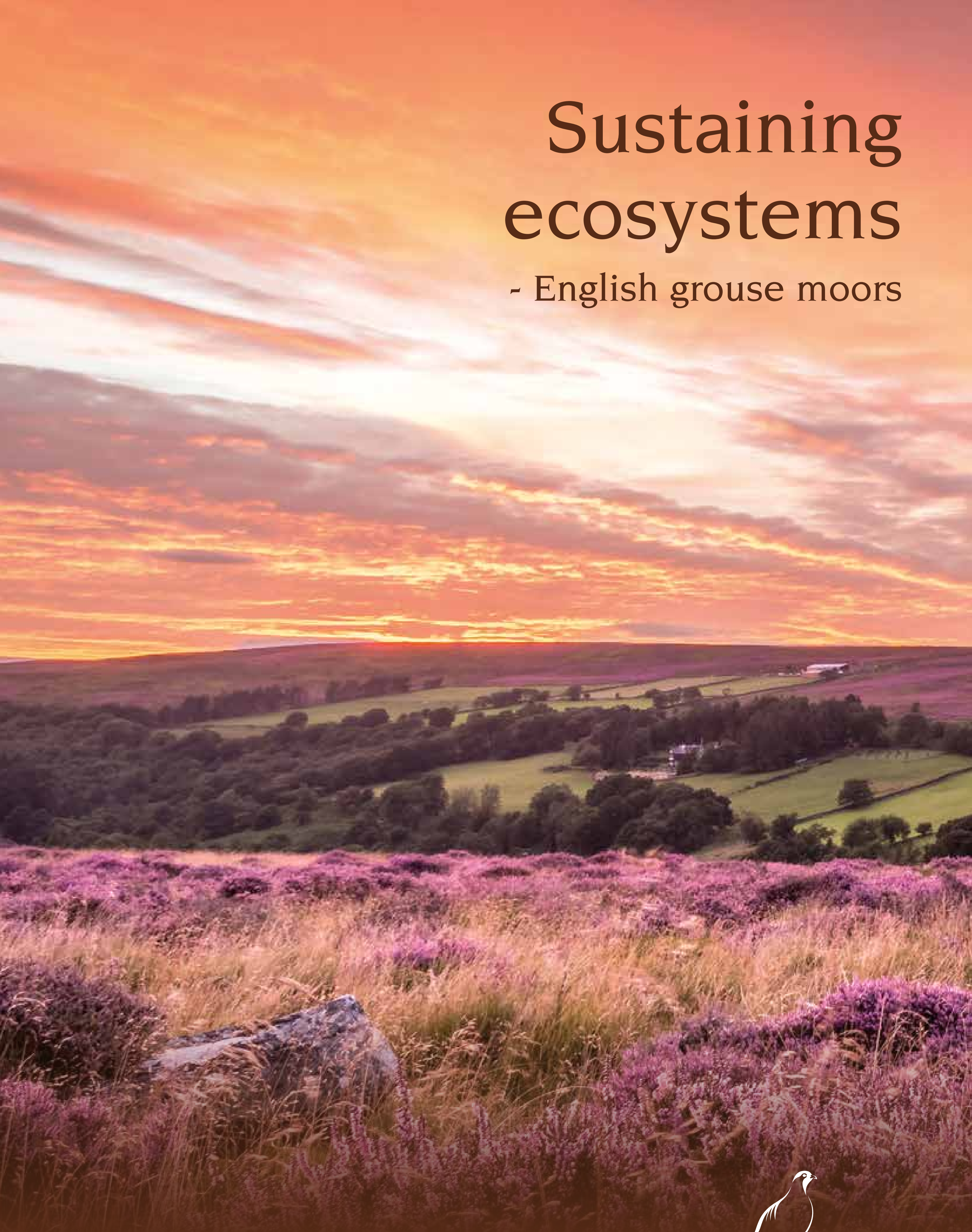
Sustaining ecosystems

- English grouse moors



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Contents

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Foreword

By Rt Hon. Sir James Paice DL., FRAgS
Chairman of Trustees
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Rt Hon. Sir James Paice

A debate over the future of our English uplands is vital. These iconic and beloved landscapes support specialist and increasingly rare plants, animals and birds; they are managed for both food production and varied recreational pursuits including wild game shoots; they act as water catchments for cities; and, they are part of the nation's approach to mitigating climate change because of the huge amount of carbon locked up in peat. Their value is reflected in their formal designations for landscape quality and wildlife abundance as well as their popularity as a visitor destination.

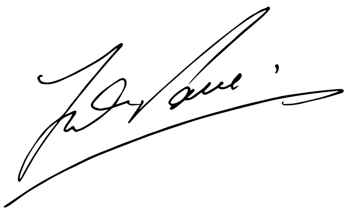
This short description signals the complexity of upland ecosystems. The multi-functionality of the associated land uses and value of the natural capital are often overlooked as it is some of the least 'agriculturally' productive land in England.

Both climate change and biodiversity loss challenges refresh the need to understand the importance of these uplands to the nation, and the responsibility held by policymakers, landowners and land managers to get the conservation and management of these special places right.

Land management is not easy and is difficult to do well with blunt policy instruments – I know as both a farmer and former Government Minister. Land management, if it is going to achieve good outcomes, has to be a process of co-creation between policymakers and the people on the ground. It means working together towards a common purpose.

The tension between the outcomes needed and desired by land managers to provide a living and support livelihoods, and the environmental outcomes desired by society is mirrored across every inch of our English countryside. As a society we want many things from the land. The problem is often the different views on how to achieve these outcomes. As a nation we have to find ways to identify the win-wins; we hope this report will help map a constructive way forward in the debate over the future of our uplands.

This is the Game & Wildlife Conservation Trust's second report that addresses the uplands and grouse moors. The first considered the carbon value of peatland in England associated with grouse moor management. This one explicitly aligns grouse moor management outcomes with public policy by considering its contribution to environmental goods and services, as defined by Defra's 25 Year Environment Plan goals; the first time that has been done.



Sphagnum moss growing on boggy moorland. Peak District National Park, Derbyshire. © Alex Hyde

Executive summary

1. Our English uplands (including grouse moors) are subject to an increasing number of societal demands and needs. This audit assesses grouse moor management's contribution to Defra's 25 Year Environment Plan (25YEP) goals – an expression of social needs – and makes recommendations for public policymakers and land managers in relation to upland land use.

2. The audit indicates the management of moorland and peatland habitats for red grouse delivers a range of 25YEP goals; supporting habitats and wildlife, delivering cleaner air and water, contributing to greenhouse gas management and mitigating climate change hazards notably flooding and wildfire.

3. We note downsides, challenges and opportunities for grouse moor management and managers. But there is evidence that grouse moor management is consciously delivering environmental goods and services for public benefit; shoot management continues to have coincidental public benefits; and that some weakly evidenced public policy risks these deliberate and co-incidental public benefits.

4. Our audit contradicts suggestions that grouse moor management has only a negative impact on ecosystems and services and that alternative upland management and land uses are required. We find little consistent evidence that the alternative land uses would better integrate, replace or sustain goods and services.

5. Our ability to undertake a comprehensive audit was limited by low data quality, gaps in data and the lack of standard methodologies employed to record outcomes.

6. This lack of relevant information is a risk to the current and future delivery of goods and services by grouse moor management – it risks diminishing the positive value of evolving grouse moor management, impedes the scrutiny of proposed alternative land uses and may lead to upland land use public policy being driven by sentiment rather than proven need or benefit.

7. We find society would lose proven goods and services if grouse moor management were so constrained that it significantly compromised the shooting incentive. When evidenced, criticisms of grouse moor management should be addressed and stakeholders should recognise the net gain delivered.

8. We believe the co-creation of a shared approach is necessary to deliver common purpose in these multi-functional landscapes and ensure grouse moor management is correctly valued for its public contribution. We recommend:

   i. Better quantifying the environmental offering of grouse moor management.

   ii. Development of environmental management plans by grouse moor managers.

   iii. Increased monitoring by practitioners of management outcomes.

   iv. Identification and acceptance of management trade-offs by public policy.

   v. Regular reviews of the evidence base to ensure policy is 'fit for purpose'.

   vi. Interdisciplinary research to fill knowledge gaps.

   vii. Collaborative initiatives such as moorland groups.

   viii. Adoption of adaptive management (rather than prescriptive) approaches.

Introduction

1.1 Scope of this report

Grouse moor management (GMM) supports grouse shooting which is one of three dominant land uses in the English uplands (land at or above 200m), the others being livestock farming and forestry. Appreciating the actual and potential contribution of English GMM is important because 423,000ha of upland are managed in this way[1]. Historically, GMM has provided the only large scale incentive and economic capacity for conserving upland bird populations, moorland habitats and the carbon stored in peat, especially compared to the alternative upland land uses. The main motivation for doing so, a sustainable harvest of red grouse, is increasingly itself recognised as a cultural, health and economic benefit[2,3].

Yet our English uplands (including grouse moors) are expected to meet an increasing number of societal demands and needs. These expectations are increasingly reflected in public policy, and grouse moor managers need to be able to assess the risks and values of aligning their land use with these policies.

We aim to help those invested in moorland to a) both better understand the Government's ambitions for air quality, biodiversity, net zero and water quality, and b) appreciate how GMM already contributes and can further develop its role in delivering the Department for Environment, Food and Rural Affairs 25 Year Environment Plan[a] from 2018 (25YEP) and Net Zero Strategy[b] (the Westminster Government's aspiration for a net carbon neutral society) goals.

To evaluate the extent to which English grouse moors *sustainably* deliver a range of environmental goods and services we audited the evidence available in support of six of Defra's *environmental* goals (nos. 1-4, 7 and 9 in TABLE 1.1), and assessed two of Defra's *socio-economic* goals (nos. 5 and 6 in TABLE 1.1). The audit considers the upsides, downsides, challenges, and opportunities for the delivery of the six 25YEP *environmental* goals relevant to the management of the uplands by grouse moors.

Our review also sets out the knowledge gaps that reduce our ability (both moorland managers' and public policymakers') to make a net improvement in these outcomes.

The report builds on the 2011 UK National Ecosystem Assessment[4] (NEA), which identified the goods and services delivered by Mountains, Moorlands and Heaths (BOX 1.1), and the environmental accounts produced by the Office for National Statistics for Mountains, Moorland and Heath, Peatland and Semi-natural Habitats[5].

TABLE 1.1 – Defra's 25YEP goals.

** Considered under Sections 4.1.2 and 4.1.4c.*

	25YEP GOALS	AUDITED (CHAPTER 4)	ASSESSED (CHAPTERS 5 & 6)
1.	Clean air	YES	–
2.	Clean and plentiful water	YES	–
3.	Thriving plants and wildlife	YES	–
4.	A reduced risk of harm from environmental hazards	YES	–
5.	Using resources from nature more sustainably and efficiently	–	YES
6.	Enhanced [….] engagement with the natural environment	–	YES
7.	Mitigating and adapting to climate change	YES	–
8.	Minimising waste	N/A	N/A
9.	Managing exposure to chemicals	YES*	–
10.	Enhancing biosecurity	N/A	N/A

a *https://www.gov.uk/government/publications/25-year-environment-plan.*
b *https://www.gov.uk/government/publications/net-zero-strategy.*

1.2 What is grouse moor management?

GMM is a package of activities undertaken on moors where driven grouse shooting (DGS)[c] is the primary land use. The main motivation for these activities is the conservation and enhancement of wild red grouse (the quarry species) populations. GMM comprises vegetation management by heather burning (see BOX 1.2), cutting and grazing, supporting grouse health and reducing predation pressure. More detail is provided online at *www.gwct.org.uk/driven-grouse-shooting*.

Male red grouse in mid-winter.

BOX 1.1

LACK OF PROGRESS IN PUBLIC POLICY EVIDENCE SINCE 2011?

The UK NEA 2011 stated that *"there is still great uncertainty over the scale of impacts from management practices such as burning"* and a *"pressing need to better understand the consequences of moorland and heath management in terms of greenhouse gas emissions across a wide scale of conditions, and ...take into account both short- and longer-term release of greenhouse gases through various pathways."*

Despite much relevant research since, our audit suggests that the evidence base for public policy has not been significantly updated. It is consequently overly precautionary in the face of important findings regarding UK peatlands in relation to climate mitigation (Section 4.1.5). For example the holistic study approach to peatland management undertaken by York University, initially for Defra[6], is already indicating that a 10 year time horizon, at least, is vital to understanding the true implications of changing management approaches on peatland.

BOX 1.2

BURNING HEATHER – IMPROVING MANAGEMENT

Fire has been used as a management technique for thousands of years in the UK uplands. Vegetation burning on moorland is now increasingly regulated.

In England, the practice is guided by a Heather and Grass Burning Code endorsed by Defra, Natural England and sector bodies, with licences required for controlled burning on Protected Sites over deep peat and consent required on SSSIs. There is comprehensive guidance (e.g. *https://moorlandmanagement.org/*) and training is currently being formalised.

Grouse moors typically maintain a burning plan that identifies which areas to burn in which years as well as sensitive and no-burn areas. Dry and calm weather between 1 October to 15 April can see teams of gamekeepers creating firebreaks to control the fire by cutting heather to define burning areas, setting test fires to appreciate that day's conditions, and using specific equipment to light, constrain and then extinguish fires under controlled conditions. Much of this guidance is aimed at producing 'cool' rather than 'hot' burns (for an explanation of types of burn see GWCT Peatland Report 2020[1]).

c 'Driving' is associated with grouse numbers high enough to be flushed from the ground and then guided toward waiting guns.

What does society want from our English uplands?

Key points

- The value of moorlands to society has increased over the last 200 years from the production of food, fibre and minerals, to include public and private recreation, health and wellbeing, climate change mitigation and biodiversity.
- Public policy can be a reflection of societal requirement and is an increasingly important driver of what management can be conducted in the uplands. Yet such policies have a mixed track record in successfully delivering contemporary needs without damaging existing goods and services.
- Demands for moorland to deliver multiple goods and services are often achievable with planning and management where a net gain or balanced outcome is the overall strategy.

There has been a notable increase in the value we place on English moorland over the last 200 years. From being almost solely a valuable source of food, fibre and minerals, moors are now valued for both these consumable goods and a range of other non-consumptive services (TABLE 2.1). National policy priorities reflect this wider stakeholder interest (from government to local communities, farmers and graziers, foresters, recreational visitors and environmental NGOs), and are increasingly a key driver of change for these landscapes.

Largely private ownership, and the associated choices of land use and investment in management, has given UK's internationally important moorlands, diverse and easily lost attributes. The 2011 UK NEA reported that our uplands are valued for their sense of nature and space, wildness, scenery and tranquillity as well the flora and fauna they support and have *"distinctive cultural identities"*[7]. This 'cultural value', the result of decades (even centuries) of management mostly by farmers and sporting managers, is so important it is 'protected' through landscape designations such as National Parks, Areas of Outstanding Natural Beauty, and the flora and fauna through designations such as SSSIs, Special Protection Areas (SPAs) and Special Areas of Conservation (SACs). Defra's review of public perceptions[8] confirmed people value local green spaces as well as having an emotional attachment to distant places such as the uplands, concluding *"It is important to ensure the cultural services delivered by both types of place are protected and enhanced."*

TABLE 2.1

The change in what society expects from our uplands over the last two hundred years.

TIMESCALE	SOCIETAL EXPECTATIONS	
200 YEARS AGO	1.	Food (meat).
	2.	Fibre (wool).
	3.	Mineral resources.
100 YEARS AGO	1.	Food (meat).
	2.	Fibre (wool).
	3.	Mineral resources.
	4.	Timber.
	5.	Private recreation (grouse shooting, fishing).
	6.	Public recreation (walking, climbing, natural history).
	7.	Clean and plentiful water.
NOW	1.	Food (meat).
	2.	Fibre (wool).
	3.	Private recreation.
	4.	Public recreation, health and wellbeing; alongside Defra's 25YEP goals:
	5.	Clean air.
	6.	Clean and plentiful water.
	7.	Thriving plants and wildlife.
	8.	Reduced risk of harm from environmental hazards.
	9.	Using resources from nature more sustainably and efficiently.
	10.	Enhanced […] engagement with the natural environment.
	11.	Mitigating and adapting to climate change.
	12.	Managing exposure to chemicals.

This multi-functional landscape reflects a 'net gain' in which not every stakeholder interest is maximised, creating both common purpose and tensions. In 2016, the Campaign for National Parks survey on what the public wanted from National Parks reinforced this point; both residents and visitors regarded 'wildlife' and 'views and landscapes'[87] as the two top features. Answers to the question *"what would make the Parks better"* epitomised the tensions: *"better conservation of wildlife"* was consistently popular but visitors wanted improvement by *"making them wilder"* whilst residents focussed on better rural services (such as broadband) and more rural funding.

The tensions and trade-offs between visitor attraction, natural asset and working landscape exist everywhere, but seem particularly noticeable in the uplands where public policy increasingly appears to be constraining historical farming and sporting practices such as grazing and burning and encouraging alternative management approaches. Such pressures are not insignificant. Government policy impacts on our uplands are important. For example, post-war policies including the draining of peat for agricultural improvement, over- and under-grazing, and the planting of commercial non-native forestry have resulted in damage to the extent and quality of upland habitat.

In recent decades GMM for DGS has been recognised as a land use that has fortuitously prevented such damaging changes in our uplands. Now GMM is being challenged to deliberately align itself with society's/public policy's wants and needs, notably around climate change mitigation which is an important societal 'need'. However history suggests that there is a risk that policy approaches could be too focused on addressing the current 'hot topic' and unintentionally damaging other critically important goods and services. If visitors value open moorland for its *sense of nature and space*, changing this with increasing tree cover would have been unwelcome[d].

There is a strong shared desire to *"protect our land"*. Visitors tend to talk about a blended experience of landscape, habitats, wildlife and land management[7]. The traditional upland management regimes, such as GMM, that have delivered these cultural landscapes should be welcomed in policies that address society's wants and needs. How to achieve a balanced delivery of best outcomes is contentious as inevitably it involves recognising and reconciling trade-offs, sometimes between subjective considerations. In this report, we propose these balanced outcomes are best found through co-creation with the common purpose of *"protecting our land"*.

Clearly, there is no simple answer to the question 'What does society want from our English uplands'? In 2018 Defra established a future value system in its 25YEP that can be taken as a proxy for what society needs; we audit the environmental goods and services delivered by GMM in that context in Section 4.

Ladybower Reservoir, Hope Valley, in the Peak District National Park, Derbyshire.

d *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/992439/Decision_support_framework_for_peatland_protection_and_the_establishment_of_new_woodland__Interim__June_2021_FINAL.pdf*

Evaluating environmental goods and services delivery

– our approach

Key points

- Moorland managed for grouse comprises a mosaic of primarily four land cover types which variously support the 25YEP environmental goods and services.
- Our audit approach takes a 'Natural Capital' accounting approach and uses data from published literature.
- In carrying out the audit we have identified ten key limitations of the available data which should be appreciated by those developing public policy that affects current and future GMM.

Office for National Statistics, Newport. © www.gov.uk

The English uplands under game and farming management are made up of a broad range of land cover types[e] including 'near-neighbour' habitats such as hill-fringe grassland and 'clough' or gill woodland. The focus of our audit – GMM – takes place on around 423,000 hectares in England[f]. The four principal land cover types (TABLE 3.1) on which GMM takes place underpin many aspects of the delivery of the environmental and socio-economic goals that grouse moors can contribute to the 25 year Environment Plan (TABLE 1.1 and TABLE 4.1.1).

The ability of a land cover to deliver environmental goods and services is determined by its extent, condition and spatial configuration, along with management and external influences such as climate or pollution[9]. The Office for National Statistics (ONS) identify five broad ecosystem condition indicators (vegetation, biodiversity, soil, water and carbon) which reflect a 'System of Environmental Economic Accounting'[10]. The condition of designated SSSI sites is sometimes used as a benchmark for determining national land cover condition (see TABLE 3.2), although this has significant shortcomings (see Section 3.2).

3.1 The natural capital accounting process

The goods and services provided by the uplands are very diverse – for example, a piece of moor can regulate water flow, sequester carbon, produce food and support valuable biodiversity (see BOX 3.2) by providing habitat for distinctive species assemblages. Natural Capital Accounting (NCA) is a way of valuing these very different goods and services, from individual assets to the delivery of environmental goods and services (FIGURE 3.1).

The 'drivers and supporting processes' (e.g. habitat management) in column three of FIGURE 3.1 that lead to environmental goods and services can have both positive and negative effects on different services.

The following points underpin our approach to the audit:

1. Where available, ONS values for the environmental goods and services delivered have been incorporated[5]. In some instances, we have prorated the ONS values for English grouse moors using the Moorland Association figures of 423,000 hectares of moorland and 282,000 hectares for peatland[1]. The ONS considers their initial values *"experimental"*, so where this information is not available, we have used other metrics to value a service.

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e UK CEH land cover maps.
f Moorland Association.

TABLE 3.1

Area of land cover types on which grouse moor management takes place in English upland areas (2015 v 2019).

Source: UK CEH land cover maps (https://www.ceh.ac.uk/ukceh-land-cover-maps).

	2015 AREA HA	AREA %	2019 AREA HA	AREA %
HEATHER	135,520	7.62	120,160	6.75
HEATHER GRASSLAND	77,211	4.34	89,073	5.01
BOG	189,086	10.63	195,317	10.98
ACID GRASSLAND	443,165	24.91	444,817	25.00

TABLE 3.2

Condition of upland habitats on protected sites (England) (%).

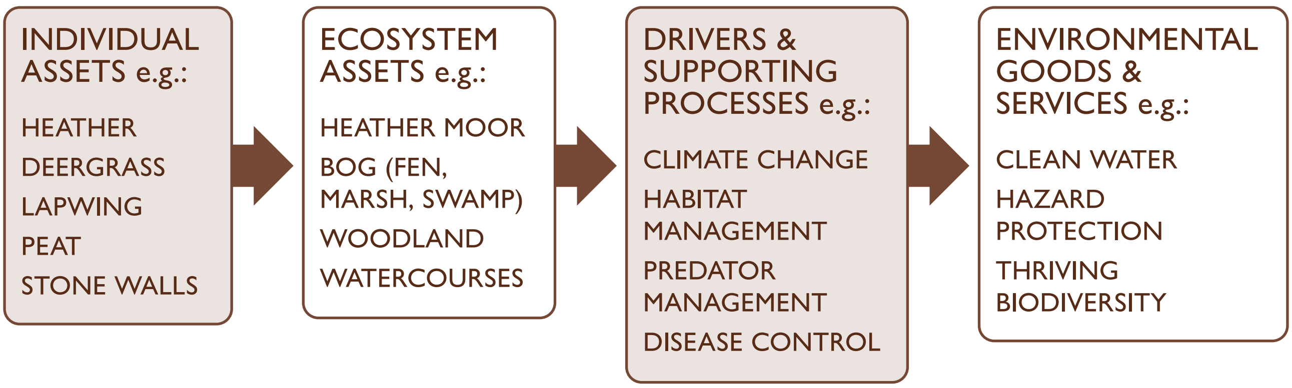
Key for Trend – stable =; positive ↑; negative ↓; marginally negative ↙

Source: ONS/Natural England.

		2012	2014	2016	2018	TREND
BLANKET BOG	Favourable	13	13	13	13	=
	Recovering	85	85	84	82	↙
	Unfavourable	2	2	4	5	↑
UPLAND FLUSHES	Favourable	33	31	31	31	↙
	Recovering	64	65	64	63	↙
	Unfavourable	3	4	5	6	↑
UPLAND HEATHLAND	Favourable	13	12	13	13	=
	Recovering	86	85	85	84	↙
	Unfavourable	1	2	2	3	↑

FIGURE 3.1

Examples of English moorland natural capital categories.



2. The ONS Principles of Natural Capital Accounting say that *"...natural capital accounts should not take into account...the disservices or negative externalities (dis-benefits) arising from ecosystem functioning (Principle 5.5)"*[11]. However, we record these as downsides (for example emissions from vegetation burning) when they reduce the 'gross value' of a given service (in this case climate mitigation) to a net value. We identify as challenges risks to the delivery of a service or good resulting in a net loss and where any ecosystem changes are irreversible or cannot be mitigated.

3.2 The risk of leaping before you look…

We have tried to provide a balanced picture of the provision of environmental goods and services from the English uplands. Our ability to account for the natural capital of grouse moors was constrained by low data quality: short runs of data, data gaps (and associated knowledge gaps) and the quality and variability of the standard methodologies employed to judge outcomes. The importance of long-term observation in environmental policy formulation is fundamental[12]. Yet significant changes in local cultures, economies and environment are being driven by short (0-10 year) policy timescales as opposed to appropriate ecological timescales. For example, since the first agri-environment scheme was introduced in 1987 there have been five major schemes launched, equating to a policy revision every 5-6 years.

We recognise the urgency in addressing climate and biodiversity crises. But the partial collection of data, its inconsistent presentation by Government and NGOs, and as a consequence often weakly evidenced policies that affect complex biodiversity and environmental networks risks exacerbating, not reducing, the impact of a changing climate and biodiversity loss.

The specific data limitations highlighted in BOX 3.1 are of particular significance when the provision of environmental goods and services is disputed, as is often the case with GMM. An example of this is the lack of a definitive peatland map. Despite years of interventionist policy only now (2020-22) is Defra undertaking a three-year project to map the extent of peat. To build confidence in the accuracy of the mapping, in Section 6.2 we recommend collaboration with moor managers (for example, to ground truth areas of degraded peatland down to sub-metre scales[13]). Such collaboration is part of the profound change in approach that we consider necessary.

BOX 3.1

KEY LIMITATIONS OF THE AVAILABLE DATA

1. **NET ZERO:** We have only a limited, slowly expanding knowledge of how greenhouse gas (carbon dioxide, carbon monoxide, methane and nitrous oxide) fluxes and stocks relate to both peatland condition and management practices (such as controlled burning, grazing, tree growth and wetting cycles) that are part of GMM and alternative upland management.

   There are limited data on how carbon enters, is stored in, and leaves peatland for accurate carbon accounting. Currently data is often from a few sites over few years risking a bias in assessment[16].

   There are some important gaps – for example global carbon budget calculations account for short-term fire emissions but routinely do not account for the beneficial conversion of biomass to biochar (see BOX 4.1.5.3) or for legacy biochar stocks. For more detail see the GWCT Peatland Report 2020[1].

   There is very little monitoring data to evaluate peatland restoration approaches and how well they actually deliver multiple public goods and services.

   We have a limited knowledge of how current and future climate will affect hydrological (water table) and environmental (soil pH) conditions which determine peat formation.

2. **FIRE EMISSIONS:** Research is needed into like-for-like contributions of wildfires and controlled fires to gaseous and particulate matter emissions.

3. **BIODIVERSITY:** There is a lack of data to identify which species are critical to ecosystem function, (such as invertebrate pollinators) and how these indicator species respond to management.

4. **ALTERNATIVE MANAGEMENT:** As well as little effective evaluation of peatland restoration for net zero, there is little data relating to the impacts of heather cutting or 'wilding' on hazard mitigation (wildfire, flooding) and biodiversity.

Continued overleaf >

5. **DESIGNATED SITES:** Site condition monitoring has been extrapolated to a national level and for features affecting net zero such as peat-soil condition for which it was not designed[14]. It is a particular concern that, despite a growing body of new evidence of how controlled burning may help meet favourable peatland condition and net zero objectives (see Section 4), the Common Standards Monitoring Guidance for Upland Habitats has not been updated since 2009[15] to recognise this beneficial role. Finally, favourable condition by standard monitoring vegetation assessments does not give ecosystem services metrics. This impedes analysis, makes management options more difficult to choose and does not provide a framework for changing management or recognising successful management.

6. **HISTORICAL AND CONTEMPORARY MANAGEMENT:** There is a lack of recent data relating to trends in the extent and pattern of still active drainage, vegetation burning and peatland restoration and the historic data on which policy decisions might be made (remote sensing data without associated ground-truthing) may be weak.

BOX 3.2

WHY DO WE VALUE BIODIVERSITY?

Currently there is no agreed valuation for biodiversity. Some have sought to determine its 'cultural' value (i.e. biodiversity itself as a national good as opposed to the services that arise from it) through visitors to nature reserves (see RSPB's Accounting for Nature 2017). Others have used values relating to the public's 'willingness to pay' e.g. the public willingness to pay for the conservation of raptors found in MMH habitats[7]. However, from an environmental goods and services perspective it is biodiversity's value as a 'supporting service' that is important.

We believe further work is needed to value upland biodiversity for society and ensure that its conservation is a policy priority.

Woodland regeneration, Peak District. © Alex Hyde

The audit – environmental goods and services delivered by English grouse moors

Key points

- We provide an audit of the key goods and services derived from managed moorland in relation to Defra's 25 Year Environment Plan. We also show the goods and services influenced by GMM for each of the main land cover (habitat) types.
- For each audited goal in the 25YEP we provide an overview and identify 'Upsides' (benefits gained through GMM), 'Downsides' (disbenefits and/or 'negative externalities' of GMM), 'Challenges (constraints on delivering or improving services) and 'Opportunities' (actions that would result in a net gain).
- The management of moorland and peatland habitats by grouse moor managers delivers on a range of 25YEP objectives, benefiting habitats and wildlife, supporting the delivery of cleaner air and water, reducing greenhouse gas emissions and increasing resilience through hazard mitigation (flooding and wildfire in particular).
- We identify downsides exerted by GMM on many of the 25YEP goals and the opportunities to use GMM to mitigate past and current downsides, while retaining social, economic and environmental sustainability.
- Both inflexible and weakly informed public policy and a lack of relevant information are repeatedly identified as risks to the current and future delivery of goods and services by GMM with disbenefits including site species loss or environmental damage.

Land management of any kind affects the delivery of environmental goods and services from ecosystems. The affects can be for better or worse depending on the management, its intensity of use and the ecosystem. For over 150 years the incentive of DGS has motivated investment in a particular package of management for upland heaths, bogs and wildlife – GMM.

We present our audit in two different ways – for public policy makers and for land managers. Section 4.1 is laid out so that those interested in public policy can reference GMM's contribution to Defra's 25YEP goals. Section 4.2 presents the same audit information by habitat type which is more immediately relevant to those whose work delivers these goods and services: the moorland managers and conservationists.

4.1 The audit – by 25YEP goals

Our audit considers (with supporting evidence) the overall net contribution of GMM to six 25YEP environmental goals (TABLE 4.1.1).

The two other 25YEP socio-economic goals ('Using resources from nature more sustainably and efficiently' and 'Enhanced […] engagement with the natural environment') are assessed in Sections 5 and 6 of this report.

TABLE 4.1.1

25 Year Environment Plan environmental goods and services delivery by best practice grouse moor management.

Yellow highlighting indicates our assessment of an overall net neutral contribution by GMM, green a net positive.

** These outcomes will be supported by Environmental Land Management Scheme (ELMS) as part of its Natural Capital approach. ** We recognise there are significant ongoing concerns about GMM impacts on raptor conservation – please see Sections 4.1.3, 6 and 7 for further consideration. *** Insufficient evidence to complete an audit.*

	DEFRA 25YEP GOALS	ENVIRONMENTAL GOODS & SERVICES DELIVERED BY BEST PRACTICE GMM
1.	CLEAN AIR	Reducing polluting gas emissions*
		Removing air pollutants
2.	CLEAN & PLENTIFUL WATER	Trapping pollutants
		Ensuring water supplies*
3.	THRIVING PLANTS & WILDLIFE	Moorland habitat conservation*
		Moorland species conservation*/**
4.	REDUCED RISK OF HARM FROM ENVIRONMENTAL HAZARDS	Reducing flood risk*
		Reducing wildfire
		Controlling tick-borne disease
5.	MITIGATING & ADAPTING TO CLIMATE CHANGE	Protecting existing carbon (peat)*
		Storing more (sequestering) carbon*
6.	MANAGING EXPOSURE TO CHEMICALS	See under Controlling tick-borne disease***
		See under Clean and plentiful water***

Lichen growing on a tree branch.

4.1.1 Clean air

Overview

Controlled heather burning and wildfires release pollutants. Controlled burning may represent a net benefit if it reduces or removes the risk of wildfire which is more likely to release proportionally more pollutants by area. Moorland vegetation captures particulates from the air reducing the risk to human health. Estimating exact contributions is not possible because of gaps in our knowledge.

It is possible that GMM makes a net contribution to the 25YEP target to:

- *meet legally binding targets to reduce emissions of damaging air pollutants – this should halve the effects of air pollution on health by 2030.*

In the next two tables we consider GMM's relationship to a) Reducing polluting gas emissions and b) Removing air pollutants.

a) Reducing polluting gas emissions.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
Controlled burning, cutting and grazing of moorland vegetation is likely to reduce the risk of high particulate matter (PM) emissions and methane from wildfires by reducing fire risk and severity by reducing fuel load. Appendix 1i-v	Reducing wildfire risk by controlled burning and cutting itself emits pollution. Appendix 1vi and vii	Public policy constraint on heather burning is likely to increase fuel load and may increase the risk and amount of PM and heavy metal emissions resulting from wildfire. Appendix 1viii	Research is needed into like-for-like contributions of wildfires and controlled fires to gaseous and PM emissions.
	Local and short term pollution may occur in relation to controlled burning if planning is poor and/or weather conditions change unexpectedly.	Climate change may increase the risk of controlled fires becoming wildfire due to projected higher temperatures, lower rainfall and drier soils. Appendix 1x	Research is needed into whether pollution from controlled burning can have an adverse impact on human health.
		Non-GMM recreation may make wildfire ignition more likely and controlled burning more difficult. Appendix 1ix	Identify the threshold at which controlled fires can reduce net wildfire emissions.


Heather burning on the North York Moors.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

b) Removing air pollutants.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
GMM moorlands have a large heterogenous perennial leaf cover which may trap air pollution and could be helping reduce healthcare costs by £1.26 million per annum. Appendix 1xi and 1xii	Open canopy woodland can be an effective pollution trap, but there have been no direct comparisons with heath, scrub or grass moorland. Appendix 1xiii-1xv	Pollution trapped on and in moorland vegetation may make restoring peatlands more difficult. Appendix 1xvi	Generally declining air pollution should help the restoration of peatland ecosystems.
		Air pollution itself reduces effective delivery of environmental goods. Appendix 1xvii	The effect of historic nitrogen air pollution may be reduced by controlled burning[16] or cutting and removing vegetation[17] to restore low nutrient peatland.
		Generally declining air pollution will reduce the value of this service. Appendix 1xviii	
		Overgrazing, wildfire and pollution may affect plant growth and reduce pollution trapping.	

Ladybird on heather.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

4.1.2 Clean and plentiful water

Overview

UK upland areas host around 80% of large public water supply dams and reservoirs[g], making them a significant source of water for domestic and industrial use. They play a role in storing and releasing water and in diluting downstream pollution. The process of 'peatland restoration' may benefit run-off patterns through re-vegetation and drain blocking but 'restored peatland' may have little or no effect once peatland is saturated (see also 4.1.4a – Reducing flood risk). There is emerging evidence both for and against poorly located management fires affecting water quality but wildfires, possibly more likely and severe under non-grouse moor habitat management, could increase release of sediment and pollutants.

It is possible that GMM makes a net contribution to the 25YEP target of:

- ***improving at least three quarters of our waters to be close to their natural state as soon as is practicable.***

Coverhead Farmhouse in the middle of the estate, which comprises moor and in-bye land including woodland and hay meadows.

CASE STUDY 1

COVERHEAD, NORTH YORKSHIRE – MOORLAND MANAGEMENT CONTRIBUTING TO CLEANER WATER AND REDUCED PEAK FLOWS

James Mawle's family farm Coverhead, in North Yorkshire, has demonstrated how grouse management integrated with farming can help to deliver clean water and mitigate the risk of flooding in towns downstream. James said: *"I have never been a fan of the grips, livestock get stuck in them and they make it difficult to travel across the moor. Once I discovered their impact on carbon release and flooding, filling them in became the obvious thing to do."* The effect has been dramatic, transforming the River Cover from one which would spate when it rained to one with lower peak flows and higher minimum flows. The river is much clearer and its flows are less destructive to aquatic invertebrates. It had also been artificially straightened in the past so James has begun the process of restoring meanders to increase its length, and thus its holding capacity, and reduce the gradient so that the water will run more slowly.

Grip blocking is often accompanied by a reduction in grazing for conservation reasons. But James believes this can be counterproductive because if the heather is stressed by rewetting it can become overwhelmed by fast-growing grass unchecked by grazing. At Coverhead the heather is doing well on the rewetted ground thanks to careful manipulation of the grazing regime. Peat-forming *Sphagnum* moss also seems to benefit from cattle on the moor with a very strong recovery seen in grazed areas. ■

g Source CIWEM – *https://www.ciwem.org/assets/pdf/Policy/Policy%20Position%20 Statement/New-public-water-supply-reservoirs.pdf.*

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
English grouse moors 'filter' and supply drinking water worth c.£84.5 million per annum. Appendix 2ii and 2iii	Heavy rain and surface water flow on any un-vegetated bare ground will release sediment and pollutants. Appendix 2v	Restoring degraded peatland increases water kept on the moor, possibly reducing water supply, though the scale and period of this are hard to predict. Appendix 2vii	Grouse moor managers must follow best practice advice on controlled burning near watercourses[18].
Controlled burning, grazing and cutting (with brash removal), by reducing fuel load, mitigates the risk of wildfire which can leave large areas of unvegetated, bare ground susceptible to erosion. See 4.1.4b Environmental Hazard Reduction – wildfire.	Poor practice use of chemicals for parasite or invasive plant species control by GMM and farming may reduce water quality and pose risks to invertebrate populations. Appendix 2vi	Under climate change moorland habitat and peatland will have to mitigate the effects of more intense rainfall, less snow cover and more drought periods on water supply. Appendix 2viii to 2ix	Grouse moor managers should gather data on the effects of their burning on water quality and supply as current knowledge is highly variable. Long term studies into the impacts of management regimes on water quality in different catchments are needed. Appendix 2xi
Run-off is reduced under diverse habitat and blocked drains scenarios increasingly typical of GMM compared to bare peat and drained moorland. Appendix 2i and 2iv Case study 1	Cutting wet moorland habitats can increase sedge dominance affecting water quality[35].	Water demand is likely to increase due to population expansion although climate change impacts on demand patterns are not well understood[19].	As in Scotland[20], public policy should recognise and adopt GMM techniques to prevent wildfires.
		Controlled burning is a diminishing factor affecting water treatment costs – reductions in atmospheric acid deposition and rising temperatures may increase Dissolved Organic Carbon levels[7,21]. Appendix 2x	GMM should continue to collaborate with Water Companies on peatland restoration and protection.
			Chemical use for parasite and invasive species control should be minimised commensurate with good animal welfare and must follow best practice guidelines[22,23].

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

4.1.3 Thriving plants and wildlife

Overview

GMM conserves internationally important, often publicly protected Annex 1[h] heather moorland and blanket bog and upland bird populations. These habitats and species, part of the cultural and recreational value of our uplands, are often under significant pressure away from GMM areas.

GMM can and does makes a net contribution to the 25YEP targets of:

- *restoring 75% of our protected sites to favourable condition and creating or restoring 500,000 hectares of wildlife-rich habitat outside the protected site network...;*
- *taking action to recover threatened, iconic or economically important species of animals, plants and fungi...;*

but in order to protect the moorland ecosystem GMM should make only a limited contribution to the 25YEP targets of:

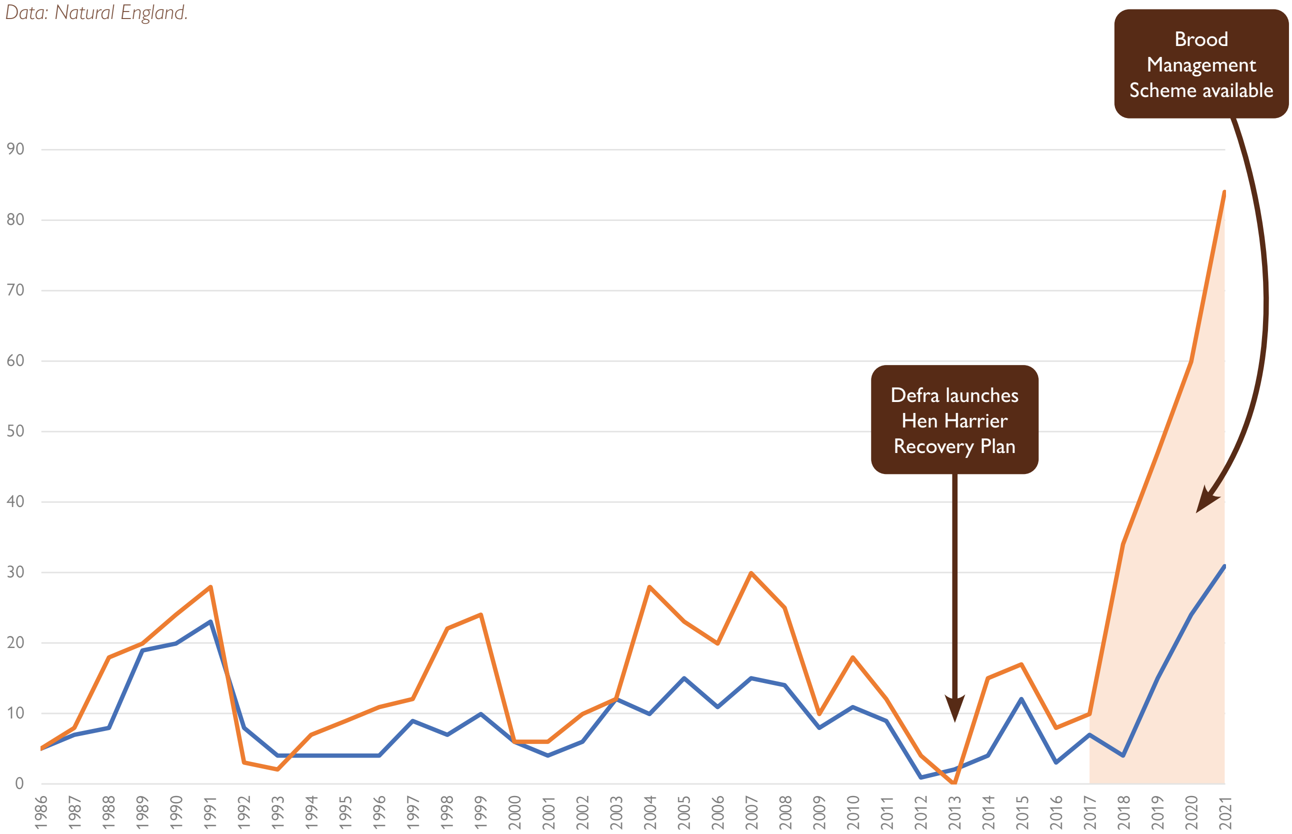
- *increasing woodland in England in line with our aspiration of 12% cover by 2060.*

Lapwing © Nick Goodrum

FIGURE 4.1.3.1

Hen Harrier nesting attempts (blue line) and number of chicks fledged (orange line) in England between 1986 and 2021, noting the introduction of the Hen Harrier Recovery Plan in 2013 and Brood Management Scheme in 2017.

Data: Natural England.



h Annex 1 habitats and species are identified by UK conservation regulations as being of particular conservation value.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
74% of the area of upland Special Protection Areas (SPAs) were designated as and remain managed as grouse moors. Appendix 3i and 3ii	Fewer raptors, notably hen harriers and peregrine falcons, on GMM areas than expected from available habitat and prey resource. Appendix 3xii	Globally important heather habitats face serious conservation issues – they have already declined by 27% since 1945. Appendix 3xiv	More grouse moor managers should commit to the maintenance and enhancement of biodiversity as much as sustainable grouse shooting. Case study 2
Four upland habitats covering 224,000 hectares of designated sites under GMM were in average to excellent condition when last assessed in 2015. Appendix 3x	Native 'clough' woodland is relatively scarce, despite recent planting, having declined in area over 50 years as a result of both farming and GMM. Appendix 3xiii	Current approaches to net zero public policy amplifies this loss as it emphasises reducing heather as part of peatland restoration (by wetting and reducing burning) and enhancing woodland cover. Appendix 3xv	GMM should continue to increase clough woodland cover. Appendix 3xix
Best practice legal GMM can support the six bird indicator species on the four upland SPAs. Appendix 3iv	There is some, but divergent, evidence that injudicious burning and grazing on blanket bogs alters habitat composition[35,88].	Climate change, agricultural policy and wilding will tend to reduce heather cover. Appendix 3xvi	Effective and humane control of predation pressure must be supported by public policy and delivered through private green investment in skills, manpower and equipment. Appendix 3xx
The English moorland bird index increased by 13% between 1994 and 2019. Appendix 3iii		Loss of GMM and heather habitats has harmed upland bird populations in both Wales and SW Scotland. Appendix 3xvii	GMM should continue to re-wet blanket peatlands to support bog species. Appendix 3xxi
Grouse moors are refuges for red-listed birds including lapwing, curlew, twite and lesser redpoll. Appendix 3v Case study 2		GMM mitigates biodiversity losses across England but there are still national declines in upland species such as merlin, whinchat and curlew. Appendix 3xviii	Grouse moor managers should be given and take more responsibility for collecting and sharing field data that provides evidence of their best practice. Appendix 3xxii
The hen harrier brood management trial has successfully integrated GMM and harrier conservation. Appendix 3vi Figure 4.1.3.1		Increased predation pressure from the recovered raptor guild.	Effective monitoring of SSSIs biodiversity could be shared with grouse moor managers if there were co-production of desired outcomes. Section 6.2

Black grouse and mountain hares benefit from GMM. Appendix 3v and 3vii			Favourable condition (especially of blanket peat) may need to be defined differently in the future due to the effects of climate change. Appendix 3xxiii
A unique group of invertebrates, some important to carbon cycling, benefit from GMM habitat structure. Appendix 3viii			Upland biodiversity should be directly valued by public policy so its conservation becomes a policy priority. Appendix 3xxiv
Specialist moorland moths, good indicators of environmental change, have increased by 80% between 1991 and 2018. Appendix 3ix			Clusters of moorland managers with shared objectives should be encouraged. Section 6.3
Sphagnum moss can benefit from removal of heather canopy by controlled burning. Appendix 3xi			

Four-spotted chaser dragonfly resting on common spike-rush.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

CASE STUDY 2

BOLTON CASTLE ESTATE, YORKSHIRE DALES – HOW TO SUCCESSFULLY CONSERVE THE CURLEW

Bolton Castle Estate is one of nine partners in the national Curlew Recovery Partnership. The estate incorporates a driven grouse moor which is home to one of England's strongholds of breeding curlew.

Management has changed over the past 20 years, switching from an emphasis on heather to a more varied habitat. Small areas of controlled cool burns on the moor create a mosaic of habitat with different lengths of heather and other moorland plants providing protection from avian predators next to space for nesting and insect rich areas for chicks. Another essential pillar of wader conservation is control of generalist predators such as foxes and crows. Tom Orde-Powlett, owner, said: *"In the '80s only grouse shooting protected these moors from forestry... If driven grouse shooting ended, predator control would stop and there would be no future for any ground nesting birds in the uplands."*

The impact on birdlife has been striking – a breeding bird survey repeated on the same grid square since 2007 shows the number of bird species has increased from 13 to 40 and total number of birds sighted from 87 to 444, including curlew, red grouse, golden plover, lapwing, snipe, woodcock, oystercatcher, short-eared owl, kestrel, merlin and peregrine. Tom said: *"Simply stamping SSSI on something won't help the wildlife in itself. Like all designations, someone's got to actively manage it."* ■

Flood risk is mitigated by well-vegetated, undrained moorland.

4.1.4 Reducing risks of harm from environmental hazards

a) Reducing flood risk

Overview

Situations typical of many moors managed for grouse shooting – well-vegetated, rough surfaces and water tables that are slightly below full capacity – can contribute to reducing rapid surface run-off and therefore flood risk. We note that public bodies do not agree on whether there is evidence that restored peatland can reduce flood risk. There is some evidence that full, complete peatland restoration could exacerbate flood risk in flood-prone catchments when fully saturated[85]. The balanced integration of GMM for habitat, which aims to maintain vegetation cover, with some peatland restoration techniques such as drain blocking is likely to deliver a good balance of flood control objectives.

We feel it is probable that GMM makes (but could increase) its net contribution to the 25YEP target to:

- ***reduce the risk of harm to people, the environment and the economy from natural hazards including flooding....***

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
Best practice GMM maintains vegetation cover and surface roughness over whole catchment scales. Appendix 4.1i	GMM can locally and for short periods result in little vegetation height or diversity if contiguous areas of vegetation are recently burnt, cut or heavily grazed. Appendix 4.1ii to 4.1iii	Climate change will exacerbate the risk of flooding through an increase in extreme rainfall events[19].	Grouse moor managers should be able to describe their approach to avoiding management that increases flood risk as part of balancing wildfire, carbon and biodiversity objectives. Section 6 Case study 3
Grouse moor managers have blocked 7,000km of drains and re-vegetated bare peat[24].		Public bodies should reconcile their divergent views on whether there is enough evidence that restored peatlands contribute to flood prevention. Appendix 4.1iv	Management including controlled burning that maintains peatland water table depth below fully-wetted may reduce flood risk and GHG emissions. Appendix 4.1viii
		There is no exact prescription for how much surface roughness or habitat type will reduce flooding in each catchment. Appendix 4.1v	Monitoring and modelling of hydrological response over long time scales and large (>100km^2) catchment scales are needed to refine where best to restore peatland and carry out habitat management activity. Appendix 4.1ix
		Some peatland restoration techniques and objectives could exacerbate flood risk in flood-prone catchments. Appendix 4.1vi to 4.1vii	Reducing wildfires by controlled burning and grazing may reduce flood risk caused by wildfire impacts. Appendix 4.1x

Bare peat erosion. © The Moorland Association

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

b) Reducing wildfire

Overview

Wildfires (uncontrolled burns that remove the surface vegetation and which can burn into the peat damaging the rootstock and peat itself) are damaging to carbon storage, biodiversity, public health (including risk to life), public infrastructure and the delivery of other environmental goods and services such as clean water and air quality[25].

Increased risk of wildfire in the uplands is a widely-recognised consequence of climate change. Changing land management (less grazing[26] and more 'managed wilding') can also increase fuel loads and thus both risk and impact. Yet mitigation measures often appear limited to ensuring peat is wet which is not easily or rapidly achievable, is not appropriate for some habitats, or effective when severe drought occurs. Integrating controlled burning to manage vegetative cover and fuel load would reduce the risk of serious damage from wildfire on dry heaths, drought-hit peatlands and degraded (drained) peatlands under restoration. Using fire to prevent fire is a technique practised globally[27] and Fire & Rescue Services should be both consulted on land management changes likely to increase fuel loads and supported in their adoption of managed fire for control purposes. Controlling wildfire in this way is probably compatible with carbon, water and biodiversity protection as the downsides of years of controlled burning are likely a fraction of the economic, human safety and environmental costs associated with one uncontrolled wildfire.

We consider it is highly likely that GMM does and will make a net contribution reducing wildfire risk and helps:

- ***reduce the risk of harm to people, the environment and the economy from natural hazards....***

CASE STUDY 3

SPAUNTON MOOR, NORTH YORK MOORS – WILDFIRE AND FLOOD HAZARD MITIGATION

Spaunton Estate has cleared 2,500 acres of bracken and swathes of rank (overgrown) heather through controlled burning, carrying out about 500 small *"cool"* burns each year. George Winn-Darley, the owner, was on Defra's Best Practice Burning Group (now the Upland Management Group) and the England and Wales Wildfire Forum, giving him contacts with fire brigades across the UK and extensive knowledge of burning on different upland habitats. He said: *"These days, the primary reason to carry out prescribed burns is in order to manage fuel loads and create firebreaks. That penny has completely dropped and fire brigades are saying, 'if you stop these gamekeepers burning heather, you will need to massively up our budget.' "*

George also sits on the Yorkshire Derwent Catchment Board and is involved in a water management project in partnership with the Environment Agency. He has planted trees along the river on the moorland fringe to stop flooding downstream. On the top of the moor a series of ponds and soakaways help capture rainfall and *"leaky dams"* made from logs and bales of heather slow the flow to the river. George explained: *"People often blame grouse moors for drying out the uplands, but the North York Moors were never drained. It is in our interests to retain as much moisture as possible."* ■

George Winn-Darley with a leaky dam made from bails of heather.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
Controlled burning and cutting with brash removal reduces the risk of wildfire by reducing the volume of burnable vegetation. Appendix 4.2i Case study 3	A very small proportion of wildfires are started by controlled burning. Appendix 4.2iii	Climate projections for hotter, drier summers, will act on land-use and recreational pressures to increase the risk of wildfires. Appendix 4.2iv and 4.2v	Wildfire mitigation should officially be recognised as a public good and wildfire prevention should be given the highest policy priority, with the Fire & Rescue Services a principal consultee, given its negative impact on almost all environmental goods and services[28].
GMM staff support Fire & Rescue services in fighting wildfires. Appendix 4.2ii	There are point-source emissions from controlled fires which can affect local air quality if conditions change during burning. Appendix 1vi	Drought lowers water tables even on re-wetted peat potentially allowing wildfire to spread. Appendix 4.2vi	Controlled fire must not cause wildfire – training in best practice fire management[29] and the developing of a fire risk model[30] are essential.
Severe fires typical of wildfire are more damaging to carbon sequestration and biodiversity than controlled fire[31] and the downsides of years of controlled burning are likely a fraction of the economic and environmental costs associated with one uncontrolled wildfire. See Box 4.1.5.1		Land use moving toward less grazing and more 'wilding' could increase moorland vegetation fuel loads and increasing the risk and impact of wildfire events. Appendix 4.2vii	Cutting with brash removal can complement controlled burning by creating firebreaks. Appendix 4.2ix
		The transition to a 'functioning' re-wetted peatland increases surface vegetation fuel loads thus increasing fire risk and impact. Appendix 4.2viii	A new assessment of the economic cost of wildfire is needed – it must include the impacts on fire, health or education services and currently unaccounted costs such as legacy water quality and carbon emissions, following erosion of bare surfaces, or biodiversity loss. Appendix 4.2x and 4.2xi

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

Above: Lyme disease erythema on a persons leg.

c) Controlling tick-borne disease

Overview

Tick numbers are often controlled on moorland under GMM to benefit sheep, grouse and other wildlife. Human exposure to Lyme and other diseases carried by ticks is likely to increase[32] through climate change and increased recreation in habitats associated with tick prevalence.

We consider it possible that GMM reduces the risk of humans being bitten by ticks carrying Lyme disease, when working in or visiting moorland areas, and improves the health and welfare of sheep flocks.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
GMM and sheep farms are the only current motivation to control tick, a human disease vector, on mountains and moorlands open for recreation. Appendix 4.3i to 4.3iii	Poor practice use of acaricides, especially livestock management just after treatment, can lead to pesticide damage of freshwater invertebrate populations[33].	Tick numbers, tick borne diseases and tick borne disease cases are increasing in number and extent across the UK and are probably under-reported. Appendix 4.3iv and 4.3v	Quantify whether acaricidal control of ticks on moorland grazed sheep reduces tick biting rates on humans in surrounding upland habitats.
GMM controls bracken which can be associated with high tick abundance[33].		Treatment of tick-borne Lyme disease is an increasing healthcare cost and there are emerging diseases such as tick-borne encephalitis. Appendix 4.3vi	If evidenced, consider public financial support for tick control on livestock in susceptible moorland areas.
		Treating ticks on livestock is an unsubsidised expense. Appendix 4.3vii	
		Constraining management for grouse could dis-incentivise tick control.	

4.1.5 Mitigating and adapting to climate change

Overview

There is increasing evidence that traditional GMM may have, fortuitously over many years, contributed to the UK's aspirations for net zero – preventing the damaging planting of trees on deep peat and through habitat management which sequesters and stabilises carbon stores. Currently GMM values local knowledge in balancing ecosystem services, including climate change mitigation and biodiversity conservation, with sustainable socio-economic use. Contemporary changes to GMM, particularly in the last few years, are likely to have further enhanced this contribution. Less vegetation will now be burned, more peatland re-wetted, with the remaining GMM reducing the risk of wildfire and associated damage. There is little evidence that large changes to upland management (various forms of wilding) over a wide range of sites and spatial scales will do more to mitigate climate change than GMM[34] (see also Section 5).

We feel it is highly likely that GMM is and will make a net contribution to the 25YEP target of:

- ***continuing to cut greenhouse gas emissions including from land use, land use change [and] … agriculture …***

In this section we consider GMM's relationship to a) Protecting existing carbon (peat), and b) Storing more (sequestering) carbon.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

BOX 4.1.5.1

EMISSIONS FROM CONTROLLED FIRE V WILDFIRE

Compared to wildfires, controlled fires are often conducted in cooler conditions with different fuel quality, are smaller and shorter lived. Davies *et al.* (2015[d]) indicated wildfires consumed and emitted nearly twice as much Carbon per ha than controlled burns. The consequences of this may be substantial.

Controlled burning to create firebreaks to mitigate wildfire impacts, at least in high-risk areas, could result in many orders of magnitude lower CO_2 emissions than one wildfire. Taking Roaches as an example, burning 3ha every year for 40 years and preventing one wildfire would be a net gain.

Year and location	Estimated wildfire emissions (tCO_2e)	Estimated emissions (tCO_2e) from controlled burning of fire breaks (one year)[d,e]	Controlled as % of wildfire emissions
2018 Roaches[a] (61ha)	11,431	282 (3ha firebreak)	3%
2018 Saddleworth[b] (1,100ha)	17,798-26,281	445-657 (55ha firebreak)	3%
2019 Flow Country[c] (7,500ha)	294,000	7,350 (265ha firebreak)	3%

Sources of area and wildfire emissions figures:

- **a** Titterton *et al.* (2019). A case study into the estimated amount of carbon released as a result of the wildfire that occurred on the Roaches in August 2018. Moors for the Future Partnership, Edale.
- **b** University of Salford & Skeggs 2018 (confidential paper).
- **c** Scottish Fire and Rescue Service (2021) – see also Ricardo (2019) Report for WWF UK.
- **d** Based on Davies *et al.* 2015 doi:10.5194/bgd-12-15737-2015 and 20 year rotations (other than for Flow Country – see note e)
- **e** Firebreaks modelled as 3-5% of wildfire area.

Controlled burns reduce the risk of wildfire.

a) Protecting existing carbon (peat).

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
Between 66 and 205mt of Carbon are stored on English grouse moors[1].	GMM heather is thought to have been burnt more often and over large areas up to 2011 – there are no reliable data on trends in burning area or frequency thereafter. Appendix 5iv and 5v	Grouse moors emit between 0.9 and 4.8% of total peatland emissions in England – yet much of the public policy focus is on upland peatland emissions instead of lowland arable emissions. Appendix 5vii	Grouse shooting and GMM compatible carbon trading incentives should be supported to provide a 'private green finance' capability for peatland restoration.
Grouse moors have been actively blocking drains cut for agriculture over the last 25 years, reducing emissions from moorland. Appendix 5i	GMM re-wetting of peatland (and a warmer climate) is likely to result in a short-term large increase in methane emissions and subsequent low level methane emissions even when pristine. Appendix 5vi	There are many important evidence gaps: accurate measures of carbon storage (peat area, depth, density and historical carbon fluxes) are lacking for all UK peatlands[35]. Box 3.1	Further study is urgently needed into biochar to quantify its positive but under-appreciated role in carbon storage and emission reduction. Appendix 5xi Box 4.1.5.3
GMM of habitat likely reduces emissions from wildfires. Appendix 5ii Box 4.1.5.1		Public policy has been slow to recognise wildfire and subsequent erosion threats to upland carbon stores and seek management solutions. Appendix 5viii	Trials are needed to show whether managing the height of peatland water tables below fully re-wetted is likely to enhance carbon storage and reduce methane emissions, reduce flood risk and support biodiversity[36].
GMM resists tree planting on peat-rich soils thus protecting carbon stores. Appendix 5iii		Unjustified, deliberate or careless conflation of the causes and impacts of historical drainage and controlled burning on peatland water tables by opponents of GMM. Appendix 5ix	Grouse moor managers need to define and adopt sustainable burning practices based on 'ecologically-driven burning cycles'. Appendix 5xii to 5xiv Box 4.1.5.5
		Unevidenced adoption of cutting rather than burning heather as being better for carbon management. Appendix 5x Box 4.1.5.2	In the face of climate change protecting our current peat stores may be a better strategy than trying to capture more peatland carbon. Appendix 5xv and Box 4.1.5.4

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

The effects of cutting rather than controlled burning remain largely unstudied. © Moors for the Future Partnership

BOX 4.1.5.2

DOES CUTTING CUT IT?

Mechanical heather cutting is physically only possible on some moors due to slopes and rocky conditions. Cut vegetation is typically retained on site. This mulch releases nutrients and CO_2 slowly, but can affect habitat recovery and act as a substantial fuel load for wildfires. There have been few studies comparing the effects of cutting to controlled burning on plant, animal or invertebrate biodiversity and net zero and the opinion of users is divided. Early results from on-going research by the University of York[a] suggest that cutting increases GHG emissions and promotes the release of Phosphorus to water through increased sedge cover and brash decomposition as well as affecting the surface micro-topography (see Appendix 4.1[b]).

Heather cutting. © Dr. Andreas Heinemeyer

MoorLife 2020[c] calculated that over 5 years cutting 1,072ha using 2 tractors per job emitted 15.16tCO_2e (0.014tCO_2e/ha) – equivalent to a typical SUV travelling 38,000 miles. To this one has to add subsequent CO_2 emissions from brash decomposition.

a Heinemeyer, A., and Ashby, M. A. 2021. An outline summary document of the current knowledge about prescribed vegetation burning impacts on ecosystem services compared to alternative mowing or no management. *https://doi.org/10.32942/osf.io/qg7z5*.

b See Appendix 4.1 Reducing flood risk, available online at *www.gwct.org.uk/englishgrousemoors*.

c Titterton, P., Benson, J., Thorpe, K., and Crouch, T. 2021. *Carbon Audit Update Report 2020*. Moors for the Future Partnership, Edale.

b) Storing more (sequestering) carbon.

UPSIDE	DOWNSIDE	CHALLENGE	OPPORTUNITY
UK upland grassland habitats sequester 1.99mt CO_2e/yr[37] (see Opportunity regarding conversion to heather cover). Appendix 5xvi	Too frequent controlled fire can suppress C accumulation on moorlands[38].	Increasing rainfall and temperature extremes will release more carbon from upland ecosystems[39] and increase the risk of wildfire[40].	Restore heather cover on grassy moorland to double carbon sequestration. Restoring *Calluna*-dominated upland heath has a carbon sequestration potential equating to c.60% of the annual UK forest carbon sink[41].
Grouse moors have blocked 7,000km of historic drainage channels to re-wet peatland and re-vegetated 27,000 hectares of bare peat in the last 20 years[42]; 50-60% of peatland will be under similar management by 2035[40].		No burn management and pro-cutting policies have a weak evidence base and may risk long-term carbon cycles on some moorland. Appendix 5xviii	Conduct a comparative risk assessment to quantify trade-offs between current and proposed net zero actions and the impacts on biodiversity, risk of wildfire, other provisioning and regulating services, cultural services and economic contribution[43,44].
Biochar following controlled fire can be a significant source of carbon sequestration. Appendix 5xi and 5xvii Box 4.1.5.3		*Calluna*-dominated heath has an important role in carbon sequestration and storage but this role is often downplayed in favour of blanket bog. Appendix 5xix See also Section 4.1.3 and Appendix 3xv	Grouse moor managers should take more responsibility for collecting and sharing field data that provides evidence of their best practice.
		New evidence suggests contemporary carbon sequestration by waterlogged peatland is not likely to add to the long term carbon store. Appendix 5xx	Re-vegetate bare peat areas to remove wind and water erosion loss of stored carbon.
		Limited mapping of the area, depth and density of peat making carbon stored and carbon balance assessment difficult. Appendix 5xxi Section 3.2	Research when (and if) a restored peatland becomes a carbon sink, with accumulations exceeding losses throughout the peat profile. Appendix 5xxii to 5xxiv
			Research the impacts of controlled burning, cutting and no-burn on carbon fluxes over a full habitat management cycle.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

BOX 4.1.5.3

BIOCHAR – HIDDEN VALUE?

Biochar (soot, char, charcoal or black carbon) is produced by the incomplete combustion of organic matter during fires. It resists further oxidation so can store carbon for very long periods. More charcoal is incorporated into the peat profile with more burning, locking away further carbon[45]. Even heating peat to less than combustion (flash heating and pyrolosis) can stabilize and protect it from further degradation[46].

More work is needed into what is an important carbon sequestration process.

Burnt heather is a form of biochar.

BOX 4.1.5.4

IS RESTORING PEAT ACCUMULATION AND HYDROLOGY NECESSARY?

Peatlands may be more resilient than policy currently anticipates, and attempts to restore historical hydrological and biological function may not be the most pragmatic way of achieving net zero and environmental outcomes in a changing climate.

Peatlands first formed to any extent in the UK during the Holocene (from 8,000 years ago). Our peatlands now, whether restored or pristine, will function very differently to those early Holocene peats given subsequent natural and man-made climate change and the impacts of pollution and historical land management.

Consequently attempting to restore a 'natural' hydrology may not return full natural function even after many years[47]. It is most likely that the best results will be achieved where the local topography is favourable[50]; in these places some peatlands in the UK can even be self-restoring and 'naturally' accumulate peat[49].

An alternative approach is to support moorland ecosystems which can maintain their structure and function over time in the face of contemporary external stresses such as climate change[48]. Other plant species, such as heather, may be as relevant in the resilience of peatland ecosystems as the current focus on *Sphagnum* given environmental change toward warmer drier summers and wetter winters[19].

Freshly planted Sphagnum *moss. © Moors for the Future Partnership*

BOX 4.1.5.5

IMPROVING SUSTAINABILITY – ECOLOGICALLY-DRIVEN BURNING

Ecologically-driven burning cycles aim to balance the maximum possible protection and sequestration of carbon with other biodiversity and landscape values.

Controlled burning can benefit *Sphagnum* mosses and cotton grass by removing heather cover[51], whilst the nutrients from the ash provide support for re-growth, and the biochar sequesters carbon. Carbon storage appears to be affected by the frequency of a controlled burn – a 10 year burning rotation has been shown to result in less carbon accumulation than unburnt (or not recently burnt) areas whilst a 20 year rotation shows similar rates of accumulation to unburnt[52].

Calculations of total Net Ecosystem Carbon balances suggest that burning regimes can be targeted at specific management outcomes without significantly impacting on total ecosystem carbon storage[53]. Given that *Sphagnum* species can resist all but the most intense wildfires, using 'cool' controlled burns on evidenced cycles could encourage the establishment of key indicator species, protect the peatland carbon stock from deep peat combustion and result in net carbon storage several years post-fire.

Sphagnum *moss. © Moors for the Future Partnership*

Heather and bilberry moorland.

4.2 The audit – by broad upland habitat type

Government policy goals and how these are affected by GMM may appear rather abstract to many land managers. How goods and services relate to their management of habitats has more immediate relevance. Here we summarise the delivery of the audited environmental goods and services by broad upland habitat type (TABLE 4.2.1 and TABLE 4.2.2). We also relate the wider goods and services to the conservation of red grouse, recognising that the incentive of a sustainable surplus of grouse to shoot is the motivation for maintaining and evolving GMM (TABLE 4.2.2).

TABLE 4.2.1

Contribution of broad upland habitat type to 25YEP environmental goods and services delivery.

Colour coding: Red – negative; yellow – net neutral; light green – likely net positive; dark green – net positive.

	CLEAN AIR	CLEAN & PLENTIFUL WATER	THRIVING PLANTS & WILDLIFE	REDUCING RISK OF ENVIRONMENTAL HAZARDS	MITIGATING & ADAPTING TO CLIMATE CHANGE
Degraded peatland (actively eroding)	[red]	[red]	[red]	[red]	[red]
Blanket bog (near natural)	[dark green]	[dark green]	[dark green]	[light green]	[dark green]
Re-wetting bog (peatland restoration)	[dark green]	[dark green]	[light green]	[light green]	[yellow]
Heather and grass dominated peatland – drained	[yellow]	[yellow]	[yellow]	[yellow]	[yellow]
Upland wet heath	[dark green]	[dark green]	[dark green]	[yellow]	[yellow]
Upland dry heath	[yellow]	[dark green]	[dark green]	[yellow]	[light green]
Hill-fringe grasslands	[dark green]	[yellow]	[yellow]	[yellow]	[light green]
Native 'clough' woodland	[dark green]	[dark green]	[dark green]	[light green]	[dark green]

Cotton grass and Sphagnum moss are typical of active blanket bog. © Moors for the Future Partnership

TABLE 4.2.2

The delivery of environmental goods and services by broad habitat type.

BROAD HABITAT & LANDFORM CHARACTERISTICS	GHG EMISSION FACTOR (CO_2e/ha/yr)[i,54]	ENVIRONMENTAL GOODS & SERVICES DELIVERY					REASON & ACTIONS FOR GMM[j]
		PLANTS & WILDLIFE	CLEAN AIR	CLEAN WATER	HAZARD RISK REDUCTION	CLIMATE ADAPTATION	
DEGRADED PEATLAND (ACTIVELY ERODING) • >40cm peat depth. • Drained. • Lowered water table. • Bare peat areas. • Eroded hagg/gully system.	13.28t	Little or no plant diversity; poor quality habitat unlikely to support wildlife.	Little or no vegetative removal of particulate matter (PM). Risk of release of air pollutants.	Water quality poor due to release of pollutants and sediment.	Wildfire risk – bare dry peat at risk of smouldering. Flooding risk – high; flashy runoff due to lack of surface roughness.	Erosion resulting in C losses via oxidation, surface run-off (especially from eroding gullies and haggs) and wind.	Limited value for adult grouse and chicks at risk in grips. • Block grips/drains. • Re-vegetate bare patches.
BLANKET BOG (NEAR NATURAL) • >40cm peat depth. • Bog vegetation dominates. • Hummock and pool features.	-0.02t	Abundant invertebrates. Habitat diversity for moorland birds. Optimal conditions for maintaining peat.	Vegetative removal of PM (though nutrient deposition could reduce species diversity).	Filtration processes by peat.	Wildfire risk – minimal except during drought conditions. Flooding – little benefit as at or near saturation. Hummock and pools reduce surface flow speed.	Important C storage and (positive) C sequestration function offset by methane emissions.	Red grouse habitat managed by: • Monitor fuel load for need to manage through burning/cutting. • Repair natural erosion events that expose bare peat.
RE-WETTED BOG (PEATLAND RESTORATION) • >40cm peat depth. • Grips/gullies blocked. • Rising water table.	3.91t	Increasing *Sphagnum* and cotton grass cover. Increasing invertebrates.	Vegetative removal of PM.	Blocking slows the flow and reduces sediment loss.	Flooding – blocking slows the flow and reduces peak flow (until saturation reached). Wildfire risk – reduced except during drought conditions.	Increased methane emissions by 46%[56]; effect could last up to 30 years[57]. CO_2 emissions reduced. Managing water table level may help balance methane fluxes.	Red grouse habitat managed by: • Block grips/gullies. • Heather management.
SEMI-NATURAL HEATHER & GRASS DOMINATED PEATLAND – DRAINED • >40cm peat depth. • Modified bog/drained. • Heather and grass dominate.	3.54t	Drainage causing lowered water table. Reduced plant species diversity. Habitat species and structure attractive to moorland birds.	Vegetative removal of PM. Risk of release of air pollutants.	Water draining these areas likely to be high in organic carbon. Flashiness of runoff reduced by surface roughness. Possible local impacts of parasite control.	Wildfire risk – high due to increased biomass. Dry peat at risk of smouldering. Flooding risk – medium; surface flow and flashiness reduced by grip blocking and surface roughness.	Heather and grass capture carbon. Possible water table equilibrium balancing C and CH_4 fluxes.	Red grouse habitat managed by: • Controlled burning of heather. • Light grazing (sheep). • Grip/drain blocking.

i Emission factors: Gregg, R. *et al.* 2021 unless otherwise stated.
j Legal predator control can enhance net wildlife conservation across all upland habitat types.

UPLAND WET HEATH • Heather dominated. • Undrained. • Shallow peat. • Indicator species present.	2.31t	Invertebrates and structural diversity good for moorland birds. Important range of vascular plants and bryophytes.	Vegetative removal of PM. Risk of release of air pollutants.	Likely contribution to detoxification of lowland waters. Possible localized impacts of poor practice in disease control.	Wildfire risk – medium; important to manage fuel load. Flooding – some benefit due to hummock and pools but limited value if saturated.	Wet flushes possible methane source. Vegetation captures carbon. C fluxes over burning cycles and value of biochar needs assessment.	Red grouse habitat managed by: • Controlled burning of heather. • Light grazing (sheep).
UPLAND DRY HEATH • Naturally free-draining, low nutrient acidic/ oligotrophic soils. • Ericaceous dwarf shrubs (heathers, bilberry) predominate.	0.054t[58]	*Calluna – Vaccinium* heaths hold important populations of moorland birds – red grouse, raptors, twite and golden plover occur widely.	Vegetative removal of PM. Risk of release of air pollutants.	Possible localized impacts of poor practice in disease control.	Wildfire risk – significant if unmanaged. Flooding – some benefit due to surface roughness.	Carbon storage (soil and vegetation). C fluxes over controlled burning cycles (15-20 years) need to be assessed. Value of biochar after controlled burning requires investigation.	Red grouse habitat managed by: • Controlled burning of heather. • Light grazing (sheep).
HILL-FRINGE GRASSLANDS • Acid or alkaline soils (dictate species). • Typical constituents are mat-grass or *Molinia* with *Juncus* rushes in wetter areas.	-0.5t (*Molinia caerulea* swards under low level grazing).	Acid grasslands can have low but rare plant species diversity. Upland waders, black grouse, breeding meadow pipits and skylarks[59] are supported.	Vegetation removal of PM.	Intense rainfall risk of surface run-off and erosion.	Wildfire risk – high if ungrazed or uncut.	Carbon storage in soils (vegetation variable due to grazing). Some sequestration but this may be increased if converted to heathland.	Grouse use when adjacent to heather moorland so some management: • Light grazing (sheep) to prevent scrub encroachment. • Bracken control to enhance habitat diversity.
NATIVE 'CLOUGH' WOODLAND • Mix of native species. • Open structure. • Dwarf shrub understory. • Bracken.	-14.5t (30-year mixed b/leaved native woodland on mineral soil).	Provides shelter/ perches for woodland birds and invertebrates e.g. green and purple hairstreak butterflies.	Vegetation removal of PM.	Reducing soil erosion.	'Low risk' wildfire habitat. Mitigating downstream flood risk.	Net carbon sequestration and storage if on mineral soils but possibly not organic soils. Shading watercourses.	Management to: • Control bracken. • Reduce scrub encroachment.

Appendices available online at: *www.gwct.org.uk/englishgrousemoors*

MPs and stakeholders need to engage to produce balanced outcomes from GMM. © Tina Brough

The assessment – does grouse moor management engage with nature sustainably and efficiently?

Key points

- This audit suggests GMM, as practiced in 2022 on many moors, is in large part a sustainable land management, supporting a wide range of public goods and services, sustained by private investment which is motivated by the incentive of driven grouse.
- Concerns that the intensity of GMM is permanently damaging the environment and biodiversity appear largely unfounded. Many of the concerns for the future are based on inaccurate, incomplete and historical views of moorland management.
- Possible alternative land uses for the uplands also require management input and their net benefit is less well evidenced than GMM.
- The future policy approach to sustainable moorland management should engage with GMM; encourage it to evidence the net environmental gain for society; not restrict GMM options; recognise the shooting incentive which motivates investment in management.

The Audit section of this report (Section 4) suggests that GMM results in a wide range of environmental services. It also indicates areas where both public policy and GMM could be better balanced so as to increase net benefits. It seems clear that public policy should be more careful in driving for changes in GMM, many of which lack compelling evidence of future benefit. Our audit suggests refining GMM practices to consciously widen environmental goods and service delivery will achieve a better balance than the constraint of GMM.

5.1 What is sustainable upland management?

Is GMM, as audited, a sustainable form of land management? Sustainable land management (SLM) was defined at the United Nations 1992 Rio Earth Summit as *"the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term* *productive potential of these resources and the maintenance of their environmental functions"*[60]. GMM is in large part an SLM – scaled approaches with spatial planning and local specificity, that bridge institutions and undertake adaptive co-management are all characteristics of GMM. Though present, more work needs to be done on monitoring and knowledge transfer so as to develop better shared earned legitimacy[86].

Because *"management that might be considered sustainable in one location, at one time, may not be considered sustainable in another location, or a different time, rendering universal definitions of* 'sustainable' *management virtually impossible"*[4] we have taken a relatively limited perspective in this report focusing on how GMM contributes to environmental and biodiversity elements of sustainable upland policy[k]. In this context, we believe our audit indicates GMM, as is being practiced in 2022 on many moors, is a sustainable land management. GMM is likely to have made significant environmental sustainability contributions historically. The most notable is probably being a key driver preventing the planting of woodlands on organic soils from 1945 onwards. Evidence is increasingly clear that this would have been detrimental to both biodiversity and carbon management[64].

The economic sustainability of GMM depends on continuing investment in management. Maintaining the current provision of goods and services identified in the audit and better balancing the provision of wider environmental goods and services by refining management practices must be paid for in a sustained manner. The incentive of driven grouse shooting (DGS) should be recognised as a key motivator for investment in current and enhanced upland management and the delivery of socially beneficial goods and services[33,61,62].

We assess current and enhanced future GMM as both environmentally and financially sustainable if DGS is both developed and supported. However it is commonly suggested there are even more sustainable upland land uses. Here we present a comparative assessment of the main alternative land uses in terms of risks to public goods delivery.

5.2 What are the alternative upland land management approaches to GMM?

If GMM were environmentally or economically unsustainable, what would be the most likely alternative land management approaches in the uplands and what would be their contributions to public policy goals (TABLE 5.1)? We consider three public policy scenarios:

5.2.1 Wilding

5.2.2 Tree planting

5.2.3 Agriculture

5.2.1 Wilding

Rewilding

Rewilding has become a conservation 'buzzword', linking *"society, culture, nature and conservation"* and *"functioning ecosystems with reduced human control and restored ecosystem processes"* at little or no public or private cost[63]. Rewilding looks to restore former ecosystems in the hope this will future-proof our current environmental goods and services. The approaches vary from the removal of human management, often called passive rewilding, to a more active approach with some intervention (see 5.2.2) and can include the re-introduction of extinct species (see 5.2.3). It has gained traction through an interest in nature-based approaches to achieving net zero and reducing species 'extinction'.

Public perception of rewilding projects is diverse, primarily because it appears the public value many current landscapes and ecosystems. Active management has ensured the protection of habitats, biodiversity and the delivery of a wide range of public services. The passive abandonment of grazing, controlled burning and predator management that sustains our culturally valued moorland landscape has been linked to reduced breeding success of vulnerable ground-nesting species including curlew and hen harrier, as seen at Langholm Moor in South West Scotland and in the Berwyn SPA in Wales (see Appendix 3). The build-up of unburned, uncut, or ungrazed vegetation will increase the risk of severe wildfire, is associated with increased tick activity, and the typical scrub woodland expansion will result in a net loss of carbon on both peatlands[64] and heathlands[54].

We feel it is unproven whether 'passive rewilding' could maintain or improve delivery of 25YEP goals. This is important as the audit above has demonstrated that the 'land-sharing' approach of GMM, where biodiversity conservation and other environmental goods and services are integrated into a productive landscape, is delivering multiple outcomes.

k We recommend 'Sustainable Driven Grouse Shooting?' by Simon Denny and Tracey Latham-Green to readers interested in the social, cultural, health and economic elements.

TABLE 5.1

Possible changes in environmental goods and services provision if GMM uplands were managed under alternative land uses (based on current available data).

** We recognise there are significant ongoing concerns about GMM impacts on raptor conservation – please see Sections 4.1.3, 6 and 7 for further consideration.*

*** Managed wilding reflects a focus on carbon farming, conservation and recreation.*

*** Rewilding equates to a cessation of management and possible introductions of species.*

Key: Impact of management: Positive = dark green; Partially positive = light green; Neutral = yellow; Partially negative = orange; Negative = red. (Adapted from UK NEA Technical Assessment) Delivery assumed in 2043.

	GMM (BEST PRACTICE)*	MANAGED WILDING**	REWILDING***	COMMERCIAL TIMBER	ENERGY	AGRICULTURE INTENSIFICATIONS
PROVISIONING						
Livestock products						
Water supply						
REGULATING						
C storage/emissions						
C sequestration						
Water quality						
Flood regulation						
Wildfire risk mitigation						
Soil erosion/peatland degradation						
Disease regulation						
CULTURAL						
Moorland landscapes						
Tourism and recreation						
Field sports						
Moorland habitats and species						

Managed wilding

A more likely approach to wilding than 'abandonment rewilding' is a managed wilding, or extensification. This is advocated by some environmental NGOs and private landowners, primarily in Scotland[l].

The managed wilding model is a compromise between *"the large-scale restoration of ecosystems and the reinstatement of natural processes"*[65] and the conscious attempt to deliver on all three pillars of sustainability – social, economic and environmental goods. Focal points for managed wilding tend to group on three outputs – carbon, conservation and recreation, which may be monetised through eco-tourism. Though perceived as low input or lower intensity much of the approach requires ongoing management, for example:

- ***to deliver peatland restoration (via re-wetting),***
- ***replacing a no-burn approach to vegetation management with cutting and grazing,***
- ***enhancing tree and scrub cover by planting and herbivore control, by culling and fencing.***
- ***provide access points, paths and interpretation; and generate revenue from tourism.***

Such a managed wilding approach can attract recreational users as they perceive that this will result in improved biodiversity[66].

Making an objective comparative audit of GMM and managed wilding is hampered by a lack of evidence. The auditable evidence base for GMM is compromised (Section 3.0) but the evidence base for managed wilding is even more limited. However using the GMM audit structure, one might assess that under managed wilding there are as many pros and cons as under GMM. TABLE 5.1 opposite summarises the anticipated changes in environmental goods and service provision, reflecting:

- Many of the GMM upsides could be reversed without a clear net benefit – e.g. heather moorlands are internationally protected and so initiatives that reduce their extent or fragment their area with woodland expansion could contravene our international biodiversity obligations.
- Some downsides would be addressed but potentially at a cost – e.g. native woodland biodiversity would expand but this would bring challenges in carbon balances if onto organic soils and reduced control of bracken could increase exposure to tick-borne diseases.
- Challenges would continue – e.g. those noted around increased wildfire risk and loss of beneficial management for wading birds.
- Opportunities would be lost – e.g. the possible net contribution of ecological burning regimes to carbon storage and sequestration and the long-term impacts of re-wetting on flood mitigation and GHG balances would not be researched.

Game shooting and managed wilding

Under GMM, many of the environmental goods and services produced and sustained are by-products of management for shooting. In managed wilding approaches, a sustainable shooting harvest is typically a by-product, though an important engagement with the natural environment, one of Defra's goals. Current wilding practice in the UK and USA suggests shooting can be a complementary sporting economic and cultural resource[67,68], but because the ecosystem would be less managed, grouse shooting would be less predictable in terms of annual availability, numbers taken or economic contribution to the management expense. The Langholm Moor Demonstration Project showed that where habitat and predation pressures are not resolved such an approach to red grouse shooting could lead to DGS becoming unsustainable. In some situations sporting shooting may not be integrated into managed wilding on ethical grounds.

Wildlife management

As noted above, the killing of wildlife has a complex relationship with wilding; entirely appropriate in order to protect trees from deer, but apparently less acceptable when it is to protect natural capital such as curlew from predators. Recent judicial challenges have resulted in more administrative and practical complexity for predator controllers, rather than better outcomes for increasingly rare biodiversity such as waders and black grouse. The risk, repeatedly seen and reported on in Wales and South-West Scotland, is that upland landscapes with reduced predator control could end up supporting both fewer prey and predators.

Species reintroductions and conservation translocations

These are proposed as part of the restoration of ecosystems and reversal of biodiversity loss. GWCT particularly welcomes Natural England's intention to form

l For instance see *www.wildland.scot* and *www.corrour.co.uk*.

a 'Species Reintroduction Task Force' to ensure proposed re-introduction of predators such as lynx and pine marten that could impact upon upland biodiversity follow IUCN (and Defra[76]) guidelines and are properly scrutinised for both their net contribution to environmental good and services, their social, cultural and economic appropriateness and the design of suitable exit strategies to cope with schemes going wrong. We hope this group will conclude that visitor experience, whilst an important social good, should not be at the expense of species conservation.

Rewilding is not a public policy, but some policies are driving elements associated with wilding. Nature-based solutions (NbS) to climate change have largely centred on two approaches – peatland restoration (audited above) and tree planting. In addition, agricultural support payments are changing.

5.2.2 Tree planting

The Government's ambition to increase tree planting of commercial timber and semi-natural timber to 30,000 hectares per year by 2025 (UK; 7,000 hectares England), and to support this with public funding[69] has significant implications for the uplands. Public policy guidance for planting 'the right tree in the right place'[70] in order to protect existing high-value environments must also give space to the nature that requires open landscapes. Without that, we risk irreversible impacts on our biodiversity – and landscape quality. In Scotland, increasing woodland cover in upland and hill fringe areas has already led to the loss of a range of red-listed species of high conservation concern such as mountain hare, black grouse, curlew, golden plover, lapwing and grey partridge[71].

5.2.3 Agriculture

Changes to agricultural support to a focus on 'public payment for public goods' could result in less stock in the uplands[72] with implications for food security and the risk of off-shoring GHG emissions. Such a change highlights the dependence of marginal livestock enterprises on the Basic Payment Scheme, the complexity of working collaboratively with neighbours to secure adequate funding, the uncertainty around reasonably valuing natural capital at a site scale, and unresolved concerns about the true carbon cost of extensive livestock production[73]. Grazing can bring significant benefits for moorland habitat diversity (and reduced grazing can result in increased grass cover and a decline in heather quality and extent[74]), maintain the rough surfaces most likely to slow surface flood-waters flow, and sheep flocks are the only feasible route for delivering tick control on moorland areas. It is essential grazing is maintained by the future Environmental Land Management Scheme (ELMS[75]), as data for upland National Parks (except the Peak District) and Severely Disadvantaged Areas suggest that grazing pressure has decreased between 2009 and 2016 in England (TABLE 5.2).

5.3 Assessing the sustainability of alternative management models against GMM

Our assessment is that less or alternative management in the uplands will not, in net terms, be more sustainable than GMM (see TABLE 5.1). We recognise that this assessment is in part because the evidence base for goods and services from alternative moorland management is extremely poor. It is not an assessment without precedent however.

In 2011 the National Ecosystem Assessment noted that the extensification of management might reduce the capacity of mountains, moorlands and heaths to sustain provisioning services and regulatory services and also change biodiversity and landscape. Grouse moors have provided an economic buffer to previous damaging policy influences. They have protected our unique and globally rare upland heathlands, grasslands and peatlands (and associated flora and fauna) that are now valued and designated from conversion to forestry.

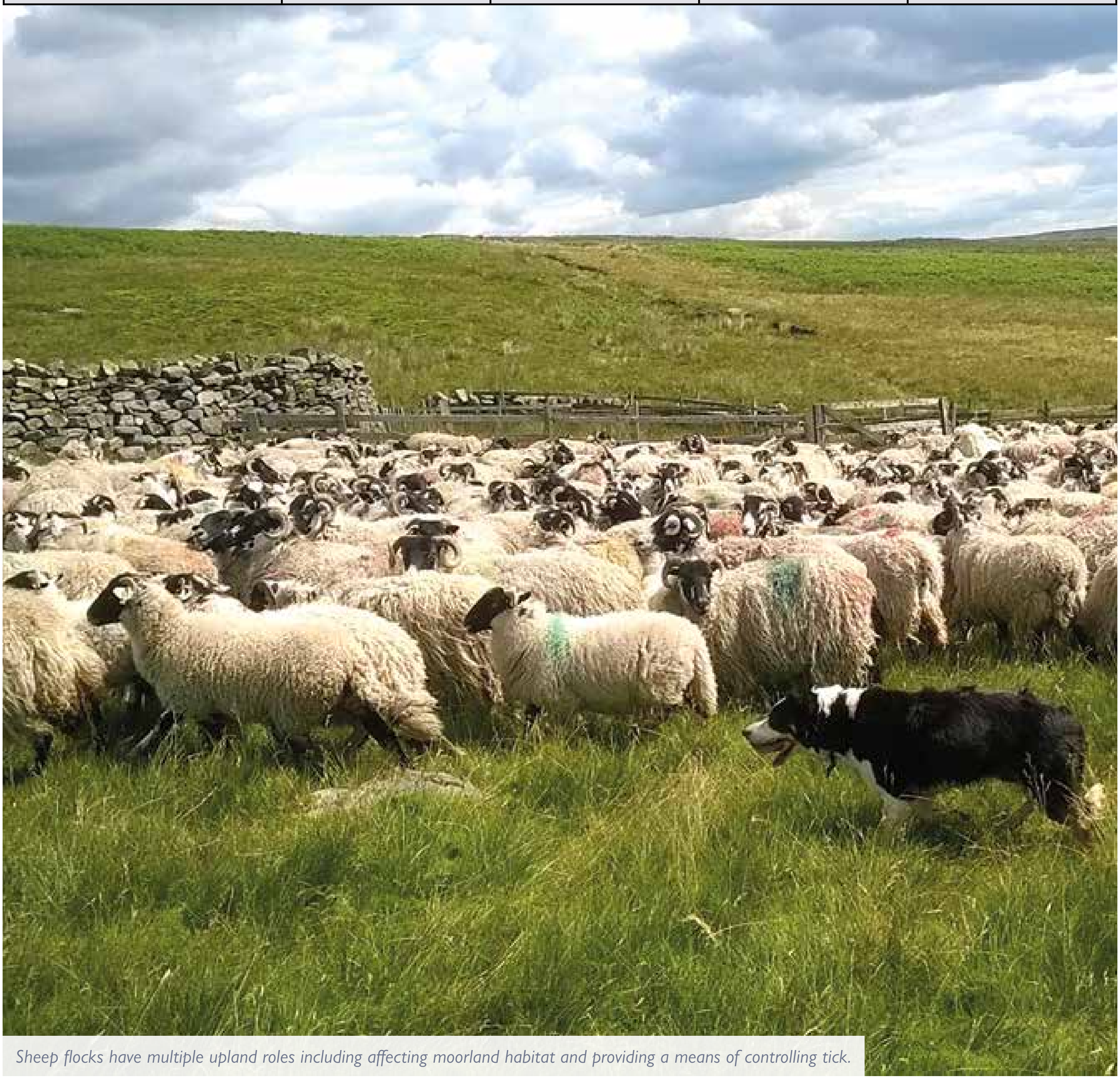
Defra's goal of *"Enhanced […] engagement with the natural environment"* would be diminished by changes away from GMM and moorlands. Moorland landscapes supported by GMM have established and recognised social and cultural value – these are explored in considerable detail in the recent report by Denny and Latham-Green[3] and in the National Ecosystem Assessment[4]. Reduced or alternate management strategies such as tree planting, no-burn or low-density grazing will grossly affect the look of our upland landscape. The public would have a very different visitor experience and would likely have to accept the loss of the unique moorland biodiversity.

TABLE 5.2

Sheep stock across upland National Parks in England (2009-2016).

Source: National Parks dataset.

NATIONAL PARK	SHEEP LIVESTOCK UNITS PER HECTARE OF GRAZING AREA			
	2009	2010	2013	2016
Dartmoor	0.359	0.345	0.371	0.279
Exmoor	0.471	0.434	0.468	0.458
Lake District	0.455	0.460	0.448	0.391
Northumberland	0.273	0.272	0.269	0.266
Peak District	0.284	0.264	0.291	0.301
Yorkshire Dales	0.418	0.410	0.408	0.339



Sheep flocks have multiple upland roles including affecting moorland habitat and providing a means of controlling tick.

Proposals for better outcomes – co-creating land management plans

that deliver the outcomes society wants

The GWCT believes that both its own ethic of *'conservation through wise use'*, or Defra's 25YEP aim of *"using resources from nature more sustainably and efficiently"* should be a fundamental part of all upland land management.

The uplands are diversified landscapes characterised by varyingly compatible land uses and, increasingly, the competing interests of different stakeholder groups. These interests mirror the evolution of our uplands from an ecosystem that supported consumptive use to a much broader range of uses including non-consumptive (cultural, recreational, environmental). Despite these tensions a broad range of environmental goods and services, in part a happy by-product of sporting and farming activity, are produced by England's uplands in 2022.

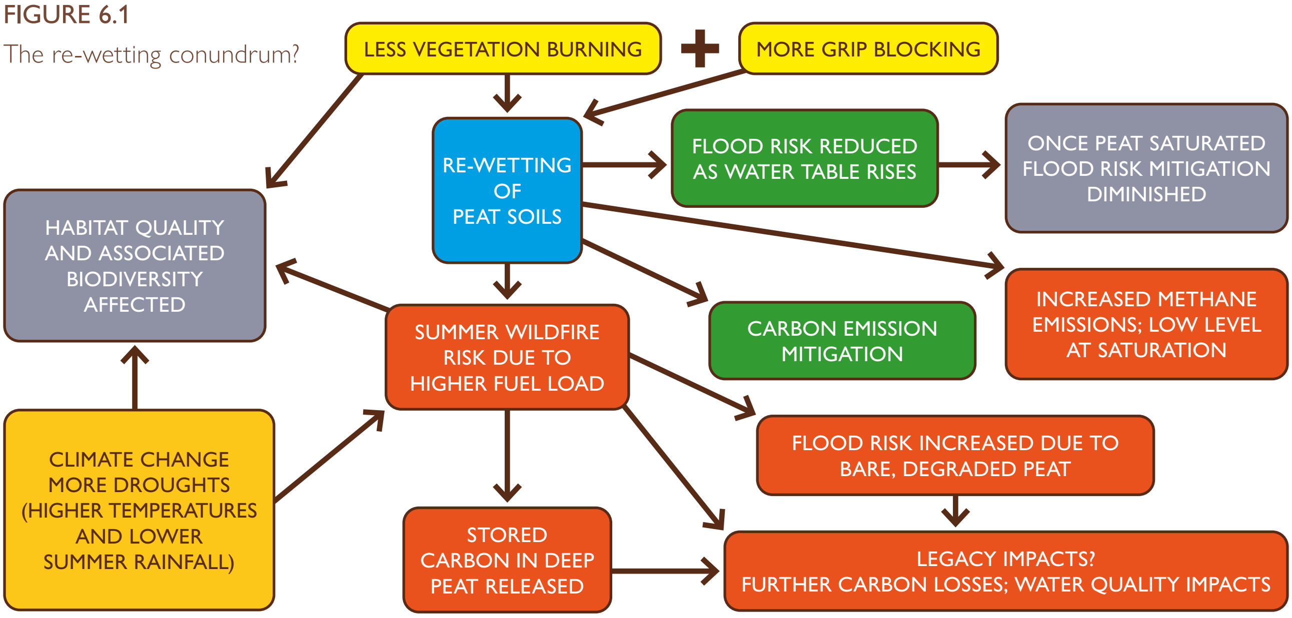
There are increasing public policy attempts to guarantee the delivery of these goods and services (some current and some new) – to make them less by-products and more deliberate outcomes. The most common levers of public policy, finance and regulation, are being used to press changes on both farming and GMM.

The need for the outcomes outlined in the 25YEP is not in dispute. However this audit strongly suggests that increasing public policy leverage may be excessive because:

1. Environmental goods and services enjoyed by the public are being delivered by GMM.
2. Grouse moor managers appear to recognise the contemporary imperative of climate change and have been willing to adjust management to adapt and mitigate – witness the 7,000km of blocked drains on grouse moors in the last 10 years.
3. Grouse moor managers are increasingly aware of the challenges and opportunities that could further enhance sporting moorland's social contribution without losing what is already being delivered – see Case studies on pages 19, 24 and 26.
4. Our understanding of the upland ecosystem is incomplete; we cannot be certain there will be no unintended consequences from forced changes to the current management practices. Re-wetting peatland is a good example of this conundrum (see **FIGURE 6.1**).

FIGURE 6.1

The re-wetting conundrum?



Opposite: Cockshaw Hill in the North York Moors National Park.

Re-wetting (and/or un-restricted predation pressure, reduced grazing, cutting heather, tree planting) delivers a different set of environmental outcomes to GMM – but whether these are better outcomes for society is, as research results emerge, increasingly uncertain.

We argue the co-creation of effective, practical policy is needed to best balance net environmental gain rather than inflexible, seemingly weakly-evidenced, top-down policy pressure[77]. Co-created policy works for all parties; we propose three key factors leading to eight recommendations:

6.1 Key Factor 1: Multi-functional landscapes[78]

This approach advocates that a) every hectare should deliver multiple environmental benefits but b) that increasing the provision of one ecosystem service should not come at the expense of another[79]. This approach needs public policy itself to develop – to move away from protection and prescription to co-created and adaptive approaches to achieving the environmental outcomes desired.

We recommend:

1. **BETTER QUANTIFYING THE ENVIRONMENTAL OFFERING**
   Grouse moor owners/managers should use this audit as a framework for assessing their environmental offering and their readiness to be *"centres of excellence"* in support of the Government's key deliverables as identified in the 25YEP, and recognising that the new Environmental Land Management Scheme (ELMS) rewards environmental goods and services.

2. **MANAGEMENT PLANS**
   Grouse moor managers should prepare management plans that explicitly state their intention to deliver the maximum range of public environmental goods and services compatible with driven red grouse shooting. The plan should identify areas where best practice management should be targeted for a range of goods and services and areas where specific goods and services should be delivered (e.g. driven grouse, wader zones, wildfire protection zones etc). These plans would identify where public policy is not enabling net environmental gain.

3. **IDENTIFICATION OF POLICY TRADE-OFFS**
   Policy and practice trade-offs are necessary to maintain our moorlands in a sustainable and productive state for future generations – no scenario provides a 'win-win'[80]. 'Moorland Groups'[m] (see recommendation 7) should be empowered by Defra or Natural England to identify where public policy could be adjusted so that grouse moor managers can maximise the net environmental benefit. A range of co-creation strategies including: local knowledge – scientific knowledge comparison[81]; Q assessment[82]; and iterative scenario model development[80] – can be used to assess the risks of action, inaction and the results of practitioner monitoring, local knowledge and inter-disciplinary research.

6.2 Key Factor 2: Evidenced landscapes

Undertaking (6.1) effectively depends on knowing what goods and services are being delivered. Yet this audit indicates the weakness of the current knowledge base. Delivery of contemporary demands for environmental goods and services is being based on fragmented, short-term, and variable monitoring approaches. GMM as a land use has been heavily criticised, scrutinised and evidenced, but even knowledge about two high profile issues, wading bird and raptor conservation status, are respectively sparsely evidenced and inconsistently publicly reported. Widespread, consistent, regular, simple recording of the key deliverables from 25YEP would give much greater clarity for all parties and start to fill the evidence gaps. The incorporation and integration of practitioner knowledge with formal research knowledge will improve understanding and outcomes.

We recommend:

4. **PRACTITIONER MONITORING**
   The collection of data on key deliverables by those undertaking GMM should be structured and undertaken as a regular part of GMM using dedicated smartphone-based apps[n]. This would encourage ownership of the deliverables and evidence improvement.

5. **EVIDENCE BASE**
   Natural England should update the review of upland management[83] as a further 10 years of research and evidence is now available. This evidence base should be co-produced using approaches outlined in 6.1.

[m] Moorland Groups are sector-led, regional-scale clusters of moors under GMM, the group structure providing a framework for knowledge exchange and collaboration.
[n] GWCT use the open source Epicollect platform and others are available.

6. INTERDISCIPLINARY RESEARCH
Consensus between policy makers and land managers is required to establish the right interdisciplinary research projects to fill the knowledge gaps highlighted in the challenges and opportunities sections of the audit. There are common themes – lack of long term data and lack of spatial scale and individual site data. Research should focus on enhancing management approaches, such as the formulation of ecologically-driven burning rotations based on individual site management plans (see BOX 4.1.5.5).

6.3 Key Factor 3: Collaborative landscapes

Delivering both the current benefits of GMM (e.g. wading bird refugia which are based on habitat management and predation pressure control) and ensuring enhanced delivery of some of the contemporary demands (e.g. climate change mitigation) will have to be achieved at the landscape scale. In the English uplands, such scales involve multiple owners and communities. Structured and facilitated collaboration has been shown[84] to aid the planning and delivery of a range of environmental goods.

We recommend:

7. COLLABORATIVE INITIATIVES
'Farmer Clusters' already exist in upland areas for flood prevention and 'Moorland Groups' are in the early stages of development in many English upland areas. 'Moorland Groups' represent a means to enable data gathering and conservation action at landscape scales – from 2021, many Scottish Moorland Groups began recording raptor species and abundance. Using approaches such as the Sustainable Upland Partnership, upland clusters that involve farmers, grouse moor managers and local communities could be enabled to prioritise key deliverables, becoming local representatives for initiatives such as Curlew Recovery Partnership.

The aim of such an approach for grouse moor managers would be to better address some of the challenges and opportunities identified in the audit, and the 25YEP ambitions. Such empowerment needs to be built on a shared approach, with facilitated interactions between land managing neighbours and communities as well as between Government and grouse moor managers.

Grouse moor managers should share their knowledge of the local habitat, species, soil, climate, social and economic requirements, and the management skills they have. They should also seek the opportunity to assess new knowledge about management or environmental ambitions and actively assess how to deliver these alongside driven grouse shooting.

8. ADAPTIVE MANAGEMENT
A weak evidence base is a poor basis for prescriptive and newly-regulated management. Instead collaborative groups should be empowered to improve the general knowledge base by undertaking, monitoring and assessing the success of management using adaptive principles. For example, collaborative groups with shared goals could use controlled burning to protect against carbon store losses due to wildfire and collect information about peat condition and biochar accumulation.

Such an approach would be better than simply applying the precautionary principle. The five environmental principles[o] should apply as a group, so the precautionary principle should always be balanced with, for example, the preventative principle (prevent, reduce and mitigate environmental harm). In the case of burning, a comparative risk assessment would determine there may be risks of action (controlled burning continuing) but also risks of inaction (the consequences of ceasing controlled burning). Adaptive management would be a way of reconciling these positions.

Multi-service wildfire training on a Lancashire grouse moor. © The Moorland Association.

o The Environment Act contains five environmental principles, namely: (a) the integration principle; (b) the prevention principle; (c) the precautionary principle; (d) the rectification at source principle; and, (e) the polluter pays principle.

Grouse shooting in August. North York Moors. © The Moorland Association

Conclusions

The future extent and condition of our uplands are dependent on past and present human influence. These landscapes and habitats are not wilderness, rather they are semi-natural, having been subject to centuries of direct and indirect human activity. The human activities that have changed our upland habitats have been driven by economic (industrialisation, food and fibre) and social (disposable income, leisure time, population growth) factors. These, in turn, have been encouraged or held back by public policies such as conservation and access regulation, or subsidy to grow food and timber. It is this complex interaction of direct and indirect factors, private management and public policy that has shaped what our uplands do now and could provide in the future.

RECOGNISING GMM'S MERITS:

GMM has been uniquely scrutinised, hence its delivery of environmental goods and services is relatively well-evidenced (at least compared to suggested alternative land uses). This audit shows GMM delivers numerous environmental goods and services for society, some almost uniquely so, such as conserving large areas of internationally important heather moorland, providing wading bird refugia and protecting peatlands from carbon damaging wildfire. 74% of England's upland SSSI's were designated whilst managed as grouse moors. That so many are now deemed to be in 'unfavourable condition' when they are under the same or better management – i.e. more aligned with approaches that aim for multiple benefits than when designated – is a reflection on the Common Standards Monitoring methodology currently employed.

This audit suggests that some of the human and climate-related changes to peat soils, including the interactions of hundreds of years of pollution, draining, over- and under-grazing, vegetation burning and future 'warming' means they may never achieve full carbon sequestration function. GMM has been responsible for a fraction of this impact but otherwise appears to fulfil the criteria of a sustainable land use, improving the resilience of our existing upland habitats and leaving future uses available.

FOUNDATION, BAGGAGE AND LEGACY OF GMM:

Despite these upsides, there are legacy issues which drive concerns that the pursuit of private interest (shooting grouse) is to the detriment of public interests (carbon storage, raptor conservation). The concerns about some elements of GMM being poorly balanced for net environmental gain are nevertheless often weakly evidenced. Valid concerns, for example around raptor conservation until the most recent years, are still often conflated with animal welfare or rights issues where the banning of shooting is the goal, rather than good environmental, social and economic outcomes for the uplands. The concerns and conflations heighten tensions between owners, lobby groups and the public and influence public policy makers.

The partial evidence for upsides, downsides, challenges and opportunities of GMM is a real risk to the public good, leaving as it does room for doubt to be sown. Better evidence is needed: to protect what is being delivered now; to enable better delivery of future environmental goods and services; and to avoid policy being based on wishful thinking not evidence.

There are valid contemporary demands on GMM in our uplands: the Net Zero Strategy is one; healthy resilient raptor populations another. Some are more contemporary than others – healthy UK raptor populations have been a 'public good' since their legal protection in 1954. The slow pace of research, management and policy successfully integrating particularly the raptor conservation requirement with GMM has polarised views about whether this management approach can show net environmental gain. Evidence gaps are too often filled by sound bites such as *"ban the burn"*, *"millions of traps"* rather than research, constructive dialogue and improvements in policy and practice. Where a 'step-back' has been taken (in books[p] or systematic reviews[q]) it is clear that ending GMM in its current form or grossly suppressing the vast majority of its practices individually is not in the public interest. Even the original contentious issue, raptor conservation, may be solvable if research, management and policy collaborate willingly – witness the recent positive change in the breeding success of hen harriers in England.

Many land management practices have evolved over time in response to public policies which increasingly demand societal outcomes as part of environmental sustainability. GMM should be supported as it seeks to further deliver the multi-functional landscape demanded by current policy (we counted 12 'functions' in Section 2).

ALTERNATIVES TO GMM:

The alternative management approaches discussed above are, compared to GMM, un-evidenced, either in relation to the delivery of the 25YEP ambitions or in comparison to GMM. However GMM can learn from managed wilding: both what environmental outcomes are desirable and how to achieve them, using novel management approaches. But, given the available evidence, a cost-effective environmental gain seems more likely if land is shared with economic and social (shooting) activity than if it is spared simply for conservation. Recognising this in public policy would avoid further moves in constraining GMM activities.

Without grouse moors much will be lost in terms of the economic and social contribution they make to the rural economy[33]. If society wishes to enjoy the same environmental goods and services that grouse moors provide (and which their owners willingly pay for) under an alternative to GMM, then taxpayer or other funding sources will have to be secured.

EVOLVING GMM:

GMM can and does contribute to society's wants and needs, but we see no reason this should not improve. A conscious shift on driven grouse moors towards delivering more goods and services than just shooting is the current trajectory for many game conservationists. A consequence of addressing the relatively few downsides in GMM noted in Section 4 would be fewer controlled burns, more clough woodland and no illegal predator control. These changes may compromise on the ability to frequently shoot the largest grouse bags, but lead to enhanced social benefit from other goods and services.

Like most land uses GMM has its critics. However society would lose proven goods and services if GMM were so constrained it significantly compromised grouse bags (size and frequency) especially as there is little evidence that the alternative land uses would integrate, replace or sustain goods and services at the same level. When justified with evidence, valid criticisms should be addressed by refining and changing management strategies to reflect the demands placed on our moorlands by society's needs and wants.

Grouse moor managers increasingly acknowledge the multi-functionality of the land under their management. It is now critical that other stakeholders recognise the improvements in peatland condition through restoration efforts, the improvement in the Hen Harrier population and other raptors through conservation measures and the positive benefit of trade-offs in management outcomes, so the best of GMM is encouraged and harnessed for public good. The co-creation of a shared approach between land managers, Government, conservation agencies and the public is going to be necessary to deliver the common purpose of environmental, economic and social benefits from our moorlands.

p E.g.: Ian Newton's book 'Uplands and Birds', Collins (2020).
q E.g.: SNH Science Advisory Committee Review 2015, Grouse Moor Management Review 2019, Sefari reviews of grouse moor biodiversity and socio-economics 2018-2020.

Curlew on moorland in Yorkshire. © Coatsey

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The GWCT's role

The Game & Wildlife Conservation Trust, (GWCT) has been researching upland game and wildlife, and the ecology of the uplands since the early 1980s, principally on grouse moors. The GWCT aims for a thriving countryside rich in game and other wildlife that delivers a range of public benefits in a sustainable and sensitive way. In recognising the multi-functional outcomes English grouse moors are under pressure to deliver, we seek not only to show how grouse moor management can contribute positively to the future through underpinning ownership and investment in our sporting moorlands but also to demonstrate that land managers and policy makers need to adapt to the challenges and conflicts that currently act as a constraint. Our emphasis on practical science means that we regularly communicate with land managers and policy makers and are therefore well placed to turn problems into solutions and to advise on good practice.

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