Assessing the costs of Environmental Land Management in the UK

Final Report

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

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Foreword

Most rural land in the UK is used for farming and the basis for our current agricultural policy was set in the 1950s. Agriculture, operating within this policy framework, has had the single greatest impact on wildlife and the environment compared to any other driver of change. With the UK preparing to leave the European Union (EU) and its Common Agricultural Policy (CAP), the UK Government and devolved administrations will have to build replacement policies. There is therefore, in this moment, an opportunity for all of us with an interest in securing the future of our natural world to achieve great steps forward for wildlife and the environment, whilst also spending public money better and nurturing a thriving farming sector and rural economy.

The task ahead is as daunting as it is exciting. Leaving the EU will affect every aspect of life in the UK, and in turn affect how new land management policies will work. Decisions over trade deals, customs unions and regulation are all relevant, but are uncertain and largely outside of the gift of those setting agricultural policy. This piece of research therefore began by laying out a few facts that will remain true for the foreseeable future. Firstly, that the UK has existing environmental and cultural heritage obligations and objectives which require significant investment in land management. Secondly, that the management required is well understood and will not be altered by exiting the EU. Thirdly, that meeting those objectives and obligations through land management will cost money and will depend on farmers and land managers as custodians of our countryside. These three slivers of certainty led us to a simple question: “how much will it cost to meet existing environmental commitments?”, and so we commissioned this work.

The drivers of cost will all be affected by the way in which the UK leaves the European Union and so this research produces both a single value for the cost of environmental land management and a model which can adapt to changing circumstances. We understand environmental land management in this report as being activities undertaken by famers and land managers to address existing environmental commitments as currently recognised in national datasets, and we base our estimates of costs on the current agri-environment funding formula of income foregone and costs incurred.

With this research we do not therefore claim to set out a vision of what the environment needs, as the choices in the model are largely derived from existing policy commitments and obligations. The level of ambition needed to leave the environment in a better state for the next generation is likely to be much greater, and we can use the model to update cost estimates as ambition is raised. Nor is the work designed to estimate the *total* budget needed for future farming policies across the UK.

The focus is on specific land management interventions, and as such we do not account for supporting investments such as advice, monitoring and evaluation, or wider funding associated with agriculture or rural development. Yet investment in these aspects will need to be significant. Finally, with a focus on land management, it does not include all practices carried out by all actors to address all environmental aims, nor account for the range of investments currently funded by domestic and EU funding mechanisms such as LIFE, the Heritage Lottery Fund and INTERREG. Continued funding for interventions such as targeted species recovery, cross-border cooperation and public engagement will all be necessary in the future, as will investment from the private sector. In a nutshell therefore, the expenditure required to both restore our natural capital and support an innovative, profitable and sustainable farming sector will be more than the number the tool we have developed has produced.

We cannot hope to remove or avoid controversy – many political decisions and value judgements lie ahead. This model contributes to the evidence-base for funding needs associated with land management in the future, and provides us with a tool that can be refined as our shared understanding of environmental need and the economic context improves. We hope this evidence will illuminate the discussion and enhance a productive debate over our shared future.

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The author is responsible for the methods employed and any errors in the analysis.

Executive Summary

Introduction and objectives

To meet the UK's objectives for a healthy environment we need to invest more resources in the management and restoration of habitats, landscape features and the historic environment, and to support land management practices that maintain and enhance soil and water resources and contribute to the mitigation of climate change. The UK's decision to leave the EU has focused attention on the future of environmental land management schemes currently funded through the Common Agricultural Policy. It also provides an opportunity to enhance funding for environmental land management in the UK, potentially by diverting financial resources from the 1st Pillar of the CAP, which currently provides £2.6 billion in direct payments to farmers out of a national CAP budget of £3.3 billion.

This report was commissioned by the RSPB, the National Trust and the Wildlife Trusts in order to understand what it will cost to meet the UK's priorities for environmental land management and how this cost will vary in response to changing economic conditions, policy drivers and improvements in data availability and understanding.

Methodology

The study involved the development of a spreadsheet model that:

- Quantifies existing land uses, priority habitats, landscape and historic environment features in the four countries of the UK;
- Identifies land management needs to meet a range of objectives for biodiversity, landscape, the historic environment, water quality, soil protection and organic farming;
- Estimates the unit costs of the identified land management measures; and
- Combines these numbers to estimate the overall costs of land management to meet environmental objectives across the UK.

The unit costs were estimated using current payment rates in existing land management schemes, and were also adjusted to take account of the underlying drivers of costs and income foregone. The model was designed to enable the effects on overall costs of changes in policy choices, as well as future economic drivers, to be assessed.

Cost estimates

Based on 'current' unit costs (using current payment rates for land management schemes as well as historic estimates of the costs of habitat creation and restoration), the total cost of meeting the identified environmental land management priorities in the UK are estimated at £2.2 billion annually.

Table ES1: 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	80	56	32	331
Organic	17	0.5	3	5	26
Total	**1,352**	**176**	**456**	**205**	**2,188**

England accounts for 62% of the overall cost estimate, followed by Scotland (21%), Wales (9%) and Northern Ireland (8%). 40% of these estimated costs relate to the management,

restoration and expansion of priority habitats, 21% to arable land, 18% to boundary features and 15% to grassland.

Using the 'adjusted' unit costs, to take account of changes in cost drivers, increases the overall cost estimate to £2,307 million annually. These costs are found to vary with changes in prices and yields for arable crops and livestock, as well as labour costs.

The model is likely to provide conservative estimates of the full costs of the required land management at national scale, since it is based on agri-environment payment rates, which reflect the income foregone and costs incurred for the average scheme entrant. Achieving full uptake at national scale may increase these costs.

Benefits

The package of environmental land management actions defined in this study will deliver essential ecosystem services on which people and the economy depend, such as climate change mitigation, maintenance of water and air quality, protection of agricultural soils, and protection against flooding, as well as supporting recreation, tourism and local economies. If delivered through public payments, they will also provide an alternative source of income and employment for land managers. While the identified financial needs are based on costs incurred and income foregone, they offer opportunities to diversify income and maintain rural employment by financing land management actions, as well as providing wider opportunities for tourism and recreation.

The study has not attempted to quantify the benefits of the measures identified. However, a range of recent studies – examining investments in SSSIs, Biodiversity Action Plans and natural capital restoration - demonstrate that the benefits of environmental land management can be substantial, and significantly exceed the costs.

Conclusions and Recommendations

The work has developed a model that can be used to estimate the overall scale of financial resources needed to achieve environmental land management needs in the UK and each of the four countries. The estimates of overall costs are similar in scale to those from a previous assessment by Cao et al (2009) for the Land Use Policy Group, which estimated the costs of meeting a similar range of environmental land management objectives at £2 billion per annum.

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. Another major issue affecting the cost assessment is the potential cost of maintaining the current land uses required to support the identified land management practices. Some current land uses – particularly in upland areas – would potentially be at risk if current CAP Pillar 1 subsidies and Less Favoured Areas payments were removed. The model makes provision for the inclusion of an area-based cost of securing basic land management, as required, though this has not been included in the cost estimates presented above, as it would require further modelling of the effect of different Brexit scenarios on the viability of continued land use.

The work has involved a detailed and wide-ranging assessment, and extensive consultations with experts and stakeholders. The model would benefit from further development and refinement in a number of areas, in particular in relation to the specification of needs for water quality, soil management, the historic environment, and the management of boundary features, the further development of the cost drivers model, and the modelling of the costs of securing current land uses in future post Brexit scenarios.

The analysis is intended to provide an initial first order estimate of the financial needs for achieving environmental land management priorities in the UK, as well as developing a model that enables alternative estimates to be derived, 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.

1 Introduction

1.1 Background and objectives

Rural land use and land management play a central role in delivering the UK's priorities for the natural and historic environment. But, to meet our objectives for a healthy environment we need to invest more resources in the management and restoration of habitats, landscape features and the historic environment, and to support land management practices that maintain and enhance soil and water resources, and contribute to the mitigation of climate change.

Much has been achieved through the CAP's rural development programmes co-financed by the EU, which demonstrate that the right land management practices can address our environmental priorities, if delivered in the right places and on the right scale. However, there is widespread evidence that we are currently not committing sufficient resources to management of the natural and historic environment, such that the current level of action is inadequate to reverse declines in biodiversity, landscape and the historic environment, or to ensure the sustainable management of natural resources.

For example, a study for the Land Use Policy Group in 2009[1] suggested that delivering a suite of environmental land management priorities across the UK would cost in the order of £2 billion annually. In comparison, public expenditure on agri-environment schemes is currently little more than £400 million annually[2]. Other studies have shown that insufficient financial resources are devoted to the pursuit of particular environmental priorities[3].

The UK's decision to leave the EU has focused attention on the future of environmental land management schemes currently funded through the Common Agricultural Policy. It also provides an opportunity to enhance funding for environmental land management in the UK, potentially by diverting financial resources from the 1st Pillar of the CAP, which currently provides £2.6 billion in direct payments to farmers out of a national CAP budget of £3.3 billion.

In order to address this challenge, it is necessary to understand what it will cost to meet the UK's priorities for environmental land management. Given the changing policy and economic climate, it will also be helpful to be able to understand how this cost will vary in response to changing economic conditions and policy drivers.

To address this challenge, the RSPB, the National Trust and the Wildlife Trusts commissioned a study to assess the scale of financial needs for environmental land management in the UK after Brexit.

The objectives of the work were:

1. To quantify the financial needs for environmental land management to meet existing environmental commitments and targets after Brexit, for the UK and each of the four countries, based on income-foregone and costs-incurred.
2. To provide a model for estimation of these costs that is transparent and user friendly, and can easily be updated to change the estimates based on different targets, assumptions, cost factors and levels of ambition.

[1] 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

[2] Defra et al (2017) Agriculture in the UK, 2016

[3] For example, funding gaps for biodiversity were quantified by GHK (2010) Costs of the UK Biodiversity Action Plan – Update.

1.2 This Report

This report presents the findings of the study, summarising the analysis of the costs of addressing the UK's environmental land management priorities, and presenting overall cost estimates.

The report is structured as follows:

- Section 2 sets out the methodology employed in the work;
- Section 3 presents an overview of land use in the UK, which provides an initial basis for the costings work;
- Section 4 identifies the priorities for land management in order to meet environmental objectives, explaining how these priorities were determined and quantified;
- Section 5 presents evidence of the unit costs of meeting land management priorities, and the methods used to estimate future changes in these costs;
- Section 6 provides an overall estimate of the costs of meeting environmental land management needs in the UK and in each of the four countries;
- Section 7 provides a short commentary on the potential benefits of the range of environmental land management actions identified; and
- Section 8 presents the overall conclusions and recommendations from the work.

The annex summarises the scoping review used to inform the approach to each of the environmental priorities.

2 Method

2.1 Scope of the Study

The study has assessed the costs of environmental land management at UK level, and in the four countries of England, Northern Ireland, Scotland and Wales. It has been based on national level assessments of land uses and environmental needs. No regional or local data are included, although the model could potentially be adapted in future to provide regional breakdowns if required.

The work has aimed to quantify the financial resources needed for the maintenance, restoration and enhancement of ecosystems and natural capital in order to deliver multiple objectives for biodiversity, landscape, the historic environment, water, soil, climate, air quality, flood management and other ecosystem services. The scope includes cultural landscapes and man-made features such as dry stone walls and built heritage features within the rural landscape, where these require a land management approach. Maintenance and restoration of buildings has not been included.

The needs assessment has focused on positive management of land and ecosystems to secure public benefits, in order to inform future analyses of public expenditure needs. The needs identified therefore go beyond existing regulatory obligations and codes of good agricultural practice, and focus on land management practices that deliver wider benefits for society.

The focus has been on the costs of land management. Coastal and wetland habitats that are subject to area based land management type actions are included (such as saltmarsh, cliff edge, grazing marsh and reedbeds), as are catchment management actions that will benefit aquatic and marine habitats and resources. Restoration or maintenance of marine and open water habitats through non land-based actions was outside of the scope of the project.

Other types of activity (such as policy, advisory, planning, education and communications actions, and investments in pollution prevention) were also outside the scope of the work. However, it is recognised that the effectiveness of land management actions is enhanced where they are backed by advice and informed by effective monitoring and evaluation programmes[4]. The most recent available data for England indicate that expenditure on advice amounted to less than 1% of agri-environment expenditure in 2008[5]; however advisory activity is constrained by budgets and an increased level of expenditure would support achievement of environmental objectives. An estimate of the costs of advice could potentially be included by upscaling the estimates of land management costs in the model.

The analysis focuses on the costs incurred and income foregone in delivering the required land management actions. Opportunity costs of alternative land management actions are included in the income foregone estimates, but the opportunity costs of wider changes in land use (e.g. the costs of foregone development) are not included.

The focus is on environmental needs only. It is recognised that additional measures may also be desirable to meet economic and social objectives in rural areas, such as through support for training, advice, farm business development and maintenance of viable rural communities. However, these are outside the scope of the current study.

In assessing the financial needs for environmental land management after Brexit, the study seeks to inform future debate about public funding for land management in the UK after the

[4] This is demonstrated by various evaluations including Boatman et al (2014), Jones et al (2015), Jones et al (2013), Environment Agency (2014) and Boatman et al (2010)

[5] Natural England (2009) Agri-environment schemes in England 2009: A review of results and effectiveness. This review indicates that expenditure on application guidance and advice amounted to £2.6 million in 2008 compared to scheme expenditure of £360 million in that year; overall administration, advisory, IT and compliance monitoring costs amounted to £40.9 million, some 11% of the value of scheme expenditure

CAP. However, it should be noted that the needs identified may not necessarily require public expenditure and some can potentially be met by other measures such as regulation. Furthermore, the purpose of the assessment is to highlight the type and scale of land management actions needed to address environmental priorities, and to stimulate debate about this. While this may help to inform debate about future agri-environment or land management policies, this report does not seek to design or advocate a particular policy or scheme.

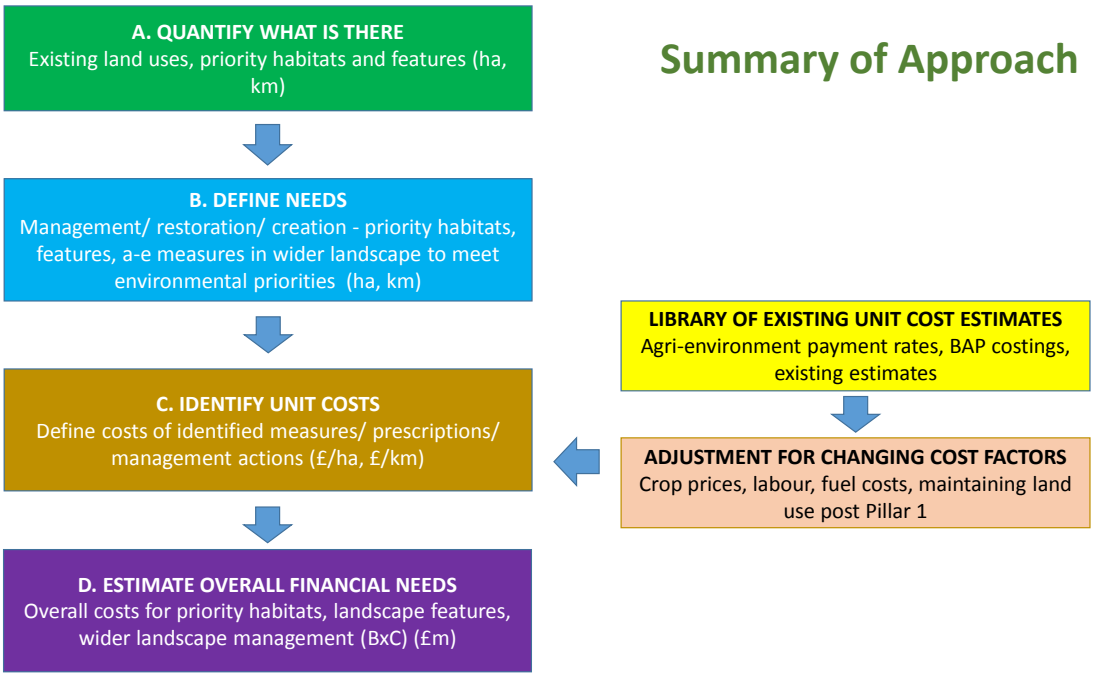
2.2 Approach

The work involved the following principal tasks:

1. Scoping and methodological design;
2. Development of an inventory of UK habitats, landscape features and land uses;
3. Assessment of land management requirements;
4. Identification of existing unit cost data;
5. Assessment of factors influencing future costs of land management;
6. Estimation of total costs;
7. Assessment of benefits; and
8. Reporting and presentation of the model.

The overall approach is illustrated in Figure 2.1

Figure 2.1: Summary of Approach



Task 1: Scoping and methodological design

The first task involved a scoping exercise to define the approach, based on available evidence and discussions with the project partners. This was presented in a methodological report.

Task 2: Inventory development

The first step in building the costings model was to develop a spreadsheet inventory of existing habitats and land uses for each of the UK countries. This provided an overall classification and quantification of priority habitats and landscapes, as well as other land uses (arable, improved grassland, forestry and urban land).

The principal sources of data for this land use inventory were:

- Latest estimates of the area and condition of priority habitats in each country, obtained from the statutory conservation agencies[6], with gaps filled using earlier UKBAP estimates;
- Data on the length and condition of boundary features, from the 2007 Countryside Survey (NERC, 2008);
- Data on the number and area of Scheduled Monuments and undesignated archaeological sites, obtained from responsible bodies in each country[7] and from various published and unpublished sources (e.g. Defra, 2012).
- Latest figures on agricultural land management, published in the agricultural census reports for each country.
- Data on woodland areas published in the Forestry Statistics 2016 (Forestry Commission, 2016);
- Data on organic farming from the UK Organic Farming Statistics (Defra, 2017).

A number of issues and challenges were encountered in this exercise. Some of the datasets used are now several years old (e.g. data on boundary features from the 2007 Countryside Survey). Some difficulties were experienced in reconciling different types of land use and land management data from different sources. For example, reconciling agricultural census statistics on the area of permanent grassland and rough grazing with estimates of priority grassland, heathland and bog habitats was not always straightforward. The exercise involved triangulating and as far as possible reconciling data obtained from different sources and often employing slightly different definitions.

Task 3: Assessment of land management requirement

Having developed the inventory, the next stage was to define needs for management of land of each type. For priority habitats and boundary features, this involved estimating the proportion of the area of land that requires maintenance, creation or restoration activities. For the wider arable and grassland landscape, it was necessary to identify a package of land management measures that would meet priorities for biodiversity, landscape, the historic environment, soils, water and climate.

Where possible, the needs assessment drew on existing policy priorities and targets, as set out in country biodiversity strategies, BAP targets, analyses of needs to meet environmental policy objectives, policy statements by the project partners, and consultations with experts. However, existing policy priorities are not always defined in sufficient detail to enable a quantitative assessment (as in the case of the country biodiversity strategies). In some cases where objectives are well defined, such as the Water Framework Directive, significant uncertainties remain about the extent and type of land management actions required to meet them.

Gaps in evidence and scientific knowledge made it difficult to specify the land management actions needed to meet certain environmental objectives. For example, while it is recognised that environmental land management actions (including tree planting, soil and wetland management) can contribute to flood management, more research is needed to

[6] The main sources were: England: Defra (2016) England Biodiversity Strategy Indicators; Northern Ireland: Unpublished DAERA data - Status and Trends of Priority Habitats in 2010; Scotland - UK BAP targets 2006 (no more recent data available); and Wales: Natural Resources Wales (2016) The State of Natural Resources Report (SoNaRR)

[7] Historic England, Historic Scotland, Cadw, Department for Communities in Northern Ireland

assess their potential at national scale. We must also note that the types of land management action that contribute to natural flood management also deliver other benefits, including for wildlife, water quality and recreation (Huggett, 2017). It was therefore not possible in the assessment to quantify the extent and type of land management needed to address flood management objectives nationally. However, the package of actions identified (including maintenance, restoration and expansion of habitats and boundary features, and measures for management of soil and water quality) will deliver multiple benefits, including for flood management.

Land management needs were defined as follows:

- Priority habitats – needs for maintenance, restoration and expansion were based on the targets in the country biodiversity strategies. Where these were insufficiently detailed, reference was made to earlier (2006) biodiversity action plan targets;
- Boundary features – assessment of restoration needs was based on estimates of the condition of features in the 2007 Countryside Survey, and for expansion on UK BAP targets;
- Historic environment – the assessment was based on consultations with experts in each country, as well as drawing on earlier analyses such as that made by Defra (2012) for England;
- Biodiversity in arable and grassland landscape – the assessment was based on advice from RSPB specialists, informed by scientific evidence of land management measures required to reverse declines in farmland birds and biodiversity (e.g. Winspear, 2010);
- Water quality – consultations revealed a scarcity in all four countries of quantitative analyses of the scale of land management activities required to meet WFD objectives. Based on advice from the Environment Agency, the model assumes similar land management actions to those defined in the Cost of Agricultural Measures (CAM) model;
- Soil – needs were based on data on soil erosion risk (ESDAC, 2015) and estimates of the area of deep peat soils in the UK, as important stores of carbon (JNCC, 2011);
- Organic farming – continuation of current rates of organic management and conversion (from Defra, 2017) was taken as the baseline requirement;
- Actions to address the priorities identified above will also contribute to other environmental objectives, such as those for climate, flood management and air quality. Available evidence made it difficult to identify and quantify distinct and finite requirements for these objectives, so they were not assessed separately, but assumed to benefit from the overall package of actions specified.

Many of the actions needed to meet different environmental objectives are overlapping. Action to restore and maintain priority habitats will deliver a wide range of benefits for landscape, climate, resource protection, flood management and delivery of other ecosystem services. In the wider countryside, similar types of prescriptions (e.g. buffer strips, field margins, beetle banks, winter cover crops, reversion of arable land to grassland in sensitive areas) can help to deliver multiple benefits for biodiversity, landscape, climate, soils and resource protection. It was therefore important to avoid double counting the extent and cost of actions required. This was achieved by:

- Specifying the land use model such that each hectare of land would be counted only once in the assessment – for example by distinguishing clearly between priority habitats and non-priority grassland and rough grazing land; and
- Estimating the areas of overlap between actions to meet different environmental priorities within each land use category. For example, taking field corners out of management is identified as a land management action that can meet both biodiversity and water quality objectives. The degree of overlap between the needs identified for biodiversity and water quality were estimated, and this overlap was subtracted from the inventory of required measures within the model.

The possibility that Pillar 1 subsidies will be removed after Brexit raised additional questions, as it potentially threatens the viability of farming in certain areas. To address this, the model includes the option of adding an additional supplementary cost to maintain land management and prevent abandonment, which can be added to the costs of land management actions for upland, permanent grassland and/or arable land as required.

In building the model, it became clear that the defined environmental land management needs vary according to the overall level of ambition, as well as the priority accorded to different environmental objectives. For example, while it is desirable for 100% of priority habitats and boundary features to be positively managed, a policy maker may decide to accept a lower target based on available resources or short term priorities. Similarly the type and extent of management prescriptions that need to be applied to arable land or permanent grassland to meet resource protection priorities is not known with certainty and is subject to an element of judgement. The model therefore includes a worksheet specifying headline "Policy Choices" which enable assumptions – typically about the assumed % of land to be managed in certain ways – to be varied. These headline policy choices are then translated into more detailed packages of management measures.

The identified needs are expressed as annual averages, over a ten year period (e.g. 2019 to 2028 inclusive). Most of these needs relate to the annual and recurrent requirements for land management. Restoration of priority habitats and landscape features is assumed to take place over a ten year period – the annual need is therefore estimated to be 10% of the overall requirement. Expansion of priority habitats is assumed to amount to 0.5% of the current habitat area annually, based on estimates in the country biodiversity strategies.

This analysis enabled quantitative estimates to be made regarding land management needs to contribute to the range of environmental objectives and targets identified.

Task 4 - Identification of existing unit cost data

Data on the unit costs of the relevant land management actions were collated. The main sources were:

- Current payment rates under agri-environment schemes in the four UK countries; and
- Estimates of the capital costs of restoration and creation of priority habitats, based on the UK BAP costings work (GHK, 2010) and updated for inflation to 2017 prices.

Task 5 - Assessment of cost drivers

The costs of land management primarily depend on:

- The costs of operations required – including costs of labour, equipment, materials and energy; and
- Income foregone – lost revenues as a result of modifications in land use or reduced yield, which in turn depend on the change in output and price of crops or livestock.

The factors influencing land management costs, such as the costs of labour, fuel and machinery, agricultural yields, food prices and exchange rates all change over time, resulting in changes in the unit costs of environmental land management actions.

The model has been developed to take account of these cost drivers and to allow estimated unit costs of land management to be updated to take account of these cost variables. This was achieved by deconstructing the current unit cost values, estimating the contribution of different elements of costs and income foregone in each case[8]. The unit cost of each type of land management action was then re-estimated based on current cost rates, food prices and yields.

[8] The main sources used were the agri-environment payment calculations set out in Natural England (2013) and in the Rural Development Programmes for Wales (Welsh Government, 2015) and Northern Ireland (DAERA, 2017)

This has enabled two estimates of the costs of meeting the identified land management needs to be made:

- A “current cost” estimate, based on existing agri-environment scheme rates and historic cost estimates; and
- A “cost-drivers” based estimate, based on recent changes in relevant cost drivers.

This should enable the cost estimates to be varied to take account of future changes in cost drivers. This could potentially allow modelling of the effects of future Brexit scenarios resulting in changing food prices and input costs.

Task 6 – estimation of total costs

The total costs of environmental land management in the UK are estimated by combining estimates in the model of the areas of land to be managed in different ways (from Task 3) and the unit costs of land management actions (from Task 5).

Estimates are made for each country, using unit costs based on both the “current costs” and “cost-drivers” elements of the model, and for the following features and land use categories:

- Priority habitats
- Boundary features
- Historic environment
- Arable land
- Grassland
- Organic farming.

Task 7 - Assessment of benefits

The study has focused on the costs of addressing environmental land management priorities, rather than the benefits. However, a short assessment of the benefits of the actions identified was also made, based on existing literature, and is presented in Section 7 of this report.

Task 8 – Reporting and presentation of model

This report describes the details of the model and presents the results of the assessment. The MS Excel model is also provided as an output from the study. The aim has been to present the model in a transparent and user friendly format, referencing source data, and highlighting assumptions in order to facilitate updates and refinements by model users.

The model comprises a series of worksheets:

- Sheet 1, “Policy Choices”, presents the main variables which determine the scale of environmental land management activity and the overall level of ambition. The user is invited to amend these variables in order to vary the overall scale of action involved and the resultant financial needs;
- Sheet 2, “Cost Drivers”, introduces the main variables driving changes in costs and income foregone, which can be varied in order to calculate the "adjusted" costs of the specified land management measures;
- Sheet 3 presents a summary of the overall cost estimates, based on estimates for different land uses, priority habitats and landscape features from sheets 25-29;
- Sheets 4-7 present existing data on land use, priority habitats and landscape features in the UK and four countries;
- Sheets 8-12 present the assessment of environmental land management needs, for priority habitats, landscape features, arable farming, grassland and organic farming. These needs are linked to the variables in the “Policy Choices” sheet;
- Sheets 13-24 form the basis of the cost assessment, presenting the costing calculations and resultant unit cost estimates;
- Sheets 25-29 present the overall estimates of financial needs for the UK and the four countries, combining the estimated needs with the unit costs of land management.

The cells in the model are colour coded to distinguish between those that contain choices and assumptions which can be varied by the user, those that contain baseline data and can be updated as new or more recent data become available, and those that contain formulae which update automatically, so do not need to be changed.

The following sections present the various results of the modelling assessment.

3 Current Land Use in the UK

Table 3.1 provides a breakdown of latest estimates of current land use in the UK. The figures indicate that agriculture accounts for 71% of the UK land area, with woodland a further 13% and urban uses approximately 11%.

Table 3.1: Estimated Breakdown of Land Use in the UK, 2016 (000 hectares)

Land Use	England	Northern Ireland	Scotland	Wales	UK	%
Woodland						
Broadleaved woodland	967	46	378	156	1,547	6%
Coniferous woodland	340	66	1,061	151	1,618	7%
Total woodland	*1,307*	*112*	*1,439*	*307*	*3,165*	13%
Agriculture						
Crops and bare fallow	4,209	47	582	89	4,927	20%
Sole right rough grazing	479	137	3,085	260	3,961	16%
Permanent grassland >5 years	3,282	653	1,118	1,066	6,119	25%
Temporary grassland	627	148	210	158	1,143	5%
Other farmland (yards, buildings etc)	153	12	155	15	335	1%
Total farmland on holdings (excluding woods)	*8,750*	*997*	*5,150*	*1,588*	*16,485*	66%
Common rough grazing	399	-	584	180	1,163	5%
Total agricultural land	*9,149*	*997*	*5,734*	*1,768*	*17,648*	71%
Freshwater (lakes, canals, reservoirs, rivers, streams)	126	67	110	11	314	1%
Urban	2,146	81	288	100	2,615	11%
Other (other habitats/ residual/ adjustment factor)	566	156	453	- 63	1,112	4%
Total land area	**13,294**	**1,413**	**8,024**	**2,123**	**24,854**	**100%**

Sources: Forestry Statistics (Forestry Commission, 2016); Agricultural Census statistics published by the agriculture departments; Countryside Survey 2007 (NERC, 2008) with projections for urbanisation based on Land Use Change statistics

Table 3.2 presents best estimates of priority habitats in the UK and in each of the four countries. These are based on latest data provided by the statutory conservation agencies. However, for Scotland, estimates of priority habitats have not been updated since the UK BAP estimates of 2006.

It is estimated that there are approximately 5.4 million hectares of priority habitats in the UK, of which 2.2 million are blanket bog, 1.1 million are native broadleaved, mixed and yew woodland, and 0.95 million hectares are upland heathland.

Table 3.2: Priority Habitats in the UK (000 hectares)

		England	Northern Ireland	Scotland	Wales	UK
Woodland	Native broadleaved, mixed and yew woodland	735.7	8.4	210.0	146.9	1,101.0
	Native pinewood	-	-	181.0	-	181.0
	Wood Pasture and Parkland	30.0	1.1	10.0	7.5	48.6
	Orchard	15.6	1.2	-	0.7	17.4
Grassland	Coastal and Floodplain Grazing Marsh	218.2	4.8	1.5	39.9	264.3
	Lowland Meadows	36.1	0.9	1.0	1.6	39.7
	Upland Hay Meadows	3.5	-	0.0	-	3.6
	Lowland Calcareous Grassland	65.6	-	0.8	1.2	67.5
	Upland Calcareous Grassland	10.4	0.9	5.0	0.7	16.9
	Lowland Dry Acid Grassland	15.5	0.4	4.4	39.5	59.7
Dwarf Shrub Heath	Lowland heathland	56.8	5.8	18.9	12.5	94.0
	Upland heathland	236.9	11.0	623.0	79.0	949.9
Fen, Marsh, Swamp	Upland Flushes, Fens and Swamps	10.7	0.3	-	14.3	25.3
	Purple Moor Grass & Rush Pastures	9.3	18.5	6.8	35.3	69.9
	Lowland Fens	22.3	5.3	0.9	6.2	34.7
	Reedbeds	7.0	2.0	0.5	0.5	10.0
Bog	Lowland Raised Bog	9.7	21.1	13.0	2.4	46.2
	Blanket Bog	280.3	139.8	1,759.0	53.2	2,232.3
Montane	Mountain Heaths and Willow Scrub	6.2	0.2	-	0.1	6.5
Inland Rock	Limestone Pavement	2.9	0.2	0.0	0.1	3.3
	Calaminarian Grassland	0.2	-	0.2	0.0	0.4
Coastal	Maritime Cliff and Slope	11.5	2.5	11.9	3.8	29.7
	Coastal Vegetated Shingle	4.1	0.1	0.7	0.1	5.0
	Coastal Sand Dunes	10.6	1.3	35.0	8.1	55.0
	Machair	-	-	30.0	-	30.0
	Coastal Saltmarsh	24.5	0.2	6.7	7.3	38.8
Total		**1,823.6**	**225.9**	**2,920.2**	**460.9**	**5,430.5**

Sources: England: Defra (2016) England Biodiversity Strategy Indicators; Northern Ireland: Unpublished DAERA data - Status and Trends of Priority Habitats in 2010; Scotland - UK BAP targets 2006 (no more recent data available); Wales: Natural Resources Wales (2016) The State of Natural Resources Report (SoNaRR)

Table 3.3 reconciles the overall land use data in Table 3.1 with the priority habitat data in Table 3.2, by subtracting the relevant priority habitats from the relevant land use categories. Most priority habitats are either farmed or wooded. In addition to the estimated 5.4 million hectares of priority habitats, there are approximately 1.9 million hectares of non-priority habitat woodland, 4.9 million hectares of crops and fallow, 1.1 million hectares of temporary grassland, 5.6 million hectares of improved permanent grassland, and 1.8 million hectares of rough grazing land. These estimates form the basis of assessment of land management needs in the wider landscape – the aim is to avoid double counting agriculture and forestry land which is also priority habitat.

Table 3.3: Estimated areas of priority habitats and non-priority habitat woodland and farmland (000 ha)

	England	Northern Ireland	Scotland	Wales	UK	Notes
Priority habitats	1,824	226	2,920	461	5,431	From Table 3.2
Other broadleaved / mixed woodland	231	38	168	9	446	Broadleaved/ mixed woodland minus priority woodland habitats
Other coniferous woodland	340	66	880	151	1,437	Coniferous woodland minus native pinewood
Crops and fallow	4,209	47	582	89	4,927	From agricultural census statistics
Temporary grassland	627	148	210	158	1,143	From agricultural census statistics
Other permanent grassland	2,923	628	1,099	948	5,597	Permanent grassland minus priority grassland habitats
Other rough grazing	288	-	1,255	293	1,836	Rough grazing minus bog and heath habitats - mostly unenclosed upland grassland. There is an anomaly for NI where estimated area of blanket bog and upland heath exceeds that of rough grazing, suggesting inconsistencies between the different datasets used.
Total	**10,442**	**1,152**	**7,114**	**2,109**	**20,817**	

Table 3.4 presents estimates of the length of woody linear features, managed hedgerow and stone walls, from the Countryside Survey 2007.

Table 3.4: Estimated length of wooded linear features, hedgerows and stone walls by country

		England	Northern Ireland	Scotland	Wales	UK
Woody linear features	km	547,000	113,719	46,000	106,000	812,719
of which managed hedgerow	km	402,000	113,648	21,000	54,000	590,648
Walls	km	82,000	11,000	79,000	14,000	186,000

Source: Countryside Survey 2007 (NERC, 2008)

Table 3.5 presents estimates of the number of historic environment sites in the UK, including scheduled monuments and undesignated sites, based on a variety of sources, with some extrapolation to fill gaps in the available data. The area of sites on agricultural land is also estimated.

Table 3.5: Estimated number and area of historic sites

	England	Northern Ireland	Scotland	Wales	UK	Sources
Number of scheduled monuments	20,000	1,993	8,164	4,186	34,343	DCMS, Historic Scotland, Cadw, Dept for Communities data
Estimated number of undesignated archaeological sites	68,979	14,687	137,656	30,721	252,043	From SHINE (England), Northern Ireland Sites and Monuments Record (NISMR), SHEA (2016, Scotland); Wales estimates by extrapolation. SHINE includes "substantive sites of known extent that can be managed under agri-environment options"; it is estimated that there up to 500,000 archaeological sites in England. The same is likely to be true to some extent in the other countries, but the definitions in the databases may not be the same. Therefore some caution is needed in comparing the estimates.
Estimated farmed area of scheduled monuments and undesignated sites (000ha)	289.7	39.2	350.0	82.1	761.0	Own estimates using estimates for average area per site from Defra (2013), Historic Scotland (2015), CAMSAR (2009)

The estimated extent of these different land uses, habitats and features forms the basis for assessment of environmental land management needs in the next section.

4 Defining Needs for Environmental Land Management

The next stage of the analysis involved estimating the areas of land, priority habitats, boundary features and historic environment features requiring different types of management in order to meet environmental objectives. Table 4.1 summarises estimates of the areas of different land, habitats and features requiring different forms of management, based on the method described in Section 2, Task 3. The areas given in the table can be varied by varying the 'Policy Choices' in the model.

Table 4.1: Summary of identified environmental land management needs

	Assumed needs	Extent of annual need
Priority habitats		
Maintenance	All land assumed to require annual maintenance	5,430,532 ha
Restoration	Habitats in unfavourable condition restored over 10 year period. All habitats, with largest areas of blanket bog and native woodland.	250,646 ha
Expansion	Creation of new habitat equivalent to 0.5% of existing area annually over 10 years. Two thirds of this is native woodland.	27,153 ha
Boundary features		
Maintenance of hedgerow	All hedges require annual maintenance	590,648 km
Restoration of hedgerows and wooded linear features	50% of hedgerow not in good structural condition, and 50% of unmanaged woody linear features, are assumed to require restoration over a 10 year period	25,870 km
Restoration of stone walls	Stone walls not in good structural condition are restored over a 10 year period	4,650 km
Historic environment		
Historic features on grassland	Sympathetic grassland management; one third of area assumed to require scrub clearance	609,885 ha
Historic features on arable land	Reversion to grassland (50%); minimum tillage (50%)	151,168 ha
Arable land		
"Mid-tier" biodiversity management	2 ha per 100 ha managed for nectar/ pollinators 3 ha per 100 ha managed for winter bird food	50% of cultivated area
"Higher tier" biodiversity management	3 ha per 100 ha managed for nectar/ pollinators 2 ha per 100 ha managed for nesting, hibernation and sheltering sites for insects and birds	30% of cultivated area

	3 ha per 100 ha managed for winter bird food	
Prevention of soil erosion	Arable soils with very strong erodibility managed with winter cover crops or reversion to grassland	1,296,000 ha
Protection of deep peat soils	Reversion to grassland of deep peat soils under arable management[9]	161,700 ha
Water quality	Riparian buffer strips on arable land	25,516 ha
Water quality	General resource protection measures in wider catchment (management of field corners, tramlines, winter cover crops, buffer strips, spring cropping)	Package of measures applied to 40% of farms
Water quality	Special resource protection measures (conversion to grassland, arable fallow, woodland and hedgerow planting)	Package of measures applied to 3% of farms
Improved grassland		
"Mid-tier" biodiversity management	2 ha per 100 ha managed for nectar/ pollinators 3 ha per 100 ha managed for winter bird food 2% of grassland area managed for breeding waders and ground nesting birds	50% of grassland area
"Higher tier" biodiversity management	3 ha per 100 ha managed for nectar/ pollinators 2 ha per 100 ha managed for nesting, hibernation and sheltering sites for insects and birds 3 ha per 100 ha managed for winter bird food 5% of grassland area managed for breeding waders and ground nesting birds	30% of grassland area
Prevention of soil erosion	Seasonal livestock removal on grassland soils with very strong erodibility	1,678,000 ha
Water quality	Riparian buffer strips on grassland	28,162 ha
Water quality	General resource protection measures in wider catchment (management of field corners, buffer strips)	Package of measures applied to 40% of farms
Water quality	Special resource protection measures (seasonal livestock removal, permanent grassland with very low inputs, woodland and hedgerow planting)	Package of measures applied to 3% of farms
Rough grazing		
Rough grazing (non-priority habitats)	Proportion of rough grazing managed with low inputs and mixed grazing	30%
Organic farming		

[9] In practice the management measures required for deep peat soils are likely to be more complex than this, and to require further research

Organic management	Maintain current area of organic management	482,800 ha
Organic conversion	Continue current rate of organic conversion	25,100 ha

5 Costs of Environmental Land Management Action

5.1 Approach

The costs of undertaking the identified land management actions were estimated using both:

- 'Current' cost rates, based on current agri-environment scheme payment rates, as well as recent cost assessments for those actions for which standardised payment rates were not available (e.g. capital costs of habitat restoration and expansion)
- Adjusted rates, obtained by building a cost model to assess costs incurred and income foregone for each of the management actions to be costed.

5.2 'Current' costs

A library of current costs was developed by selecting appropriate agri-environment options from the agri-environment handbooks in each of the four countries. Country specific payment rates were identified – this resulted in some differences in the unit cost rates for each country. Where gaps were encountered, these were filled by averaging payment rates in the other countries. Agri-environment rates were available for most of the annual management actions for priority habitats, boundary and historic environment features, arable and grassland landscapes.

It should be noted that applying agri-environment payment rates may underestimate the full cost of achieving the required environmental land management practices at national scale. Payment rates are based on estimates of income foregone and costs incurred for the average scheme entrant. However, these costs are likely to vary between farms, such that the marginal costs of securing the required changes can be expected to increase in line with uptake. As a result, achieving full uptake at national scale may require higher payment rates than those currently paid. For this reason, the current cost rates identified are likely to provide conservative estimates of the full costs of the required land management.

The capital cost of investments in habitat restoration and creation are more variable and standard payment rates are not generally applied. In these cases it was necessary to rely on previous cost assessments such as the UK BAP costings (GHK, 2010), and to update relevant unit cost estimates to account for inflation[10].

5.3 Adjusted costs

The unit costs of relevant land management actions can be expected to vary over time, as a result of variations in the factors that influence the costs incurred and income foregone. These factors that influence costs are summarised in Table 5.1.

Table 5.1 Summary of cost drivers

Value of output	- Prices of crops and livestock - Crop and livestock yields
Cost of inputs	- Labour - Machinery - Fuel - Fertilisers - Pesticides - Seeds - Materials (stone, fencing materials etc.) - Veterinary services - Animal feed - Working capital

[10] Using the HM Treasury GDP deflator

In order to enable the unit cost rates to be varied and updated, a cost model was developed that estimated the different cost elements for each of the identified management actions. For each action, estimates were made of changes in income foregone and costs incurred. The model was designed to allow variable data to be inputted for each of the output and cost drivers, in order to estimate changes in unit cost rates.

The calculations of costs and income foregone for the current Countryside Stewardship scheme in England[11] was the principal source of the cost equations for each environmental land management action. Reference was also made to cost calculations included in the current Rural Development Programmes for Wales (Welsh Government, 2015) and Northern Ireland (DAERA, 2017). The Nix farm management pocketbook (Nix, 2017) was used as the main source for updating the cost drivers.

5.4 'Current' costs vs 'adjusted' costs

Using the methodology described above, the model gives two sets of unit cost estimates, based on current cost rates and based on adjusted cost drivers.

The adjusted unit cost rates tend to be lower than current agri-environment payment rates for arable land, reflecting declines in arable gross margins since 2012. In contrast, the adjusted costs for grassland, based on cost drivers from Nix (2017), tend to be higher than current agri-environment scheme payment rates.

The two sets of unit cost data were used to arrive at overall estimates of financial needs for land management in the UK, presented in the next section.

[11] Natural England (2013, unpublished) New Environmental Land Management Scheme Calculation of Income Foregone by Participants 2013. Report prepared by Natural England for DEFRA Sustainable and Soils Division

6 Estimates of the Costs of Environmental Land Management in the UK

Estimates of the costs of the identified land management needs, based on the current cost rates, are presented in the following tables.

All of the figures represent estimated annual costs, over a 10 year period (e.g. from 2019 to 2028 inclusive).

The figures presented here include only the estimated costs of undertaking specified land management actions. It is recognised that the viability of the farming systems that deliver the required environmental land management practices may be threatened if existing CAP Pillar 1 subsidies are withdrawn. This is particularly the case in upland areas where the financial viability of current farming practices is at greatest risk, potentially leading to a risk of abandonment of priority upland grassland, heathland and blanket bog habitats, as well as a reduction in grazing in the wider landscape. The model includes an option of including a cost of securing basic land management (i.e. preventing abandonment), which can be applied to upland, grassland and arable systems as required. However, estimating this cost would depend on modelling the effects of different Brexit scenarios on the viability of farming systems, which has been beyond the scope of the current project. **The following cost estimates therefore focus on securing the land management practices required within existing land use systems, rather than supporting the viability of current land uses.**

The costs of maintenance, restoration and expansion of priority habitats are estimated at £876 million per annum. 37% of these costs are for annual maintenance, 53% for restoration and 10% for expansion (Table 5.1). The largest costs relate to native broadleaved, mixed and yew woodland (55%), followed by blanket bog (10%) and coastal and floodplain grazing marsh (9%) (Table 5.2). The estimated costs are annual figures over a 10 year period, and will decline thereafter, since there will be no further need for capital expenditures on restoration.

Table 5.1: Estimated annual costs of maintenance, restoration and expansion of priority habitats, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Maintenance*	190,022	13,727	64,371	56,184	324,303
Restoration	250,376	15,309	146,620	52,917	465,221
Expansion	31,036	3,141	41,461	11,095	86,733
Total	**471,433**	**32,177**	**252,451**	**120,196**	**876,257**

Note: Maintenance cost is the cost of securing environmental land management within existing land uses; these figures do not include the cost of maintaining existing land uses should these become unviable following cessation of CAP subsidies; however, provision is made for this in the model as required.

The estimated costs for boundary features are given in Table 5.3. The estimated annual cost of maintenance, restoration and expansion of hedgerows and restoration of stone walls is £402 million annually. Three quarters of this cost relates to the restoration of hedgerows and stone walls.

Table 5.2: Estimated annual cost of maintenance, restoration and expansion of priority habitats, based on current costs (£000)

		England	Northern Ireland	Scotland	Wales	UK
Woodland	Native broadleaved, mixed and yew woodland	296,229	5,797	118,354	64,388	484,767
	Native pinewood	-	-	45,055	-	45,055
	Wood Pasture and Parkland	3,619	162	1,832	1,012	6,626
	Orchard	4,676	407	2,173	477	7,733
Grassland	Coastal and Floodplain Grazing Marsh	69,476	1,295	444	7,002	78,217
	Lowland Meadows	8,498	192	134	419	9,243
	Upland Hay Meadows	747	-	7	-	754
	Lowland Calcareous Grassland	16,472	-	134	432	17,039
	Upland Calcareous Grassland	2,043	201	589	170	3,003
	Lowland Dry Acid Grassland	4,354	93	646	11,233	16,326
Dwarf Shrub Heath	Lowland heathland	17,369	561	2,618	1,544	22,091
	Upland heathland	10,615	620	7,290	5,091	23,616
Fen, Marsh, Swamp	Upland Flushes, Fens and Swamps	461	12	-	2,165	2,638
	Purple Moor Grass & Rush Pastures	2,777	3,579	1,387	7,413	15,156
	Lowland Fens	2,159	285	77	928	3,449
	Reedbeds	1,373	464	162	84	2,083
Bog	Lowland Raised Bog	3,243	4,844	3,733	937	12,757
	Blanket Bog	13,445	12,996	54,353	9,366	90,160
Montane	Mountain Heaths and Willow Scrub	267	6	-	6	279
Inland Rock	Limestone Pavement	416	43	4	11	474
	Calaminarian Grassland	16	-	16	4	36
Coastal	Maritime Cliff and Slope	1,735	225	973	728	3,661
	Coastal Vegetated Shingle	913	11	152	24	1,100
	Coastal Sand Dunes	2,879	373	8,710	1,542	13,504
	Machair	-	-	3,030	-	3,030
	Coastal Saltmarsh	7,652	10	578	5,220	13,460
Total		**471,433**	**32,177**	**252,451**	**120,196**	**876,257**

Table 5.3: Estimated annual costs of maintenance, restoration and expansion of boundary features, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Maintenance					
Hedgerows	48,240	11,422	1,733	5,346	66,740
Restoration					
Hedgerows	132,057	25,214	12,810	19,131	189,211
Walls	51,250	6,311	50,560	9,758	117,879
Expansion					
Hedgerows	23,316	3,277	126	1,215	27,934
Total	**254,863**	**46,224**	**65,228**	**35,450**	**401,765**

The estimated annual cost of maintenance of agricultural land around historic environment features is put at £92 million annually in the UK (Table 5.4).

Table 5.4: Estimated annual costs of maintaining historic environment features on agricultural land, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Grassland management	5,389	1,118	9,449	2,340	18,297
Arable reversion	23,397	381	8,673	505	32,956
Minimum tillage	4,349	77	1,382	162	5,971
Scrub management	8,122	1,913	20,788	4,337	35,159
Total	**41,257**	**3,490**	**40,292**	**7,344**	**92,383**

The estimated annual cost of the identified land management measures for arable land are £461 million annually, based on current agri-environment scheme payment rates. The combined package of measures in the table is designed to meet objectives for biodiversity, climate, soil protection and water quality, and take account of overlaps between the actions needed to meet each objective. The largest costs relate to winter cover crops, followed by reversion of arable land to low intensity grassland (Table 5.5).

Table 5.5: Estimated annual costs of arable land management measures, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Nectar Flower Mix	9,841	100	1,284	198	11,423
Flower Rich Margins and Plots	8,575	83	1,091	169	9,917
Two-year sown legume fallow	8,305	93	1,134	175	9,707
Autumn sown bumblebird mix	8,750	98	1,195	185	10,228
Cultivated areas for arable plants	10,691	157	1,587	212	12,647
Buffer strips on cultivated land	11,823	135	2,267	269	14,494
Watercourse buffer strip on cultivated land	9,584	849	1,879	246	12,558
Beetle banks	2,399	25	283	47	2,755
Nesting plots for ground nesting birds	2,194	33	328	44	2,598
Harvested low input cereal	1,114	12	150	23	1,299
Skylark plots	11,060	86	838	156	12,140
Winter bird seed	28,135	289	1,937	560	30,922
Unharvested cereal headland	8,039	85	1,128	139	9,391
Winter stubble	18,464	208	2,888	566	22,126
Arable reversion to grassland[12]	139,911	5,073	8,322	442	153,747
Winter cover crops	110,013	6,154	11,665	908	128,740
Manage overwinter tramlines	7,436	83	1,016	157	8,691
Arable fallow	6,556	73	896	138	7,664
Total (£000)	**402,889**	**13,635**	**39,888**	**4,635**	**461,047**

Table 5.6 summarises the costs of the equivalent package of measures for grassland. The costs for improved grassland are estimated at £308 million annually, with the largest costs relating to seasonal livestock removal for soil and resource protection.

In addition, the cost of rough grazing management is estimated at £23 million annually.

[12] Note: the costs for management of deep peat soils are likely to be underestimated, because of the high value of crops often grown, as well as uncertainties about the required management practices. Further analysis would be helpful.

Table 5.6: Estimated annual costs of grassland land management measures, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Legume and herb rich swards	16,366	3,572	5,959	5,089	30,985
Permanent grassland with very low inputs	2,183	487	923	615	4,208
Take field corners out of management	24,240	5,291	8,830	7,538	45,898
Lenient grazing supplement (Permanent grassland with very low inputs)	1,473	326	594	428	2,821
Ryegrass seed-set as winter/spring food for birds	10,521	2,296	3,830	3,271	19,919
Pasture managed for waders/ ground nesting birds	23,309	3,758	4,822	5,326	37,215
Seasonal livestock removal	70,301	60,211	16,286	2,222	149,020
Riparian buffer strips	5,491	2,843	618	403	9,355
4-6m buffer strips on intensive grassland	4,829	908	1,288	1,292	8,316
Total for improved grassland	***158,712***	***79,691***	***43,150***	***26,183***	***307,736***
Rough grazing management					
Low intensity grazing with cattle and sheep	5,272	- [13]	12,426	5,709	23,406
Total	**163,983**	**79,691**	**55,575**	**31,893**	**331,142**

The estimated annual costs of organic management and conversion are £26 million annually, comprising management costs of £23 million and conversion costs of £3 million (Table 5.7).

Table 5.7: Estimated annual costs of organic management and conversion, based on current costs (£000)

	England	Northern Ireland	Scotland	Wales	UK
Conversion (£000)					
Improved grassland	411	27	69	547	1,055
Unimproved grassland	73	6	21	26	125
Rotational land	1,142	10	24	220	1,395
Horticulture	179	1	8	56	243
Top fruit	20	0	1	3	24
Subtotal	*1,825*	*44*	*121*	*851*	*2,841*
Management (£000)					
Improved grassland	4,697	260	1,401	2,512	8,870
Unimproved grassland	624	53	725	237	1,639
Rotational land	6,895	98	287	1,105	8,385
Horticulture	2,602	28	196	526	3,353
Top fruit	522	0	24	6	552
Subtotal	*15,340*	*439*	*2,633*	*4,386*	*22,799*
Total	**17,165**	**483**	**2,754**	**5,237**	**25,640**

[13] NI rough grazing costs in table 5.6 are estimated from the estimated area of non-priority habitat rough grazing in Table 3.3. A statistical quirk results in a zero estimate for Northern Ireland, since the estimated area of upland bog and heath from the priority habitats data exceeds the estimated area of rough grazing in the agricultural statistics. In practice we would expect some non-priority habitat upland grazing to require appropriate management.

The overall costs of the suite of environmental land management measures identified to meet the range of objectives for biodiversity, landscape, historic environment, soils, water quality and climate are summarised in Tables 5.8 and 5.9.

Based on 'current' unit costs, the total cost of meeting the identified environmental land management priorities in the UK are estimated at £2,188 million annually.

England accounts for 62% of the overall cost estimate, followed by Scotland (21%), Wales (9%) and Northern Ireland (8%). 40% of these estimated costs relate to the management, restoration and expansion of priority habitats, 21% to arable land, 18% to boundary features, and 15% to grassland.

Table 5.8: 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	80	56	32	331
Organic	17	0.5	3	5	26
Total	**1,352**	**176**	**456**	**205**	**2,188**

Using the 'adjusted' unit costs, to take account of changes in cost drivers, increases the overall cost estimate to £2,307 million annually.

Table 5.9: Summary of overall annual costs of meeting environmental land management priorities, based on adjusted costs (£m)

	England	Northern Ireland	Scotland	Wales	UK
Priority habitats	493	40	383	113	1029
Boundary features	226	44	63	42	375
Historic environment	41	3	33	7	84
Arable land	379	14	38	4	436
Grassland	170	75	73	39	358
Organic	17	0.5	3	5	26
Total	**1,326**	**177**	**594**	**210**	**2,307**

The effect of changes in cost variables on the overall cost estimates, using the adjusted costs model, is shown in Table 5.10. The main variables affecting the cost estimates are arable crop and livestock prices and yields, as well as labour costs. A 20% change in each of the price of arable crops, livestock or labour results in a change in overall cost estimates of 8.4%, 5.0% or 3.6% respectively, while a 20% increase or decrease in all three of these variables changes the estimated costs by 17%. Increasing crop and livestock yields in the model from "average" to "high", based on the figures in the Nix farm management

pocketbook[14] increases the estimated costs by 12.5% overall, by increasing the income foregone from the land management measures.

Table 5.10: Estimated changes in cost estimates based on changes in cost drivers

Scenario	Overall cost estimate, UK, based on adjusted costs (£m)	Change against baseline (%)
Baseline	2,307	0%
Price of arable crops +20%	2,501	+8.4%
Price of arable crops -20%	2,114	-8.4%
Price of livestock +20%	2,424	+5.0%
Price of livestock -20%	2,191	-5.0%
Cost of labour +20%	2,389	+3.6%
Cost of labour -20%	2,226	-3.6%
Price of arable crops + livestock + labour +20%	2,699	+17.0%
Price of arable crops + livestock + labour -20%	1,915	-17.0%
Baseline prices, high arable and livestock yields	2,596	+12.5%
Baseline prices, low arable and average livestock yields	2,133	-7.5%

[14] The differences between high and average yields vary, ranging from 15-50% for different crops and 0-10% for livestock

7 Benefits of delivering the land management actions identified

The package of environmental land management actions defined in this study will deliver substantial benefits to people and the environment across the UK. These benefits will result from:

- Enhancing biodiversity by maintaining, restoring and expanding priority habitats and reversing species' decline in the wider countryside;
- Protecting and maintaining landscapes, including through maintenance and restoration of boundary features, and enhancing the diversity of land management and farmland features;
- Protecting and maintaining the historic environment, through maintenance and sympathetic management of scheduled monuments and undesignated sites;
- Safeguarding soils, by protecting soils most at risk of erosion and maintaining deep peat soils;
- Enhancing water quality, through management of riparian land and resource protection measures in wider catchments;
- Mitigating climate change, by protecting and restoring woodland, peatland, wetland and grassland ecosystems, protecting and restoring hedgerows, and enhancing soil carbon stores;
- Contributing to a range of ecosystem services, such as mitigation of floods and enhancement of air quality;
- Increasing opportunities for outdoor recreation, and providing benefits for tourism and local economies.

The package of actions – if delivered through public payments - will also provide an alternative source of income and employment for land managers. While the identified financial needs are based on costs incurred and income foregone, they offer opportunities to diversify income and maintain rural employment by financing land management actions, as well as providing wider opportunities for tourism and recreation.

The study has not attempted to quantify the benefits of the measures identified. However, a range of recent studies demonstrate that the benefits of environmental land management can be substantial, and significantly exceed the costs. For example:

- Christie et al (2011) estimated the value of ecosystem services that would be delivered by the UK Biodiversity Action Plan, involving actions of a similar type and scale to those for biodiversity in the current assessment. The benefits of current levels of expenditure under the UK BAP were estimated at £1.36 billion. It was estimated these benefits would increase by a further £747 million annually if expenditure were increased to allow full delivery of the UKBAP targets, giving total annual benefits amounting to £2.1 billion per annum. This compared to estimates by GHK (2010) of the costs of UKBAP delivery which amounted to £837 million per annum. The largest benefits were for climate regulation and water regulation.
- GHK (2011) used a willingness to pay study to estimate the current benefits of sites of special scientific interest (SSSIs) in England and Wales at £956 million per annum. This benefit would increase by £769 million per year if SSSIs were all restored to favourable condition. The benefits compared to estimated annual public expenditures of £111 million on SSSIs at that time.
- The Natural Capital Committee (2015) has found that there is a strong economic case for delivering a wide range of ecosystem restoration projects (Box 7.1).

Box 7.1: Benefits of Restoring Natural Capital

The Natural Capital Committee (2015), in its third report, found that there was a strong economic case for investing in the restoration and enhancement of natural capital. The following examples were given:

- Woodland planting of up to 250,000 additional hectares, located near towns and cities, could generate net societal benefits in excess of £500 million per annum;
- Peatland restoration on around 140,000 hectares in upland areas would deliver net benefits of £570 million over 40 years in carbon values alone, as well as providing water quality, recreation and wildlife benefits;
- Wetland creation on around 100,000 hectares, particularly in areas of suitable hydrology, upstream of major towns and cities, would deliver typical benefit: cost ratios of 3:1, with up to 9:1 possible in some cases;
- Intertidal habitat creation would provide a wide range of benefits including coastal flood protection (reducing costs of maintaining concrete defences), carbon storage, areas for wildlife and the provision of nursery grounds for important commercial fish stocks.

8 Conclusions and Recommendations

The work has developed a model that can be used to estimate the overall scale of financial resources needed to achieve environmental land management needs in the UK and each of the four countries.

The overall costs of meeting the range of identified objectives for environmental land management in the UK are estimated to be in the region of £2.2 billion annually, based on the assumptions and scenarios employed.

This estimate is similar in scale to that derived from a previous assessment by Cao et al (2009) for the Land Use Policy Group, which estimated the costs of meeting a similar range of environmental land management objectives at £2 billion per annum.

However, 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 to derive the model.

A major variable relates to the overall level of ambition applied in deriving the estimates of land management needs. The assessment indicates that a major shift in the allocation of resources is needed to meet the defined objectives for environmental land management. The costed package of measures assumes that the entire area of priority habitats, boundary and historic environment features is sympathetically managed, and that all of those habitats and features not in good condition are restored over a ten year period. Wide ranging actions are also specified for soil and water protection and biodiversity in the wider landscape. It would be possible to specify a less ambitious package of land management measures, with lower overall costs, that would deliver reduced benefits and contribute only partially to the relevant environmental objectives. The model has been specified in a way that allows the policy choices to be varied, particularly in relation to the level of ambition applied.

Another major issue affecting the cost assessment is the potential cost of maintaining the current land uses required to support the identified land management practices. Some current land uses – particularly in upland areas – would potentially be at risk if current CAP Pillar 1 subsidies and Less Favoured Areas payments were removed. The model makes provision for the inclusion of an area-based cost of securing basic land management, as required, though this has not been included in the cost estimates presented above. In order to estimate the additional costs involved, it would be necessary to model the effects of different post Brexit policy scenarios. As an illustration, including an extra cost of £50 per hectare to maintain existing land uses for upland priority habitats and other rough grazing would raise the overall cost estimates by £250 million per annum in the UK.

It should also be noted that the costs presented here do not cover all of the costs of addressing some of the defined environmental objectives. For instance water quality is affected by a range of issues not related to rural land use and much of the cost of achieving the Water Framework Directive targets will be borne by non-agricultural industries. Biodiversity is another case in point where, while habitat management represents the bulk of costs, other costs such as education, pest management or legal enforcement are outside of the scope of this model.

The work has involved a detailed and wide-ranging assessment, and extensive consultations with experts and stakeholders. However, the model would benefit from further development and refinement in a number of areas, in particular in relation to:

- The specification of needs for **water quality**. The current assessment is based on broad assumptions about the type and extent of appropriate management measures. Further work to estimate the extent of management needs to meet water quality objectives in each country would be desirable;
- The specification of needs for **soil management**. Further attention could be paid to the type and extent of measures needed for management of soils at risk of erosion, and

deep peat soils, as well as the costs of these measures, particularly for arable soils used for growing high value crops;

- The estimation of the area of land management required to meet **historic environment** objectives, and the identified management measures. Gaps in data meant that a number of assumptions and extrapolations were required in the assessment;
- The assessment of needs for the management of **boundary features**. The assessment relied on data from the 2007 Countryside Survey, which is now 10 years old. It could be refined through improved data on the condition of hedges and walls, and more detailed analysis of management needs for different types of woody linear features;
- A greater focus on the differences in land management requirements and associated costs in the **four countries of the UK**. While efforts were made to collect data on existing land uses, habitats and landscape features in each country, as well as to identify land management needs and associated costs, data gaps limited the ability to provide a fully tailored analysis at country level. In general, more complete evidence was found for England than the other three countries. For example, little evidence could be found of environmental land management needs to meet water quality objectives outside England. The analysis of cost drivers also relied to a large extent on the more detailed data available for England;
- Further development and refinement of the **cost drivers model**. The model would benefit from further, country specific analysis, as well as refinement of the cost equations for different land management actions; and
- Modelling of the **costs of securing current land uses in future post Brexit scenarios.** To take account of potential increases in the costs of securing the basic land uses on which the identified land management practices are based, the effects of alternative policy and economic scenarios on the financial viability of different farming systems could be assessed.

The analysis is intended to provide an initial first order estimate of the financial needs for achieving environmental land management priorities in the UK, as well as developing a model that enables alternative estimates to be made, 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.

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Annex – Scoping review informing the approach to different environmental priorities

The following profiles present early scoping work which informed the approach to different environmental priorities. The analysis was developed further as the project progressed.

A1.1 BIODIVERSITY

Overall needs: Overall needs were defined at UK level between 1992 and 2012 in the UK Biodiversity Action Plan[15] and subsequently at country level in the country biodiversity strategies[16]. The UKBAP included detailed targets for habitats and species which were amenable to costing; however the country biodiversity strategies are broader strategic documents which are themselves insufficiently detailed to allow a financial needs assessment. Therefore analysis of needs requires reference to background papers and more detailed working documents. A detailed cost assessment of the UKBAP by GHK (2005-2010) found that the principal financial needs relate to:

1. The maintenance, restoration and expansion of priority habitats; and
2. Land management measures required to reverse the decline of widespread species in the wider countryside.

Existing assessments: GHK (2010) estimated the costs of delivering action plans for UK priority habitats at £516 million per annum for 2010-2015 and £477 million per annum between 2015 and 2020. The area of priority habitats covered by the UKBAP targets amounted to 5.5 million hectares, approximately 23% of the overall UK land area. The cost estimates were broken down by habitat and by country and by maintenance, restoration and expansion. A separate modelling approach was used to estimate the costs of meeting targets for lowland farmland birds and other widespread species. It was estimated that, to meet these targets, approximately 25% of lowland areas would need to be covered by "entry level" agri-environment schemes, a further 7.5% by "higher level" agri-environment measures and a further 5% by sympathetic woodland management, at an overall cost of £274 million per annum. The overall cost of delivering the UK BAP was put at £837 million per annum between 2010 and 2015 and £798 million per year between 2015 and 2020. This exceeded levels of current expenditure on biodiversity which were put at £564 million in 2010/11. Another study by Cao et al (2009) for LUPG used a spatial mapping approach to estimate the costs of biodiversity actions at UK level at £1003 million per annum. It was estimated that action would be needed over 18.5 million hectares of the UK, a wider area than that used in the GHK BAP costings study. Defra (2013) estimated that the costs of delivering biodiversity outcomes in England could amount to around £500 million per annum to 2020, based on estimates by Natural England (2012) that delivering Biodiversity 2020 outcomes for agriculture alone would cost at least £398 million per annum.

Types of action required: Varies by habitat/ land use. Maintenance, restoration and creation of priority habitats can normally be costed on an area basis, applying relevant unit costs for capital investments in restoration/ creation followed by area based annual maintenance costs. Widespread species require suitable habitat management actions in the wider countryside, applying relevant agri-environment and woodland management measures. The Farm Wildlife website outlines a range of measures for arable and livestock farms relating to existing wildlife habitats, field boundaries, wet features, flower-rich habitats, seed-rich habitats and the farmed

[15] http://jncc.defra.gov.uk/page-5155
[16] http://jncc.defra.gov.uk/page-5701

area[17]. The GHK study assumed that farmland bird targets could be met through a combination of entry level and higher level agri-environment measures (with the former involving a suite of prescriptions using a points based model, and the latter involving restoration and management of priority habitats), as well as sympathetic woodland management. Cao et al assumed that provision of habitats in arable areas would include hedgerows, field margins and headlands, winter stubble and wild bird cover crop, and in grassland areas managed open grassland with appropriate stocking densities, and that relevant measures would be targeted at areas with existing assemblages of relevant species.

Suggested approach: Priority habitats can be assessed using a similar approach to that used by GHK – estimating area of habitats requiring maintenance, restoration and creation and applying relevant unit cost estimates per hectare, using data from agri-environment schemes as well as other estimates of the costs of relevant operations. It would then be necessary to identify the extent and type of actions needed in the wider countryside – i.e. to cover arable, grassland and woodland outside priority habitats. This could be done by defining a package of actions based on modelling or scientific judgement, estimating the extent of action required, and applying relevant unit costs – expert advice from RSPB ecologists would be sought at this stage.

Overlaps with other objectives: There are significant overlaps with other environmental objectives – maintaining, expanding and restoring priority habitats should deliver a wide range of ecosystem services – helping to enhance storage of carbon, protection of water quality, prevention of flooding etc. There are also significant overlaps between biodiversity and other environmental objectives in the wider countryside – with similar types of management measures often contributing to more than one objective. The Cao et al (2009) study for LUPG took biodiversity priorities as the starting point for the analysis, estimating and adjusting for overlaps with other priorities, and finding that biodiversity related measures accounted for 51% of overall financial needs. To avoid double counting, it makes sense to begin with priority habitats, defining a comprehensive approach that will meet biodiversity priorities while contributing to wider environmental objectives. Then, for the wider countryside, it will be necessary to define a package of agri-environment and forest-environment related measures that will be sufficient to meet biodiversity and wider environmental objectives, if sufficiently well targeted.

Geographical variations: Financial needs are influenced by variations in the area of priority habitats and other land requiring management, the extent of management need (e.g. degree of restoration need), and the costs of management (which are influenced by labour costs, agricultural productivity and other factors). GHK estimated that, in 2010-2015, 67% of the overall UKBAP costs would relate to England, 19% to Scotland, 8% to Wales and 4% to Northern Ireland. Cao et al estimated that 62% of biodiversity costs related to England, 25% to Scotland, 7% to Wales and 6% to Northern Ireland.

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[17] https://farmwildlife.info/plan.aspx?id=103

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A1.2 LANDSCAPE

Overall needs: Priorities for landscape include protecting and maintaining areas designated for their high landscape quality (especially AoNBs, NSAs and National Parks) as well as maintaining landscape features in the wider countryside. There are significant overlaps with biodiversity, especially with regard to natural features and habitats; however geographical prioritisation of landscape actions may vary in line with designations, while landscape management also incorporates the built environment (including walls, historic features and buildings). There are 46 AoNBs (covering 23,000 km^2), 40 NSAs (covering 10,000 km^2 of Scotland) and 15 National Parks (covering 22,000 km^2)[18].

Existing assessments: LUPG (2009) estimated that landscape actions were required over 3.97 million hectares of designated landscapes in the UK. In addition, it was estimated that 181.3 million metres of stone walls across the UK would require management. Management of hedgerows and other habitats was classed as being required to meet biodiversity objectives. It was assumed that landscape designations could be addressed through a nominal whole farm payment of £10 per hectare (as a supplement to maintain landscape character, and in addition to costs for specific habitats), and that restoration of stone walls would cost £20 per metre. This gave a total cost of £39 million per year for landscape designations and £181 million per year for stone walls. In England, Defra (2012) estimates to inform the current RDP suggested that, within protected landscapes alone, £95.5m of agri-environment funds per year is required to maintain landscape quality alongside other scheme outcomes.

Types of action required: In pastoral and mixed farming areas, including the uplands, the primary landscape need is to conserve and restore characteristic landscape features such as hedgerows, hedgebanks, walls, small farm woodlands and trees, and semi-natural habitats. In intensive arable landscapes the emphasis needs to be on enhancing the landscape by reintroducing landscape structure and diversity, for example, through the use of wide buffer strips to strengthen field boundaries and through the reintroduction of semi-natural habitats and areas of non-arable habitat to create localised areas of diversity and interest (LUC, 2013).

Suggested approach: Most of the actions and options required to meet landscape objectives are common to those for biodiversity and the historic environment. However, land management

[18] http://www.nationalparks.gov.uk/students/whatisanationalpark/nationalparksareprotectedareas

schemes need to support the protection, maintenance and restoration of the built environment as well as habitats and natural features, as well as ensuring that sufficient funding is allocated to enable management of the natural and built environment in designated landscape areas. The model will therefore need to include relevant features such as dry stone walls not captured by biodiversity priorities, as well as to ensure that the overall scale of management of the natural environment in the wider countryside is sufficient to ensure adequate rates of coverage of designated landscape areas.

Overlaps with other objectives: Significant overlaps with biodiversity, as most landscape features are also habitats. Some, such as walls and built environment features are of greater interest for landscape than biodiversity. May be an additional role for landscape planning on a whole farm basis as suggested by Cao et al (2009).

Geographical variations: Landscape character and hence management needs vary regionally. Costs depend on variations in the extent and type of landscape features to be maintained and managed, the extent of designations, as well as the costs of relevant measures (which depend on variations in labour costs and agricultural productivity). Cao et al (2009) estimated that 49% of annual costs would be in England, 39% in Scotland, 8% in Wales and 4% in Northern Ireland.

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A1.3 HISTORIC ENVIRONMENT

Overall needs: Numerous scheduled monuments and historic features occur within the farmed and forested environment and require protection and sympathetic management.

Existing assessments: Cao et al (2009) estimated that historic sites (around scheduled ancient monuments) covered an area of 58,493 ha in the UK (36,357ha in England, 10,096 ha in Scotland, 3,343 ha in Wales and 8,697 ha in Northern Ireland). Costs of management were estimated to average £250 per hectare, giving a total cost of £15 million annually.

Types of action required: Historic sites require sympathetic management to avoid damage by cultivation or other agricultural operations, manage vegetation and prevent the encroachment of scrub. Options in agri-environment schemes include the maintenance and enhancement of archaeological sites under permanent grassland; reversion of arable land to permanent grassland or minimum cultivation where there is an archaeological site; clearance of scrub; and maintenance of engineered water bodies and traditional irrigation systems. Capital works to protect and restore historic sites may also be required.

Suggested approach: Historic sites can be added to the inventory of needs – sources may include existing assessments and databases held at country level (e.g. SHINE in England). Financial needs

can be estimated by gathering updated estimates of the number and extent of historic sites requiring protection and management and the unit cost of relevant prescriptions.

Overlaps with other objectives: Historic environment features contribute to landscape character and quality; they include natural features such as hedgerows and wood pasture/ parkland which are classified as priority habitats; overlaps can be avoided by ensuring that the same types of features are included in the assessment only once.

Geographical variations: Financial needs vary according to the number and area of historic sites and their management needs – costs are higher in intensively managed and productive areas where income foregone is high. Cao et al estimated costs at £9m p.a. in England, £2.5m in Scotland, £2.2m in Northern Ireland and £0.8m in Wales, in line with the number and area of sites.

Key references:

English Heritage (2005) Farming the historic landscape. An introduction for Farm Advisers
Defra (2012) Defra RDPE Call For Evidence: Landscape & Historic Environment Evidence, Measures and Mechanisms for the Next Rural Development Programme. July 2012
Gormley, S., Donnelly, C., Bell, J., & Hartwell, B. (2009). Condition and Management Survey of the Archaeological Resource in Northern Ireland (CAMSAR). Stationery Office.
Historic Scotland (undated) Scotland Rural Development Programme. Management of Scheduled Monuments: Annual recurrent options and capital items
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
SHINE – Selected Heritage Inventory for Natural England

A1.4 WATER QUALITY/ RESOURCE PROTECTION

Overall needs: Achieving Water Framework Directive objectives requires widespread action to reduce sediment loading due to run-off and soil erosion; reduce diffuse nutrient pollution of water; reduce pesticide pollution of water; and reduce water pollution from livestock (Cao et al, 2009).

Existing assessments: Cao et al (2009) estimated financial needs at £154 million per annum in the UK, based on management of 9.75 million hectares of land. This was based on spatial mapping of area at risk of soil erosion of greater than 2 tonnes per hectare (709,600 ha), and WFD catchments at risk from diffuse pollution (6,951,606 ha) and manure loads (2,093,362 ha). However, the areas used for the costings were significantly reduced (by 34-50%) because of overlaps with other priorities. More recently the Impact Assessment of the proposed update of River Basin Management Plans in England put the costs to the rural land management sector of a broader range of measures at £350 million per annum in England over a 37 year period (Environment Agency, 2015). These costs included not only improved soil management and prevention of livestock from accessing watercourses, but also management of animal slurry/manure to reduce pollution, improved use of pesticides and reductions in water abstraction through more efficient use and greater use of on-farm storage. Edwards (2013) estimated the costs of achieving good ecological status of WFD waterbodies in England that are N2K/ SSSI at £226m in 2020. Another

estimate quoted by Defra (2013) was that fully addressing diffuse pollution from agriculture through the Rural Development Programme in England might cost around £460m per annum.

Types of action required: Avoidance of soil erosion and soil organic matter loss through arable reversion or use of buffer strips / winter cover crops. Avoidance of pollution (fertilisers and chemicals) through use of barriers (buffer strips / beetle banks) and winter cover crops. Effective grazing management and fencing off of watercourses.

Suggested approach: A number of assessments have estimated the scale of agri-environment action required to meet WFD objectives; reviewing this evidence and consulting with experts should help to inform the definition of a package of agri-environment measures capable of meeting WFD objectives. The assessment will need to examine the degree of overlap with other priorities and the scope for relevant measures to contribute to multiple objectives.

Overlaps with other objectives: Some overlap with biodiversity and landscape objectives since similar prescriptions (e.g. buffer strips, field margins, beetle banks, cover crops, riparian habitats) may have multiple benefits if suitably located.

Geographical variations: Costs vary according to the extent of areas at risk as well as variations in labour costs and income foregone. Cao et al estimated annual financial needs by country at £99m (England), £19m (Scotland), £23m (Wales) and £13m (Northern Ireland).

Key references:

Environment Agency (2015) Update to the river basin management plans for England's water environment – Impact Assessment. https://www.gov.uk/government/publications/update-to-the-river-basin-management-plans-impact-assessment

Letts J and Stewart L (2012) The cost and benefit of Environmental Stewardship to improve Diffuse Water Pollution from Agriculture for the Water Framework Jamie Letts & Lindsey Stewart, Version 8, 25th Nov 2012.

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

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

Environment Agency (2014) Consultation on the draft update to the river basin management plan. Part 3: Economic analysis – extended report

Environment Agency (2014) Progressing towards WFD objectives – the role of agriculture

Newell Price, J.P., Harris, D., Taylor, M., Williams, J.R., Anthony, S.G., Duethmann, D., Gooday, R.D., Lord, E.I. and Chambers, B.J., Chadwick, D.R. and Misselbrook, T.H. (2011) An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture

A1.5 SOIL MANAGEMENT

Overall needs: Sustainable management of soils plays an important role in supporting the sustainability of agricultural production and delivering wider environmental benefits (such as pollution prevention and climate change mitigation). Good management of soils is a fundamental element of good farming practice and contributes to the sustainable profitability of farm businesses as well as benefiting the environment. A study by Graves et al (2011) estimated the

annual costs of soil degradation through erosion, compaction and loss of organic matter at £0.9 to £1.4 billion per year in England and Wales, with 80% of these costs occurring off site through loss of ecosystem services (especially climate regulation). Soil protection is covered by cross compliance (GAEC) in all four of the UK countries.

Existing assessments: The Cao et al (2009) assessment focused on avoidance of soil erosion and soil organic matter loss through arable reversion or use of buffer strips / winter cover crops. The estimated annual cost was put at £114 million, based on an area of high risk agricultural soil in the UK of 2.4 million hectares. The Graves et al (2011) study did not estimate costs of prevention but provided estimates of the areas of soils at risk.

Types of action required: Good soil management requires careful management of agricultural operations, cropping and grazing, land cover and nutrient management to maintain soil organic matter and prevent damage from compaction and erosion. Much of this represents good agricultural practice and delivers net benefits to the farming sector. Agri-environment measures tend to focus on more demanding actions that help to protect agricultural soils while delivering wider environmental benefits, such as through reversion to grassland, cover crops and buffer strips in areas at high risk of soil erosion.

Suggested approach: It will be necessary to decide the extent to which soil management should be targeted through agri-environment measures rather than being regarded as good agricultural practice. It seems appropriate to focus on actions that impose costs on the farming sector but which deliver wider benefits through ecosystem service delivery – particularly measures such as arable reversion, cover crops and buffer strips which deliver multiple benefits.

Overlaps with other objectives: There are substantial overlaps with resource protection (for which prevention of soil erosion plays an important role) as well as climate change mitigation (safeguarding carbon stores in agricultural soils). Relevant measures may also deliver benefits for biodiversity and landscape. A package of measures could be defined for arable areas which contribute to prevention of soil degradation in areas at risk, as well as meeting other objectives.

Geographical variations: Costs will vary according to the area of soils at risk as well as the returns from agriculture and labour costs (and hence the income foregone and costs incurred for relevant measures). The Cao et al estimates put costs at £95 million in England, £18 million in Scotland and less than £1 million per year in both Wales and Northern Ireland.

Key references:

Defra (2009) Safeguarding our Soils - A Strategy for England
DAERA (undated) Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland
Graves, A., Morris,J., Deeks, L., Rickson, J., Kibblewhite, M., Harris, J. and Fairwell, T. (2011) The Total Costs of Soils Degradation in England and Wales. Cranfield University
Environment Agency (2012) Guidance – Soil Management Standards for Farmers
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

A1.6 CLIMATE CHANGE MITIGATION

Overall needs: Agriculture is a major source of greenhouse gas emissions, accounting for 10% of overall emissions in the UK, including 74% of total nitrous oxide emissions, 51% of total methane emissions, and 1% of total carbon dioxide emissions (Defra, 2016). Agriculture and forestry also play an important role in the sequestration and storage of carbon in soils and biomass, while forestry and other land uses can, in certain circumstances, also contribute to climate mitigation through the provision of renewable energy. Agriculture and forestry therefore play an important potential role in meeting the UK's emission reduction targets. Evidence suggests that much progress can be made through measures that have negative costs (e.g. reduced cultivation, improving livestock genetic resources, use of plant varieties with efficient N uptake, integrated fertiliser and manure use) but that other measures (e.g. arable reversion, reduced overall fertiliser applications) result in costs or income foregone for the farmer while delivering benefits to society through climate change mitigation (Price et al.. 2011; Eory et al, 2015).

Existing assessments: Cao et al (2009) estimated that climate change actions would be required over an area of 8 million hectares, at an overall cost of £270 million in the UK annually, through planting of energy crops, maintenance of carbon stores in woodland and peatland, and GHG abatement measures (in the top 10% emission emission-generating areas), with the latter accounting for 90% of the estimated costs. A later study by Eory et al (2015), examining marginal abatement cost curves for agriculture, found that cost effective measures could reduce agricultural emissions in the UK by between 0.53 Mt CO2e (low) and 6.31 Mt CO2e (high) in 2030, with afforestation providing much of this abatement potential.

Types of action required: Maintenance or improvement of condition of peat, wetlands, woodlands and avoidance of erosion of vulnerable soils; planting of energy crops; actions to reduce GHG through improving animal productivity, efficiency of use of fertiliser, storage/use of manures, reduced cultivation, arable reversion, afforestation.

Suggested approach: A number of actions for biodiversity, landscape and resource protection (such as management of blanket bog, wetlands, woodlands, grasslands and other habitats; natural regeneration of woodland; grass margins and cover crops on arable land etc.) will also offer climate mitigation benefits. It will be necessary to decide whether there is a need to support additional actions to deliver climate benefits, and the extent and type of actions required. This requires some policy decisions – e.g. the extent to which afforestation and/or energy crops should be supported.

Overlaps with other objectives: Significant overlaps with other objectives including biodiversity, landscape, resource protection, soil management.

Geographical variations: Costs are influenced by variations in levels of emissions and potential to implement the identified solutions, as well as economic factors which influence labour costs and income foregone. Cao et al (2009) estimated annual costs of £173 million for England, £37 million for Scotland, £29 million for Wales and £31 million for Northern Ireland. Peat carbon stores are concentrated in Scotland but the largest levels of emissions from farming practices are concentrated in England.

Key references:

Defra (2016) Agricultural Statistics and Climate Change. 7th edition

Newell Price, J.P., Harris, D., Taylor, M., Williams, J.R., Anthony, S.G., Duethmann, D., Gooday, R.D., Lord, E.I. and Chambers, B.J., Chadwick, D.R. and Misselbrook, T.H. (2011) An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture
Eory, V., MacLeod, M., Topp, C.F.E., Rees, R.M., Webb, J., McVittie, A., Wall, E., Borthwick, F., Watson, C., Waterhouse, A., Wiltshire, J., Bell, H., Moran, D., Dewhurst, R. (2015) Review and update the UK Agriculture Marginal Abatement Cost Curve to assess the greenhouse gas abatement potential for the 5th carbon budget period and to 2050
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

A1.7 FLOOD MANAGEMENT

Overall needs: Severe flooding events in recent years have led to demands for new approaches to flood management, and significant interest in the role of natural flood management. Catchment-based approaches may be more cost-effective than relying solely on structural defences, and deliver wider long term economic, social and environmental benefits. They may involve a variety of measures including improved management of agricultural soils, actions to prevent soil erosion and maintain sediment, measures to reduce run-off (e.g. storage ponds, drain and ditch barriers, rough-grassland or vegetated buffer strips and soil banks), reconnection of floodplains and restoration of rivers. However, a shortage of empirical evidence on the effectiveness of catchment-wide approaches is a barrier to their implementation (POST, 2014). A recent paper concluded that there is evidence that natural flood management interventions can reduce the risks of small floods in small catchments, but there is still a lack of evidence to demonstrate that they can have a major effect on the most severe events, or that they are effective at larger catchment scale (Dadson et al, 2017). Huggett (2017) makes similar points while emphasising that natural flood risk management measures can deliver multiple benefits including for wildlife and prevention of water pollution.

Existing assessments: Overall needs are difficult to estimate given gaps in the evidence base which make it difficult to define a programme of action. Cao et al (2009) estimated needs by mapping soils prone to run-off in the uplands (78,000 ha in the UK) and floodplains/ flood risk zones in the lowlands (1.94 million hectares in the UK). It was assumed that flood risk would be reduced through tree planting in the uplands and floodplain management in the lowlands, at a total cost estimated at £92 million annually.

Types of action required: Actions to improve flood management can take a wide variety of forms and include tree planting, restoration and management of wetlands, peatlands and moorland, improved management of agricultural soils, actions to reduce run-off including arable reversion, cover crops, hedges and buffer strips, and river restoration.

Suggested approach: It is difficult to specify a programme of action at national scale due to uncertainties about the role and effectiveness of natural flood management measures; however, actions that contribute to natural flood management will deliver multiple benefits for biodiversity, landscape, resource protection, soil and climate mitigation. It is therefore suggested that – as well as actions to expand, restore and maintain habitats such as blanket bog, woodland and wetlands – a package of agri-environment measures could be specified for arable and improved

grassland areas that enhance flood management as well as delivering wider benefits for biodiversity, landscape, resource protection and climate.

Overlaps with other objectives: Significant overlaps with other objectives, including resource protection, soil management, biodiversity, landscape and climate change mitigation.

Geographical variations: Costs vary according to the susceptibility of land to flooding as well as the costs of relevant measures, which depend on agricultural productivity and labour costs. Cao et al (2009) estimated that annual costs would amount to £43 million in England, £28 million in Scotland, £14 million in Wales and £7 million in Northern Ireland.

Key references:

Parliamentary Office of Science and Technology (2014) Catchment-Wide Flood Management. POSTnote Number 484 December 2014

Dadson SJ et al. 2017 A restatement of the natural science evidence concerning catchment-based 'natural' flood management in the UK. Proc. R. Soc. A 473: 20160706. http://dx.doi.org/10.1098/rspa.2016.0706

Huggett D (2017) Working with nature to reduce flood risk. Blog, 30 March 2017. Environment Agency.

Environment Agency (2015) Cost estimation for land use and run-off – summary of evidence

Pilkington, M, Mount, D, Walker, J, Allott, T, Ashton-Waird, R, Evans, M, Hammond, G, Huggett, D, Nisbet, T, Rose, S (2015) Natural Flood Management; an appraisal of current status. Moors for the Future Partnership, Edale, Derbyshire, UK.