of delivering these actions using appropriate unit cost estimates. Two cost estimates were made – the first (termed "current costs") applied current agri-environment and woodland grant payment rates in the four countries, while the second (termed "adjusted costs") re-estimated these costs based on drivers of costs and income forgone (farm output prices and input costs). The overall cost of meeting UK environmental land management priorities was estimated at £2.2bn (based on "current costs") to £2.3bn (based on "adjusted costs") (Rayment, 2017).

A follow-up study in 2019 involved further research and modelling work designed to help to improve our understanding about how and how much land managers should be paid by the Government to meet environmental land management priorities across the UK. The work built on and further developed the model developed in 2017 to assess the financial costs of land management in the UK after Brexit, as well as strengthening the analysis in key areas (notably advisory services, the costs of securing long term changes in land management, and the costs of maintaining land management on marginal high nature value farms). The analysis aimed to provide a fuller assessment of the costs of meeting environmental land management priorities, addressing limitations in the current system (such as under-provision of advice and insufficient incentives for long term changes in land management), as well as the need to address future challenges for the provision of environmental public goods after the removal of Pillar 1 subsidies. The study also examined the financial implications of moving from the current costs and income forgone approach to calculating land management payments, to test alternative approaches such as payments based on natural capital values.

The different elements of the work were developed through a series of working papers, the findings of which are compiled in this final report.

1.2 This Report

This Final Report presents the findings of the study. It is structured as follows:

- Section 2 presents updated cost estimates of meeting environmental land management priorities in the UK, developed by updating the costings model to take account of changes in cost drivers since 2017;
- Section 3 presents estimates of the costs of providing advice to support the delivery of environmental land management priorities across the UK;
- Section 4 presents estimates of the additional costs of securing public goods in high nature value farming systems, which may be at risk of cessation of farming activity or changes in land use after Brexit;
- Section 5 presents estimates of the additional costs of securing long term changes in land use and land management, recognising that investment in creation and restoration of habitats and landscape features would benefit from long term incentive structures;
- Section 6 summarises the overall implications of the analyses in Sections 2-5 for the costs of meeting environmental land management in the UK, based on the updated estimates of costs and income forgone presented in the model; and
- Section 7 considers the potential role of alternative payment mechanisms for environmental land management in the UK, looking beyond the current approach (which pays for land management activities, calculating payments based on costs and income forgone). It examines the potential case for paying for environmental outcomes rather

than land management activities, and for varying the method used for calculating payments (for example, to reflect the value of benefits rather than costs and income forgone).

Each section provides a brief introduction to the issue, sets out the methodology used in the analysis, and presents the findings and conclusions.

Annex 1 and Annex 2 present further details of the costs and benefits of environmental land management with respect to maintenance and restoration of blanket bog, and management of arable land for pollinators and farmland birds, the two case studies presented in Section 7.

2 Updated cost estimates of meeting environmental land management priorities in the UK

2.1 Introduction and method

The 2017 estimates of environmental land management costs were based on estimates of the unit costs of land management actions from that year. The model was designed to enable the unit costs applied to be updated to reflect future changes in farm output prices and input costs. Further details are provided in the 2017 report and in the model itself.

In the current study, the model has been updated to reflect latest available data on output prices and input costs, including crop and livestock prices and yields, and the costs of labour, machinery, seeds, fertilisers and sprays. The data were taken from the latest (2019) edition of the John Nix Farm Management Pocketbook (Redman, 2018).

Based on these input and output data, the model calculates updated estimates of the "adjusted" unit costs of land management actions and combines these with the (unchanged) estimates of the extent of different land management practices required, to estimate the overall costs of land management requirements.

2.2 Updated Unit Cost Estimates

The prices of most agricultural crops and livestock have increased since 2017. Most input costs have also increased (Table 2.1).

Table 2.1: Changes in selected output prices and output costs, 2017-2019

Outputs	Nix (2019)	Nix (2017)	% change
Feed winter wheat (£/te)	150	130	+15%
Winter oilseed rape (£/te)	335	300	+12%
Spring suckler calf (£/kg, live weight)	1.95	1.80	+8%
Dairy finishing (£/kg, live weight)	1.80	1.77	+2%
Upland spring lamb (£/kg, live weight)	2.00	1.75	+14%
Labour costs (£/hr)	12.80	10.13	+26%
Tractor costs (185 hp, £/hr)	32.34	30.49	+6%
Fertiliser costs (N, £/kg)	0.652	0.49	+33%

As a result, the costs incurred and income forgone from undertaking most environmental land management practices has increased since 2017. This is reflected in general increases in the "adjusted" unit costs of a range of land management practices in the costings model. This in turn is reflected in increases in the "adjusted" costs of addressing environmental land management priorities in the UK.

There are estimated increases in the "adjusted" costs of all management options for arable farmland, boundary and historic environment features, and restoration and creation of priority habitats. For the management of priority habitats and grassland, the costs have increased for some habitats and grassland management options and decreased for others. This reflects the increases recorded in both livestock prices and input costs. As a result, gross margins have declined for some livestock and increased for others (with mixed effects on income forgone), while costs of labour and other inputs have increased.

2.3 Updated Overall Cost Estimates

The overall result is to increase the UK "adjusted" cost estimate from £2,307 million to £2,538 million. This compares to the (slightly updated) estimate of "current" costs, based on current agri-environment and woodland grant payment rates (most of which were set several years ago) of £2,155 million.

Table 2.2: Summary of overall annual costs of meeting environmental land management priorities, based on "adjusted" costs (£m)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	518	42	381	120	**1,061**
Boundary features	261	50	77	49	**437**
Historic environment	50	4	39	8	**102**
Arable land	486	18	47	5	**556**
Grassland	187	54	75	40	**356**
Organic	17	0	3	5	**26**
Total	**1,520**	**168**	**622**	**227**	**2,538**

As might be expected, the "adjusted" estimates of environmental land management costs diverge from the "current" cost estimates over time, as the prices of farm outputs and inputs diverge from the base levels which were used to estimate costs and income forgone when the payment rates were set.

Table 2.3: Summary of overall annual costs of meeting environmental land management priorities, based on "current" costs (£m)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	471	32	252	120	**876**
Boundary features	255	46	65	35	**402**
Historic environment	41	3	40	7	**92**
Arable land	403	14	40	5	**461**
Grassland	164	47	56	32	**298**
Organic	17	0.5	3	5	**26**
Total	**1,352**	**143**	**456**	**205**	**2,155**

3 Costs of advice to support environmental land management in the UK

3.1 Importance of Environmental Land Management Advice

The 2017 estimates of the costs of meeting environmental land management priorities focused on the costs of land management actions. The report recognised that the effectiveness of land management actions is enhanced where they are backed by provision of good quality advice to land managers, and that an increase in the provision of advice is needed for environmental land management priorities to be met. However, the costs of providing advice were not included in the analysis.

The importance of advice in enhancing the effectiveness of environmental land management schemes, and the delivery of environmental outcomes, is recognised by several studies and evaluations (Box 3.1).

Box 1: Role of advice in enhancing outcomes of environmental schemes

Various studies and evaluations have found that provision of good quality and targeted advice helps to enhance the outcomes of environmental land management schemes. For example:

- Boatman et al (2014) found that the provision of advice was valued by participants in the Higher Level Stewardship (HLS) scheme and made a strong contribution to delivery of environmental outcomes.
- Jones et al (2015) found that two-thirds of the Environmental Stewardship agreement holders surveyed said that the advice and support received had made them more aware of management requirements. The authors concluded that the overall impact of the advice and support is strong, that agreement holders receive considerable benefit from it, and as a result are more aware of what the intended outcomes of the agreement should be.
- Natural England (2014), in evaluating the delivery of catchment sensitive farming, found that successful delivery of environmental outcomes was underpinned by effective farmer engagement and delivery of advice, achieved through a combination of: direct delivery by project staff; work commissioned through contractors; and partnerships with industry bodies and other organisations.
- Boatman et al (2013) found that the best outcomes from environmental land management schemes result from well-targeted action, and that the provision of high quality on-farm advice is essential to achieve this. They gave numerous examples of instances in which enhanced provision of advice would increase the uptake and effectiveness of agri-environment options.
- Boatman et al (2008) found that the provision of targeted advice would enhance the effectiveness of the Entry Level Stewardship scheme for biodiversity (including arable plants and the brown hairstreak butterfly) and water quality.
- Lobley et al (2013) found that educational and advisory programmes can play a positive role in increasing farmer engagement in AES and changing attitudes to environmental management. Bespoke group training events were found to help to fill knowledge gaps, equip farmers with a range of management skills, improve confidence and engender a more professionalised approach to agri-environmental management. The majority of participants indicated that this had positively influenced environmental management on their farm.

The most recent available data for England indicate that expenditure on guidance and advice to support the delivery of the agri-environment programme amounted to £2.6 million in 2008/09, less than 1% of the value of agreements, which amounted to more than £400 million annually. Since then, resources have been further constrained by reductions in public

expenditure, with reports that farmers are often unable to access the advice they need to support agri-environment delivery[1].

This led the report of the Environmental Audit Committee Inquiry into the Future of the Natural Environment after the EU Referendum[2] to state that "it is widely recognised that the potential benefits of agri-environment schemes have been reduced by minimal training of farmers and advice on scheme implementation".

Scotland's Farm Advisory Service is part of the Scottish Rural Development Programme (SRDP) which is co-funded by the EU and Scottish Government[3]. It has a budget of £20 million over the five years to December 2020, suggesting annual average expenditure of £4 million. This covers a wide range of topics including cross compliance, veterinary medicines, business advice as well as environmental advice. There is a special focus on outreach to farmers and crofters in remote areas, such as islands. Much of the advice is provided on a one to many basis. One to one advice is provided through the production of farm plans, including business and environmental plans. Agri-Environment and Climate Plans are estimated to cost an average of £2-3,000 per farm, with a maximum of £800 per plan paid by the government. There is no facilitation fund in Scotland, though some advisory funding is provided from a variety of sources including the Knowledge Transfer and Innovation Fund, Peatland Action Fund, Working for Waders project, and Scottish Forestry.

No previous estimates could be found of the scale of provision of advice needed to meet environmental land management priorities in the UK.

3.2 Assessing the Unit Costs of Environmental Land Management Advice

The costs of providing advice to support delivery of environmental land management priorities across the UK has been estimated by developing a simple advisory module within the environmental land management costings model.

The model assumes that advice is provided to groups of farmers at a local level, working at a landscape scale to address common environmental land management priorities. It is assumed that advice is delivered through a combination of group workshops and one to one advice. Group workshops allow basic advice and information to be provided cost effectively to groups of land managers, encouraging them to work together and share knowledge and experience. This is supplemented by one to one advice targeted to the needs and priorities of individual land managers. This is similar to the Farmer Clusters approach[4] championed by the Game and Wildlife Conservation Trust (GWCT), and other group approaches working with land managers at landscape scale, as supported by Natural England through the Countryside Stewardship Facilitation Fund. By October 2017, this had funded sixty-one groups with more than 1400 farmer/land manager members working to improve the natural environment at a landscape scale[5].

One of the features of this group approach to environmental land management advice is that it enables funding to be pooled from a variety of sources. In England, as well as public support through the Countryside Stewardship Facilitation Fund, provided on a competitive basis, groups of land managers have benefited from grants from charitable trusts and other organisations, and contributions from participating farmers. For example, participants in the Martin Down Farmer Cluster have contributed £1 per hectare per year, raising £7,000 per annum towards the employment of a full-time adviser.

The basic approach to modelling advisory costs involves:

[1] https://www.theguardian.com/environment/2019/jan/29/agency-protecting-english-environment-reaches-crisis-point

[2] https://publications.parliament.uk/pa/cm201617/cmselect/cmenvaud/599/59907.htm

[3] https://www.ruralpayments.org/publicsite/futures/topics/all-schemes/advisory-service/

[4] https://www.farmerclusters.com/

[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/656911/csff-case-studies.pdf

- Estimating the cost of employing a full-time advisor, taking account of salary, other staffing costs and overheads;
- Estimating the number and area of farms supported by each advisor, taking account of the capacity and workload of the advisor and the support needs of each group (assumed to be met through a combination of group workshops and one-to-one advice); and
- Estimating the cost of advice per hectare per year, by dividing the annual costs of each advisor by the number of hectares covered.

The modelling approach makes clear that the cost of advice is sensitive to a number of variables. As well as salary and overhead costs, these include:

- The intensity of advisory provision, and volume of advice provided to each group of land managers;
- The utilisation rate of the advisor – i.e. the number of days per year spent actively providing advice (rather than undertaking administration, recruitment, information gathering, training and other activities). This is also affected by the application window for agri-environment schemes, which concentrates activity at certain times of the year; and
- The local context and structure of the farming system. The per hectare unit costs of advisory support are reduced in areas where the average farm size is large, as costs are divided over a larger number of hectares.

The modelling work was informed by interviews with farm advice specialists in RSPB, Natural England, the National Trust, The Wildlife Trusts, the Yorkshire Dales National Park Authority and FWAG, to gather data for different advisory models in different contexts.

Estimated average per hectare advisory costs are given in Table 3.1.

The current estimate of advisory costs is £4.35 per hectare per year, based on the average UK farm size of 81 hectares in 2017 (Defra, 2018).

Table 3.1: Estimated unit costs of environmental land management advice – average across UK

Advisor costs		
Advisor salary	£30,000	per annum
x cost multiplier	1.5	to account for other staff costs and overheads
= cost of advisor (full cost recovery)	**£45,000**	per annum
Number of working days per year	225	
% of time spent providing practical advice	50%	excluding time spent on admin, recruitment etc and taking account of application window
Number of days advisory work per year	112.5	
Cost of advice per day	**£400**	
Farmer group		
Number of farms in group	20	
Average size per farm	81	UK average farm size
Average number of hectares per group	**1,620**	
Advice provided per group per 5-year agreement period		
Number of group workshops	4	
Number of days 1:1 advice per farm	4	
Time per workshop (prep + delivery)	2	Days
Advisory time per group over 5-year agreement		
Workshops	8	Days
1:1 advice	80	Days
Total	**88**	**Days**
Number of groups per full time advisor	6.4	
Overall costs of advice		
Total cost of advice provided per group	£35,200	days x day rate
Annual cost of advice provided per group	£7,020	average per annum for 5 years
Annual cost of advice provided	**£4.35**	**per hectare per year**

This average varies widely between different farming systems in different parts of the country. For example, using the same model, the RSPB estimates average per hectare costs for delivery of advice to arable farmers in the Fens, where average farm size is more than 200 hectares, at less than £2/ha/year.

Table 3.2 illustrates how per hectare costs of this model are likely to vary for different farming systems with different farm structures across the UK. The figures assume the same advisory inputs per farm and per group and illustrate the economies of scale of providing advice to larger farms. The assumption that the same advisory inputs per farm are required irrespective of farm size is perhaps not unrealistic, given the fixed cost element in providing advice, and the fact that many large farms are often more specialised while small farms are often more diverse (and biodiverse). Wide variations in farm size can have a dramatic influence on unit costs, which are estimated to range from less than £1 per hectare per year for LFA cattle and sheep farms in Scotland to £35 per hectare per year for crofting on the Uists.

Table 3.2: Illustrative estimates of per hectare advisory costs for different farm types and regions, due to scale effects

Farm type and region	Average farm size (ha)	Cost per hectare per year (£)
Crofting, Uists	10	35.20
Average farm, Northern Ireland	41	8.59
Average farm, Wales	48	7.33
Upland livestock farm, Pennines	65	5.42
Mixed farm, South Devon	70	5.03
Average UK Farm	**81**	**4.35**
Arable farm, Fens and Hampshire	200	1.76
LFA Cattle and Sheep, Scotland	528	0.67

The figures in Table 3.2 are likely to oversimplify the costs of providing advice to different types of farms, since they focus on variations in farm size only and do not take account of other factors such as the costs of working with farms in remote rural areas. This may increase costs in some areas such as the Scottish uplands.

3.3 Assessing the Overall Costs of Environmental Land Management Advice

The overall costs of providing advice to support the delivery of environmental land management action at UK level can be estimated by multiplying the per hectare unit costs by the estimated number of hectares over which advice is provided.

If it is assumed that all the environmental land management activity identified in the national costings model is supported by advice, the area of land in the UK requiring advisory support amounts to 14.2 million hectares (Table 3.3).

Table 3.3: Estimated Area of Land Requiring Advisory Support (hectares) and Costs (£m)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	1,832,693	227,020	3,154,527	463,233	**5,677,473**
Historic environment	289,747	39,235	349,968	82,102	**761,053**
Arable land	4,144,767	102,585	468,306	63,309	**4,778,967**
Grassland	1,195,682	384,314	675,257	208,496	**2,463,749**
Organic	296,517	8,298	121,620	81,482	**507,916**
Total area (ha)	**7,759,405**	**761,452**	**4,769,679**	**898,621**	**14,189,158**
Total cost (£m/year)	***34***	***3***	***21***	***4***	***62***

Based on the estimate of advisory costs of £4.35 per hectare per year, this gives an estimated total cost of £62 million annually across the UK.

This is an estimate of the overall costs of the advice needed to support environmental land management activity. It should be noted that this cost could be met through a variety of sources, including public funds and contributions from land managers, or a combination of these.

3.4 Changes in Payment Methods – Implications for Advisory Costs

The above cost estimates are based on assessment of the advice needed to support the current system of environmental land management schemes in the UK, in which land managers are paid to implement prescribed activities and are required to follow specified rules.

While advice has been shown to be important in the current agri-environment payment system, its importance could increase further if alternative payment methodologies for environmental land management – such as results-based payments - were to be adopted in the UK. Under a results-based system, the basis for payments would switch from prescribed activities to environmental outcomes, giving land managers much more flexibility in the practices they apply in pursuit of the targeted results (see Section 7). It is likely that advisory needs and costs will increase under such a system, at least in the early years.

EU experience and guidance on results-based payments for biodiversity provide some insights into the role of advice (Box 3.2).

Provision of on-farm advice and training are seen to have played an essential role in the results-based agri-environment payment pilot in England (LePage, 2018).

Box 3. 2: Role of Advice in Supporting Results-based Payments for Biodiversity

A European Guidance Handbook on results-based payment schemes for biodiversity (Keenleyside et al, 2014) identified provision of high levels of facilitation, advice and support to farmers as one of the key success factors, especially where they need to alter normal farming practices to achieve biodiversity results. This requires a wider range of skills and much better understanding of biodiversity than is necessary for management-based schemes, but is critical for building the necessary trust, knowledge and understanding between the farmer and the scheme organisers.

The Handbook states that advice and training for results-based schemes should focus on:

- Explaining the rationale of the scheme;
- Explaining the biodiversity objectives and the reason for using result indicators;
- Identifying the result indicator species on the farm;
- Advice on types of management that will help to achieve the intended results;
- The importance of timing of particular actions for optimum impacts for biodiversity;
- Best practices for different types of activities; and
- Methodology and protocols for measuring indicators on the farm.

Some species may be very sensitive to even small changes in environmental conditions and management practices (such as stock type, timing of grazing and cutting etc), which need to be understood and communicated to land managers. Regular feedback on the yearly results of the scheme is helpful in building knowledge, skills and engagement.

The following examples were given:

- In the Niedersachsen pilot meadow scheme, farmers were trained by experienced botanists, enabling them to recognise indicator species reliably;
- In the Burren Farm Conservation Programme (BFCP), the adviser works closely with the farmer and advises on priority tasks, where, how and when they should be done. The adviser also inspects grasslands and awards condition scores, which form the basis for the results-based payment.

As well as face-to-face advice, results-based schemes often produce guidance documents for participants, examples of which are given in a Supplement to the Guidance Handbook.

On its website, the CLA argues[6] that the pilots in England have revealed that a shortage of expertise and advice represent constraints to results based payment schemes:

The study is already highlighting some interesting issues; in particular, the quality of available seed and the lack of agronomical expertise related to environmental delivery. When you are being paid to deliver, as with agricultural production, you need access to high quality inputs and advisers; it's questionable whether these currently exist. Natural England are also considering technical issues like how many different payment rates do you need and what advice and support do farmers need to meet the higher end of environmental delivery.

The modelling work could potentially include estimates of the advisory costs of moving to alternative, results-based payment systems. However, more information would be needed on the implications for advisory work and costs, drawing on examples such as the pilot schemes in England.

[6] https://www.cla.org.uk/advice/payment-results-piloting-revolution-agri-environment-schemes#

4 Costs of securing public goods in vulnerable high nature value farming systems

4.1 The Issue

The 2017 assessment estimated the costs of a package of specified actions designed to address environmental land management priorities across the UK. The assessment focused on the costs and income forgone associated with undertaking these actions, on the assumption that the farming systems required to implement the specified practices would continue to be in place. The report recognised that this approach potentially underestimated the full costs in areas where farming systems are vulnerable to abandonment or changes in land use, noting that some current land uses, particularly in upland areas, would potentially cease to be viable if current CAP Pillar 1 subsidies and Less Favoured Areas payments were removed. If the overall land management system ceases to be economically viable, payments for specific agri-environment practices may not be sufficient to meet environmental priorities. The model made simple provision for the inclusion of an area-based cost of securing basic land management, as required, but did not examine such costs in detail.

The risk of cessation of land management or changes in land use is perhaps greatest for high nature value (HNV) farming systems, which are often characterised by smaller-scale holdings on more marginal land, often in remote areas, using the least intensive practices, and rich in environmental and cultural value (RSPB et al, 2011).

This issue has been recognised in previous studies. For example, a report for the Land Use Policy Group (Barnes et al, 2011) investigated alternative payment approaches for non-economic farming systems delivering environmental public goods in England and Scotland (Box 4.1). The report used broad indicators such as presence of rough grazing and stocking densities to estimate support needs, rather than attempting to estimate areas of HNV farming or land that was delivering particular public goods.

Box 4.1: Study of alternative payment approaches for noneconomic farming systems delivering environmental public goods

Barnes et al (2011) examined a range of options for alternative payment approaches for non-economic farming systems, one of which was based on full cost of management. This approach estimated the full (variable + fixed costs + normal profit) of management of specific uneconomic parcels of land within farms (rather than whole farms), allocating fixed costs as a proportion of the total area of the holding. The estimates focused on the proportion of rough grazing land supported (from 25% to 100%). This was found to substantially increase the support provided to non-economic farms, helping to maintain the management of land that would otherwise be abandoned or converted to non-agricultural use.

The report also examined alternative approaches including a holding wide payment for areas with natural constraints (based on stocking densities) and a payment for opportunity costs (based on differentials between returns to farm labour and comparative non-agricultural wage rates).

Using these three methods, the report estimated support needs at £35-101/ha for LFA cattle and sheep farms and £27-88/ha for specialist SDA sheep farms in Scotland, and £163-895 for LFA cattle and sheep farms and £1-297 for lowland cattle and sheep farms in England.

This section examines the likelihood of cessation or changes in land management in HNV farming systems in the UK, and how this can be incorporated into the costings model.

4.2 Farm Incomes and CAP Subsidies

The vulnerability of farming systems to the removal of CAP Pillar 1 subsidies in the UK can be examined by analysing Farm Business Survey data. Table 4.1 presents FBS data for different farm types in England in 2016/17 and 2017/18.

Table 4.1: Farm Business Income compared to income from Basic Payment Scheme, England

Farm Type	Year	Average per farm (£)		
		Farm Business Income	BPS Receipts	FBI net of BPS
Cereals	2016/17	43,100	39,100	4,000
	2017/18	64,200	44,000	20,200
General Cropping	2016/17	70,100	45,500	24,600
	2017/18	93,300	52,500	40,800
Dairy	2016/17	15,000	27,300	-12,300
	2017/18	79,500	31,000	48,500
Lowland Livestock	**2016/17**	**16,100**	**17,200**	**-1,100**
	2017/18	**21,900**	**18,300**	**3,600**
LFA Livestock	**2016/17**	**27,000**	**26,500**	**500**
	2017/18	**21,900**	**29,900**	**-8,000**
Specialist Pigs	2016/17	57,800	11,400	46,400
	2017/18	31,300	9,400	21,900
Specialist Poultry	2016/17	54,200	8,300	45,900
	2017/18	96,000	9,200	86,800
Mixed Farms	**2016/17**	**28,800**	**30,700**	**-1,900**
	2017/18	**41,800**	**37,000**	**4,800**
Horticulture	2016/17	43,800	4,600	39,200
	2017/18	47,700	4,900	42,800
All farms	2016/17	38,000	28,000	10,000
	2017/18	56,500	31,700	24,800

The figures focus on Farm Business Income, the most widely used measure of farm incomes, which represents the financial return to all unpaid labour on the capital invested in the farm business, including land and buildings. It is equivalent to net profit and is designed

to compare performance across different types of farming[7]. The table compares FBI with receipts from the Basic Payment Scheme (BPS) in England.

It should be noted that the figures are averages for each farm type, whereas there is a wide variation in profitability across different farm sizes and between low- and high-performing farms.

It should also be noted that a simple static comparison of farm incomes with BPS payments does not necessarily indicate the actual effect on farm incomes if BPS payments were removed, because it does not take account of possible changes in farm business practices to adapt to such a change, or potential changes in the prices of inputs and outputs. For example, Defra (2018a, 2018b), in its analysis to support the Agriculture Bill, estimated that removal of direct payments (which are capitalised in the rents paid by tenanted farms) will result in a reduction in farm rents averaging £23,700 per farm. Furthermore, there is evidence that direct payments, though in theory decoupled, have an effect in stimulating production and raising input costs, such that removing them would enhance efficiency. Defra suggests that farms will be able to make a variety of changes to enhance farm incomes and adjust to the removal of direct payments, including improving efficiency to reduce input costs, optimising investment decisions, diversifying and joining environmental schemes, improving farm business management and enhancing the value of outputs through improved animal and plant health and better marketing.

The figures indicate that most farm types in England would have been profitable in 2016/17 and 2017/18, even if direct payments were removed. However, the profitability of **LFA livestock**, **lowland livestock** and **mixed farms** appears to be sensitive to removal of direct payments, with farm business incomes turning negative or close to zero in each case.

Table 4.2 gives similar figures for Scotland, Wales and Northern Ireland for 2016/17. As well as the Basic Payment Scheme, the figures include other farm subsidies including coupled livestock subsidies in Scotland and Less Favoured Areas/ Area of Natural Constraint payments in Northern Ireland and Scotland. The figures show that without these support payments farm incomes would be negative or close to zero for LFA livestock, lowland livestock and mixed farms in all three countries. The same would also apply to cereals and dairy farms in Scotland and Northern Ireland that year.

Table 4.2: Farm Business Income compared to income from farm subsidies, UK countries, 2016/17

Country and Farm Type	Average per farm (£)		
	Farm Business Income	Total subsidy payments (including LFA/ANC)	FBI net of farm subsidies and LFA payments
Scotland			
Specialist sheep (LFA)	14,048	27,292	-13,245
Specialist beef (LFA)	25,565	37,035	-11,470
Cattle and sheep (LFA)	35,284	40,368	-5,084
Cereals	20,589	31,073	-10,484

[7] It should be noted that FBI is a measure of profitability, which does not necessarily reflect the cash position of the business and its ability to survive in the short term. Businesses with positive FBI may have negative cash flows if investing in fixed assets, while others with zero or negative FBI may be able to survive by depreciating or liquidating their assets.

General cropping	47,080	35,165	11,915
Dairy	34,696	34,174	522
Lowland cattle and sheep	18,253	31,669	-13,416
Mixed Farms	24,168	37,664	-13,496
All types	26,402	34,338	-7,936
Northern Ireland			
Cereals	16,492	25,527	-9,035
General Cropping	27,616	16,889	10,727
Pigs	58,673	14,123	44,550
Dairy	23,618	22,572	1,046
Cattle and Sheep (LFA)	21,352	29,679	-8,327
Cattle and Sheep (Lowland)	16,578	23,324	-6,746
Mixed	27,637	22,910	4,727
All types	21,928	25,814	-3,886
Wales			
Dairy	31,300	19,700	11,600
Cattle and sheep LFA	23,100	24,900	-1,800
Cattle and sheep Lowland	22,700	17,100	5,600
All types	24,500	23,100	1,400

The figures demonstrate that the removal of direct payments may impact negatively on the future viability of upland livestock, lowland livestock and mixed farms across the UK, and potentially to cereals and dairy farms in Scotland and Northern Ireland. This potentially becomes an environmental issue in instances where the delivery of environmental public goods is dependent on the ongoing viability of these systems in certain places or habitat types. Agri-environment schemes with payments based on costs incurred and income forgone may be insufficient to maintain the viability of farms where this is necessary to secure public goods, because they are designed to pay for the costs of undertaking prescribed activities, rather than to support farm incomes. In these cases, the full costs of delivering environmental goods include a share of the costs of maintaining the farming systems which deliver these goods.

4.3 The Effect of Farm Business Performance on Profitability

Farm Business Survey data

It is helpful to consider how farm business incomes vary according to the relative performance of different farms, to examine the potential for improvements in performance to enhance profitability, without the need for public support.

Table 4.3 compares data on Farm Business Income and Basic Payment Scheme receipts for lowland and LFA grazing livestock and mixed farms in England. The data are taken from the Farm Business Survey.

The figures indicate that there is a large difference in incomes between the top performing quartile and lowest performing quartile of farms for all three farm types. Average farm business incomes for the highest quartile of farms by performance exceeded BPS receipts by £29,500 for lowland livestock farms, £18,400 for LFA grazing livestock farms and £62,400 for mixed farms in England in 2017/18. This suggests that, if all farms were able to raise their profitability to equal that of the top performing quartile, farms of each type could achieve positive farm business incomes even if Basic Payments were removed.

However, the figures also demonstrate that farm size appears to be a major contributor to relative performance. The top quartile of performers has an average farm area 4.5 times larger than the lowest quartile for LFA livestock farms, 2.3 times larger for lowland livestock farms and 2.1 times larger than mixed farms. This suggests that lower performing farms may need to amalgamate to reap economies of scale and raise their performance to that of the top performing quartile.

Table 4.3: Farm Business Income and Basic Payments for different farm performance bands, England, 2017/18

	Lowest 25%	Middle 25%	Top 25%	All
Grazing livestock (lowland) farms				
Average farm area (ha)	57	94	133	95
Farm Business Income (FBI)	- 2,600	17,200	55,400	21,900
BPS receipts	10,700	18,200	25,900	18,300
FBI – BPS	-13,300	-1,000	29,500	3,600
Grazing livestock (LFA) farms				
Average farm area (ha)	79	134	356	177
Farm Business Income (FBI)	-6,400	21,400	75,300	28,300
BPS receipts	12,900	24,500	56,900	29,900
FBI – BPS	-19,300	- 3,100	18,400	-1,600
Mixed farms				
Average farm area (ha)	119	175	250	180
Farm Business Income (FBI)	-17,300	32,900	115,400	41,800
BPS receipts	23,900	35,200	53,000	37,000
FBI – BPS	-41,200	-2,300	62,400	4,800

The Farm Business Survey data therefore suggest that improvements in performance do have potential to enhance profitability, if there is substantial structural change in the industry.

However, without such changes, the levels of profitability achieved by high performing farms are unlikely to be achievable by all.

The extent to which scale is a factor in environmental performance is unclear, although there is some evidence that HNV farming is associated with smaller farms. There are also political implications associated with a policy change that implies significant industrial change. CPRE (2017) argues that continuing losses of small farms pose risks for wildlife and the environment, as well as the rural economy and society.

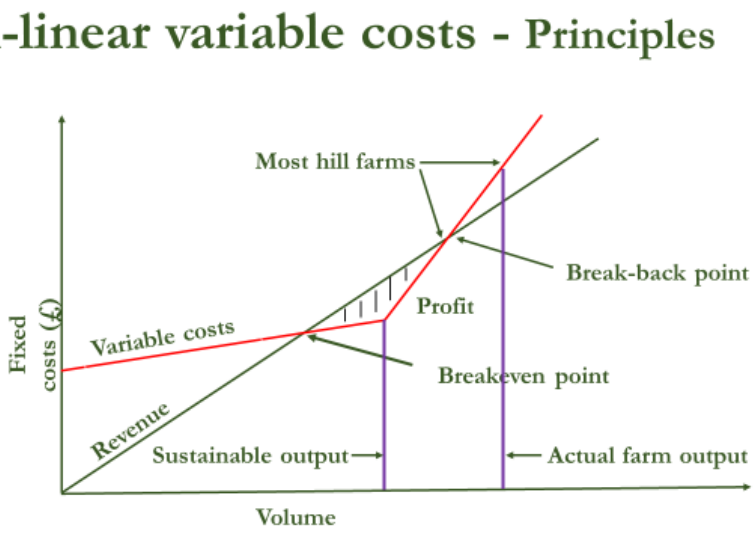
Profitability and Maximum Sustainable Stocking Rates

Current work by Chris Clark for the RSPB, National Trust, The Wildlife Trusts and others is examining the performance and sustainability of upland livestock farms in England and the potential for them to enhance profitability as well as environmental sustainability by reducing stocking rates.

Working with neighbouring farms in the Yorkshire Dales, Clark has found that most have sought to grow their income by increasing output, with resultant reductions in profitability. He has found that there is a Maximum Sustainable Stocking Rate (MSSR), related to the availability of natural (free-issue) grass. Stocking rates above the MSSR level can only be achieved by adding additional "corrective" variable costs (CVCs), including expenditures on fertilisers, sprays, purchased concentrates, vets bills, winter forage and over-wintering. This results in a non-linear variable cost curve, which kinks upwards above the MSSR. Farms which seek to increase output above this level suffer a reversal in profitability (Figure 4.1).

The diagram indicates that there is a break-even point at which volume of output is sufficient for revenues to cover fixed and variable costs – marked by the left-hand intersection between the red cost curve and green revenue curve. However, there is also a maximum level of sustainable output (MSSR) beyond which volumes can only be increased by purchasing additional inputs and thereby increasing variable costs at the margin. This point is marked by the kink in the red cost curve. Beyond this point, the cost curve tilts more sharply upwards, intersecting the revenue curve again at a "break-back" point, beyond which the farm ceases to be profitable. Profits are indicated by the hatched area between the revenue and cost curves and require volumes to be between the break-even and break-back points. Clark argues that profit is likely to be maximised by maintaining output at the MSSR, but finds that many farms mistakenly exceed this level, increasing output at the expense of profitability.

Figure 4.1: Illustration of effects of output on profitability of hill farms



Source: Clark (2019)

The implications of this are that reducing stocking rates to more sustainable levels could enhance the profitability of upland livestock farms, as well as enhancing their environmental performance (through reduced grazing pressure on upland vegetation, and lower use of fertiliser).

Clark argues that increasing the focus on margins rather than volumes will enhance the profitability and sustainability of hill farms. However, given natural constraints, this may not be sufficient to make all farms profitable, and there is also a need to explore new opportunities to add value and increase the price that consumers are willing to pay. Clark's analysis is relevant to this report, as it suggests that there are ways to improve profitability without the restructuring associated with improving profitability through scale as described above. This is relevant to any discussion about how much public support is needed to secure public goods from these farming systems, although there is currently insufficient data to factor this into the analysis below.

4.4 Quantifying the support needed to secure public goods from marginal farming systems

The Agriculture Bill in England and the 'Brexit and our Land' consultation paper in Wales, embrace the principle of public money for public goods. In these parts of the UK, support for agriculture will shift away from direct payments based on land area and reward practices that enhance the environment, cultural and natural heritage, improve public access, contribute to climate change mitigation and adaptation, protect against natural hazards, and enhance the health and welfare of animals and plants. Although less clear, it is likely that similar support will form a prominent part of future payments in Scotland and Northern Ireland.

In some instances, provision of public goods depends on the continuing viability of the farming systems that deliver them. Restoration and management of grassland and farmed habitats (e.g. maintenance of pastures by grazing and management of meadows), maintenance of landscape and historic environment features, and management of public access, can all depend on the continuation of farming practices. There will be benefits in taking some land out of agriculture, to re-create woodlands and other wildlife habitats, contributing not only to biodiversity conservation but also to climate change mitigation, enhanced water quality and protection against flooding. However, in some instances meeting priorities for the environment and cultural heritage will depend on the continuation of farming.

The data above suggest that the future delivery of environmental public goods may require tailored support mechanisms in areas where the removal of direct payments calls into question the viability of marginal farming systems. For example, the management of hay meadows would cease if farms no longer required forage for over-wintering cattle. In these cases, there may be a need to provide ongoing support for maintaining the farming systems in some cases, linked to the delivery of environmental public goods.

This could feasibly be achieved either by:

- Targeting enhanced levels of support to farms or areas of high nature value; or
- Linking enhanced levels of support to land management practices identified in the costings model which deliver public goods but are vulnerable to the loss of the farming systems required to support them.

These two options are explored in more depth below.

Linking Support to High Nature Value farming

This approach would target support for maintaining land management to farming systems recognised to have high nature value. These systems make the greatest contribution to the delivery of public goods, and, because they tend to be less intensive, are often marginal and

at greatest risk of abandonment of farming activity or change of land use (RSPB et al, 2011).

The concept of High Nature Value (HNV) farming developed in the early 1990s in recognition of the importance of traditional low intensity farming systems for biodiversity and the environment across the EU[8]. HNV farming is characterised by long-established, low-intensity and often complex farming systems using labour intensive practices, livestock breeds, and crop types highly adapted to local soils, vegetation, and climate (Keenleyside et al, 2014).

The European Environment Agency (EEA) has identified three broad types of HNV farmland (Paracchini et al, 2006):

Type 1 – Farmland with a high proportion of semi-natural vegetation.

Type 2 – Farmland with a mosaic of low intensity agriculture and natural and structural elements, such as field margins, hedgerows, stone walls, patches of woodland or scrub, small rivers etc.

Type 3 - Farmland supporting rare species or a high proportion of European or World populations.

In a UK context, HNV farming is mainly associated with extensive beef and sheep farming in the uplands and marginal farming areas, which relies on unimproved semi-natural vegetation for grazing. There are also examples from the lowlands which include some low input arable/mixed farming systems and coastal habitats which contain a mosaic of semi natural features which support a rich assemblage of wildlife. HNV farming relies upon the sympathetic land management practices – such as low intensity grazing, traditional mowing of hay meadows, leaving fallow areas, using seaweed as fertiliser, and traditional approaches to managing semi-natural vegetation – to maintain habitats and species[9].

Various efforts have been made to define, map and quantify HNV farming systems in the UK context. Keenleyside et al (2014) estimated a range of between 6,590,000 and 7,190,000 hectares, based on estimates of the extent of semi-natural grassland. This is approximately 37%-41% of the agricultural land area of the UK. Scottish Government (2011) estimated the area of HNV in Scotland at 2.3 million hectares, or 40% of the utilised agricultural area, using the area of rough grazing as the main indicator. Chaplin et al (2017) estimated that approximately 25% of farmland in England is of High Nature Value, by combining estimates based on the three HNV types defined by the EEA.

A criticism of previous efforts to define and map HNV systems in the UK is the broad and inclusive nature of the indicators used (e.g. including semi-natural vegetation or rough grazing irrespective of the way in which it is managed). This has led to large estimates of the extent of HNV farming, which often map closely to designations of Less Favoured Areas, and do not necessarily capture the specific farming practices typically associated with HNV systems. As a result, broad areas of the uplands have been mapped as HNV, whether or not they are delivering benefits to the environment.

This has led to efforts to develop tighter definitions of HNV farming, using more specific indicators. For example, the RSPB is currently exploring the potential to map HNV farming based on a set of bird indicator species (corncrake, chough, curlew, lapwing, redshank, twite and whinchat) typical of farming systems of high biodiversity value in uplands and Less Favoured Areas. Such an indicator would significantly reduce the area of land classified as HNV, excluding large areas of the uplands that are covered by broader indicators. One limitation is that the focus on bird indicator species does not necessarily capture wider biodiversity value associated with HNV systems.

The challenges of defining and quantifying HNV farming systems using simple indicators mean that it is not possible to use them as a basis for estimating financial needs. It is also

[8] http://www.high-nature-value-farming.eu/what-is-hnv/

[9] http://www.highnaturevaluefarming.org.uk/what-is-high-nature-value-farming/

difficult to reconcile broad estimates of the extent of HNV farming with the costs in the existing costings model, which are discussed in the next section.

Linking Support to Land Management Practices that deliver Public Goods

An alternative approach is to identify land management actions specified in the costings model which deliver public goods and are dependent on the maintenance of vulnerable farming systems.

This includes:

- The maintenance, restoration and creation of upland priority habitats;
- The maintenance, restoration and creation of lowland priority habitats that depend on grazing;
- The maintenance and restoration of historic environment features;
- Management of low intensity arable land for the benefit of biodiversity, landscape and the wider environment (including in mixed farming systems); and
- Management of upland rough grazing with low inputs and mixed grazing, for the benefit of biodiversity, landscape and the wider environment.

Maintenance, restoration and creation of habitats and low intensity farming systems deliver a range of public goods, benefiting biodiversity and landscape and delivering a variety of ecosystem services such as climate regulation, water purification, flood management and recreation. Priority habitats in upland and lowland areas which are most at risk from cessation of grazing management are summarised in Table 4.4.

Table 4.4: Priority Habitats dependent on maintaining livestock farming

Upland/ LFA Priority Habitats	Grazed Lowland Priority Habitats
Upland Hay Meadows	Coastal and Floodplain Grazing Marsh
Upland Calcareous Grassland	Lowland Meadows
Upland Heathland (some sites)	Lowland Calcareous Grassland
Upland Flushes, Fens and Swamps	Lowland Dry Acid Grassland
Limestone Pavement (some sites)	Lowland Heathland
Calaminarian Grassland	Purple Moor Grass & Rush Pastures
Machair	Lowland Fens (some sites)
	Maritime Cliff and Slope (some sites)
	Coastal Saltmarsh (some sites)

Other priority habitats such as reedbeds, sand dunes and woodlands are less dependent on agricultural grazing systems and it is assumed that they can be maintained whether or not farming remains viable, through habitat management actions undertaken by landowners, contractors and conservation organisations. The maintenance and restoration of blanket bog is not reliant on grazing and blanket bog would generally benefit from reductions in grazing pressure (IUCN, 2014). Some habitats, such as limestone pavement, lowland fens, maritime cliff and slope and coastal saltmarsh, as well as upland heathland (much of which is managed as grouse moor), require continued agricultural grazing at some sites but not others. In these cases, we have assumed that 50% of the habitat area depends on continuation of farming.

The approach excludes land targeted by resource protection measures in agriculture. The model includes a range of measures designed to enhance the management of soils and to protect water resources within arable and grassland systems. However, these measures are

addressing resource management challenges related to agricultural systems which would no longer be required if farming activity ceased.

A new sheet has been added to the costings model (Sheet 14. Needs - Maintaining Land Management). This estimates the area of land requiring support to ensure continuing viability of management. There are three elements:

1. The proportion of land (LFA grassland, lowland grassland, arable land) covered by identified environmental land options in the model that is vulnerable to cessation or change of land use and therefore requires further support to maintain the viability of land management. Working estimates are 100% for LFA grassland, 70% for lowland grassland and 12% for arable land, based on the estimated areas of land in each category on Mixed, Lowland Livestock and LFA Livestock farms. In practice, higher performing farms in these categories may not require this extra support, but lower performing ones are likely to require higher than average levels of support. Support for these farm types would help to sustain the delivery of environmental public goods listed above;
2. Whether support is provided to maintain land management for land under different types of features/ management practices (priority habitats; historic environment features; arable land/rough grazing with biodiversity and landscape measures). The assumption is that support is only provided for maintaining the management of land that delivers public goods and goes beyond the delivery of resource protection measures for agricultural production purposes alone;
3. Estimation of the areas in each category for which support for continued land management is provided, by applying the above ratios and assumptions to the area needs for each category in the costings model.

Based on this approach, it is estimated that 1.7 million hectares of land across the UK may require ongoing support to maintain the viability of land management in order to sustain delivery of public goods (Table 4.5). 60% of this land is covered by priority habitats, of which nearly half is upland heathland. These areas represent an estimated 19% of all priority habitats, 29% of rough grazing land and 2% of arable land in the UK, based on the areas in the model that would be managed for the delivery of environmental public goods.

Table 4.5: Estimated area of land requiring financial support to maintain land management

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	467,150	31,630	383,832	156,869	1,039,480
Arable land	119,451	1,083	11,834	2,002	134,369
Rough grazing	79,937	-	374,274	86,253	540,464
Total	**666,538**	**32,712**	**769,940**	**245,124**	**1,714,314**

4.5 Estimating Financial Support Needs for Land Management Practices that deliver Public Goods

Estimating support needs per hectare

Having determined the area of land requiring support to maintain land management, the next step is to estimate the amount of support required per hectare to sustain the land management required to deliver environmental public goods.

To achieve this, it is assumed that support would be set at a level designed to ensure a minimum level of income per farm. To maintain viability, this minimum income level would need to be above zero, to ensure that the farm received some compensation for unpaid work undertaken by the farming family/farm business partners.

Farm Business Survey data indicate that the value of unpaid manual labour (supplied by the farmer, spouse and farm business partners) averaged £25,700 for the average lowland livestock farm, £26,300 for the average LFA livestock farm, and £32,000 for the average mixed farm in England in 2017/18.

This suggests a minimum level of farm business income of at least £25,000 per annum would be required to provide compensation for unpaid labour. Table 4.6 estimates the average level of per hectare support that would need to be made to different types of farm in each country, if direct payments and other farm support payments were removed, in order to achieve this level of farm business income, and thereby sustain the land management systems delivering the identified environmental public goods.

Table 4.6: Average level of support per hectare farmed, by farm type, to achieve average farm income of £25,000

	Year	LFA Livestock	Lowland Livestock	Mixed Farms
England	2017/18	£131.40	£215.38	£99.41
Northern Ireland	2016/17	£389.33	£483.93	£273.59
Scotland	2016/17	£78.34	£330.89	£235.02
Wales	2017/18	£159.28	£168.47	£99.41

Source: Farm Business Survey data

This analysis suggests that there are, for certain public goods, systemic costs that are not included in conventional estimates used to date for agri-environment schemes. One potential option to link this uplift in funding clearly to the provision of public goods would be to provide it as a per hectare supplement for agri-environment contracts that met certain criteria, such as beneficial management of priority habitats associated with non-economic grazing systems. This would be justifiable within the constraints of WTO rules on the basis of broader definition of costs, and is an approach already allowed for under European Commission guidance for member states on estimating agri-environment payment rates.

These per hectare figures can be added to the per hectare costs of environmental land management specified in the model, to give a higher per hectare cost which reflects the systemic costs of maintaining land management as well as the costs of the specified environmental land management practices. The modelling approach:

- Increases the annual per hectare costs of maintaining upland habitats (such as upland heathland, upland hay meadows and upland calcareous grassland) as well as the costs of low intensity management of upland rough grassland for environmental

public goods by £131 in England, £389 in Northern Ireland, £78 in Scotland and £159 in Wales;

- Increases the annual per hectare costs of maintaining lowland grassland habitats (such as coastal and floodplain grazing marsh, lowland meadows and lowland heath) by £215 in England, £484 in Northern Ireland, £331 in Scotland and £168 in Wales; and
- Increases the annual per hectare costs of low intensity management of arable land for biodiversity and landscape in mixed farming systems by £99 in England, £274 in Northern Ireland, £235 in Scotland and £99 in Wales.

Estimating the costs of supporting land management

The costs of sustaining the land management practices required to deliver environmental public goods in vulnerable systems have been estimated at national level by combining the area estimates (Table 4.5) with the enhanced per hectare support needs (Table 4.6). The additional costs of adding these area-based supplements to estimated per hectare management costs are given in Table 4.7.

Table 4.7: Estimated costs of maintaining land management (£000s per annum)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	88,462	14,660	47,014	25,926	176,061
Arable land	11,874	296	2,781	199	15,151
Rough grazing	11,774	-	30,653	13,772	56,199
Total	**112,110**	**14,956**	**80,448**	**39,897**	**247,411**

The additional costs at UK level to maintain the farming systems required to deliver these environmental goods are estimated at £247 million annually. 70% of the costs relate to the maintenance of priority habitats.

Provision of farm business advice for marginal farms

Section 4.4 above suggested that there is potential to enhance both the profitability and sustainability of marginal farming systems in the UK, especially in the uplands, by focusing on profit margins and reducing production to maximum sustainable levels.

Farm business advice could play an important role in enhancing profitability, by focusing on boosting margins rather than volumes, as well as identifying opportunities to add value to produce and enhance income through diversification. This could potentially reduce over time the costs of supporting the farming systems needed to deliver environmental public goods.

Provision of farm business advice over the land area detailed in Table 4.5 above would involve costs of approximately £5.4 million per year for a period of 10 years, based on estimates of the average size of each farm type in each country and assuming that each farm was provided with an average of 10 days advice at an average cost of £500 per day (Table 4.8). Provision of farm business advice would help to enhance profitability and thereby reduce the cost of maintaining vulnerable farming systems providing environmental public goods.

Table 4.8: Estimated costs of providing farm business advice to support vulnerable farming systems (£000s per annum for 10 years)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	2,192	229	701	209	1,082
Arable land	353	7	36	6	403
Rough grazing	272	-	503	336	1,111
Total	**2,817**	**236**	**1,241**	**1,115**	**5,409**

Evidence demonstrates that only a minority of farms currently undertake standard business management practices such as producing budgets, analysing gross margins, preparing cash flow forecasts or producing in-depth profit and loss accounts. This proportion was as low as 17% for LFA livestock farms and 18% for lowland livestock farms in 2016/17 (Defra, 2018a). The low take-up of advice suggests a role for public intervention – such as the provision of free or subsidised advice – to enhance farm business planning and management.

The Role of Alternative Payment Methodologies in enhancing the viability of land management

Introducing a new payment methodology for environmental land management in the UK could also play a role in helping to sustain the viability of land management systems delivering environmental public goods. One of the limitations of the current approach of limiting agri-environment payments to costs and income forgone is that this provides limited profit for land managers. As a result, removal of Pillar 1 subsidies is expected to reduce the profitability of farming and adversely affect the viability of marginal farms, even if those subsidies are redirected to environmental land management payments.

Alternative payment systems – if they offered payments exceeding costs and income forgone – would have the potential to enhance the incomes of land management businesses delivering environmental public goods. Focusing payments on environmental public goods would potentially redistribute payments towards high nature value areas, where opportunities to provide environmental benefits are greatest, potentially providing new income streams in areas which face disadvantages for food and timber production.

The issue of alternative payment methodologies is dealt with in more detail in Section 7 of this report.

4.6 Conclusions

The 2017 costings model estimated the annual cost of the management practices required to achieve environmental priorities in the UK at £2.3 billion per annum. This estimate was based on the costs incurred and income forgone to deliver the required management practices. It was recognised that this was likely to be an underestimate of the full costs of meeting these priorities in cases where farming systems cease to be viable if CAP direct payments are removed. In instances where delivery of environmental public goods is dependent on the maintenance of otherwise unviable farming systems, the costs of maintaining the systems required to deliver environmental public goods also need to be included in the analysis.

This section sets out a simple modelling approach that enables these additional systemic costs to be factored into the cost assessment. It is estimated that maintaining the delivery of environmental public goods may incur additional costs over an area of 1.7 million hectares, especially in priority habitats in upland areas of the UK. The additional costs of sustaining the systems required to deliver these environmental public goods is estimated at slightly

less than £247 million annually in the UK. These costs are based on current farm structures and practices. However, there is scope for farms to enhance their profitability through cost reductions (particularly by lowering stocking rates and input costs) and through amalgamation to achieve economies of scale, potentially reducing future support needs. There is also great scope to improve farm business practices, and interventions to facilitate the provision of business advice to vulnerable farms that deliver environmental public goods could be a cost-effective means of achieving this.

5 Costs of securing long term environmental benefits

5.1 The Issue

As well as ongoing management activities, agri-environment and woodland management schemes fund capital investments designed to deliver environmental benefits over the longer term. These include changes in land use, through creation of habitats, woodlands and landscape features, as well as restoration actions intended to deliver long term environmental benefits.

The long-term nature of these investments raises the following questions:

1. How can schemes be designed to attract participation by land managers, especially given uncertainties regarding the future returns and opportunity costs of long-term changes in land use or management?
2. How can schemes be designed to ensure that the public benefits from land management investments are secured over the longer term, and are not lost when initial agreements come to an end?
3. What are the cost implications of addressing these considerations?

Typical five-year agri-environment agreements present potential problems in this respect, providing limited certainty to taxpayers about the security of public benefits in the longer term, particularly since investments in creating or restoring habitats may take many years to deliver their potential benefits. There is therefore a risk that the benefits of publicly funded investments will be lost (or will fail to materialise at all) after contracts expire.

Similarly, while agreements require land managers to make long term decisions about land use and management, they provide limited certainty about future income streams, over timescales in which other factors that affect business decisions (such as commodity prices and exchange rates) are likely to change. This may discourage entry into such agreements.

A range of financial, legal and contractual measures can be considered to address these issues, and to enhance the security of long-term benefits from environmental investments. These include:

- Long term contracts for agri-environment and woodland management;
- Incentives for maintaining long term management regimes;
- Results based payments;
- Conservation covenants to secure long term land use change, which may be accompanied by incentive payments; and
- Tax incentives.

These measures can be expected to influence the costs of environmental land management payments, as land managers are likely to require compensation for the opportunity costs and potential forgone option value of committing to long term changes in land use and/or land management. The cost implications of these alternative measures can be assessed through the environmental land management costings model.

This section provides a brief review of existing arrangements relating to long term investments in agri-environment and woodland management in the UK, before examining the potential role of each of the options listed above. The potential costs of implementing these options are then assessed.

5.2 Existing arrangements in agri-environment and woodland grant schemes

Countryside Stewardship, England

Countryside Stewardship provides grants for:

- Management options – most agreements last for 5 years, but some options can be 10 or 20 years long;
- Capital items – a range of grants for specific capital works or items – work must be completed within 2 years.

Some Higher Tier agreements last for more than 5 years, where options involve complex changes with long-term impacts on environmental conditions and land use.

10-year agreements include:

- Creation of a range of habitats including coastal sand dunes, vegetated shingle, wet grassland for breeding waders, wintering waders and wildfowl, reedbed, fen, traditional orchards, species-rich grassland, grassland for target features, heathland, woodland, wood pasture;
- Raised water level supplement;
- Management of moorland;
- Restoration of species-rich grassland, lowland heathland from forestry and woodland, wood pasture and parkland;
- All agreements on commons and shared grazing land.

20-year agreements include creation of inter-tidal and saline habitat on arable land, on intensive grassland, and by non-intervention, and making space for water.

Annual payment rates are fixed for the duration of the agreement.

Capital items receive one off payments for 2-year programmes of capital works and there are no ongoing conditions – e.g. restoration and planting of hedgerows, blocking of grips, planting of woodlands.

Environmental Farming Scheme, Northern Ireland

The Environmental Farming Scheme issues contracts with a 5-year duration. For the establishment of native woodland, applicants must be prepared to retain native woodland for a period of 15 years after the scheme, while EFS payments will be made for the successful establishment and management of the woodland in its first 5 years.

AECS and Forestry Grant Scheme, Scotland

The Agri-Environment Climate Scheme involves a standard contract period of five years.

The Forestry Grant Scheme offers initial payments for creation of woodland, as well as annual management payments for a period of five years.

Glastir, Wales

Glastir agreements are for a contract period of 5 years. Maintenance payments for newly created woodlands are made for a period of 12 years.

5.3 Potential mechanisms to secure long-term benefits

Long term contracts

The previous section indicates that most agri-environment and woodland management schemes in the UK involve 5-year agreements. Longer 10- or 20-year agreements are applied to long term habitat creation and restoration options in England, as well as management of moorland and common land. Maintenance payments are made for 12 years for newly created woodlands in Wales.

Even for extended agreements, the timescales are short compared to those over which habitat creation and restoration are likely to achieve their full potential, which for most habitats is likely to take several decades. For example, Morris et al (2006) found that, while some wetland creation and restoration projects may take just a few years, creation of grassland habitats of nature conservation value may take around 80 years, while new woodlands may take hundreds of years to reach their full nature conservation potential.

Capital payments are usually made on satisfactory completion of the agreed works and are not subject to ongoing conditions. However, newly created woodlands are subject to relevant legislation (e.g. tree felling licences).

These arrangements provide little security that the benefits of habitat creation and restoration will be maintained over the long term. Moreover, uncertainty for land managers regarding future payments may be a disincentive for them to enter agreements.

The current mid-term EU funding cycle, whereby budgets for the European Agricultural Fund for Rural Development (EAFRD) and other funds are programmed over a 7-year period, may present barriers for long term financial agreements.

A report by Rollett et al (2008) highlighted the importance of long-term contracts for ensuring that agri-environment measures deliver long term benefits. It noted that agri-environment schemes are typically short to medium term in duration. Schemes that commit farmers for only five years may fail to deliver environmental benefits, especially since the desired practices may cease at the end of the agreement. The report highlighted the Vittel case study, France, as a good example of a scheme which delivered benefits via a long-term approach, offering contracts of between 18 and 30 years, thereby also helping to secure the quality of a commercially valuable natural resource.

In order to secure the benefits of long-term investments in creation and restoration of habitats and landscape features, schemes would ideally involve longer term contracts of more than 30, and perhaps 50 or 100 years.

Extending contract durations in this way would also likely require changes in payment rates to reflect variations in costs and income forgone over time, e.g. through periodic payment reviews that provided some certainty to land managers and the authorities while enabling payments to change to reflect financial conditions. Alternatively, payments could be designed to provide incentives for long term management or linked to the delivery of outcomes over time.

Incentives for long term management

Incentive structures could be designed to secure long term changes in land management. This could involve, for example:

- Tiered payment structures, with increasing payment levels over time;
- Loyalty bonuses, offering rewards for maintaining the agreed management regime, paid for example every 10 years;
- Performance bonuses or top-ups, where supplementary payments are made for achieving specified milestones (e.g. in relation to species-richness of grassland, tree height, vegetation structure, water levels etc.). These could be similar to results-based payments (see below) but offered as a supplement to basic payments based

on costs and income forgone, thereby reducing risks to participants (Schwartz et al, 2008; OECD, 2016) or applying in situations with complex outcomes or situations (Waldon et al, 2017).

Such incentives could be offered as part of long-term contracts or as an alternative to them. For example, contracts could be renewed periodically, with incentives being offered for contract renewal.

Results-based payments esteem

Moving the basis of payments from costs incurred and income forgone to environmental outcomes would help to incentivise long term changes in land management, particularly for options which take many years to deliver their intended outcomes. For example, Schwarz et al (2008) gave the example of grassland restoration payments, where a payment by results approach would be expected to skew payments towards the latter year of an agreement. Increasing payments over time would tend to encourage long term participation in schemes.

A Swedish study (Franzen et al, 2016) examining farmers' willingness to enter long term wetland creation schemes found that one of the main reasons given for non-participation were the high costs involved. As well as increases in financial support for participation, the researchers suggested that results-based agri-environment schemes could be useful in increasing participation, where payment is given for provision of an ecosystem service, such as nutrient retention, rather than a specific management action. It was argued that result-based schemes could encourage farmers to innovate in order to manage their farms more sustainably because they will be paid for what they produce, rather than paid for an action with an uncertain outcome.

Most results-based schemes in Europe currently have a relatively limited history, and there is therefore limited evidence of long-term environmental outcomes (Allen et al, 2014). In order to incentivise long term outcomes, a long-term commitment to payment for outcomes over time is likely to be needed.

A disadvantage of pure results-based schemes, particularly where outcomes take many years to materialise, is that they can increase risks to land managers, requiring up-front investments which may yield uncertain future returns. These risks and uncertainties could be reduced by combining payments for actions with results-based bonuses (see previous section).

Conservation covenants

A conservation covenant is a private, voluntary agreement between a landowner and a "responsible" body, such as a conservation charity, government body or a local authority. It delivers lasting conservation benefit for the public good. A covenant sets out obligations in respect of the land which will be legally binding not only on the landowner but on subsequent owners of the land (Defra, 2019). The recent government consultation on conservation covenants argued that leaving our environment in a better state than we found it requires long-term investment and stability, that there is currently no adequate mechanism for land owners to secure long term environmental outcomes, and that a new legal tool is needed to achieve this.

The government proposes that covenants would deliver a conservation purpose which is for the public good, such as to conserve the natural and/or historic environment of the land. They would contain obligations which could be either positive (managing the land to secure a conservation outcome) or restrictive (requiring the landowner not to do something to secure a conservation outcome). The covenant would be binding on all future owners of the land after the current owner has disposed of it and would be indefinite unless agreed for a shorter period), and enforceable through the courts (Defra, 2019).

Conservation covenants could potentially be used alongside agri-environment and woodland grant agreements to ensure that they achieve long term conservation benefits – effectively requiring a commitment to long-term conservation management.

The recent Defra consultation paper stated that conservation covenants would be entered voluntarily and would therefore not impose additional costs on land managers. However, while some landowners may agree to a conservation covenant for altruistic reasons, many would likely require compensation for the potential opportunity costs of agreeing to long term changes in land use. The paper noted that conservation covenants entered by landowners could be used to secure the benefits of payments for ecosystem service schemes, with payments coming from either the public or private sector.

The Law Commission (2014) report on conservation covenants noted that they can be used to enhance the security of long-term outcomes from agri-environment schemes or payments for ecosystem services (Box 5.1). The report noted that conservation covenants are able to secure longer term benefits than can usually be achieved by agri-environment schemes, particularly since they are legally binding even if the ownership of land changes.

Box 5.1: Example of role of conservation covenants in securing long term environmental outcomes

A water company wishes to pay land managers to block drainage ditches on an upland mire in order to make the mire retain more water, which should mitigate flood risk and improve water quality further down the catchment. The proposal would change the farming practices on the land in the very long term, if not permanently. The private individual may be the landowner who farms the land himself, the tenant who does so, or the landlord of such tenants. He is willing to provide the necessary management of the land in return for payments, but at present the proposal lacks a

suitable legal vehicle which will bind the parties for the appropriate length of time. A conservation covenant would suit this situation very well.

Source: The Law Commission (2014)

The Law Commission report suggested that conservation covenants are unlikely to involve long term payment arrangements; instead, a one-off payment for entering a conservation covenant is likely to be made at the time the covenant is agreed, with subsequent management requirements best secured through an appropriate management agreement.

Covenants can represent a cost-effective means of securing long term conservation commitments, when compared to acquisition of land or property. Some other countries offer incentives through tax reliefs or grants to landowners to take out covenants. For example, reductions in income and/or capital gains tax are offered in the US, Australia and Canada, and grants in New Zealand (Green Balance, 2008).

Tax incentives

The tax system has the potential to influence decisions about long term land use. Agricultural land and property qualifies for Agricultural Relief for Inheritance Tax[10]. Land which is transferred from agriculture to other uses potentially becomes subject to Inheritance Tax, and this may discourage changes in land use.

However, land entered into long term habitat creation schemes remains eligible for agricultural relief, even where this involves cessation of agricultural production over extended time periods. HMRC guidance is provided on this issue.[11] In addition, relief from Inheritance Tax and Capital Gains Tax is also provided for national heritage assets, including some buildings, land, works of art and other objects of heritage value, providing the new owner undertakes to conserve them and make them accessible to the general public. This includes land of outstanding natural beauty and spectacular views and land of

[10] https://www.gov.uk/guidance/agricultural-relief-on-inheritance-tax

[11] https://www.gov.uk/hmrc-internal-manuals/inheritance-tax-manual/ihtm24065

outstanding scientific interest including special areas for the conservation of wildlife, plants and trees[12].

Maintaining these tax reliefs will clearly be important in ensuring that there is no disincentive to enter long term habitat creation and restoration schemes.

Consideration could be given to extending tax reliefs as an incentive for landowners to take out conservation covenants, as occurs in the US, Australia and Canada.

5.4 Assessing the costs of securing long term environmental benefits

Measures designed to secure long term benefits potentially increase the costs of agri-environment and woodland grant schemes.

Expansion of Priority Habitats

The existing model estimates the costs of expansion of priority habitats in the UK as follows (Table 5.1).

Table 5.1: Estimated base costs of expansion of priority habitats (£000 per annum, adjusted costs model, average over 10 years)

	England	Northern Ireland	Scotland	Wales	UK
Capital costs	14,642	1,829	28,839	3,946	**49,256**
Annual costs	22,140	2,464	18,371	4,831	**47,806**
Total	**36,782**	**4,293**	**47,209**	**8,777**	**97,061**

The latest estimates for the costs of expansion of priority habitats amount to average capital costs of £49 million and annual costs of £48 million per year over 10 years, giving an annual average cost total of £97 million per year.

Assuming no further expansion activity after the initial 10 years, but ongoing maintenance of the newly created habitats, the net present value of these costs over a 100-year period amounts to £2,636 million, using the standard social discount rate of 3.5% (HM Treasury, 2018).

Box 5.2: Calculating the Net Present Value of the Costs over Time

Long term investments in the creation and restoration of habitats and other features incur up-front capital costs and ongoing costs of annual maintenance, which also take account of the opportunity costs (income forgone) from changes in land use.

The concept of time preference means that each £1 of cost incurred today has a higher value than £1 of cost incurred in the future, because we would prefer to have money now rather than next year. Discount rates are used to calculate the present value of future flows of costs and benefits. The HM Treasury Green Book specifies a standard social discount rate of 3.5%, which means that each £1 today is worth the same as £1.035 next year, and £1.41 in ten years' time (£1 x 1.035^{10}).

Overall costs over time of different options can be compared by using discount rates to calculate the present value of future flows of costs and summing them to give the net present value.

For example, if the creation of a hectare of reedbed incurs an up-front capital cost of £1800 per hectare then an annual maintenance cost of £440 every year for 10 years, the net present value of the costs of creation and ongoing maintenance over 10 years would be £1800 + £440/1.035 + £440/1.035^2 +… + £440/1.035^{10} = £5459.

The estimates above relate to the costs incurred and income forgone of undertaking the required land management practices. Introducing additional safeguards to secure long term

[12] https://www.gov.uk/guidance/tax-relief-for-national-heritage-assets

changes in land use and land management can be expected to increase these costs, if land managers demand additional compensation to enter long term contracts or conservation covenants.

These increases in costs depend on the individual attitudes and circumstances of farmers and are difficult to estimate in general terms. Quantifying them would ideally involve interviews with land managers to survey their willingness to accept compensation for long term changes in land use.

However, potential increases in costs have been illustrated through a simple modelling approach using the following scenarios:

Scenario 1: Enhanced incentives for long term management, through long term contract. In the first scenario, it is assumed that land managers are offered an incentive to enter long term (100 year) contracts. This involves a standard % increase (in real terms) in all annual maintenance payments made to land managers over the duration of the 100-year contract. This is modelled as a standard % uplift in costs and income forgone for annual management over the 100-year period, with capital costs of expansion remaining unchanged.

Scenario 2: Long term loyalty bonus or performance top up. In this scenario, enhanced annual payments would be made to land managers for maintaining the agreed land use practices over time. These would be increased periodically and cumulatively over the course of the 100-year period (e.g. a % uplift every 10 years). These increases in payments could be performance related – e.g. conditional on achieving set thresholds relating to the condition of the newly created habitats. This differs from scenario 1 in that payments would increase only at 10-year intervals but would rise cumulatively over time.

Scenario 3: One off incentive for taking out a conservation covenant. In this scenario, land managers would be paid an up-front sum as an incentive for taking out a conservation covenant. This could be similar to Scenario 1, i.e. based on a set % of ongoing maintenance costs and income forgone but paid as a one-off capital sum rather than as an annual payment, reflecting the binding and perpetual nature of the commitment.

The effect of these three scenarios on the costs of habitat creation is summarised in Table 5.2.

Table 5.2: Summary of cost increases for habitat creation under three scenarios, Net Present Value over 100 years, UK

	NPV (£m)	% change compared to baseline
Baseline costs	2,636	-
Scenario 1: Incentive to enter long term contract		
5% uplift on annual management costs	2,747	4.2%
10% uplift on annual management costs	2,858	8.4%
15% uplift on annual management costs	2,970	12.7%
Scenario 2: Long term loyalty bonus		
5% uplift on annual management costs	2,940	11.5%
10% uplift on annual management costs	3,303	25.3%
15% uplift on annual management costs	3,737	41.8%
Scenario 3: One off incentive to take out conservation covenant		
5% uplift on annual management costs	2,747	4.2%
10% uplift on annual management costs	2,858	8.4%
15% uplift on annual management costs	2,970	12.7%

Scenarios 1 and 3 increase the overall net present value of costs by between 4% and 13% over a 100 year period, based on an uplift of between 5% and 15% in annual management

costs. The net present value is similar under these two scenarios, since they involve a similar overall uplift in costs, the only difference being that Scenario 1 involves a set % increase in annual management payments over the whole period whereas Scenario 3 converts this into a one-off capital sum.

Scenario 2, which has similar costs to the baseline scenario in years 1-10 but then involves cumulative increases in costs every 10 years, increases the net present value of costs by between 12% and 42% over the 100-year period, for a cost uplift of between 5% and 15% every 10 years. Because the cost uplifts in scenario 2 are cumulative, they increase costs compared to scenarios 1 and 3, as annual management costs rise steeply in the latter decades of the 100-year period. A 3.75% cost uplift every 10 years under Scenario 2 has a similar effect on overall costs as a one-off 10% increase in costs for the whole 100-year period under Scenarios 1 and 3.

Box 5.3 presents a worked example for the expansion of reedbeds in the UK.

Box 5.3: Net Present Value of Reedbed Creation

The costings model estimates that 356 hectares of reedbeds will need to be created each year across the UK to meet habitat expansion targets in the four countries. The capital costs of creation are estimated at £1802 per hectare and subsequent annual costs at £440 per hectare per year (using adjusted unit cost estimates). This gives an annual average cost of £1.43 million per year at UK level for the next 10 years.

Assuming no further expansion of reedbeds after 10 years but including the ongoing annual costs of management of the 3560 hectares of newly created reedbed, the net present value of expansion amounts to £41.9 million over 100 years. The effect of discounting means that the present value of annual maintenance falls from £1.1 million in year 11 to £0.3 million in year 50 and £0.05 million in year 100, under the baseline scenario.

Scenario 1: Enhanced incentives for long term management, through long term contract involves a standard % uplift in costs and income forgone for annual management over the 100-year period, with capital costs of expansion remaining unchanged. A 10% uplift in annual management payments to £484 per hectare per year over the whole 100-year period would increase the net present value of costs over the 100-year period to £45.5 million, an overall increase of 8.7%. While annual management costs increase by 10% overall, capital costs of expansion remain unchanged.

Scenario 2: Long term loyalty bonus or performance top up, involves a periodic and cumulative increase in annual management payments over the course of the 100-year period. For example, annual payments for reedbed management could be increased by 10% every 10 years, from £440 per hectare per year in years 1-10 to £484 per hectare per year in years 11-20, £532 in years 21-30, up to a maximum of £1037 in years 91-100. These cumulative increases mean that the net present value of overall costs would increase to £52.8 million over the 100-year period, an increase of 26.1% compared to the baseline scenario.

Scenario 3: One off incentive for taking out a conservation covenant, would involve a similar uplift in annual incentives to Scenario 1, but with the extra incentive paid as a one-off capital sum rather than as an annual payment, reflecting the binding and perpetual nature of the commitment. Land managers would receive an annual management payment of £440 per hectare per year as under the baseline scenario, plus a % uplift paid as a capital sum up-front on taking out the covenant. A 10% uplift would amount to £44 per hectare per year, which would equate to an up-front capital value of £1216 per hectare. The net present value of total costs at UK level be the same as Scenario 1, at £45.5 million.

Restoration of Priority Habitats

The existing model estimates the costs of restoration of priority habitats in the UK as follows (Table 5.3). The costs of maintenance of habitats restored or undergoing restoration are included in the overall estimates of habitat maintenance costs in the model, rather than being itemised separately.

Table 5.3: Estimated base costs of restoration of priority habitats (£000 per annum, adjusted costs model, average over 10 years)

	England	Northern Ireland	Scotland	Wales	UK
Capital costs	278,504	17,028	163,091	58,862	**517,485**
Annual maintenance costs	95,824	11,138	75,028	23,043	**205,032**
Total	**374,327**	**28,166**	**238,119**	**81,904**	**722,517**

The latest estimates for the costs of restoration of priority habitats amount to average capital costs of £517 million and annual costs of £205 million per year over 10 years, giving an annual average cost total of £723 million per year.

Assuming no further restoration activity after the initial 10 years, but ongoing maintenance of the restored habitats, the net present value of these costs over a 100-year period amounts to £9,974 million, using the standard social discount rate of 3.5% (HM Treasury, 2018).

Potential increases in costs in securing long term land management can be illustrated through a similar modelling approach as for habitat creation, above.

The effect of these three scenarios on the costs of habitat restoration is summarised in Table 5.4.

Table 5.4: Summary of cost increases for habitat restoration under three scenarios, Net Present Value over 100 years, UK

	NPV (£m)	% change compared to baseline
Baseline costs	9,974	-
Scenario 1: Incentive to enter long term contract		
5% uplift on annual management costs	10,257	2.8%
10% uplift on annual management costs	10,541	5.7%
15% uplift on annual management costs	10,825	8.5%
Scenario 2: Long term loyalty bonus		
5% uplift on annual management costs	10,626	6.5%
10% uplift on annual management costs	11,404	14.3%
15% uplift on annual management costs	12,337	23.7%
Scenario 3: One off incentive to take out conservation covenant		
5% uplift on annual management costs	10,257	2.8%
10% uplift on annual management costs	10,541	5.7%
15% uplift on annual management costs	10,825	8.5%

Scenarios 1 and 3 increase the overall net present value of costs by between 3% and 9% over a 100-year period, based on an uplift of between 5% and 15% in annual management costs. The net present value is similar under these two scenarios, since they involve a similar overall uplift in costs, the only difference being that Scenario 1 involves a set % increase in annual management payments over the whole period whereas Scenario 3 converts this into a one-off capital sum.

Scenario 2, which has similar costs to the baseline scenario in years 1-10 but then involves cumulative increases in costs every 10 years, increases the net present value of costs by between 7% and 24% over the 100-year period, for a cost uplift of between 5% and 15% every 10 years. Because the cost uplifts in scenario 2 are cumulative, they increase costs

compared to scenarios 1 and 3, as annual management costs rise steeply in the latter decades of the 100-year period. A 4.4% cost uplift every 10 years under Scenario 2 has a similar effect on overall costs as a one-off 10% increase in costs for the whole 100-year period under Scenarios 1 and 3.

Planting of Hedgerows

The existing model estimates the costs of planting of hedgerows, and maintenance of newly planted hedgerows, in the UK as follows (Table 5.5). The costs of maintenance of newly planted hedgerows are included in the overall estimates of hedgerow maintenance costs in the model, rather than being itemised separately.

Table 5.5: Estimated base costs of planting hedgerows (£000 per annum, adjusted costs model, average over 10 years)

	England	Northern Ireland	Scotland	Wales	UK
Capital costs of planting	24,703	6,984	1,290	3,318	36,295
Annual maintenance costs of newly planted hedgerows	1,313	371	69	176	1,929
Total	**26,016**	**7,355**	**1,359**	**3,495**	**38,225**

The latest estimates for the planting of hedgerows amount to average capital costs of £36 million and annual costs of £2 million per year over 10 years, giving an annual average cost total of £38 million per year.

Assuming no further hedgerow creation activity after the initial 10 years, but ongoing maintenance of the newly created hedgerows, the net present value of these costs over a 100-year period amounts to £390 million, using the standard social discount rate of 3.5% (HM Treasury, 2018).

Potential increases in costs in securing long term land management can illustrated through a similar modelling approach as for habitat creation, above.

The effect of these three scenarios on the costs of habitat restoration is summarised in Table 5.6.

Table 5.6: Summary of cost increases for hedgerow creation under three scenarios, Net Present Value over 100 years, UK

	NPV (£m)	% change compared to baseline
Baseline costs	390	-
Scenario 1: Incentive to enter long term contract		
5% uplift on annual management costs	394	1.1%
10% uplift on annual management costs	399	2.3%
15% uplift on annual management costs	403	3.4%
Scenario 2: Long term loyalty bonus		
5% uplift on annual management costs	402	3.1%
10% uplift on annual management costs	417	6.9%
15% uplift on annual management costs	434	11.4%
Scenario 3: One off incentive to take out conservation covenant		
5% uplift on annual management costs	394	1.1%
10% uplift on annual management costs	399	2.3%
15% uplift on annual management costs	403	3.4%

Scenarios 1 and 3 increase the overall net present value of costs by between 1% and 3% over a 100-year period, based on an uplift of between 5% and 15% in annual management costs. The net present value is similar under these two scenarios, since they involve a similar overall uplift in costs, the only difference being that Scenario 1 involves a set % increase in annual management payments over the whole period whereas Scenario 3 converts this into a one-off capital sum.

Scenario 2, which has similar costs to the baseline scenario in years 1-10 but then involves cumulative increases in costs every 10 years, increases the net present value of costs by between 4% and 14% over the 100-year period, for a cost uplift of between 3% and 11% every 10 years. Because the cost uplifts in scenario 2 are cumulative, they increase costs compared to scenarios 1 and 3, as annual management costs rise steeply in the latter decades of the 100-year period. A 3.7% cost uplift every 10 years under Scenario 2 has a similar effect on overall costs as a one-off 10% increase in costs for the whole 100-year period under Scenarios 1 and 3.

6 Overall implications for the costs of meeting environmental land management priorities

This section summarises the overall estimates of the costs of meeting environmental land management priorities in the UK, combining the analysis in sections 2 to 5 of this report.

Table 6.1 presents the combined cost estimates, bringing together updated estimates of the costs in the environmental land management costings model (Section 2) with the additional cost elements for environmental advice (Section 3), securing vulnerable high nature value farming and associated farm business advice (Section 4), and securing long term changes in land use.

Table 6.1: Estimated overall costs of meeting environmental land management priorities in the UK (£m per annum over 10 years)

Land management costs	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	518	42	381	120	1,061
Boundary features	261	50	77	49	437
Historic environment	50	4	39	8	102
Arable land	486	18	47	5	556
Grassland	187	54	75	40	356
Organic	17	0	3	5	26
Total land management	***1,520***	***168***	***622***	***227***	***2,538***
Additional elements					
Environmental land management advice	34	3	21	4	62
Securing vulnerable high nature value farming	112	15	80	40	247
Business advice to vulnerable HNV farms	3	0	1	1	5
Securing long term changes in land use	6	1	4	1	12
Sub-total: Additional cost elements	***154***	***19***	***107***	***46***	***326***
Total	**1,674**	**188**	**729**	**273**	**2,864**
Proportion of total	60%	7%	25%	9%	100%

These additional cost elements increase the overall estimated annual cost of meeting environmental land management priorities in the UK to £2.9 billion per annum over the next 10 years.

This figure represents an updated overall estimate of the costs of meeting environmental land management priorities in the UK, as defined in the 2017 report. The largest increases arise from the inclusion of estimates of the costs of maintaining vulnerable high nature farming systems, which were not included in the previous estimates.

As before, some care is needed in interpreting the figures presented. The exercise has highlighted that there is no single correct answer to the question, and that the cost estimates are sensitive to the assumptions and inputs used in the model. One major variable relates to the overall level of ambition applied in estimating land management needs, and the model was therefore designed to allow the policy choices and assumptions regarding the scale of need to be varied. While the work involved a detailed and wide-ranging assessment, and extensive consultations with experts and stakeholders, the previous report noted that the model would benefit from further development and refinement in several areas. These include the specification of needs for water quality, soil management and the historic environment.

As well as providing a broad assessment of the financial needs for achieving environmental land management priorities in the UK, the model can be used to make alternative estimates of financial needs, based on different inputs, assumptions, and policy and economic scenarios. It is hoped that the assessment and the model can be further refined and developed, based on peer review, expert input and further targeted research, and that the model will be helpful in informing further discussion regarding financial needs for environmental land management after Brexit.

7 Potential alternative ELM payment methodologies

7.1 The Issue

Until now, agri-environment payments and woodland grants in the UK have mostly paid land managers for undertaking prescribed activities designed to protect and enhance the environment. Payments have been calculated based on the costs incurred and income forgone in undertaking the defined land management practices, in accordance with EU rules. The costings model described in this report uses a similar approach, estimating the extent of land management activities required to deliver environmental priorities, and assessing the costs of delivering these activities based on costs incurred and income forgone (based on average yields and cost structures).

Defra and the Welsh Government are both currently exploring potential options for new payment methodologies which incentivise the delivery of public goods by rewarding outcomes and reflect the value of natural capital and ecosystem services in the payments made.

This section examines alternative methodologies for environmental land management payments, and their potential advantages, disadvantages, applications, limitations and costs.

7.2 Current thinking on ELM payment methodologies in England and Wales

Defra and the Welsh Government have both announced an intention to change the way that land managers are paid for environmental public goods and are reviewing the methods used to calculate payments. No such proposals have been announced so far in Scotland or Northern Ireland.

England

In *Health and Harmony*, its consultation on the future for food, farming and the environment in a Green Brexit (Defra, 2018a), the Government announced its intention to introduce a more 'user friendly' design for environmental land management payments in England, which will aim to reduce prescription and bureaucracy, while encouraging participation and enabling environmental improvements to occur countrywide. It also pledged to investigate innovative mechanisms with the potential to achieve better environmental outcomes and improve value for money. Such mechanisms could include reverse auctions, tendering, conservation covenants and actions which encourage private investment in natural capital. Different payment options will be explored through these mechanisms, with the potential to offer fair rewards and strong incentives for participation, in return for increased levels of public benefits from improved environmental outcomes. Responses to the consultation generally supported the idea of outcome-based payments, but also highlighted some of the challenges involved in such an approach (Defra, 2018b).

The commitment to explore the potential of alternative payment mechanisms was reiterated in the Government's announcement in August 2018 that it would extend the Payment by Results pilot in England by two years[13]. Announcing the extension, Secretary of State Michael Gove criticised current agri-environment schemes as being overly bureaucratic and inflexible, impeding innovation by farmers who wish to improve the environment. He stated that the Payment by Results pilot marks a shift in how the Government thinks about rewarding farmers for their work, and an example of the future of farm payments, rewarding delivery of environmental public goods.

In December 2018, Defra launched a tender for a study to identify and assess alternative payment methodologies for the new ELM scheme in England[14]. The contract will identify and appraise four alternative payment methodologies, one of which will be the existing

[13] https://www.gov.uk/government/news/environmental-farming-scheme-given-green-light

[14] Defra (2018) Invitation to Tender - Environmental Land Management Payments Methodology

methodology based on costs and income forgone. The advantages, disadvantages, practical applications and value for money of these alternative methodologies will be assessed. The terms of reference make clear that the Government favours a system of payments that is linked to delivery of environmental outcomes and is more flexible and less prescriptive than the current approach, with the calculation of payments likely to be informed by assessments of the value of the environmental benefits delivered. The new ELM system will be underpinned by natural capital principles, so that the benefits the natural environment provides to people and wildlife are properly valued and used to inform land management decisions. An annex to the terms of reference lists four types of "innovative mechanisms" that could be used to deliver agri-environment benefits – payment by results, reverse auctions, agglomeration payments and conservation covenants.

Wales

Welsh Government (2018) thinking is set out in the consultation paper *Brexit and our land: Securing the future of Welsh farming*. This proposes a Public Goods scheme (providing ongoing payments for environmental and social outcomes from active land management) alongside an Economic Resilience scheme (supporting economic activities such as food and timber production through investment in physical and human capital). It is envisaged that the public goods scheme will pay for outcomes for which there is currently no market, such as carbon sequestration, water quality improvement, public health, education, heritage management, habitat and species resilience, community resilience and the maintenance of rural social capital.

The consultation paper states that the current Glastir agri-environment scheme is limited, since funding is restricted to costs incurred and income forgone. It is argued that this limits payments in marginal farming systems where income forgone is low or negative, leaving insufficient incentive for participation. Schemes are also restricted in their scope, focusing on environmental outputs and not social ends, and on inputs rather than outcomes, such that land managers may meet scheme requirements without delivering the desired outcomes.

The Welsh Government instead proposes an outcome-based scheme that focuses on rewarding delivery. Land managers will be paid an appropriate value for outcomes related to domestic or international commitments, rather than being compensated for input costs. The scheme will be outcome based and it is envisaged that proxy outputs will often be used to calculate payments. For example, 'improved mitigation of climate change risk' could be paid for through payments for the number of tonnes of carbon dioxide sequestered in new woodland on a farm, estimated by land area and type of woodland. 'Healthy and functioning habitats and ecosystems' could be rewarded through an output proxy based on hectares of habitat land under active positive management.

Valuation of outcomes will be important, and it is acknowledged that new tools will be required to determine appropriate social values for the outcomes sought, as well as robust methodologies for measuring outcome. Valuation will seek to reflect the social value of keeping land actively managed through the retention of people on the land. It is argued that the scheme will need to go beyond payment of costs incurred and income forgone, even though this is the limit specified by WTO rules on agri-environment payments. Responses to the consultation are currently (April 2019) still being processed.

7.3 Defining a typology for alternative ELM payment methodologies

To identify options for an ELM payment methodology, it is first helpful to define a typology that identifies and categorises the different elements.

Any methodology for setting ELM payments will have several dimensions, as set out in Table 7.1.

Table 7.1: Dimensions of an ELM Payments Methodology

Objectives of the ELM payment	The overall objectives of ELM payments will define what public goods are paid for and how payments should be determined. These objectives may be set nationally and/or locally, e.g. through national policies, national and/or local natural capital plans.
Basis for payment	Payment can be based on activities (land management practices) and/ or results (environmental outcomes). Outcomes can be measured at different levels and in different ways, from direct effects on extent and condition of ecosystems/natural capital (e.g. wetness and vegetation structure of peatbogs) to longer term outcomes and effects on ecosystem services (e.g. carbon sequestration, water quality, species populations)
Payment calculation method	Payments may be based either on costs and income forgone, or on the value of benefits being sought, or on a combination of these. Alternatively, they may be individually determined using other methods such as reverse auctions or negotiated agreements.
Payment units	The units used to calculate payments vary according to the payment basis and take a variety of forms (e.g. £ per plan, £ per hectare, £ per grip blocked, £ per point, £ per breeding pair, £ per tonne CO_2e).
Payment structure	Payments may comprise capital and/or annual payments and be structured through fixed universal payment rates, tiered payment structures, geographical supplements, spatially targeted payments, performance related top-ups, or by individual agreement with land managers. Other factors include payment frequency, contract periods and whether payments are fixed or variable over time.
Geographical scale	Payment schemes may cover different spatial scales – e.g. local, catchment, regional or national, or with respect to specific environmental objectives (e.g. within a species breeding range or designated landscape area).
Stakeholders	Relevant stakeholders include eligible beneficiaries (e.g. farmers, foresters, landowners, other businesses, NGOs; either individually or as groups), public authorities (with responsibilities for setting objectives and payment rates, scheme administration, monitoring and evaluation), advisors, private buyers (e.g. water companies) and wider interests (e.g. environmental groups).
Delivery arrangements	Payments are also defined by various practical considerations including contractual arrangements, institutional structures, procedures for administering payments, monitoring and verification processes, and supporting measures such as advice and facilitation.

In practice individual payment methodologies will involve different combinations of these dimensions. Considering each of these dimensions will help in defining a discrete and coherent set of options.

While the different dimensions listed above will together define the payment methodology, some of them (e.g. delivery arrangements, payment units) might be regarded as matters of detail, while others are more central in distinguishing between the main types of payment

methodology. Two elements are likely to be central in defining alternative payment methodologies:

1. The basis for payment (either activities or results); and
2. The methodology used to set payment rates.

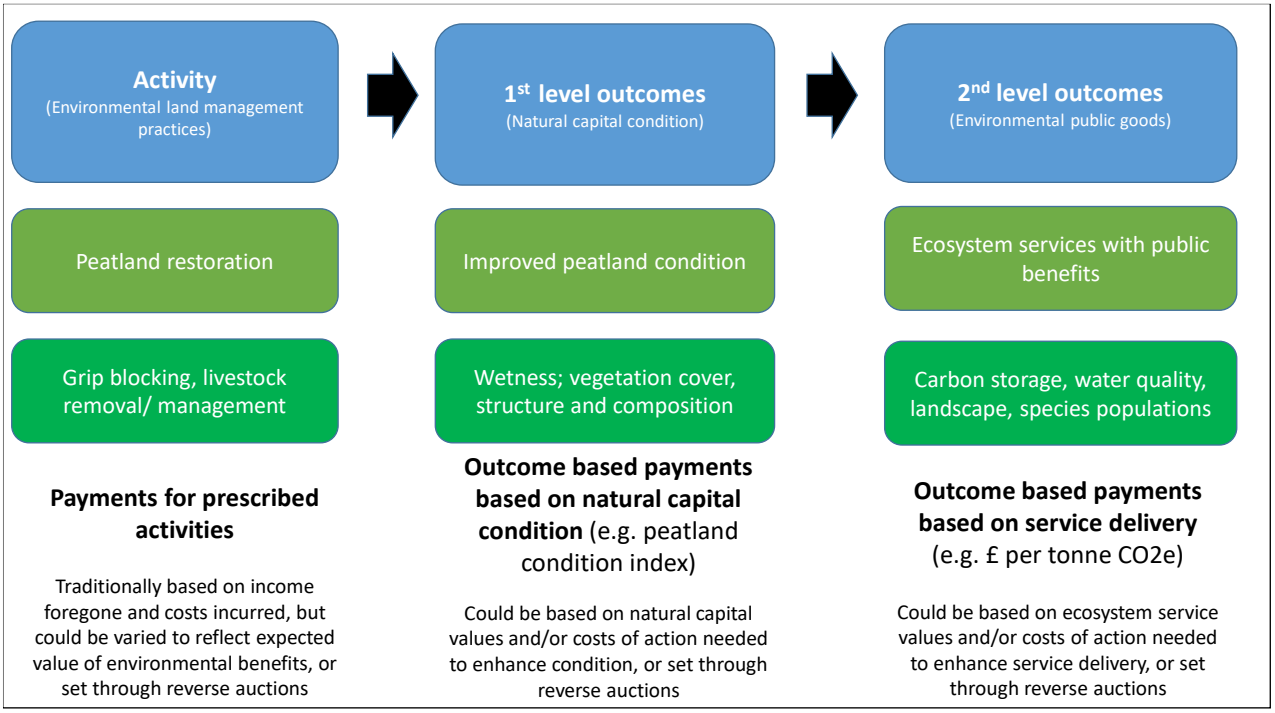
Different methodologies can involve different combinations of these two dimensions. The current system generally pays for prescribed activities, with payment rates calculated from estimates of costs incurred and income forgone. However, payments for the defined activities need not necessarily be based on costs alone and could take account of the value of the benefits that those activities deliver. Alternatively, results-based payments could be calculated from estimates of the costs of the activities that would be expected to be required to deliver the target results, and/or the value of the target outcomes.

7.4 Options for the basis for setting payments – the ELM logic chain

Payments for environmental land management may be made for prescribed activities or for outcomes. Outcomes may be measured in terms of improvements in the extent and condition of natural capital assets, or their effect on the delivery of environmental benefits and ecosystem services.

Figure 7.1 presents a logic chain linking ELM activities and environmental outcomes, using the example of peatland restoration.

Figure 7.1: Logic chain for ELM payments



The current agri-environment schemes in each country offer capital payments for grip blocking and annual payments for the prescribed activities of moorland management and re-wetting, subject to conditions for management of livestock, deer and vegetation. Payment rates (per hectare and per grip blocked) are calculated based on costs and income forgone. An alternative approach could be to base payments on the outcomes of peatland restoration activity, either in relation to the condition of the peatland itself or the ecosystem services it delivers. Peatland condition may be assessed using appropriate indicators relating to wetness, vegetation cover and structure. Relevant ecosystem services may include enhanced carbon storage and sequestration, improved water quality and/or increases in species populations.

Basing payments on environmental outcomes has the potential to incentivise land managers to maximise the environmental outcomes from ecosystem restoration, rather than merely adhering to the prescribed practices. It may also allow more flexibility to land managers in their choice of management practices, and encourage innovation designed to enhance environmental outcomes. However, basing payments on outcomes introduces challenges relating to the quantification, monitoring, verification and valuation of outcomes, as well as the timescales and uncertainties surrounding their delivery.

Figure 7.2 illustrates the range of outcomes expected from activities specified in the environmental land management costings model.

Figure 7.2: Activities specified in the environmental land management costings model, and their expected outcomes

Activities specified in ELM costs model	1st level outcomes – Changes in natural capital condition	2nd level outcomes – Environmental public goods
Priority habitats Maintenance of priority habitats Restoration of priority habitats Expansion of priority habitats	Extent of each priority habitat (hectares) Proportion of each habitat in favourable condition (%) Condition indicators for each habitat based on vegetation structure and diversity, hydrology, soil condition etc. e.g. species richness of hay meadows; wetness, vegetation cover and diversity of bogs	Biodiversity, e.g. species populations Landscape and visual amenity Recreation Carbon storage and sequestration Water quality management Air quality management Flood management Pollination
Boundary features Maintenance of hedgerows Restoration of hedgerows and walls Creation of hedgerows	Extent of hedgerows and walls (km) Proportion of hedges and walls in favourable condition (%) Structure, height and species diversity of hedgerows Structure, height and state of repair of walls	Landscape and visual amenity Cultural heritage values Biodiversity, e.g. numbers of nesting birds Carbon storage and sequestration Water quality management Air quality management Flood management
Historic environment features Management of grassland Clearance of scrub Management of arable land (minimum tillage) Reversion of arable to grassland	Condition of historic environment features Proportion of historic environment features at risk	Cultural heritage values Educational and scientific values Landscape and visual amenity
Management of arable land Management for nectar and pollinators	Density and diversity of nectar and pollinator plants Numbers of seedheads of plants providing winter bird food	Biodiversity, e.g. numbers of breeding and wintering birds Landscape and visual amenity

Management for winter bird food (winter bird seed, winter stubbles) Management for nesting, hibernation and shelter for insects and birds Reversion to grassland (high erosion/ pollution risk and deep peat soils) Winter cover crops Riparian buffer strips Management of field corners, overwinter tramlines, spring cultivation for resource protection Arable fallow	Quality of habitat for nesting/hibernation/ shelter Soil cover and vegetation structure	Recreation Pollination Carbon storage and sequestration Water quality management Control of soil erosion Flood management
Management of grassland Management for nectar and pollinators Management for winter bird food (winter bird seed, winter stubbles) Management for nesting, hibernation and shelter for insects and birds Seasonal livestock removal Buffer strips Take field corners out of management Low input grassland management	Numbers and diversity of nectar and pollinator plants / length of flowering season Numbers of seedheads of plants providing winter bird food / length of time seed is available Quality of habitat for nesting/hibernation/ shelter Soil cover and vegetation structure Vegetation species diversity and sward structure	Biodiversity, e.g. numbers of breeding and wintering birds Landscape and visual amenity Recreation Pollination Carbon storage and sequestration Water quality management Control of soil erosion Flood management
Organic farming Organic management of land Organic conversion	Soil structure, formation and function Water retention Vegetation cover Number and diversity of plant species, including nectar /pollinator plants and seed sources	Biodiversity Pollination services Carbon storage and sequestration Water quality management Control of soil erosion Flood management

7.5 Methods for setting payment rates

Whether based on activities or outcomes, payment rates can be set in different ways, based on:

- The costs and income forgone for undertaking the management practices required (or assumed to be required to deliver the target outcomes);
- The value of outcomes delivered;
- Individual agreements between the buyer (the state) and sellers (land managers or groups of land managers), which set mutually acceptable payment rates. This could be achieved through negotiation or tendering processes such as reverse auctions.

A combination of these approaches is also possible, for example setting core payment rates based on costs and income forgone with top-ups to reflect natural capital/ ecosystem service values.

7.6 The pros and cons of alternative payment methodologies

Payments for activities vs payment for outcomes

The current approach to paying for environmental land management activities has several advantages:

- It is tried and tested – having been implemented since the first agri-environment schemes in the 1980s;
- Through a process of trialling, monitoring and evaluating different prescriptions, we have an increasing (though still incomplete) knowledge base on what works and what prescriptions will deliver the required outcomes;
- It is relatively easy to understand – clear rules can be set about the practices required, permitted and not permitted – as a basis for eligibility for payments;
- The system provides certainty to land managers about the levels of payments they receive, providing they undertake the practices required – this reduces risk and provides a stable source of income;
- Basing payments on specified activities makes payment calculations relatively straightforward using the costs + income forgone approach, as there is a clear link between the prescribed activities and the costs incurred and income forgone;
- Payment for activities gives budgetary certainty, as the levels of payments are known at the time the agreement is established.

However, the current system also has several limitations:

- It has been criticised as being inflexible and bureaucratic, requiring land managers to follow a set of pre-determined rules to be eligible for payments;
- Nationally determined rules about land management practices may fail to reflect local variations in farming conditions which may influence environmental needs and outcomes;
- Payments require land managers only to deliver a minimum level of environmental activity to qualify for the payment – there is no incentive to go beyond this or to strive to deliver additional environmental outcomes;
- A rules-based system offers limited opportunity for land managers to apply local knowledge or try new approaches to enhance environmental outcomes;
- Monitoring compliance with management prescriptions may not always be easy. For example, it may be more difficult to check compliance with prescribed limits on fertiliser applications than to assess changes in vegetation structure and composition; and
- The system as a whole has so far failed to address environmental land management priorities in the UK. For example, farmland wildlife continues to decline, and water quality targets have not been met. It can be debated whether the

payments methodology has contributed to this failure, along with other factors such as limitations on funding and the scale of activity supported. The modelling estimates in this study suggest a significant upscaling in action and resources is needed if environmental land management priorities in the UK are to be fully addressed.

Results based payments therefore offer potential advantages compared to activity-based payments. By paying for results rather than actions, they provide more freedom and incentive to land managers to vary land management actions, to adapt approaches to local conditions and knowledge, to test new approaches, and to seek to enhance environmental outcomes over time. Providing measurable outcomes can be defined, they potentially offer advantages in monitoring, because results can be observed and there is no need to verify compliance with rules.

Challenges with the results-based approach include:

- It is more uncertain for participants, because the results of land management actions may not be predictable. As well as gaps in knowledge and skills, uncertainty may be increased by changes in external variables such as weather conditions or wider environmental pressures;
- There may also be uncertainties for the authorities, as budgetary costs will be affected by uncertainties in scheme results;
- Time lags may affect the delivery of environmental outcomes. The condition of ecosystems may take time to respond to changes in management practice. For example, it may take decades for peatlands to reach favourable condition following restoration activities. Depending on the payment structure, this may create large time lags before land managers are paid for results;
- Some outcomes (e.g. water quality, species populations) may be beyond the direct control of individual land managers. The “first level outcomes” illustrated in Figure 7.1 above are likely to respond more directly to changes in land management, and be subject to less uncertainty regarding external influences, than the “second level outcomes”;
- The ability to set payments and determine eligibility is dependent on the ability to define robust results-based indicators. This may vary between different environmental outcomes. Results based payments will be difficult to implement if results are difficult to measure or to monitor or are subject to fluctuations. For example, while the number of plant species in a meadow might be relatively easy to measure and verify (with appropriate skills), numbers of butterflies fluctuate greatly from day to day and year to year in response to weather conditions and other variables. Some outcomes (e.g. carbon sequestration) might need to be modelled rather than measured directly, introducing potential uncertainties regarding estimation methods.

With reference back to the logic chain in Figure 7.1, the choice of outcomes on which payments are based is likely to be an important factor when seeking to address the challenges associated with results-based payments. Linking payments to first level outcomes (natural capital condition) may reduce uncertainty and time lags and may help in defining robust and measurable indicators on which to base payments. This approach has been used in results-based payment schemes in Europe, such as:

- Payments for flower rich grasslands in Germany, which are based on the presence of indicator species[15];

[15] http://ec.europa.eu/environment/nature/rbaps/articles/2_en.htm

- The Burren Farming for Conservation Programme, Ireland[16], which combines results-based payments based on condition scores for grassland and other habitats with payments for capital works;
- The Ergebnisorientierter Naturschutzplan (ENP - 'Results-based nature conservation plan') in Austria, which offers results-based payments for each parcel of land based on measurable indicators for habitats and species[17];
- RAPCA (Red de Áreas Pasto-Cortafuegos de Andalucía)[18] in Andalucía, Spain, which bases payments designed to control wild fires on assessments of vegetation structure
- Ecological compensation areas – for species rich vineyards and species rich grasslands in Switzerland[19], where payments are set at a standard per hectare rate but conditional on achieving a minimum ecological condition score;
- Grassland management schemes in France[20], where payment is made for achieving a minimum level of ecological condition or the presence of indicator species.

These examples indicate that results-based payments may be varied according to an indicator score (as in the Burren scheme) or merely conditional on achieving a minimum level of ecological condition (as in the case of the French and Swiss grassland schemes).

A similar approach is being adopted in the England RBAPS pilots (Le Page, 2018):

- In the arable pilot, payments are tiered by the number of plant species providing seed heads as winter bird food and the number of summer flowering plant species benefiting pollinators; and
- In the Wensleydale pilot, payments are based on hay meadow condition score (including numbers of positive and negative plant species present, and whether there are damaging activities), and a habitat score for breeding waders (based on vegetation height, rush cover, scale and quality of wet features and presence of damaging operations).

Experience from the England pilots to date suggests that results have been promising in incentivising environmental management and encouraging land managers to enhance results over time and in building knowledge and buy-in. They are also more flexible and can be less bureaucratic than rules-based schemes. A significant up-front investment is required to provide advice to land managers and to build confidence. External variables such as the weather can affect results and introduce risks. Another challenge relates to the scalability of locally based schemes and whether it is feasible and practicable to use them as the basis for a national programme.

Elsewhere in Europe, schemes have also based payments on the presence and number of pairs of breeding species (e.g. harriers in Germany, golden eagles in Finland, waders in the Netherlands, and large carnivores in Sweden) (IEEP, 2014). However, there is often an element of compensation in these schemes (i.e. they could be seen as payments for tolerating the species and adapting to its presence), and it is arguable how closely payments link to results (since low population density species are likely to be insensitive to management practices).

[16] http://ec.europa.eu/environment/nature/rbaps/fiche/burren-farming-conservation-programme-bfcp_en.htm

[17] http://ec.europa.eu/environment/nature/rbaps/fiche/results-based-nature-conservation-plan-ergebnisori_en.htm

[18] http://ec.europa.eu/environment/nature/rbaps/fiche/rapca-red-de-areas-pasto-cortafuegos-de-andalucia-_en.htm

[19] http://ec.europa.eu/environment/nature/rbaps/fiche/search/country_CH_en.htm

[20] http://ec.europa.eu/environment/nature/rbaps/fiche/search/country_FR_en.htm

Costs and income forgone vs payments based on natural capital values

Costs incurred and income forgone

The current approach to basing payments on costs and income forgone is defined in WTO rules, and applied in the EU through the Rural Development Regulation. WTO rules state that to be green box compliant, agri-environment payments should not exceed costs incurred and income forgone. The RDR states that payments shall compensate beneficiaries for all or part of the additional costs and income forgone resulting from the commitments made. Where necessary, they may also cover transaction costs up to a value of 20% of the premium paid for the agri-environment-climate commitments. Where commitments are undertaken by groups of farmers or other land managers, the maximum level shall be 30%. These percentage limits have been set by the EU rather than being specified by the WTO. However, payments in the UK have generally not included an allowance for transaction costs. Some commentators (e.g. Bureau, 2017) have argued that the Commission has made an overly strict interpretation of WTO rules in the RDR, and that more flexibility could be applied in diverging from the costs and income forgone approach in order to reward environmental outcomes.

The advantages of the current approach are that:

- It is an established, tried and tested system that has been implemented in the UK for the last 30 years;
- It is a relatively low-cost way to procure land management activities - setting payments on costs and income forgone limits budgetary costs while still achieving widespread uptake;
- There is some flexibility within the method to vary payment rates to enhance incentives and uptake where necessary, particularly relating to the assumptions adopted regarding the baseline practices, costs and income forgone. Applying more generous assumptions regarding these variables allows higher payment rates. Higher rates of uptake can be achieved by basing the costs and income forgone calculations on the types of farms and farm systems that need to be enrolled to achieve the target rate of uptake. It could also potentially be extended to take account of the whole costs of management of marginal high nature value farms (see Section 4);
- The method is practicable – while there may be some debate about the assumptions that can be employed to arrive at payment rates, they are relatively easy to calculate based on existing data;
- Standard payment rates can be set, providing certainty to participants and reducing administrative burdens; and
- It is compatible with WTO rules on green box payments (and would be likely to remain so, even if applied in a more flexible way).

Disadvantages are that:

- The system relies on an assumption that the benefits of the practices supported exceed the costs, which may not necessarily be the case;
- Costs and incomes vary between different types of farm and in different locations. Payment rates therefore need to be set based on “average” businesses and will inevitably overcompensate some while undercompensating others. In consequence:
  - Schemes will tend to attract participants that can comply most easily and cheaply with the stated requirements (or already do so), not necessarily those with potential to deliver the greatest environmental benefits;
  - Payment rates may be sufficient to achieve a moderate level of uptake but may need to increase significantly as target levels of uptake rise. Setting standard payment rates may fail to achieve high levels of uptake without greatly overcompensating low cost participants;

- Where payments do equate to costs and income forgone, this offers little profit for the average land manager. A shift from direct payments to ELM payments based on costs and income forgone will therefore tend to reduce farm incomes (other things being equal). ELM payments made on this basis may not be sufficient to maintain the viability of marginal high nature value farms (see Section 4). At the same time, it is important to recognise that farms have different characteristics and cost structures and that payment rates based on costs and income forgone for the average farm will be profitable for many farms.

The second issue could potentially be addressed by varying payments to reflect differences in costs between regions and farming types, though this would increase complexity and administrative burden and might face resistance from beneficiaries.

Natural capital values and benefits

Recognising these problems and limitations, Defra and the Welsh Government are both interested in exploring alternative payment methodologies to the costs and income forgone approach. Defra has indicated that the new ELM system will be underpinned by natural capital principles, so that the benefits the natural environment provides to people and wildlife are properly valued and used to inform land management decisions. While recognising that not all aspects of natural capital and the benefits provided to people can be easily measured and valued in monetary terms, Defra has indicated that ELM payments will likely require some form of estimation of the value of environmental benefits in order to calculate payments. Similarly, the Welsh Government has proposed that land managers be paid an appropriate value for outcomes, rather than being compensated for input costs, acknowledging that valuation of outcomes will be important and that new tools will be required (especially for social outcomes).

Payments based on natural capital values and benefits have the potential to enhance environmental outcomes by:

- Contributing to the delivery of the natural capital approach, increasing focus on the importance of investing in the creation, restoration and maintenance of natural capital assets, the public benefits this delivers and their value to society;
- Enhancing the rewards that land managers receive from participating in ELM schemes, helping to incentivise ELM activities while sustaining and diversifying incomes;
- Encouraging the choice and location of ELM practices where they have potential to maximise public benefits; and
- Attracting private sector finance for ELM, by providing a framework in which additional buyers can pay for the delivery of different benefits.

However, this approach has several challenges and potential limitations:

- It is not yet clear how payments based on natural capital values and benefits would work in practice, and how valuation evidence would be used to calculate payment rates;
- Evidence of the value of natural capital and ecosystem services is incomplete. Some services (e.g. carbon storage and sequestration) are relatively easily valued, while others are much more difficult to value (e.g. biodiversity) or to quantify (e.g. flood management). Further complications are that natural capital values vary geographically, and that evidence of marginal as well as total values is likely to be needed to inform calculations of payment rates;
- Basing payments on natural capital values rather than costs presents a risk that budgetary costs will increase significantly, since most evidence suggests that the benefits of ELM actions greatly exceed their costs. Given that public budgets for ELM schemes are likely to be finite, basing payments on values rather than costs could increase payment rates per hectare and therefore limit the scale of ELM action that can be delivered.

We have estimated the overall costs of meeting ELM priorities in the UK – based on costs incurred and income forgone, at around £2.5 billion annually (Section 2). Given that there is much evidence that the benefits of ELM action greatly exceed the costs, the overall cost of basing payments on environmental benefits could be much larger than this. Constraints on the ELM budget would likely limit the scale of ELM action that could be delivered if levels of payment increased.

In its Future Farming and the Environment Evidence Compendium, Defra (2018) estimated a benefit cost ratio of 3.2: 1 for ELM payments in England – i.e. each £1 spent on scheme payments delivers public goods to the value of £3.20. This suggests that payment rates could be tripled and still deliver value for money for the taxpayer. Such a change would substantially increase profits for land managers, while reducing the level of ELM activity that could be paid for within a fixed budget. For this reason, it is unlikely that payment rates would be based directly on estimates of the value of benefits – it is more likely that setting of payment rates would be informed by estimates of value.

Studies of the value of environmental benefits have been used to inform evaluations of schemes, helping to assess value for money[21]. They can also help spatial targeting of payments by providing information about how values vary by location[22]. Examples of natural capital valuation evidence being used directly to calculate ELM payment rates are, however, lacking.

Basing payments on costs or values – implications for consumer and producer surplus

A shift from payment based on costs and income forgone to the value of outcomes is likely to entail a shift in the value of **consumer and producer surplus** resulting from ELM schemes.

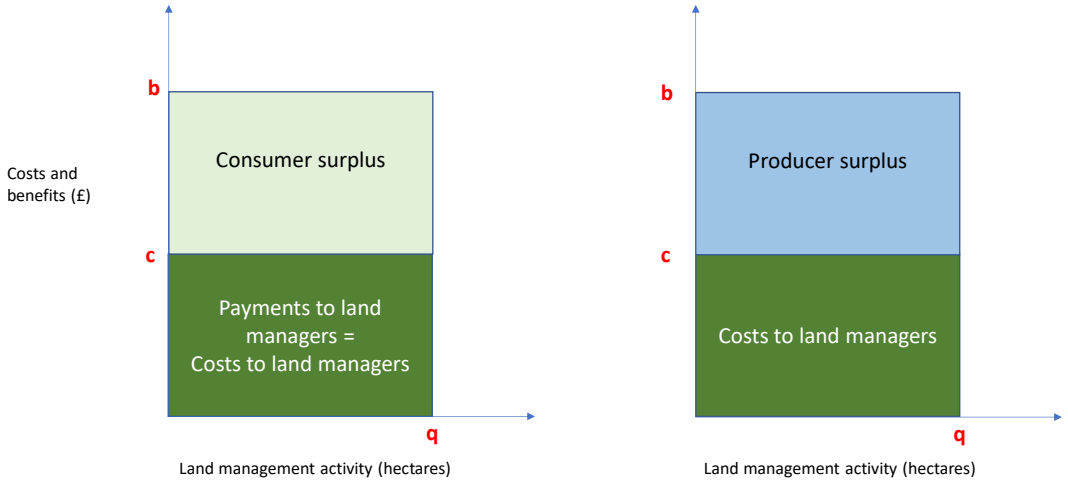
Consumer surplus is the difference between the amount a consumer is willing and able to pay for a good or service, and the price actually paid. In the case of ELM schemes, this can be seen as the difference between the value of the benefits of these schemes to society, and their costs to the taxpayer. Defra's estimate that each £1 spent on ELM payments yields benefits of £3.20 suggests that the current system delivers substantial levels of consumer surplus – i.e. the benefits to society greatly exceed costs to the taxpayer.

Producer surplus is the difference between the price a producer is paid for supplying a good or service and the minimum price at which they would be willing to supply it. Assuming that land managers require financial compensation to adopt ELM practices, the minimum payment they would be prepared to accept would be equivalent to the costs incurred and income forgone. Producer surplus is therefore the difference between the ELM payment and the cost and income forgone for the individual farm.

[21] E.g. Defra valuation studies of environmental land management schemes, Biodiversity Action Plan, SSSIs etc

[22] For example, using tools such as Natural Capital Valuation Online (NEVO)

Figure 2: Simple illustration of potential changes in consumer and producer surplus



A. Payment rate set at c (costs + income foregone)

B. Payment rate set at b (value of benefits)

The figure above illustrates the potential effects on producer and consumer surplus in changing the payment methodology. Let us assume, for simplicity, that environmental land managers all have similar cost structures and incur costs and income forgone of £c per hectare in undertaking ELM practices. In example A, the government is therefore able to procure ELM practices over q hectares at a cost to the taxpayer of £qc. If we also assume that for each hectare, environmental land management delivers benefits of £b, the benefits to the taxpayer amount to £bq and there is a consumer surplus of £q x (b-c). However, there is no producer surplus and land managers receive the minimum reward for their efforts. The government can pay land managers more than £c and up to £b per hectare, resulting in a reduction in consumer surplus and an increase in producer surplus, enhancing the incomes of land managers. A payment of £b per hectare would shift the entire consumer surplus to producers (example B).

As well as affecting the balance of costs and benefits between producers and consumers, the choice of payment rate also affects the budgetary cost of the ELM scheme and the amount of land management activity that can be procured. In the example above, the increase in payment rate from c to b results in a major increase in the cost to the taxpayer (from qc to qb) for the same level of environmental land management activity (q). In reality, the ELM budget is likely to be limited, so the higher payment rate would reduce the extent of ELM activity that could be procured. On the other hand, the assumption of a flat supply curve is unrealistic, so even payments based on costs and income forgone would likely have to increase to enhance uptake. Furthermore, a change in the payment mechanism and level might be expected to incentivise higher value land management activities, helping to enhance benefits as well as costs.

The example above is an oversimplification, since environmental land managers vary widely in their cost structures, knowledge and skills, motivations and local circumstances, so the assumption of a horizontal supply curve (where the government can procure any amount of ELM activity at price c) is far from the reality. The costs, income forgone, and benefits of ELM activities vary widely and are difficult to quantify and standardise. The benefits from ELM activity can also be expected to vary widely in relation to local circumstances and land management practices. The marginal benefits would also normally decline as ELM activities increase – for example the added benefit of an extra hectare of habitat or landscape might be expected to decline as supply increased.

While highly simplified, the example does help to illustrate the potential effects of changing the payment mechanism on producer and consumer surplus, budgetary costs and land managers' incomes.

An important consideration is how these relationships may change as ELM payments are upscaled and move from the second pillar of the CAP to play the central role in public support for land management. To date, there has been generally widespread uptake of agri-environment schemes based on costs and income forgone, though this has been constrained by the payment rates offered for some options, and there have also been some fluctuations in uptake following introduction of new schemes. However, we might expect a significant upscaling of ELM activity to require increases in rates of payment - i.e. the supply curve would slope upwards. This would enable land managers with lower costs to profit more from the delivery of environmental public goods, hence increasing producer surplus. A major limitation of the costings model is that it is based entirely on existing ELM payment rates – it assumes that the levels of environmental land management activity required to meet environmental priorities can be achieved at existing levels of payment. We might expect, however, that increasing ELM activity overall would require payment rates to increase, in order to attract land managers who are less motivated to join schemes or incur higher costs in doing so.

Evidence that there is a large gap between the current costs of ELM schemes and the benefits delivered suggests that payment rates could increase, enhancing rewards to land managers and incentivising uptake, while still delivering good value for money for the taxpayer. At the same time, budgetary constraints will mean that care needs to be taken to limit ELM payment rates to enable broad participation and to maximise the contribution of schemes to environmental objectives. All of this suggests a need – when setting payment rates - to find an appropriate balance between costs/income forgone and the value of benefits. Valuation of benefits is a tool which can help in finding this balance, rather than a direct means of determining rates of payment.

Both the costs/ income forgone and natural capital values-based approaches therefore present challenges in setting payment rates that are acceptable to land managers, reflect variations in local conditions and business structures, take account of environmental benefits and values, and find the right balance between the costs of service delivery and the value of benefits delivered.

It should be noted that combined methodologies – which calculate payments with reference to both costs and income forgone and the value of benefits – could also be considered. For example, one approach would be to use costs and income forgone as the starting point in calculating payment rates but varying them to incentivise environmental outcomes and reflect variations in natural capital values.

Reverse auctions

Reverse auctions have the potential to address many of these challenges and to establish prices for ELM delivery that balance costs and benefits and are acceptable to both buyers and sellers. Reverse auctions are competitive bidding systems in which multiple sellers compete to supply a service, bidding down prices and enabling buyers to locate the most competitive sellers, thereby helping to allocate budgets efficiently (World Resources Institute, 2007). They can potentially be used to procure ELM activities (i.e. land management practices) and/ or public good outcomes. One of the best-known examples internationally is the BushTender auction for vegetation protection in Victoria, Australia, begun in the early 2000s, which has subsequently followed by numerous other examples in that country (Rolfe et al, 2017). In the UK, EnTrade - an online reverse auctions platform used by Wessex Water, United Utilities and Natural England - had run six auctions in eight catchments by December 2017, receiving bids for over 150 tonnes of nitrogen at a cost of over £300,000 (Peacock, 2017).

Advantages of reverse auctions are that they:

- Help to set prices that are acceptable to both buyers and sellers, helping to overcome problems associated with imperfect and asymmetric information;
- Address the problems associated with fixed payment rates and varying cost structures, by providing flexibility for land managers to vary their bids according to their circumstances; and
- Have been shown to deliver environmental land management activities cost-effectively where they have been applied.

Potential limitations are that they:

- Have mostly been implemented on a limited scale only, to address specific local needs. According to Rolfe et al (2017), theory and experiments clearly suggest that uniform prices are likely to be more efficient in large scale, repeat tender settings;
- May have high administrative and transaction costs, because of the time needed by land managers to present bids and by the authorities to evaluate them and select successful bidders;
- May present challenges in allocating resources across competing bids which promise different combinations on disparate environmental outcomes; and
- Are unfamiliar to most land managers; a process of learning and support to build confidence may be required to secure participation.

7.7 Case studies of the potential for alternative payment methodologies

The following case studies explore the potential to consider alternative payment methodologies in two different environmental land management settings:

A. Management and restoration of blanket bog; and

B. Management of arable land for farmland birds and pollinators.

A. Management and restoration of blanket bog

ELM needs and priorities

Blanket bog is a wet peatland habitat that dominates much of upland Britain and is one of the most extensive remaining semi-natural habitats in the UK, covering a total of around 2.25 million hectares of which 80% are in Scotland. Much of the UK resource has been degraded through drainage, burning, afforestation, overgrazing, peat cutting and/or air pollution, and less than 20% is estimated to be in a natural or near-natural condition (Taylor et al, 2015). This adversely affects its habitat value and the delivery of ecosystem services (such as regulation of climate, water flows and water quality). Action is needed to restore degraded blanket bogs, by blocking drains to raise water levels, reducing grazing pressure, removing plantations and revegetating bare peat. Ongoing management depends on avoiding overgrazing and other damaging operations such as burning (JNCC, 2008).

Current agri-environment payment prescriptions and rates

Agri-environment schemes in all four countries of the UK offer payments for maintenance and restoration of blanket bog, as well as capital grants for blocking grips and drainage channels and erecting fencing to exclude livestock. Basic management payments range from £1.24/ha/yr (Scotland, for managing deer only) to £58/ha/yr (Wales). Various supplements are provided for management of vegetation, rewetting and/or excluding livestock, which mean that annual payments can vary between £1 and £100 per hectare per year depending on the management adopted. Further details of payment rates are given in Annex 1.

Financial needs identified in environmental land management costings model

The costings model estimates the annual costs of maintaining blanket bog habitats at between £34 million and £109 million per year, with additional restoration costs at £56-62

million per year over a 10-year period. Evidence in the wider literature suggests a wide range of restoration costs from £200-£7,000 per hectare, depending on the condition of the ecosystem, and suggests that the above estimates may be conservative. Some further details of the costs of blanket bog restoration and management are given in Annex 1.

Benefits of ELM – outcomes, ecosystem services and values

Blanket bog delivers valuable ecosystem services. The most important of these include:

- Climate regulation;
- Water quality regulation;
- Flood prevention; and
- Biodiversity.

The delivery of these services is greatly influenced by natural capital condition. Degradation of peatlands can change then from a carbon sink to a carbon source, undermine their adaptive capacity to climatic and other changes and compromise the delivery of the critical services they provide (Glenk and Martin-Ortega, 2018).

A variety of studies have valued blanket bogs and the services that they provide:

- ***Climate regulation services*** have been assessed by estimating the value of carbon stored and sequestered, and valuing this using the non-traded price for carbon. Studies have estimated a wide range of per hectare benefits of restoration, depending on the condition of the ecosystem and the restoration method. eftec (2015) estimated benefit cost ratios of around 2:1 for most restoration works, based on carbon values alone, but rising to 20:1 for low cost measures such as cessation of burning and reduction of overgrazing. The Natural Capital Committee (2015) found that peatland restoration on around 140,000 hectares in upland areas would deliver net benefits of £570 million over 40 years, based on carbon values alone.
- ***Water quality improvements*** can be assessed through estimates of reduced water treatment costs, with peatland restoration improving water quality by reducing sediment, phosphate and dissolved organic carbon. Benefits vary by location so are less easily estimated through standardised assessments. eftec (2015) estimated the water quality benefits of restoration of peatlands at Keighley Moor at £97/ha/year and suggested that this figure could be extrapolated to other upland areas with high rainfall close to centres of population. The water quality benefits of a PES project at Pumlumon (Cambrian Mountains) were estimated at £75/ha/year.
- ***Flood management*** benefits are potentially significant and seen through reductions in the costs of flooding and expenditures on flood defence measures. However, they vary widely by location and scientific uncertainties make them difficult to estimate.
- ***Biodiversity benefits*** have been estimated using surveys of the public's willingness to pay to protect and restore blanket bog habitats. These studies have typically assessed biodiversity values in combination with other ecosystem services (such as climate and water quality regulation). Glenk and Martin-Ortega (2018) estimated the benefits of improving Scottish peatlands from poor to good condition at £242-302 per hectare per year, and from intermediate to good from £0 to £414 per hectare per year. It was estimated that a 10,000-hectare restoration programme would deliver a net present value of £7.9 million and a benefit: cost ratio of 1.39. Christie et al. (2011) estimated the benefits of blanket bog in the UK at £275/ha per year, rising by a further £136/ha/year if the UK Biodiversity Action Plan were fully implemented.

Further details of the value of benefits of blanket bog, and associated restoration activities, are included in Annex 1. Overall, evidence of the value of blanket bog and the services it provides is relatively strong compared to most other ecosystems, reflecting the scale of the asset, the strength of the investment case and the relative ease of valuation (especially in relation to carbon).

Potential for alternative payment methodologies

The current approach

The current rules-based approach is relatively simple to administer and has achieved high rates of uptake in England, with an estimated 205,000 hectares (92% of the priority habitat area) covered by basic moorland management and restoration options under Countryside Stewardship, more than for any other priority habitat (Atkins, 2018). No information on the effectiveness of schemes for blanket bog ecosystems is available.

Possible drawbacks of the current system are:

- The standard rules-based approach may not reflect the diversity of local conditions, drivers and needs of blanket bog ecosystems;
- Land managers are required to follow basic prescriptions to qualify them for payments. There is no incentive to go beyond these basic requirements or to try new approaches designed to enhance the condition of bogs and the services they provide;
- The income forgone approach results in low payment rates for annual management. These may limit incentives for uptake (e.g. in Scotland where payment rates per hectare are very low) or the level of environmental improvements achieved (e.g. in England, where there are high rates of uptake but less evidence of environmental effectiveness);
- Capital payments cover a limited range of works such as grip blocking and fencing. However, blanket bog restoration often requires a wider range of interventions such as re-seeding and planting. These are often addressed through more specialist peatbog restoration projects (e.g. those funded under the EU LIFE programme and SNH Peatland Action programme).

Results-based payments

Results-based payments offer the potential to address some of these limitations by increasing the flexibility for land managers to vary management practices to enhance the condition of peatbog ecosystems, and by incentivising management actions designed to enhance ecosystem outcomes. This would help to reward the delivery of public benefits, and hence to ensure that payments delivered their intended results. Land managers would be encouraged to tailor management and restoration practices to local conditions and needs to achieve specified outcomes.

Payments could be based either on:

- Ecosystem condition - assessed on the basis of wetness, vegetation cover and/or vegetation species diversity. These criteria could be used to establish ecosystem condition scores, with payment made on a £ per point basis, or made on a banded basis (with higher payments for land judged to fall within different condition score bands).
- Ecosystem services - assessed through changes in carbon sequestration, effects on water quality and flooding, enhancements in landscape quality and visual amenity, and/or populations of target species (e.g. numbers of pairs of breeding waders). However, while outcomes for landscape and biodiversity could be observed directly, other ecosystem services (such as carbon sequestration and effects on downstream water quality and flood risk) would need to be modelled based on changes in ecosystem condition. Therefore, ecosystem condition would likely serve as a proxy measure for ecosystem service delivery.

Payment rates could be set based on either costs and income forgone, or in relation to the value of natural capital outcomes. Payments based on costs and income forgone could adopt one of two approaches:

- Setting the average payment based on average costs and income forgone, and offering higher or lower rates of payment for above average outcomes; or
- Estimating the differences in the costs of alternative practices likely to be associated with different levels of ecosystem condition.

There would be several challenges in applying results-based payments to blanket bog restoration and management.

- **Technical knowledge and skills.** Land managers may lack the knowledge and skills to be able to deliver the changes in land management practice and the specific restoration methods needed to enhance ecosystem condition. There will only be benefits in moving from the current rules-based approach if land managers are able to deliver environmental enhancements without following specified prescriptions. Provision of expert advice and guidance may help but is likely to be costly to deliver.
- **Timescales for ecosystem restoration**. The timescales for restoration of degraded blanket bog can be very long, and are often uncertain (Natural England, 2013). Results based payments for restoration activities may therefore be received only after many years, following up-front capital costs;
- **Uncertainties in ecosystem response.** The responses of the ecosystem to management and restoration measures are subject to scientific uncertainty and are likely to vary by location. Uncertainties make it difficult to assess the investment case for restoration and create risks for land managers investing in blanket bog restoration.

These are major challenges and may make an approach focused purely on (long-term) ecosystem outcomes infeasible. There may be a need to share the risks between the land manager and payment authorities, and to ensure an appropriate balance between short term and long-term returns. This could be achieved by an approach which combines capital grants with payments for long term outcomes. Alternatively, a results-based approach could seek to ensure that sufficient reward was provided to short term outcomes (e.g. changes in water levels), while also rewarding longer term improvements in condition (e.g. vegetation structure and diversity).

Payments based on natural capital values

An alternative to the costs and income forgone method for calculating payments would be to base them in some way on the value of improvements in natural capital and the ecosystem services it provides. Evidence of natural capital and ecosystem service values could potentially be used to set ELM payment rates, either on the basis of:

- **Payment for ELM actions**. Evidence of the value of benefits suggests there would be a case for enhancing payment rates for bog restoration and maintenance in cases where current payments are insufficient to incentivise uptake. The value of payment rates could be informed by estimates of the expected value of outcomes from the actions supported.
- **Payment for ecosystem outcomes**. Valuation evidence could potentially be used directly in setting the value of outcome-based payments. For example, payment rates could be informed by estimates of increases in the value of services delivered (based, for example, on the value of enhanced carbon sequestration estimated to result or estimates of society's willingness to pay for enhanced service delivery).

Evidence of natural capital and ecosystem service values can be used to identify upper limits on ELM payment rates, to ensure that the benefits of ELM schemes exceed the costs. Payment rates need to be set below estimates of the value of benefits to ensure that schemes deliver net benefits to society. Setting payment rates at or close to estimated benefit values would increase returns to land managers but could significantly increase the costs of ELM schemes, which in turn would reduce the extent of land management activity that could be funded from a fixed budget. Abandoning the cost and income forgone approach to calculating payments would also contravene WTO rules on green box agri-environment payments.

The advantage of this approach is its potential to incentivise action where it has potential to deliver greatest benefit. For example, payments that reflect the value of blanket bogs for water quality and flood regulation will encourage restoration in those areas where these services have greatest value (especially those located close to centres of population).

Potential challenges and disadvantages of this approach are:

- There are significant **gaps and uncertainties in valuation evidence** – a full and robust estimate of the benefits of blanket bog restoration and maintenance is not yet possible;
- There is **stronger evidence of the value of some services** (e.g. climate regulation) **than others** (e.g. flood regulation), and therefore a risk that valuation prioritises some services over others. Payments based on carbon values should deliver wider ecosystem service benefits, though they are unlikely to incentivise action in locations where other services are maximised;
- Strong evidence that the benefits of bog restoration exceed the costs (with benefit cost ratios upwards of 2:1) raises a risk that payments based on valuation evidence could be higher than at present, potentially **limiting the extent of action that can be funded**. For this reason, payment rates are more likely to be informed by valuation evidence, rather than solely based on estimates of values.

The ability to map current and potential natural capital values to reflect a wide range of ecosystem services would enable payments to be differentiated spatially. However, in the absence of comprehensive valuation evidence, alternative approaches could be considered (e.g. locational supplements in areas prioritised for the delivery of particular services, based on physical mapping of flood risk or species' ranges).

Payments based on the value of carbon storage and sequestration are more easily calculated than for other services, although estimates of net changes in carbon vary widely by location and restoration undertaken. Rewilding Britain (2019) suggests an annual payment of £292/ha for restored heathland and peatlands, based on a mid-level estimate of net gain of 2 tonnes of carbon (7.3 tonnes of CO_2e) per hectare per year and a price of £40/tonne/CO_2e.

Reverse auctions

Reverse auctions offer strong potential as a means of setting payment rates for capital restoration works for blanket bog, providing an opportunity for bidders to tender to deliver a range of restoration actions suited to local conditions and needs (e.g. revegetation as well as rewetting of degraded bogs).

Using reverse auctions to set payments for ecosystem outcomes is potentially more challenging. Uncertainties in the ecological responses to restoration and management activities make it difficult and risky for land managers to submit bids to deliver outcomes based on changes in natural capital condition or ecosystem service delivery.

Combined approaches – using reverse auctions to price capital restoration works – followed by results-based payments based on longer term changes in natural capital condition – could therefore be considered.

Illustration of potential payment options and rates

Table 7.2 summarises the potential payment structures and payment rates that might apply to the options discussed above. There are uncertainties about how payment rates would be calculated, particularly if they were based on the value of benefits rather than costs, making it possible to specify only the likely direction and broad range of estimates within which they would be likely to fall.

Table 7.2: Options for payment mechanisms, payment structures and costs

Option	Payment Structure	Payment Rates
Current approach: payment for blanket bog restoration and management activities,	Annual management payments - fixed rate payments for blanket bog management	Basic payment rates/ha/yr vary from £1.24 (Scotland) to £58 (Wales), increasing to £30-£100+ including supplements

with payment rates calculated based on costs incurred and income forgone.	- supplements for revegetation, rewetting, livestock exclusion Capital grants for grip blocking, fencing to exclude livestock	Capital grants paid per dam, per metre fence etc. at standard rates. Restoration costs per hectare vary widely (£200-7,000 per hectare), average £830/ha
Payment for results: changes in natural capital condition, calculated based on costs and income forgone	Annual payments would be varied to reflect blanket bog condition, e.g. tiered payments to reflect wetness, vegetation cover and presence of key plant species. Payments based on costs and income forgone of assumed management practices – e.g. assumption that minimum condition would require very basic management and high level condition would require more intervention and lower stocking levels etc. Capital payments for restoration might still be offered; if payments were purely results based with no capital grants, higher annual payments would be needed	Tiered annual payments based on blanket bog condition, e.g. minimum payment of £20/ha/yr for achieving basic condition score rising to £100/ha/yr for highest condition score Capital grants could still be offered as currently; if not, a higher annual payment would be needed in a pure results-based scheme.
Payment for results: changes in ecosystem services, calculated based on value of services	Annual payments reflecting value of services delivered by blanket bog. Payments could reflect value of carbon sequestration and storage – this would likely have to be modelled based on natural capital condition. Value of other services – water quality, flood management, biodiversity – could also be incorporated, where valuation is possible. Annual payments would reflect estimated value of these benefits based on extent and condition of natural capital.	Not straightforward. Payments would need to reflect – but be set somewhere below – estimated value of benefits for carbon, water, flood management, biodiversity. Cost benefit ratios based on carbon alone are 2:1 for most capital restoration works and up to 20:1 for low cost measures (ceasing burning and overgrazing) – this suggests payments could be higher than at present. Annual benefits of restoration activities may range widely, e.g. £100 to £1427 per hectare per year based on net changes in CO_2e of 1.5 to 21.3 tonnes per hectare and current non-traded carbon price of £67/te CO_2e. Rewilding Britain (2019) suggests an annual payment of £292/ha/yr for restored peatbogs, based on carbon values alone. Evidence of water, flood prevention and biodiversity benefits is patchy – possibility to vary payments where these services are important.
Reverse auctions	Land managers bid to maintain and restore blanket bog habitats, specifying a payment rate for activities (e.g. specified capital and annual management works) and/or outcomes (e.g. achieving a specified level of natural capital condition).	Payment rates would be unique to individual bidders and could be lower or higher than under current system.

Conclusions on the potential for alternative approaches

- There is a strong investment case to enhance and upscale action to restore and manage blanket bog in the UK.

- Results-based payment mechanisms offer potential to incentivise action to enhance the outcomes from blanket bog restoration and management. However, they present significant challenges because of the long timescales and uncertainties related to the delivery of outcomes.
- In view of these challenges, there may be merits in combining capital grants with results-based payments linked to ecosystem condition, or in structuring results-based payments to reward short term outputs as well as longer term ecosystem outcomes.
- Reverse auctions offer promise as a means of establishing and pricing capital restoration works.
- Evidence of natural capital and ecosystem service values can help to inform decisions about payment rates, helping to provide guidance about maximum potential payment rates. It can also help to inform variation of payment rates to incentivise action where it delivers greatest value, though evidence of monetary values is not necessarily required to enable this.
- There are good reasons not to base ELM payment rates directly on estimates of natural capital value. As well as presenting practical difficulties in valuation, such an approach could result in large increases in payment rates, transferring consumer surplus entirely to producers, and limiting the level of ELM activity that could be funded from a fixed budget. Payments exceeding costs and income forgone would no longer be classified in the green box, under WTO rules.

B. Management of arable land for farmland birds and pollinators

ELM needs and priorities

Declines in farmland birds, pollinators and wider arable biodiversity are a widely understood issue and addressing them is a national policy priority; this is reflected in the design of agri-environment schemes in all four countries.

Current agri-environment prescriptions and rates

Agri-environment schemes in all four countries of the UK include options for farmland birds and pollinators in arable land. These are more numerous in England, which has the largest area of arable land. There is a focus on annual management payments, because arable land management follows short term cycles rather than requiring long term restoration or habitat creation work.

In England, Countryside Stewardship includes options for nectar and pollen sources for insect pollinators and insect-rich foraging for birds (£511-539/ha/yr), winter bird food (£640/ha/yr) and additional resources and habitats (payments ranging from £18/ha/yr for skylark plots to £532/ha/yr for cultivated areas for arable plants). A range of arable options is also available in the agri-environment programmes in Northern Ireland, Scotland and Wales. Further details are given in Annex 2.

Financial needs identified in environmental land management costings model

The costings model defines a package of measures designed to benefit biodiversity and landscape in arable farmland areas. In total, these entail agri-environment prescriptions covering 1.1 million hectares, at an annual cost of £460 to £560 million per annum in the UK. The focus is on annual management options, with no costing of capital items (maintenance, creation and restoration of landscape features such as hedgerows is costed separately). Further details are given in Annex 2.

Benefits of ELM – outcomes, ecosystem services and values

Farmland birds and the wider biodiversity of arable land are widely recognised as valuable public goods. However, markets for these goods are lacking, and evidence of their value can only be gained by asking people about their willingness to pay to protect them. Perhaps surprisingly given the prominence of the farmland bird conservation issue, valuation evidence is very limited and confined to older studies:

- Foster and Mourato (2000) estimated a willingness to pay of £13.50 per household per year to prevent the loss of a single species of farmland bird;
- Defra (2013) used the estimates of Foster and Mourato to estimate the potential benefits of proposed ecological focus areas (EFAs) under the CAP at around £1,300m (present value, £2013 prices) over the period 2015-2020.
- Christie et al (2006) estimated that people were willing to pay £74 per year for conservation of biodiversity through agri-environment schemes in Cambridgeshire and Northumberland. Overall willingness to pay to avoid the decline of "both rare and common familiar species" was estimated at £95 per hectare per year in both areas. eftec (2015) upscaled this figure to estimate a willingness to pay of approximately £2.2 billion per year to prevent biodiversity decline in England.
- Boatman et al (2010) used a contingent valuation study to estimate that the public was willing to pay an average of £35 per household per year to secure the biodiversity and landscape benefits of Environmental Stewardship. This gave an overall estimate of benefits of £818 million per year across England (2009 prices), and a benefit: cost ratio of 1.80. Including carbon values increased the midpoint benefit cost ratio to 2.38.

Annex 2 gives further details of these studies.

While there are large estimates of the total value of pollination services nationally, evidence of the marginal value of benefits resulting from specific management practices or options is lacking. These values can be expected to vary widely locally depending on other food sources and presence of crops benefiting from pollination services.

The available valuation evidence illustrates the overall benefits of agri-environment measures for biodiversity, in terms of the public's willingness to pay for them but says little about the value of benefits of specific agri-environment actions.

Potential for alternative payment methodologies

Current approach

The current approach offers payments to managers of arable land for undertaking prescribed activities, with payment rates based on estimated costs and income forgone. Land managers are offered a range of options and can apply those that fit with local conditions, crop rotations and farm business priorities.

There is evidence that arable agri-environment options can be effective in reversing declines in target species when effectively applied at the local level, even if they have not been sufficient to reverse declines in the biodiversity of arable farmland nationally. For example, targeted application of arable options in agri-environment schemes in England has been effective in reversing population declines in birds such as the cirl bunting and stone curlew. Other farmland birds, arable flora and invertebrates have shown positive responses to arable management prescriptions at field scale, but not nationally (Boatman, 2011; Natural England, 2009).

Limitations of the current approach include:

- While arable options have been shown to be effective at field scale and when targeted locally and backed by advice, they have not been applied on a sufficient (landscape) scale to reverse declines in farmland birds and pollinators regionally or nationally;
- There can be a tendency for land managers to select easier, lower cost options, including management of boundaries rather than in-field options, rather than options that deliver greatest biodiversity benefits;
- The current system offers no incentive to go beyond the minimum conditions required to receive the payment.

Results-based payments

There is potential for results-based to work at one of two levels:

- **Payments for changes in habitat condition** – e.g. abundance and diversity of native plant species, quality of nesting habitat, presence and abundance of summer and winter food;
- **Payments for changes in biodiversity outcomes** – e.g. breeding pairs of farmland birds, diversity and abundance of pollinators.

The first approach is taken in the England RBAPs arable pilot, which sets condition scores for winter bird food (based on numbers of seed heads of target plant species, with tiered payments of 0-£842/hectare) and nectar and pollinators (based on number and coverage of plant species, with tiered payments from 0 to £705 per hectare). No prescriptions have been specified, but advice has been provided to farmers to help them achieve the targeted results.

The early results from the pilot appear to be positive, helping to achieve increases in winter bird food and nectar and pollinator species. Other advantages of the approach are that it has provided land managers with flexibility and freedom, enabled them to use local knowledge, provided an incentive to deliver better results, and enhanced farmer knowledge and buy-in. Disadvantages are the risk of failure to deliver the intended results, increased administrative and transactions costs, and therefore uncertainty regarding the scalability of the approach (Robinson, 2018).

Arable agri-environment measures seem particularly amenable to a results-based approach, given that results may be expected more quickly than for other ecosystems such as peatlands. This reduces risks, uncertainties and time lags in measuring results and allocating payments. On the other hand, short term risks may be increased because of the recurrent nature of actions required – for example the failure of an annual nectar crop due to adverse weather or pests may reduce payments.

Basing payments on habitat condition appears to be more feasible than payments based on the outcomes for farmland bird populations or pollination services, given the challenges in monitoring and evaluating biodiversity outcomes. Where results-based schemes have made payment for bird species outcomes in the EU, these have tended to focus on rarer species such as breeding harriers (in Germany) and waders (in the Netherlands).

Payments based on natural capital values

It does not seem feasible to base payments for arable biodiversity options on the value of benefits for natural capital and ecosystem service benefits, given that there are substantial gaps in valuation evidence. While there is general evidence that benefits for biodiversity and pollination are valuable, and that the public's willingness to pay exceeds the costs of schemes, fine-grained evidence which enables valuation of the benefits of specific actions and their outcomes appears to be lacking.

However, as for other difficult to value ecosystem services, there may be merits in varying payments to reflect differences in expected values, based on non-monetary indicators, either quantitative or qualitative. This could involve higher rates of payments in areas with high – or potentially high – biodiversity value, such as hotspots for farmlands bird or arable plants, or the core ranges of target species such as turtle dove or cirl bunting. Landscape scale approaches – for example including premium payments for delivery of action on neighbouring farms – could also be rewarded, based on the expected value of agglomeration benefits compared to single farm approaches. Payment rates could also be varied to reflect variations in the value of pollination services, with higher rates in areas where these are more variable (for example, due to the presence of insect pollinated crops).

Such an approach could involve setting payment premiums (e.g. a % increase in payment rates in target areas) to reflect differences in the expected value of the services delivered, rather than seeking to value ecosystem service outcomes.

Reverse auctions

Reverse auctions could potentially be applied to arable options, asking land managers to bid to deliver packages of arable management actions and/or outcomes (e.g. specifying

payment rates for delivering improvements in arable habitats). This could help to enhance the cost-effectiveness of delivery by setting payment rates competitively in a way that is acceptable to both buyers and sellers.

However, it could be argued that the case for considering reverse auctions is perhaps less than in the case of blanket bog restoration, where conservation needs, costs and benefits are likely to vary widely and call for bespoke approaches. By comparison, arable agri-environment options tend to be more standardised and better understood, so a fixed price menu works relatively well. The case for reverse auctions would need to weigh up the potential savings through competitive bidding with the likely increase in administrative and transaction costs in the process of inviting, submitting and evaluating bids.

Illustration of potential payment options and rates

Table 7.3 summarises the potential payment structures and payment rates that might apply to the options discussed above. There are uncertainties about how payment rates would be calculated, particularly if they were based on the value of benefits rather than costs, making it possible to specify only the likely direction and broad range of estimates within which they would be likely to fall.

Table 7.3: Options for payment mechanisms, payment structures and costs

Option	Payment Structure	Payment Rates
Current approach: payment for management options on arable land, with payment rates calculated based on costs incurred and income forgone.	Annual management payments - payments for provision of nectar and pollinators, and winter bird seed, at fixed rate per hectare per year	Payment rates for provision of nectar and pollinators range from £465/ha/yr in Northern Ireland to £539/ha/yr in England Payment rates for winter bird seed mixes are £322.63/ha/yr in Scotland, £590/ha/yr in Northern Ireland and £640/ha/yr in England
Payment for results: changes in natural capital condition, calculated based on costs and income forgone	Annual payments would be varied to reflect quality of habitat for birds and pollinators. Payments could be banded with higher payments for greater number and diversity of plants for nectar/pollinators and winter bird seed – as in arable results-based pilot in England Payments based on costs and income forgone of assumed management practices – e.g. assumption that minimum condition would require basic management and high level condition would require more management.	England Arable Results Based Agri-Environment Pilot offers payments as follows: Winter bird food. 6 tiers of payment based on number of established sown species producing seed: 0 - £0/ha/yr; 1 - £168/ha/yr; 2 - £337/ha/yr; 3- £505/ha/yr; 4 - £674/ha/yr; 5+ - £842/ha/yr Pollen and nectar. 10 tiers of payment based on number of sown flowering species present and percentage cover of flowering sown species. Payment rates range from £0 (Tier 1) to £141/ha/yr (Tier 2), £212/ha/yr (Tier 3) up to a maximum of £705/ha/yr (Tier 10). Tier 10 applies to 5+ sown species present and 90-100% ground cover by these species.
Payment for results: changes in ecosystem services, calculated based on value of services	Annual payments reflecting value of services delivered by the arable habitats. Annual payments would reflect estimated value of benefits for biodiversity and pollination.	Calculation of payment rates would be difficult given gaps in evidence regarding value of biodiversity benefits and pollination services from arable agri-environment schemes.

Reverse auctions	Land managers bid to provide agri-environment actions (e.g. sowing plants for nectar, pollinators and winter bird food) and/or outcomes (e.g. number and coverage of nectar, pollinator and winter bird seed plants).	Payment rates would be unique to individual bidders and could be lower or higher than under current system.

Conclusions on the potential for alternative approaches

- Arable agri-environment measures for biodiversity and pollinators appear to be amenable to payments for outcomes, measured through habitat indicators such as abundance and diversity of plant species providing nectar and winter bird food.
- Early experience from the results-based arable pilot in England seems to be positive, though there may be challenges in scalability given administrative and transaction costs, and advisory support needs.
- There are major gaps in valuation evidence, which suggest it is unlikely that this could be used to set payment rates.
- Non-monetary indicators could be used to inform variations in payment rates based primarily on assessments of costs and income forgone.

7.8 Conclusions on alternative payment methodologies

The UK's departure from the EU provides a major new opportunity to change the system of land management payments in each of the four countries, focusing payments on the delivery of public goods and potentially changing the way that these payments are calculated. The administrations in England and Wales have both signalled an intention to change the current methodology for calculating environmental land management payments, which offers payments for prescribed activities based on estimates of costs incurred and income forgone. The current system is criticised as being inflexible and bureaucratic, and doing too little to incentivise delivery of environmental outcomes.

An ELM payments methodology has many dimensions, but two important distinguishing features between the main options are the question of what is paid for (activities or outcomes) and how the payment is calculated (through estimates of costs and income forgone, the value of benefits, or individually determined payment rates (which may be set by negotiation or bidding processes such as reverse auctions).

Basing payments on land management activities is a well-understood approach that can work well where defined actions are known to be effective and there is a clear pathway between actions and results. It may be less effective where there is a need for locally targeted actions based on local conditions and knowledge. A major limitation is that this approach requires land managers only to follow the prescribed activities and does not incentivise them to deliver higher levels of environmental outcomes. Advice which engages and raises awareness land managers can play a role in helping to achieve this.

Outcome-based payments offer greater incentives for land managers to increase environmental outcomes over time, provided that suitable outcome indicators and related control and verification systems can be devised. They may require greater investments in advice, particularly in the short term, to be effective.

Calculating payments based on costs and income forgone helps to limit payment rates and control the costs of schemes but may offer limited profit to the average land manager and – as applied at present - may be insufficient to achieve high rates of uptake. Nevertheless, there is potential to apply the approach in a flexible way, varying assumptions about costs and baseline practices, and to enhance uptake by varying the calculations to reflect the cost structures and practices of target farms. Variations on the costs and income forgone

approach can be considered, offering geographical or performance related supplements or rewarding commitments to deliver long-term changes in practice.

Costs and income forgone may be used as the basis for calculating outcome-based payments, by making assumptions about the activities required to deliver the target outcomes, setting payment rates accordingly, and then giving land managers the flexibility to vary practices as they wish. This approach has been applied in the English results-based payment pilots – early results appear to be promising, though scalability may present a significant challenge.

Calculating payments based on estimates of the value of environmental benefits has the potential to incentivise actions that deliver the greatest benefits. However, major gaps in valuation evidence mean that it is not feasible to apply this approach to all ecosystems and their services, as illustrated in the two case studies. For reasons of value for money, where valuation evidence is available, it is likely to inform methods of calculating payment rates rather than be used to calculate them directly. If a values-based approach is applied, it is likely to rely on a combination of monetary and non-monetary evidence of ELM benefits in order to guide setting of payment rates.

Combinations of these approaches can also be considered. For example, ELM payments might supplement payments for activities with bonuses to reward the delivery of environmental outcomes. Payments may be based initially on estimates of costs and income forgone but varied to reflect differences in the value of benefits achieved by location and/or performance.

References

ADAS, CCRI and FERA (2013) Evidence requirements to support the design of new agri-environment schemes. Report to Defra.

Allen B, Hart K, Radley G, Tucker G, Keenleyside C, Oppermann R, Underwood E, Menadue H, Poux X, Beaufoy G, Herzon I, Povellato A, Vanni F, Pražan J, Hudson T, Yellachich N (2014) Biodiversity protection through results based remuneration of ecological achievement. Report Prepared for the European Commission, DG Environment, Contract No ENV.B.2/ETU/2013/0046, Institute for European Environmental Policy, London

Agricultural Census and Farm Business Survey statistics in four countries of the UK

Atkins (2018) Assessing the contribution of agri-environment schemes to climate change adaptation. Report to Natural England

Barnes, A.P., Schwarz, G., Keenleyside, C., Thomson, S., Waterhouse, T, Polakova, J. and Stewart, S., McCracken, D., (2011). Alternative payment approaches for non-economic farming systems delivering environmental public goods. Final Report for Scottish Natural Heritage, Scottish Environment Protection Agency, Countryside Council for Wales and Northern Ireland Environment Agency, May 2011. Scottish Agricultural College, Institute for European Environmental Policy, Johann Heinrich von Thünen Institut

Beaufoy G and Jones G (undated) HNV farming in England and Wales –findings from three local projects. EFNCP, Portree

Boatman (2011) Agri-environment schemes – can they help to reverse biodiversity declines? Presentation.

Boatman N, Short C, Elliott J, Cao Y, Gaskell P, Hallam C, Laybourn R, Breyer J and Jones N (2015) Agreement scale monitoring of Environmental Stewardship 2013-4. Assessing the impact of advice and support on the environmental outcomes of HLS agreements. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19197&FromSearch=Y&Publisher=1&SearchText=LM0432&SortString=ProjectCode&SortOrder=Asc&Paging=10

Boatman N, Willis K, Garrod G and Powe N (2010) Estimating the Wildlife and Landscape Benefits of Environmental Stewardship

Boatman, N., Conyers, S., Parry, H., Pietravalle, S. & Ramwell, C. (2008). Estimating impacts of ELS on key biodiversity indicators and diffuse pollution of surface waters by nutrients. Defra contract No. MA01041

Bureau J-C (2017) Does the WTO discipline really constrain the design of CAP payments? http://capreform.eu/does-the-wto-discipline-really-constrain-the-design-of-cap-payments/

Cao, Y., Elliott, J., McCracken, D., Rowe, K., Whitehead, J. and Wilson L. (2009) Estimating the Scale of Future Environmental Land Management Requirements for the UK. Report for LUPG

CEH (2013) Development of an Outcomes Model for Evaluating the Benefits of Environmental Stewardship. Report for Natural England

Chaplin S., Hinton G., Rogers M., Leatherland D. 2017. Developing a measure of High Nature Value Farmland (HNVF) for the Rural Development Programme for England. Natural England Research Report NERR068. York.

Christie, M., Hanley, N., Warren, J., Murphy, K., Wright, R. and Hyde, T. (2006) Valuing the diversity of biodiversity. Ecological Economics 58(2):304-317

Christie M, Hyde T, Cooper R, Fazey I, Dennis P, Warren J, Colombo S and Hanley N (2011) Economic Valuation of the Benefits of Ecosystem Services delivered by the UK Biodiversity Action Plan. Report to Defra.

Clark (2019) The Challenges of Farming the Uplands Profitably. Presentation to Lake District National Park Partnership

Country Biodiversity Strategies http://jncc.defra.gov.uk/page-5701

CPRE (2017) Uncertain harvest: does the loss of farms matter? file:///C:/Users/N103222/Downloads/CPREZUncertainZHarvest.pdf

DAERA (2017) United Kingdom - Rural Development Programme (Regional) - Northern Ireland, 2014-2020

Defra (2013) Implementation of CAP Reform in England. Consultation Document

Defra (2018a) Health and Harmony: the future for food, farming and the environment in a Green Brexit

Defra (2018b) Health and Harmony: the future for food, farming and the environment in a Green Brexit. Summary of responses

Defra (2018) Agriculture in the UK 2017

Defra (2018) The Future Farming and the Environment Evidence Compendium

Defra (2019) Countryside Stewardship: Higher Tier Manual

Defra (2019b) Conservation Covenants. Consultation paper, February 2019

Dwyer J, Mills J, Ingram J, Taylor J, Burton R, Blackstock K, Slee B, Brown K, Schwarz G, Matthews K and Dilley R (2007) Understanding and influencing positive behaviour change in farmers and land managers - a project for Defra

eftec (2015) The Economic Case for Investment in Natural Capital in England: Final Report for the Natural Capital Committee

English Heritage (2005) Farming the historic landscape. An introduction for Farm Advisers

Franzén, F., Dinnétz, P. & Hammer, M. (2016) Factors affecting farmers' willingness to participate in eutrophication mitigation — A case study of preferences for wetland creation in Sweden. Ecological Economics. 130: 8–15 DOI:10.1016/j.landusepol.2015.02.007

Foster V and Mourato S (2000) Valuing the Multiple Impacts of Pesticide Use in the UK: A Contingent Ranking Approach. Journal of Agricultural Economics, 51 (1), January 2000

Glenk K and Martin-Ortega J (2018) The economics of peatland restoration, Journal of Environmental Economics and Policy, 7:4, 345-362

Green Balance (2008) The Potential of Conservation Covenants - A report to the National Trust

Harlow, J., Clarke, S., Phillips, M. & Scott, A. (2012). Valuing land-use and management changes in the Keighley and Watersheddles catchment. Natural England Research Reports, Number 044

HM Treasury (2018) The Green Book: Central Government Guidance on Appraisal and Evaluation

HM Treasury (2018) Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. IAG spreadsheet toolkit for valuing changes in greenhouse gas emissions

House of Commons Environmental Audit Committee (2016) The Future of the Natural Environment after the EU Referendum

IEEP (2014) Biodiversity protection through results based remuneration of ecological achievement. http://ec.europa.eu/environment/nature/rbaps/handbook/docs/rbaps-report.pdf

IUCN (2014) IUCN UK Committee Peatland Programme. Briefing Note No 7. Grazing and Trampling

JNCC (2008) UK Biodiversity Action Plan - Priority Habitat Descriptions – Blanket Bog

Natural England (2015) A Strategy for the Restoration of Blanket Bog in England - An Outcomes Approach

Jones G, Boatman N, Crowe A and Flari V (2013) Entry Level Stewardship Training and Information Programme (ETIP) Value for Money Analysis: Final report. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=1853

7&FromSearch=Y&Publisher=1&SearchText=etip&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

Jones N, Short C, Elliott J, Cao Y, Gaskell P, Hallam C, Laybourn R, Breyer J, Conyers S and Boatman N (2015) ES quality assurance programme, 2013/14. Assessing the role of advice and support on the establishment of HLS agreements. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=19197&FromSearch=Y&Publisher=1&SearchText=LM0432&SortString=ProjectCode&SortOrder=Asc&Paging=10

Keenleyside C, Radley G, Tucker G, Underwood E, Hart K, Allen B and Menadue H (2014) Results-based Payments for Biodiversity Guidance Handbook: Designing and implementing results-based agri-environment schemes 2014-20. Prepared for the European Commission, DG Environment, Contract No ENV.B.2/ETU/2013/0046, Institute for European Environmental Policy, London.

Keenleyside, C, Beaufoy, G, Tucker, G, and Jones, G (2014) High Nature Value farming throughout EU-27 and its financial support under the CAP. Report Prepared for DG Environment, Contract No ENV B.1/ETU/2012/0035, Institute for European Environmental Policy, London.

Law Commission (2014) Conservation Covenants. Presented to Parliament pursuant to section 3(2) of the Law Commissions Act 1965

Le Page A (2018) Results Based Agri-Environment Payment Scheme. Grassland conference, 27 November 2018. file:///C:/Users/N103222/Downloads/RBAPS%20Grassland%20Conference%20Presentations.pdf

Lobley, M., Saratsi, E. & Winter, M. (2009) Training and advice for agri-environmental management. Review paper. Centre for Rural Policy Research, Department of Politics, University of Exeter.

Morris R K A, Alonso I, Jefferson R G and Kirby K J (2006) The creation of compensatory habitat—Can it secure sustainable development? Journal for Nature Conservation 14 (2006) 106—116

Natural England (2009) Agri-environment schemes in England 2009: A review of results and effectiveness. http://publications.naturalengland.org.uk/publication/46002

Natural England (2010) England's peatlands: Carbon storage and greenhouse gases (NE257)

Natural England (2013) Restoration of degraded blanket bog (NEER003)

Natural England (2014) Catchment Sensitive Farming Evaluation Report - Phases 1 to 3 (2006 - 2014). http://publications.naturalengland.org.uk/publication/6510716011937792

Nix J (2017) Farm Management Pocketbook

OECD (2016) Alternative Payment Approaches for Biodiversity Conservation in Agriculture. http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2014)46/FINAL&docLanguage=En

Paracchini, M L, Terres, J M, Petersen, J-E and Hoogeveen, Y (2006) Background Document on the Methodology for Mapping High Nature Value Farmland in EU27. European Commission Directorate General Joint Research Centre and the European Environment Agency.

Peacock J (2017) Paying for itself: using reverse auctions for environmental improvement. http://green.brightblue.org.uk/blog/2017/12/8/paying-for-itself-using-reverse-auctions-for-environmental-improvement

Rayment M (2017) Assessing the costs of Environmental Land Management in the UK. Final Report for the RSPB, the National Trust and The Wildlife Trusts. https://nt.global.ssl.fastly.net/documents/assessing-the-costs-of-environmental-land-management-in-the-uk-final-report-dec-2017.pdf

Redman G (2018) John Nix Pocketbook for Farm Management – for 2019. 49th edition. Agro Business Consultants Ltd, Melton Mowbray, Leicestershire.

Rewilding Britain (2019) Rewilding and Climate Breakdown: How Restoring Nature Can Help Decarbonise the UK.

https://www.rewildingbritain.org.uk/assets/uploads/Rewilding%20and%20Climate%20Breakdown%20-%20a%20report%20by%20Rewilding%20Britain.pdf

Robinson V (2018) Results Based Agri-Environment Payment Schemes. Presentation to the RBAPs Arable Conference

Rolfe J, Whitten S and Windle J (2017) The Australian experience in using tenders for conservation. Land Use Policy 63 (2017) 611–620

Rollett A, Haines-Young R, Potschin M and Kumar P (2008) Delivering environmental services through agri-environment programmes: a scoping study. Report to the Land Use Policy Group

RSPB, EFNCP and BirdLife Europe (2011) High Nature Value Farming - How Diversity in Europe's Farm Systems Delivers for Biodiversity

Schwarz G, Moxey A, McCracken D, Huband S and Cummins R (2008) An analysis of the potential effectiveness of a Payment-by-Results approach to the delivery of environmental public goods and services supplied by Agri-Environment Schemes. Report to the Land Use Policy Group

Scottish Government (2011) Developing High Nature Value Farming and Forestry Indicators for the Scotland Rural Development Programme. Summary Report of the Technical Working Group on High Nature Value Farming and Forestry Indicators. Edinburgh

Taylor E, Smyth M, Littlewood N, Moxey A, Prior S (2015) Section 3: Quantifying the potential biodiversity benefits of peatland restoration projects under the Peatland Code. In Crichton Carbon Centre (2015) Developing Peatland Carbon Metrics and Financial Modelling to Inform the Pilot Phase UK Peatland Code

UKNEA (2011) The UK National Ecosystem Assessment

Waldon J, Bishop K and Jones G (2017) Locally-led Agri-environment Schemes: Ideas from the Dartmoor Workshop on 13th and 14th March 2017

Welsh Government (2015) United Kingdom - Rural Development Programme (Regional) – Wales, 2014-2020.

Welsh Government (2018) Brexit and our land: Securing the future of Welsh farming. Consultation paper

World Resources Institute (2007) Paying for Environmental Performance: Using Reverse Auctions to Allocate Funding for Conservation

Annex 1: Management and Restoration of Blanket Bog – Further Details of Costs and Benefits

A.1.1 Current agri-environment payment prescriptions and rates

England

In England, the following annual management payments are available under Higher Level Stewardship:

- UP3 – Management of moorland - £43/ha/yr
- UP4 – Management of moorland, vegetation supplement – to encourage recolonisation of Sphagnum and other key species - £10/ha/yr
- UP5 – Management of moorland, rewetting supplement – in accordance with bog restoration measures, including maintenance of grip blocks - £18/ha/year
- UP6 – Upland livestock exclusion supplement – to exclude livestock from habitat under restoration - £16/ha/yr.

Capital payments include:

- WN1 – Blocking grips or drainage channels - £14.80 per block
- Fencing.

Northern Ireland

Under the Environmental Farming Scheme, Higher Level, annual management payments are available for:

- Moorland (blanket bog) remedial management - £40/ha/yr (up to 50 hectares); £20/ha/yr (50-100 hectares); £10/ha/yr (>100 ha).

Scotland

Under the Agri-Environment and Climate Scheme in Scotland (where the areas of blanket bog are much more extensive), annual management payments are available for:

- Moorland (including peatland) management - £3.60/ha/yr (managing livestock only); £1.24/ha/yr (managing deer only); £4.84/ha/yr (managing deer and livestock)
- Stock disposal - £24.83/ha/yr
- Away wintering sheep - £25.83/ha/yr.

Capital payments include:

- Ditch blocking – peat dams - £13 per peat dam, minimum payment £300;
- Ditch blocking – plastic piling dams - £62-385 per dam, depending on width;
- Stock bridges for fen, bog or wetland management - £220-880 per bridge, depending on span.

Wales

The Glastir Advanced scheme offers the following annual management options:

- Option 41a – Grazing Management of Open Country (including blanket bog) - £58/ha/yr;
- Option 41b – Grazing Management of Open Country with Mixed Grazing - £70/ha/yr;
- Option 403 – Additional management payment – rewetting - £25.38/ha/yr;
- Option 411 – Additional management payment – reduce stocking - £267.60 per livestock unit.

Capital grants are available for:

- Grip blocking - £124 per item
- Fencing.

A1.2 Costs and financial needs

In the environmental land management costings model we estimate that there are 2.2 million hectares of blanket bog in the UK, of which nearly 1.8 million (80%) are in Scotland. It is estimated that more than 40% of this area is in unfavourable condition and requires restoration. Annual management costs are estimated using current agri-environment payment rates, and capital costs of restoration are estimated at between £595 and £662/ha. The annual costs of maintaining blanket bog habitats are estimated at between £34 million and £109 million per year, and restoration costs at £56-62 million per year over a 10 year period.

eftec (2015) found a wide range of estimates of the capital costs of peatland restoration, from £200-£7,000 per hectare, depending on the condition of the ecosystem. Annual operational and opportunity costs were found to range between £25 and £200 per hectare per year, with the upper estimates relating to changes in land use from grouse shooting. Glenk and Martin-Ortega (2018) quote a range of capital costs from the SNH Peatland Action scheme of £300-£5000/ha, and suggest an overall average cost of about £830 per hectare for all types of restoration.

A1.3 Benefits of ELM – outcomes, ecosystem services and values

Blanket bog delivers valuable ecosystem services. The most important of these include:

- Climate regulation;
- Water quality regulation;
- Flood prevention; and
- Biodiversity.

The delivery of these services is greatly influenced by natural capital condition. Degradation of peatlands can change then from a carbon sink to a carbon source, undermine their adaptive capacity to climatic and other changes and compromise the delivery of the critical services they provide (Glenk and Martin-Ortega, 2018).

A variety of studies have valued blanket bogs and the services that they provide:

- Climate regulation services have been assessed by estimating the value of carbon stored and sequestered, and valuing this using the non-traded price for carbon;
- The value of water quality improvements can be assessed through estimates of reduced water treatment costs. These tend to vary by location so are less easily to estimate through standardised assessments.
- Benefits for flood management are potentially significant and seen through reductions in the costs of flooding and expenditures on flood defence measures. However, they vary widely by location and scientific uncertainties make them difficult to estimate.
- Studies have estimated society's willingness to pay to protect and enhance blanket bog ecosystems, to assess the value of biodiversity as well as wider ecosystem services.

Overall, evidence of the value of blanket bog and the services it provides is relatively strong compared to most other ecosystems, reflecting the scale of the asset, the strength of the investment case and the relative ease of valuation (especially in relation to carbon).

Climate regulation

There are estimated to be 138 million tonnes of carbon in England's blanket bog peat soils, but their ability to store and sequester carbon depends on their condition. It has been estimated that less than 20,000 tonnes of carbon dioxide a year are sequestered by undamaged blanket bogs, while most upland peatlands are net sources of greenhouse gases (Natural England, 2010). Restoration and appropriate management of blanket bog therefore plays an important role in delivery of climate regulation services. However, eftec (2015) found a wide range of estimates of potential changes in emissions according to changes in peatland condition, as well as wide ranging estimates of the timetables over which emissions reductions could be achieved.

The benefits of actions to restore and maintain blanket bog can be valued by modelling their effects on net carbon emissions and valuing these using an appropriate carbon price. The HM Treasury (2018) toolkit for valuing changes in GHG emissions gives a central estimate of the non-traded price for carbon of £67 per tonne CO_2e in 2019, increasing to £79 in 2030.

Eftec (2015) estimated the net present value of peatbog restoration investments at £5461/ha (revegetation of bare peat), £3266/ha (cessation of burning), £5970/ha (gully blocking and revegetation to restore eroded peat); £1113/ha (grip blocking), £4030 (restoration of Molinia dominated peat) and £3624/ha (prevention of overgrazing). Based on carbon values alone, the figures suggest benefit: cost ratios for most capital restoration works of around 2:1, but rising to as high as 20:1 for low cost measures such as cessation of burning and reduction of overgrazing.

The eftec estimates drew on an earlier study by Natural England (2010) which estimated the net present value per hectare of peatland restoration at £5690 (preventing overgrazing), £4892 (reseeding bare peat), £3730 (stabilisation of bare peat), £2850 (blocking grips), £2764 (planting bare peat) and £2246 (gully blocking), and £3266 (cessation of moorland burning), using a central estimate of the shadow price of carbon of £52/te CO_2e.

The Natural Capital Committee (2015) found that peatland restoration on around 140,000 hectares in upland areas would deliver net benefits of £570 million over 40 years, based on carbon values alone. The Committee concluded that further work is needed to determine water quality, recreation and wildlife values, which, if included, will significantly increase the net benefits of such investments.

Water quality

Upland areas provide about 70% of the UK's total drinking water. Degraded peatlands can lead to increased sediment and phosphate loadings into river catchments as well as dissolved organic carbon leading to water colouration, which results in higher treatment costs, while peatland restoration can lead to rapid improvements in water quality (eftec, 2015). As a result, water companies have invested in peatland restoration as a means of reducing water treatment costs.

eftec (2015) estimated that the benefits of restoration of peatlands at Keighley Moor delivered water quality benefits equivalent to £97/ha/year, and suggested that this figure could be extrapolated to other upland areas with high rainfall close to centres of population. The water quality benefits of a PES project at Pumlumon (Cambrian Mountains) were estimated at £75/ha/year.

Flood management

The condition of peatlands has a significant influence on the regulation of water flows. The rate at which water leaves a peatland is accelerated by drainage channels and the loss of vegetation (eftec, 2015). eftec (2015) used GIS analysis to identify 20,733 hectares of upland peatland areas with high rainfall in proximity to centres of population, that would be expected to deliver significant benefits through improvements in flood regulation. Valuation of benefits is difficult because they are location specific and because significant uncertainties make estimation of effects on flood risk difficult.

Biodiversity and wider ecosystem services

Peatlands comprise the largest remaining semi-natural habitat in the UK, hosting a range of specialised plant and animal species that are adapted to waterlogged, acidic and nutrient-poor conditions. Peatland habitats are, therefore, recognised as being a conservation priority under UK and EU law with many sites classified under the EU Habitats and Species Directive. Peatland species are sensitive to changes in land management, many are rare or threatened, and declines have been noted in populations and distributions of typical species across a range of taxa including birds and invertebrates. Restoration of degraded blanket bog offers potential to enhance its biodiversity value (Taylor et al, 2015).

Glenk and Martin-Ortega (2018) used a choice-experiment study to estimate the public's willingness to pay for peatland restoration in Scotland. Participants were given pictorial representations of changes in ecosystem condition and ecosystem services (water quality, carbon and biodiversity). The benefits of moving from poor to good condition were estimated at £242-302 per hectare per year, and from intermediate to good from £0 to £414 per hectare per year. It was estimated that a 10,000 hectare restoration programme would deliver a net present value of £7.9 million and a benefit: cost ratio of 1.39.

Christie et al. (2011) estimated the economic benefits of ecosystem services delivered by the UK Biodiversity Action Plan. The study used a choice experiment study to elicit the public's willingness to pay for a range of ecosystem services delivered by the UKBAP, then allocated these values to different BAP habitats using the judgement of an expert panel. The benefits of blanket bog were estimated at £607 million per annum at current rates of BAP expenditure; if expenditure was increased to allow full implementation of the UK BAP, it was estimated that these benefits would rise by £300 million per annum annually. The benefits of current conservation actions for blanket bog were estimated to be equivalent to £275/ha per year (averaged across the whole UK habitat area), rising by a further £136/ha/year if the BAP were fully implemented (such that targets for restoration and management of blanket bog habitat were met).

Harlow et al (2012), using values from Christie and other studies, estimated benefit cost ratios of 3:1 for blanket bog restoration and 5:1 for expenditures to prevent further deterioration in the Keighley and Watersheddles catchment.

Annex 2: Management of arable land for farmland birds and pollinators – Further details of costs and benefits

A2.1 Current agri-environment prescriptions and rates

Agri-environment schemes in all four countries of the UK include options for farmland birds and pollinators in arable land. These are more numerous in England, which has the largest area of arable land. There is a focus on annual management payments, because arable land management follows short term cycles rather than requiring long term restoration or habitat creation work.

In England, the Arable Offer under Countryside Stewardship requires applicants to pick at least one option from each of three categories:

- Category 1: Improve nectar and pollen sources for insect pollinators and insect foraging birds
    - Nectar flower mix - £511/ha/yr
    - Flower rich margins and plots - £539/ha/yr
- Category 2: Introduce additional winter food sources for seed-eathing birds
    - Winter bird mix - £640/ha/yr
- Category 3: Improve habitats and other resources for specific species
    - Management of hedgerows - £8/100m/yr
    - Skylark plots - £18/ha/yr (for minimum 2 plots per ha)
    - Nesting plots for lapwing and stone-curlew - £524/ha/yr
    - Enhanced overwinter stubble - £436/ha/yr
    - Cultivated areas for arable plants - £532/ha/yr
    - Supplementary winter feeding for farmland birds - £632/tonne/yr for every 2 hectares winter bird food option
    - 4m to 6m buffer strip on cultivated land - £353/ha/yr
    - Buffering in-field ponds and ditches on arable land - £501/ha/yr

In Northern Ireland, the Environmental Farming Scheme offers the following arable biodiversity options:

- Pollen and nectar margins - £465/ha/yr
- Annual wildflower margins - £2530/ha/yr
- Rough grass margins - £841.50/ha year 1, then £707/ha/yr in years 2-5;
- Cultivated uncropped - £702/ha/yr;
- Provision of winter feed crop for wild birds - £590/ha/yr;
- Retention of winter stubble - £85/ha/yr.

In Scotland, options under the Agri-Environment and Climate Scheme include:

- Unharvested Conservation Headlands for Wildlife - £657.57/ha/yr
- Wild Bird Seed for Farmland Birds - £322.63/ha/yr
- Forage Brassica Crops for Farmland Birds - £436.36/ha/yr
- Stubbles Followed by Green Manure in an Arable Rotation - £498.49/ha/yr
- Retention of Winter Stubbles for Wildlife and Water Quality - £96.18/ha/yr
- Beetlebanks - £495.64/ha/yr
- Grass Strips in Arable Fields - £495.62/ha/yr
- Water Margins in Arable Fields - £495.62/ha/yr
- Cropped Machair - £239.76/ha/yr

In Wales, arable options under Glastir Advanced include:

- Fallow Crop Margin - £500/ha/yr
- Retain Winter Stubbles - £122/ha/yr
- Unsprayed Spring Sown Cereals and Pulses - £284/ha/yr
- Unsprayed Spring Sown Cereals Retaining Winter Stubbles - £440/ha/yr
- Plant Unsprayed Rootcrops on Improved Land without Direct Drilling - £497/ha/yr
- Establish a Wildlife Cover Crop on Improved Land - £604/ha/yr

- Unharvested Cereal Headland - £525/ha/yr
- Unfertilised and Unsprayed Cereal Headland - £445/ha/yr
- Buffer Zones to Prevent Erosion and Run–Off from Land under Arable Cropping - £397.80/ha/yr
- Unsprayed Autumn Sown Barley Crop for Corn Bunting (Nesting and Feeding) - £325.81/ha/yr
- Unsprayed Spring Sown Barley Crop for Corn Bunting (Nesting and Feeding) - £455.88/ha/yr
- Unsprayed Spring Sown Cereals, Oilseed Rape, Linseed or Mustard Crop for Lapwing (Nesting) - £302.82/ha/yr
- Fallow plots for lapwing (nesting) - £497.02/ha/yr.

A2.2 Financial needs identified in environmental land management costings model

The costings model defines a package of measures designed to benefit biodiversity and landscape in arable farmland areas. Based on advice from RSPB ecologists, it is estimated that halting declines in farmland birds and wider biodiversity requires application of "middle tier" measures to 50% of the arable landscape, and "high tier" measures to a further 30%. Under the "middle tier", it is assumed that 2 hectares of land management options designed to benefit nectar and pollinators and 3 hectares of options designed to provide winter bird food are required per 100 hectares of arable land. The nectar and pollinator options include provision of nectar flower mixes; flower rich margins and plots; two-year sown legume fallow; autumn sown bumblebird mix and cultivated areas for arable plants. The winter bird food options include sowing of crops for winter bird seed and winter stubbles. In total, this amounts to agri-environment prescriptions amounting to 1.1 million hectares, at an annual cost of £460 to £560 million per annum in the UK.

The focus is on annual management options, with no costing of capital items. Planting, restoration and management of hedgerows and other boundary features will also benefit farmland birds and biodiversity, but is costed separately in the model as a landscape measure (with an estimated annual cost of £250 million at UK level).

A2.3 Benefits of ELM – outcomes, ecosystem services and values

Farmland birds and the wider biodiversity of arable land are widely recognised as valuable public goods. However, markets for these goods are lacking, and evidence of their value can only be gained by asking people about their willingness to pay to protect them.

Perhaps surprisingly given the prominence of the farmland bird conservation issue, valuation evidence is very limited and confined to older studies. Foster and Mourato (2000) used a contingent ranking survey to ask members of the public to rank different combinations of options involving the price of bread, the number of cases of ill-health caused by pesticide use, and the numbers of farmland bird species in decline. They estimated a willingness to pay of £13.50 per household per year to prevent the loss of a single species of farmland bird.

Defra (2013) used the estimates of Foster and Mourato to estimate the potential benefits of proposed ecological focus areas (EFAs) under the CAP. Updating the estimates to take account of inflation and GDP growth, multiplying them by the number of households in the UK, and applying estimates of the probabilities of reversing farmland bird declines (based on expert judgement), Defra estimated the present value of EFA measures at around £1,300m (£2013 prices) over the period 2015-2020.

Another study by Christie et al. (2006) estimated the public's willingness to pay for conservation of biodiversity in Cambridgeshire and Northumberland. Using a contingent valuation approach, they estimated that households were on average willing to pay £74 per year for biodiversity conservation activities through agri-environmental schemes. The overall willingness to pay to avoid the decline of "both rare and common familiar species" was estimated at £95 per hectare per year in both areas. eftec (2015) upscaled this figure to estimate a willingness to pay of approximately £2.2 billion per year to prevent biodiversity decline in England.

Boatman et al (2010) used a contingent valuation study to estimate that the public was willing to pay an average of £35 per household per year (midpoint value) to secure the biodiversity and landscape benefits of Environmental Stewardship. This gave an overall estimate of benefits of £818 million per year across England (2009 prices), and a benefit: cost ratio of 1.80. Including carbon values increased the midpoint benefit cost ratio to 2.38.

While there are large estimates of the total value of pollination services nationally, evidence of the marginal value of benefits resulting from specific management practices or options is lacking. These values can be expected to vary widely locally depending on other food sources and presence of crops benefiting from pollination services.

The available valuation evidence illustrates the overall benefits of agri-environment measures for biodiversity, in terms of the public's willingness to pay for them, but says little about the value of benefits of specific agri-environment actions.