

Sustaining Scotland's Moorland

The role of sporting management
in sustaining our upland ecosystems

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Game & Wildlife
CONSERVATION TRUST
Scotland

Foreword

This is the first time since the seminal 'A Question of Balance' was published, that the Game & Wildlife Conservation Trust has drawn together its views on a number of upland issues, and taken a look forward. 'Sustaining Scotland's Moorland' is a living document which we intend to update regularly as new science informs us and best practice evolves.

In a global context, heather moorland of the sort maintained by grouse shooting is one of the rarest habitat types and enjoys some of the highest conservation designations. Many of these moors were not designated "Sites of Special Scientific Interest" (SSSI's) in spite of being grouse moors, but because they were grouse moors!

We believe they are current and future refuges for wildlife in our country. This is well illustrated when we consider that the critically endangered curlew and lapwing still thrive on grouse moors in Scotland.



There is no question that well conducted management for grouse shooting can be a force for good in the Scottish uplands. Its demise would pose significant challenges for the landscape, biodiversity and many small but locally important rural economies. We recognise, however, that there is always room for improvement. For example, we believe grouse moors may be able to play a greater role in protecting and enhancing peat storage, thus capturing carbon and water. However with the consequently wetter ground it is likely there will be effects on agriculture and nature, so balances will need to be struck.

If we are to find the correct balance for the many issues that face us in managing moorland, we need to develop new processes and reassess long-held beliefs. Some traditional features of grouse moor management are being challenged, which is understandable. We feel that private investors and public policy need evidence from research and demonstration to help guide these developments. Grouse moors should be considered as part of a suite of land uses, such as forestry or livestock farming, in developing a sustainable future for the uplands. Alternative land uses should also be assessed to demonstrate the public benefits they provide and where the trade-offs are in terms of negative impacts.

We look forward to contributing to the ongoing discussion on sustainable moorlands and how grouse moor management can continue to contribute to a productive landscape, which is rich in both game and wildlife.

Andrew Salvesen
Chairman Scotland

Endorsement by Andrew Hopetoun

Chairman of the Scottish Moorland Group, a part of Scottish Land & Estates

The Scottish Moorland Group warmly welcomes the "Sustaining Scotland's Moorland" project by the Game and Wildlife Conservation Trust (GWCT).

Those who look after Scotland's moorlands want to be guided by the best available science, so much of which GWCT is in a position to provide given its deep knowledge acquired over many years and its credentials as an impartial scientific organisation. Our members want to find the best way forward on many moorland management issues so we welcome the approach of the project and the challenges it sets out, not just for the grouse management sector but also for Government, agencies and NGOs.



The project is an important reference library of facts and research about moorland management in Scotland, and through that it tackles many of the misconceptions publicised by commentators who do not have the GWCT's detailed knowledge. People from all backgrounds have passionate views about moorlands and that throws up a particular set of challenges for managers, to balance very wide ranging requirements. There needs to be greater understanding of the natural limitations of moorlands and the trade-offs between those different requirements. GWCT sets these out with great clarity.

This project comes at a very good time, following the Review of Sustainable Moorland Management by the Scientific Advisory Committee of Scottish Natural Heritage and the "Moorland Management Guidance" initiative being set up by Scotland's Moorland Forum. It will help the moorland management sector to be fully involved in that process and will develop along with it. It is also highly relevant to Wildlife Estates Scotland, the sector's own certification initiative, set up to help development of best practice; most of the estates accredited to date have some moorland sporting enterprise and many more grouse moors are actively working towards accreditation.

The Game and Wildlife Conservation Trust has not pulled its punches in identifying areas which need to be addressed and the Scottish Moorland Group is already working on these with moorland owners and managers. Communication with policy makers and the public is being improved through regional groups and the Gift of Grouse initiative and we work with other stakeholders on the Moorland Forum and elsewhere to develop guidelines, training and governance. There is much still to do and collaboration is the way ahead; this project from the GWCT sets out a clear framework as to how it can be achieved.

Moorlands of Scotland

Moorland is one of the UK's most distinctive landscapes and Britain and Ireland have been called "the world's greatest moorland countries"¹. A globally rare suite of habitats, moors support specialist and rare flora and fauna, which deliver a range of other public goods and services such as drinking water, carbon storage and recreation². Though they may feel wild compared to the lowlands, they are not "wilderness", having been subject to thousands of years of human influence. Deforestation by burning probably began as early as the Mesolithic period (9,000 to 4,500 years BC) and then may have included natural fires as well as those set by man. Moorland is a "cultural landscape" emphasizing the role of man in its creation and maintenance³.

Habitat

Upland habitats form a large and variable mosaic, including montane upland vegetation types such as heather moorlands, mires, blanket bog, and poor quality grasslands⁷. The managed moors of Scotland are a range of semi-natural priority habitats; the heaths and blanket bogs. Heather (*Calluna*), heaths (*Ericas*) and berries are characteristic of the dwarf-shrub upland heathlands, contributing to the iconic blaze of purple colour in the hills from July to September. The blanket bogs are also variable but typically less heather-dominated, with more abundant sphagnum mosses and sedges such as cotton grass on wetter, deeper peat soils⁴.

Extent

Moorland habitats represent around 50% of Scotland⁵ with upland heath covering approximately 778,000 ha⁶. The extent, composition and quality of these habitats are influenced by climatic conditions, historically subsidised drainage, industrial pollution, overgrazing by sheep and deer, burning, forestry and increased recreation activity⁷. There were no significant changes in the area of these habitats between 1990 and 2007, however, it is notable that species richness is in decline⁸. In 2014 the proportion of Sites of Special Scientific Interest in favourable or unfavourable recovering status in Scotland was 72% for upland designations⁹.

Land uses

Scottish moorlands are used for a variety of land uses such as sheep farming, forestry, renewable energy, sporting enterprises and recreation. They deliver a range of ecosystem services, including water, electricity and carbon storage. The uplands are an iconic landscape of high aesthetic value, and as a result are often closely associated with National Parks and Nature Reserve designation⁷.

Plantation forestry, supported by Government subsidy, saw a notable increase in area from the 1940s to the late 1980s in the Scottish uplands resulting in significant losses of moorland, heath and mountain habitat². More recently onshore wind farms have impacted on the landscape aesthetics and biodiversity of upland areas with an estimated 30% of installed wind farms sited in core moorland, mountain and heath habitat².

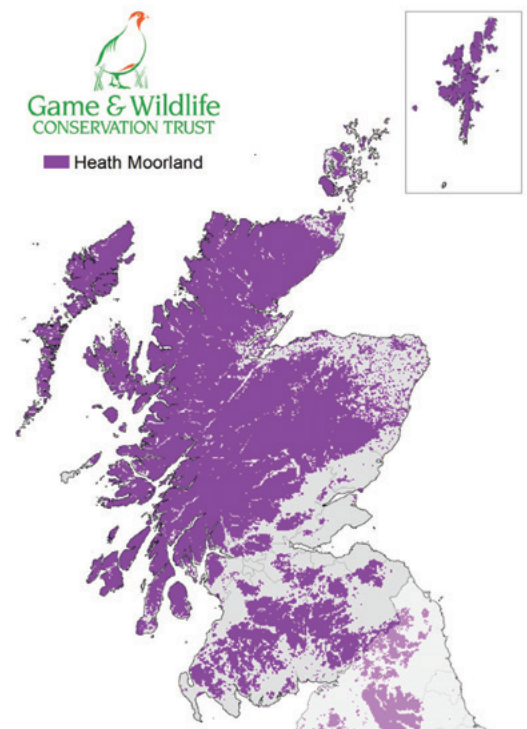
Livestock farming is commonplace in Scotland with 55% of agriculture dedicated to sheep and cattle farming in the uplands¹⁰, bringing the associated benefits of socio-economic activity and maintaining a habitat mosaic. However, there are challenges with overgrazing, particularly in winter, that reduces heather cover and damages bog vegetation¹¹.

In 2009 it was estimated that there are 304 grouse moors in Scotland covering over 1 million hectares¹². Heather burning and sheep grazing are used to produce a pattern of older, denser and taller habitats mixed in with younger, shorter and more nutritious vegetation that are both utilised by red grouse. This management focus tends to protect heather habitats and associated public goods and services, but in certain circumstances it has been shown to contribute to a change in the nature of some moors from bogs into drier heaths¹³.

The principal motivating factor for managing a moor to produce a surplus of grouse for driven shooting, as opposed to walked up shooting, is the greater consistency of opportunity to shoot. In turn the income that can be generated from letting driven days is markedly higher than for walked up days, thereby producing some return on the financial investment expended on the management¹⁴.

Sustainable sporting moorlands

The suite of predator control, disease control and habitat management used to encourage grouse productivity brings many collateral benefits, for example the conservation of increasingly rare species such as curlew, together with challenges, such as the need to secure the conservation status of birds of prey³. The key to safeguarding the future of sporting moorland is to ensure that they are managed 'sustainably': in such a way as to meet a full range of demands without the ecosystem becoming permanently depleted or damaged. We believe that there is evidence that the trade-offs necessary for best practice grouse moor management still leave Scotland's moorland with a net gain, and that driven grouse moors have an important role to play in the future of the uplands.



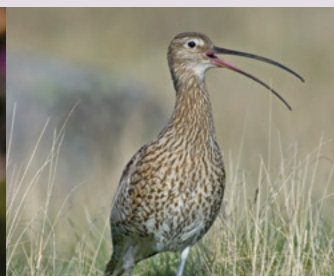
Predominant areas containing heath moorland in Scotland Data from Land Cover Map.

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Some flora and fauna that are part of the moorland community:

- Snipe
- Dunlin
- Ring ouzel
- Black grouse
- Red grouse
- Lapwing
- Golden plover
- Curlew
- Mountain hare
- Meadow pipit
- Hen harrier
- Short-eared owl
- Peregrine falcon
- Kestrel
- Merlin
- Heather
- Mosses
- Bilberry
- Cowberry
- Lichens
- Spiders
- Moths
- Butterflies
- Bees



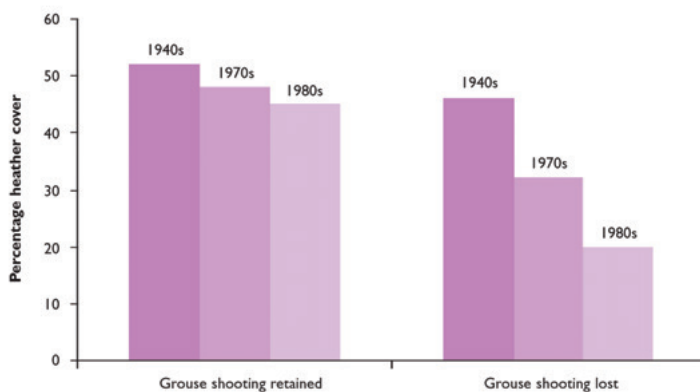
Benefits of grouse moor management

Our moorlands are home to specialist flora and fauna and deliver a range of other public goods and services such as drinking water, carbon storage and recreation. They are no longer "wilderness", having been subject to centuries of human influence either direct or indirect¹. The key to their future is to ensure that they are managed 'sustainably', in such a way as to meet a full range of demands, without the ecosystem becoming permanently depleted or damaged. The GWCT believes that producing enough grouse for driven shooting is one of the best ways to ensure that people live and work on moorlands, encouraging and protecting wildlife, habitat and healthy peatlands.

Scottish sporting moorlands currently deliver many public goods, both in the immediate vicinity and further afield. Given the competing demands placed on our moorlands by overlapping policy objectives and land uses, increasing awareness of the range of public goods delivered by grouse moor management is necessary in order to protect its future. Those public benefits currently provided include:

1. Retention and restoration of heather habitat

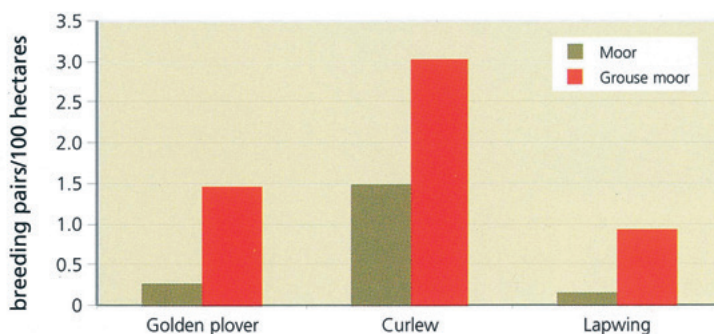
Heather is a globally important habitat - 75% of the world's heather habitat is found in Britain² - which is utilised by red grouse and other species. Heather moorland is of cultural and aesthetic value to local communities³ and the thousands of tourists who visit our iconic purple clad hills every year, whilst being an internationally important resource that is of high conservation priority⁴. Grouse moor management promotes the retention and restoration of heather habitat through sensitive grazing by sheep and rotational patchwork burning (muirburn). Red grouse shooting has been a disincentive to overgrazing and the planting of conifer forests on these protected habitats. In Scotland grouse shooting interests are widely accepted as having protected 953km² of Scottish heather moorland from conversion into grassland and forestry in the last 50 years⁵.



An analysis of aerial photographs from the National Countryside Monitoring Scheme in Scotland. A random sample of sites photographed in 1940 showed that 49% were being managed as grouse moors. Of these, 57 sites remained as active grouse moors and 46 had given up grouse management by the 1980s. Over this 40-year period the grouse moors lost 24% of their heather cover; whereas where the grouse shooting was lost, the heather cover had been reduced by 41%. From a study by Robertson & Barton⁶.

2. Support for our declining wader populations and other ground-dwelling species

Many of our most iconic, and yet threatened, upland species such as curlew, lapwing, golden plover, black grouse and hen harrier nest on the ground and are therefore susceptible to predation. GWCT research has shown that reducing predation by legally controllable common predators, as undertaken on driven grouse moors, can protect ground-nesting species by improving their chances of fledging young^{7,8}. In addition, the presence of mountain hares is strongly associated with grouse moor management, with 80% of mountain hares found on moors managed for grouse⁹.



Numbers of breeding waders found on grouse moors compared with moorland not managed for grouse. Golden plovers and lapwings were over five times as common on grouse moors compared with other moorland, and curlews twice as common. RSPB and GWCT joint-authored research¹⁰.

3. Cost-effective statutory conservation

Consequent to points (1) and (2) above, grouse moor management provides a framework for the conservation of habitats and wildlife, supporting the statutory targets for habitats and species such as blanket bog, dry heaths and black grouse^{11,12}. Without this private investment in our uplands we believe that there would be greater financial pressures on Government bodies and charities to maintain habitats and to deliver population recovery of our wildlife at a landscape scale.

4. Delivery of clean water and carbon storage policy objectives

Moorland is a key component in the delivery of drinking water and downstream flood protection. It can support our ability to meet climate change targets through carbon capture¹³. Best practice grouse moor management contributes to these aims by maintaining heather and peat cover; reducing the risk of wildfires through sensitive burning regimes¹⁴ and filling in historically subsidised drainage ditches (grip blocking)¹⁵. Further research is needed on improving carbon lock-up in peat, understanding both the carbon cycles on managed moorland and the restoration of *Sphagnum* mosses, and refining burning practices to maximise carbon storage.

5. The provision of jobs in economically vulnerable areas

The uplands are an economically vulnerable area, with limited opportunities for local communities to develop sustainable and year round income. It has been estimated that shooting contributes £200 million per year (GVA) to Scotland's economy¹⁶ both directly and indirectly through local services such as hotels and garages. In 2011/12 it was estimated that grouse shooting accounted for 2640 FTE (full time equivalent) jobs and £30m of wages per annum¹⁷. There are also benefits to integrated and extensive hill farming, which is increasingly under pressure, through improved habitat management and payment for treating sheep to control ticks. This income is important in ensuring the sustainability of remote rural communities and their supporting education, health and other services^{18,19}.

Large reductions in grouse densities (either through naturally occurring pressures such as disease or Government-led policy objectives) could stifle investment in upland management and subsequently have a negative impact on local communities²⁰.

6. Contributions to our cultural heritage

Grouse moor management contributes to the conservation of moorland flagship species and habitats. These are part of our cultural heritage and underpin aspects of Scottish tourism. Wildlife tourism contributes £138 million to the Scottish economy, with 'landscape and scenery' being one of the most important attractions to tourists²¹.

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Grouse moor management – what are the alternatives?

There is room for different forms of management to coexist within the upland landscape, but each will have its own effect on wildlife. The evidence suggests that grouse moorland is one of the most positive and economically viable land uses. Game management is a significant motivation for private investment, often at uneconomic levels, in habitat and species management on moorlands. Reducing the leverage of that motivation, or promoting other economic land uses, could lead to woodland expansion, intensive sheep farming and further wind farm expansion, all of which have been supported by publicly funded policy incentives. Historical data indicates this would reduce and fragment the area of heather moorland¹ with consequent impacts on associated flora, fauna and visitor experience. Given that heather moorland in Britain is considered to be internationally important and its retention is a high conservation priority, the loss of heather to alternative land uses could contravene our EU obligations². Grouse shooting interests are likely to have protected 953km² of Scottish heather moorland from conversion into grassland and forestry in the last 50 years³.

In recent years government policy⁴ has been, in part, to provide alternatives to the traditional sporting land use which has dominated much of the Scottish uplands⁵. Policies and support mechanisms offer both destocking and restocking initiatives for sheep and cattle, and increased woodland planting. Renewable energy in the shape of windfarms has extended its coverage in the uplands. Some areas are seeing a reduction in management, or extensification, of inputs and drivers. This management is commonly called 're-wilding', and is often visually characterised by increased woodland regeneration. Managing the reversal of government-subsidised moorland drainage and forestry planting in the 1960s and 70s to theoretically enhance carbon capture and modify water flow is also a new upland activity. Change may come about indirectly; certain aspects of land reform, such as the re-introduction of sporting rates, could reduce investment in traditional sporting management that support moorland habitats.

Sporting is not written out of these alternative land uses. Many of these practices would be consistent with the continued practice of walked-up shooting as an alternative to driven. However, with fees per brace for walked-up grouse being significantly lower than for driven shooting, few estates would be able to generate enough income to support the moorland management required. This in turn could result in moor owners reducing their commitment to moorland, with the loss of both full-time (gamekeepers) and casual (shoot day) employment. Furthermore, as estates spend 93.8% of their wage and supplier spending in Scotland, any decreased activity would inevitably mean reduced benefits to the surrounding local economies⁶.

The challenge to alternative upland land uses remains that the current sporting management offers a great deal to Scotland in terms of known public service. The UK National Ecosystem Assessment noted that extensification of management may reduce the capacity of mountains, moorlands and heaths to sustain public goods (such as food provision), and also change biodiversity and the landscape⁷. In the table overleaf we suggest how some of the alternative management models discussed above could change a range of public goods and services currently delivered by grouse moor management.

The negative impacts, on some aspects of biodiversity, of current moorland management have been one of the primary reasons for calls to produce alternatives, to 're-wild' and 'de-intensify' management. These impacts must be addressed, or the benefits of best practice sustainable grouse moor management will be overlooked. The grouse sector needs to emphasise the multi-functional use of the land (not just its sporting value) and to refine existing management practices to ensure sustainable moorland environment. Government and conservation agencies need to acknowledge the interdependence of the management tools employed so that any policy changes reflect a thorough understanding of the trade-offs between the perceived negatives, the benefits identified, and the effects of competing land uses.

We believe alternative land uses should be challenged to produce evidence of the net gain they will bring to society over current land use, if this is to be disincentivised. This is because alternative land use models, which might address the concerns about grouse moor management practices, may compromise the ability of moorlands to exist and deliver a wide range of provisioning, regulating and cultural services. Commercial forestry for example, as noted by the SNH-commissioned moorland review⁸, not only fragments heather habitat but can also impede the hydrological function of nearby blanket bog; support an increased number of predators, which can impact ground-nesting birds; and escalate tick densities.

Unmanaged heather increases the risk of wildfire⁹, and changes in the sward composition, such as bracken encroachment, will impact on important upland ground-nesting species, affect its grazing value, and change a culturally valued landscape. Cessation of grazing, burning and predator management will affect the breeding success of vulnerable ground-nesting species⁹ including hen harrier, as seen at Langholm Moor in southwest Scotland¹⁰ and in the Berwyn SPA in Wales¹². The economic output from moorland areas (hill farming and sporting) could also be significantly reduced. If conservation management were to replace grouse moor management then this would need public funding and may have negative socio-economic consequences for upland communities, if widely replicated.



Table 1

Key public goods* provided by Sporting moorlands under current management	Alternative management models and hypothesised impacts		
	Less intensive/ Extensification	Extensification/Re-wilding	Best practice
Provisioning/primary production			
Livestock (sheep, cattle)			
Game (grouse, deer)			
Traditional lifestyle products (heather, honey etc)			
Regulating			
Climate regulation (C storage/sequestration)			
Water quality			
Flood regulation			
Wildfire risk mitigation			
Soil erosion/peatland degradation			
Disease regulation (tick borne diseases)			
Cultural			
Landscapes			
Tourism and recreation			
Field sports			
Moorland habitats and species			

Key: Impact of change in management from status quo (and corresponding value): Positive = dark green (+10); Partially positive = light green (+5); Neutral = yellow (0); Partially negative = orange (-5); Negative = red (-10) * adapted from UK NEA Technical Assessment

In the first two scenarios where management input is reduced or removed, we need to test our belief that fundamental changes to current practices would affect the ability of our moorlands to deliver multiple public goods. The third column (best practice) is based on the belief that sporting and public interest objectives can be achieved on the same moor in a sustainable way. In order to achieve this 'sustainable' approach, refinements to existing practices, such as muirburn, may be needed.

The future

Alternative land uses have a role in adding resilience by diversification to rural communities. But many alternatives could reduce current and potential future benefits without clearly offering greater net rewards. The role of best practice grouse moor management in safeguarding dwarf shrub heath from conversion to other land uses needs to be acknowledged by government, conservation agencies and the public. However, wider acceptance of the sustainability of grouse moor management is only likely to be achievable if refinements and enhancements are made to the current management practices that attract the greatest criticisms and present significant trade-offs in outputs such as carbon storage. In addition, the delivery of public goods comes at a perceived cost, with the lack of a market value giving land managers little incentive to manage for carbon sequestration or improved water quality.

Given the complexity of moorland ecosystems and the interaction between different land uses, more research is required to analyse changes at local and landscape scales before decisions are made that impact on the viability and sustainability of grouse moors alone.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none"> Promote the multi-functional use of the land, not just its sporting value. Work with government to develop new markets to value the provision of public goods and services. Increase awareness of the many public goods provided by grouse moors at little or no cost to the taxpayer. Continue to develop best practice and work to ensure its adoption. 	<ul style="list-style-type: none"> Challenge the ability of other management models to deliver a range of public goods including conserving key upland flora and fauna. Embrace best practice grouse moor management as a sustainable, multi-functional and cost-effective model for the attainment of biodiversity and other policy targets. Accept the right of ownership and ability to make investment decisions are fundamental to the delivery of public goods and services.

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Challenges facing grouse moor management

The Game & Wildlife Conservation Trust believes sustainable grouse moor management should play a role in the delivery of carbon, water, socio-economic and biodiversity policy objectives in the Scottish uplands. However, there are regular public challenges which contend that the pursuit of private interests (shooting grouse) is detrimental to matters of public interest (such as biodiversity). This is resulting in tensions between moor owners, policy makers, certain conservation bodies and the general public. Finding well informed answers and balanced management solutions to these issues would allow these parties to work together to support our moorlands.

The challenges faced by the grouse moor community are summarised below with some discussed in more detail in accompanying position statements.

1. Low biodiversity: There are concerns that a perceived increasing "intensity of management" on grouse moors is maintaining, and driving ever lower, biodiversity in these habitats. Our moorlands are naturally low in overall biodiversity, even though a quarter of the 81 upland plant communities are globally rare or well represented, and moorland bird assemblages contain many which are rare or internationally uncommon. Though only a few moors manage for this rare biodiversity 'by design', it is a common outcome of best practice grouse and grazing management on moorland. Moorland managers could address the perception of 'damaging biodiversity' by establishing management plans, and incorporating all their economic and environmental objectives such as sheep farming, forestry, tourism and sporting, and grouse shooting. Evidence for declining diversity appears limited to a few species groups, at variable scales. So these plans should also include monitoring of biodiversity and its response to management. Such data will help the sector emphasise its ability to meet sustainable management objectives, including the integration of wildlife resources, with wider land and water management objectives, as set out by Scottish Government and SNH.
2. Sustainability: Grouse moor management is often challenged that it is not sustainable. Grouse moor managers need to deliver sustainability at two levels. First, the sustainability of the grouse shooting itself: harvesting and management must not damage the future prospects of the harvested grouse population, while providing sufficiently large and consistent numbers of grouse to deliver an adequate return, and appeal to those who are willing to pay for shooting. Secondly, sustaining private investment in the wide range of ecosystem services which upland areas can and do deliver. These include maintaining both culturally and economically important heather-dominated habitats; storing water and carbon; and supporting rare, threatened and designated species such as wading birds and some raptors (see *Benefits of grouse moor management*). In addition, grouse moors provide jobs in economically vulnerable areas, ensuring the sustainability of remote rural communities. Delivering these desirable outcomes requires grouse moor managers to carefully balance a number of important trade-offs.
3. Predator management: Predator management remains, for some, a contentious issue due to historic perceptions of inhumane techniques and widespread removal of predators. Whilst some critics remain concerned about man interfering in the predator:prey relationship, research has demonstrated that the legal control of common predators is an effective conservation tool when combined with good habitat management (see *Predation control*). Predator control techniques are now well regulated and have become more target specific, effective and humane. Increased support by Government of the role that predator control can play in conservation is needed. The GWCT believes that predator control should be integrated into new agri-environment schemes, and, in cases of proven damage by predators whose conservation status is favourable, moor owners should be able to have recourse to the existing licence system. The GWCT will continue to research and refine techniques used to control predators, ensuring that they are effective and deliver a high standard of animal welfare.
4. Illegal killing of birds of prey: The illegal killing of protected birds of prey, including those which have attained favourable conservation status, sits alongside the evidence that in some circumstances raptor predation has been shown to prevent the economic sustainability of a grouse moor, and consequently the conservation of endangered upland waders. The GWCT condemns illegal crimes against wildlife and is committed to finding an effective and practical resolution to the conflict between red grouse and raptors. Our involvement in the Langholm Moor Demonstration Project is testament to this intent. We believe the best of traditional moorland management can and should be married to new approaches and techniques in order to support more birds of prey, leading to a more sustainable distribution across suitable moorland habitat (see *Raptors and grouse moor management*).



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5. Heather burning, carbon storage and water quality: Moorland vegetation is managed by a balanced interaction between rotational muirburn and grazing. Some research has indicated negative impacts of burning on deep peat habitats, though few of these studies have looked at the characteristics of the burn. Burning for grouse, as the Muirburn Code states, produces quick, cool burns that remove the canopy but leave stick and do not damage the moss or litter layer or expose bare soil. Moorland managers should strive to produce such fires, and to limit prescribed burning, as far as does not reduce grouse productivity, on the area burnt. We believe that a no-burn policy, largely based on fears for peatlands, could impact on other public goods such as above-ground biodiversity, including the risk of damaging wildfires and loss of heather habitat. We would like to identify how best to manage heather cover and enhance current patchwork burning practices to minimise any short-term and long-term impacts on water quality or carbon storage (see *Burning on grouse moors*).
 6. Rewetting on peatlands: Many moors managed for grouse are undertaking important steps to raise the water table on degraded bog habitats, such as blocking up grips which drain the moor. The GWCT believes that the potential trade-offs from re-wetting deep peat with modified vegetation have not been adequately quantified and there is a need for continued research and monitoring to identify the impact of re-wetting policies on methane production, nationally declining waders, existing land uses such as extensive sheep farming, and wider biodiversity. Supported by research and demonstration, the grouse sector may be able to aid restoration of the 80% of peatlands in Scotland which are not protected.
 7. Disease management: The successful management of diseases in grouse has resulted in a more stable economic model for grouse shooting, underpinning investment by moor owners and supporting rural employment. However, there are concerns expressed over interference with wild animal populations, environmental contamination, the emergence of 'new' diseases and the risk of drug resistance. Therefore the grouse sector needs to ensure compliance with existing guidance that encourages best practice disease control in conjunction with the sustainable management of grouse populations. The success of disease management should give the grouse sector the confidence to work actively towards increasing raptor numbers by using adaptive management techniques such as diversionary feeding and brood management schemes (see *Disease management in red grouse*).
 8. Embracing change - the need for a shared vision: Much public and policy attention has been directed at the perceived negative impacts of 'intensive' moorland management, although these criticisms have been on individual aspects rather than 'global' effects. Solutions to many of the challenges identified already exist in terms of codes of practice and sector-led best practice derived from scientific research. The regular collation and synthesis of practical experience is essential in understanding where future management changes can happen sustainably. Sector-led initiatives such as Wildlife Estates Scotland and the Golden Plover Award are useful tools in identifying change in practice and attitudes. Their findings need to be compiled and advice and demonstrations made available. There needs to be a coordinated and focused approach by land managers, government and conservation agencies to develop a coherent and comprehensive framework for the sustainable management of Scottish moorlands. This, in our view, should encompass all land uses, not just sporting. Failure to do this may result in greater levels of well meant but possibly damaging regulation to protect the public interest.

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Raptors and grouse moor management

The Trust condemns crimes against wildlife and we are committed to finding an effective and practical resolution to the conflict between red grouse and raptors. Our work with the Langholm Moor Demonstration Project and Scotland's Moorland Forum's Understanding Predation project are testament to this intent. We believe that traditional moorland management can and should be married to new approaches and techniques such as diversionary feeding and brood management to support more birds of prey, leading to a more even distribution across suitable moorland habitat.

Most birds of prey have expanded in range and number over the last 30 years^{1,2}, following legal protection in 1954. The buzzard has spread back to all counties, the peregrine falcon and sparrowhawk are close to their historical peak abundances, and merlin are commonly found on kept moorland³. This is a welcome change from the 19th century when the drive to increase game abundance led to intense predator control that was responsible for the disappearance of many raptors from large parts of Britain, and the 20th century when pesticides maintained and enhanced this suppression⁴.

This is not the case for all raptors in all areas; for example hen harriers are still recovering across their former range in Scotland (although globally they are not threatened¹¹). Grouse moors are criticised because there is evidence that some managers illegally kill hen harriers and other species to reduce their impact on red grouse⁵. A real conflict has developed because there is evidence that raptor predation can suppress red grouse recovery from low densities, threatening wider moorland investment and conservation, as proven by a joint research project carried out mainly on Langholm Moor in the early 1990s.

Raptor conflict research

Langholm Moor was the principal site where this research was undertaken by the Joint Raptor Study, which ran from 1992 to 1997⁶, studying the impact of hen harriers and other raptors on red grouse. During that project, hen harrier numbers increased, peaking at 20 breeding females in 1997. Because of predation by hen harriers, red grouse autumn densities declined by 50% and, as a consequence, the estate laid off its gamekeepers. Management of the moor then largely stopped, leading to significant loss of biodiversity and socio-economic activity⁶. Widespread concerns were expressed because extensive surveys confirmed that Langholm Moor had similar characteristics to many other moors, half of which might expect to suffer the same demise if harrier numbers built up in the same way⁷.

Subsequently, the Langholm Moor Demonstration Project (LMDP) was launched in September 2007. It aims to re-establish Langholm Moor as a viable driven grouse moor in co-existence with hen harriers and to meet SSSI and SPA conservation targets. Despite impressive achievements, the project has illustrated the challenges facing many grouse moors, particularly those trying to recover from low grouse densities.

The LMDP staff, including the team of keepers, has met the project's target of expanding the area of heather and improving heather condition and exceeded the target for the number of raptors on the moor. Diversionary feeding can now be recommended as a technique to reduce impacts when harriers are few and nest close to access points and there are relatively few grouse. But the project has not yet achieved the desired co-existence of red grouse and raptors. The quality of keeping is good, but grouse mortality all year round is high and, in recent years, 78% of adult grouse found dead were killed by raptors. Despite seven years of keeping, grouse numbers have not recovered sufficiently to allow driven shooting (the target is 1,000 brace, or 2,000 grouse, shot in one year). It has not yet proved possible to restore Langholm to a productive grouse moor with the available policy and management tools⁸. The project ends in 2018.

Going forward

We argue that conservation thinking needs to widen from a single focus issue/species to take a more holistic approach to species management and establish how best to deliver multiple conservation benefits through existing land uses.

We emphatically do not advocate a return to the levels of raptor removal that were prevalent around the turn of the 19th century. Our collective objective should be to reduce the predation pressure of raptors on wildlife using the most satisfactorily humane methods available, while at the same time maintaining or indeed enhancing the community of raptors in the country as a whole. We need an adaptive approach whereby agreements are reached between landowners and government, allowing sustainable numbers of both raptors and prey to be achieved. Grants, intra-guild effects, limited culls, target predator densities and other mechanisms should be used to serve the long-term interest of raptors as well as game species and other wildlife⁹.



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The raptor/red grouse conflict is also a conflict between parties with differing land use and conservation objectives. A simple protectionist approach to the conflict is unhelpful as it fails to recognise the role that grouse moors could play in the conservation of raptors in Scotland - assuming appropriate mitigation measures to protect their socio-economic viability are in place¹⁰.

We view the low densities of certain raptor species on some moorland areas as the single biggest hurdle that must be overcome as regards the acceptance of grouse moor management as a legitimate conservation tool and deliverer of public goods. The grouse moor community needs to accept that the public's preference is for management options which result in sustainable numbers of raptors and they will need to be accommodated, especially as grouse densities can be supported at driven shooting densities by disease management.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none">• Eliminate illegal persecution.• Develop codes of practice and training.• Adopt novel non-lethal management techniques such as diversionary feeding.• Engage in research into and demonstration of acceptable mitigation measures for birds of prey.	<ul style="list-style-type: none">• Balance interests through the appropriate use of the licensing system.• Consider a flexible regional system of control.• Endorse grouse sector-led codes of practice and training.• Take forward lessons from Langholm II and use them to guide species conservation and conflict resolution.

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Burning on grouse moors: carbon, water and biodiversity policy objectives

The GWCT supports the practice of delivering 'cool' burns, as they maintain habitat quality whilst protecting the storage of carbon. We further support practitioners matching the frequency of burning to heather growth rates in order to preserve the maximum possible ecosystem services from these areas.

GWCT wants to see more evidence quantifying the benefits of re-wetting carbon rich soils for carbon capture and flood risk alleviation and to understand the impact and potential trade-offs that may occur on grazing quality and habitat suitable for ground nesting birds. We believe that policy makers should not ignore the benefits of best practice muirburn in preserving heather moorland. The grouse moor community must accept carbon and water issues as management objectives and modify current management activity to mitigate or reduce the perceived negative effects. Adoption of strategic burning plans, investment in manpower and equipment and adherence to the reviewed Muirburn Code would be a relatively straightforward way of ensuring the continuation of muirburn as a management tool, whilst addressing the concerns of policy makers and the general public.

Rotational burning of moorland, or muirburn as it is commonly referred to in Scotland, is a traditional tool for upland farmers (who burn to improve grazing quality) and sporting managers. Different ages of heather support different stages of the life cycle of red grouse and other ground nesting birds, providing food, nesting cover; protection from predators and territorial structure.

This is achieved by burning, or sometimes cutting, strips or patches of heather in rotation so that a small proportion of the overall area is burnt annually, thereby creating a patchwork of heather at different stages of growth¹. Burning is a skilled operation requiring training and an experienced assessment of how wind speed, age of heather, slope angle and fuel moisture will affect the safety and quality of the burn. The aim is to achieve low intensity, quick 'cool burns' in small patches that remove the canopy but do not affect the underlying litter or moss layer².

Blanket bog and deep peat

Calls for a reduction in, or banning of, burning on moorland are often driven by concerns about the potential negative impacts of this practice on the functional integrity of blanket bog and, subsequently, water quality³. We have concerns over calls for a ban on burning as a means to aid peatland restoration, as there remains much contradictory evidence about the actual positive or negative impact of burning when longer time-scales are taken into account⁴. Research shows that heather cover on peat soils, as typically maintained by muirburn, is more favourable for carbon storage than grass cover⁵. Furthermore, the management of fuel load through rotational burning, particularly on upland heath dominated peat, is vitally important in the prevention of wildfires through the creation of fire breaks, when carried out in accordance with the muirburn code².

Bog restoration is being undertaken in the uplands to retain and enhance peat depth and maximise soil water retention, storing carbon, reducing flooding risk and protecting water quality. While there are challenges with greenhouse-gas emissions, such as methane gas production in re-wetted areas⁶, in the short term, GWCT recognises the potential long-term environmental value of re-wetting areas of deep peat (peat depth greater than 40 cm) and restoring degraded bog habitat in pursuit of these aims. In our view, it is important that a variety of approaches to re-wetting are promoted to ensure they can be integrated with ongoing land use such as farming and sporting.

There are four main actions currently being promoted to enhance *Sphagnum* moss growth and thus restore areas of deep peat⁷.

1. Blocking ditches and gulleys to raise the water table.
2. Re-seeding bare soils and exposed surfaces with moorland plants including *Sphagnum* mosses.
3. Adjusting burning regimes.
4. Adjusting grazing regimes.



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A number of moors managed for red grouse in Scotland are undertaking many of the measures above. There should be a comprehensive resource summarising the extent of this activity, its success and ease of integration with the existing land use so that others can learn from this experience.

Biodiversity and Conservation

We believe that burning remains a valuable management tool, as identified by the SNH review of Sustainable Moorland Management, which identified muirburn as 'creating and maintaining high conservation value in plant, invertebrate and bird communities'⁸.

Reducing heather dominance, which is maintained by burning and grazing, is increasingly being recognised as aiding *Sphagnum* recovery and peatland restoration⁹. But land managers and some NGOs remain concerned that simply restricting burning will not result in the recovery that is being sought. They also express concern for the other benefits derived from burning, notably browse quality and nesting cover¹⁰, which support conservation and food production in remote rural areas. In addition to trade-offs with carbon, muirburn can also prevent the reformation of native scrub such as juniper. We believe that this needs to be addressed at a landscape scale in some areas of Scotland.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none">• Compliance with the reviewed Muirburn Code.• Research and adoption of fire danger rating systems.• Establishment of estate muirburn and grazing plans as required by WES or SRDP.• Investment in training, equipment and personnel.• Increased understanding of carbon and water issues and the need to manage for these.• Support research into enhancing burning practices to maximise ecosystem service provision.	<ul style="list-style-type: none">• SRDP funding of moorland grazing plans.• Utilise the extensive muirburn knowledge existing within the grouse moor sector.• Grant out of season muirburn licences to adapt to conservation demands and changing climatic conditions.• Ensure trade-offs between land uses are fully understood and valued.• Provide a central resource for advice on restoration, grant sources and application procedures.

GWCT studies

The GWCT's position has been informed by its support of the following studies, two of which have been published, while others are being prepared for publication.

Does prescribed burning on peat soils influence Dissolved Organic Carbon (DOC) concentrations in soil and runoff waters?

Results from a 10-year chronosequence¹¹.

- The study showed that prescribed burning by gamekeepers had no significant effect on DOC concentrations in soil water or surface runoff water in the years following burning. In other words, burning did not greatly intensify the "colour".

Carbon stocks and carbon fluxes from a 10-year prescribed burning chronosequence on a UK blanket peat³.

- This study showed that burning was only one of a number of factors in determining measured CO₂ readings.
- Burn years 1 and 3 were net sinks of gaseous CO₂.

Can prescribed burns contribute to carbon storage in peat soils?

- Sites such as traditional grouse moors where burning has been practised continuously for over 75 years represent greater average annual sinks of carbon than unburnt sites at all burn frequencies of five years or longer.
- The study shows that significant carbon savings could be achieved by extending the burn frequency on areas already under burn management.

GWCT core site monitoring 2012-present

- Trust researchers have been recording peat depth and burning intensity on all our core grouse count sites where we already record numbers of passerines, waders and mountain hares.
- Interim results suggest that the number of fires keepers choose to have is correlated with peat depth, being less on deep peat sites, and that burning rotations on heath of 12 years and bogs of 25 years support good levels of grouse breeding success.

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Disease management in red grouse

Disease management is a powerful tool for moorland managers to stabilise grouse abundance and stimulate ongoing investment in moorland. But with the ability to treat or control a wild animal comes great responsibility. GWCT believes there should be a continued emphasis on industry-led initiatives to comply with evolving best practice guidance. Further research is needed into how best to deploy gritting holidays when worm burdens are low, in order to prevent the onset of drug resistance.

Moorland managers should support further work into identifying how well grouse need to breed, and how many need to be shot to reduce parasite-induced crashes and minimise the use of medication. Grouse productivity should also be seen by moorland managers and policy makers in the light of sustaining grouse densities sufficiently high to be able to accommodate some predation and disturbance losses to birds of prey, while maintaining investment in jobs and management.

We note that at present, grouse moor managers are effectively alone in undertaking a comprehensive programme of tick control to the certain benefit of livestock and potential benefit of wildlife and human health..

Strongylosis and medicated grit

Medicated grit is a treatment available for use under veterinary prescription to control the disease Strongylosis. This is caused by a parasitic threadworm, *Trichostrongylus tenuis*, that at high levels can cause a significant reduction in breeding success and increased mortality¹, resulting in the cyclical fluctuations historically seen in red grouse populations². The parasites are most prevalent when grouse stocks have been high, but the disease can also reduce breeding success on low-density moors, preventing numbers from increasing.

Medication as a strategy is not undertaken lightly as it is expensive, time consuming and requires vet approval. The ability to limit the impact of this disease by medication is critical to recovering grouse populations to driven shooting densities³ and to maintaining consistent densities of grouse thereafter. Without recovery and consistency in red grouse abundance there can be years of little or no shooting. The lack of return may cause moor owners to abandon grouse moor management in favour of other forms of economic activity which are less favourable to conservation interests, such as extensive timber production⁴ and which may not deliver the same economic and social benefits to local communities.

GWCT will continue to research and monitor disease in red grouse. This will further our understanding of diseases in wild bird populations and support, in a wider context, the conservation status of other species which are supported by moorland habitats that are managed for grouse shooting.

Medicated grit - what, when and how

Red grouse habitually eat grit to aid the physical breakdown of heather, which makes up a large proportion of their diet. Grouse moor managers typically supplement natural grit by supplying plain (unmedicated) quartz grit at gritting 'stations'. GWCT has researched the use of a 'medicated grit' which is coated in an anthelmintic (wormer), Flubendazole, which is not soluble in water nor does it break down in sunlight, but delivers a low but steady dose to the bird. This product is widely used in the uplands by farmers to control parasites in sheep and cattle. Grouse moors that supply medicated grit in appropriate seasons and scales typically see reductions in worm burdens, fewer symptoms of disease and improvements in grouse survival breeding success³.

Medicated grit requires investment in time, money, training and best practice. As medicated grit should only be used in response to need, GWCT recommends that moors assess their need on an annual basis, undertaking specialist counts to gauge worm burdens in their grouse. Only if worm burdens are at a level that is likely to affect grouse health and breeding success should medicated grit be made available. If worm burdens are low then we recommend that medicated grit is not used. Experience has shown that medicated grit may only be required one year in three, thereby helping reduce the risk of resistance developing within the worm population⁵. However, if worm burdens indicate treatment is needed, managers should make medicated grit available at gritting stations for restricted periods (typically over winter, in spring and in early summer) withdrawing the drug a minimum of 28 days before grouse enter the food chain in accordance with the licence requirements.



Moorland managers condition grouse to take supplementary grit from gritting stations placed within their breeding territory. To begin with, plain grit is provided in boxes on a regular layout of stations known as a gritting grid. In early spring, by which time the grouse have become accustomed to accessing grit in this way, the plain grit is switched to medicated grit. Consideration should be given to mapping the grit station locations using GPS. Marking grit box locations enables the withdrawal of medicated grit which must remain inaccessible to the grouse throughout the shooting season. GWCT best practice recommends a particular design of grit box to aid the withdrawal of medication.

Effective harvesting

As Strongylosis is most prevalent when grouse densities are high, shooting enough grouse must be part of the overall disease management plan. If autumn densities are not reduced through shooting there may be an increased risk of disease transmission. Suitable and effective harvesting strategies have not always accompanied the use of medicated grit.

Louping-ill and tick control

Louping-ill is a viral disease transmitted by sheep ticks (*Ixodes ricinus*). As a result, sheep flocks are regularly treated to protect against diseases transmitted by ectoparasites such as tick. In red grouse the virus can cause high levels of mortality, with 79% of infected grouse chicks dying from the virus in laboratory and field conditions^{6,7}. Upland wader chicks (lapwing, golden plover and curlew) have been observed with high numbers of ticks, but no incidence of viral infection in these chicks has been detected from the relatively small sample tested⁸.

The GWCT has been working on the control of louping-ill since the late 1970s, and in 2001 we reported on the success of treating the major tick hosts (sheep) with acaricides (tick-killing pesticides)⁹. Some Scottish estates have adopted this treatment along with vaccination to reduce the prevalence of louping-ill in their sheep flocks. In Scotland deer and mountain hares also carry ticks, thereby perpetuating the disease, and so management of these wild hosts, through the erection of deer fences and culling strategies, has also been adopted on some estates. To test the effectiveness of an estate's control programme on the prevalence of louping-ill in red grouse, blood samples are collected from red grouse on shoot days. With correct application of these techniques it is possible to suppress louping-ill and sheep ticks to levels where their impact on red grouse and on sheep flock health is reduced to a minimum. This could have two important wider benefits: through improved sheep welfare and productivity¹⁰; and in reducing the transmission of Lyme disease.

Emerging disease of red grouse

Cryptosporidiosis is a disease caused by the parasite *Cryptosporidium baileyi* that is found in poultry, gamebirds and many other species of bird. Common symptoms appear to be swollen eyes and an excessive production of mucus from the nasal passage and eyes, which has led to the disease being referred to as 'bulgy eye'. This is not to be confused with the Mycoplasma disease in other birds, also called 'bulgy eye'.

As a ubiquitous disease it has most likely always been present on the moor without birds showing symptoms. It was first diagnosed in red grouse in northern England in 2010 and in southern Scotland in 2013. By 2014, it was observed on over 50% of moors surveyed across northern England and up to 80% of moors in the north Pennines¹¹. Greater infection rates are found on moors with higher densities of red grouse, highlighting the need for effective control of population densities by shooting. However, early survey work shows up to 15% of grouse show typical Cryptosporidiosis symptoms at any one time, with variable infection rates between moors.

The GWCT is taking the emergence of this disease in red grouse seriously because of:

- The large geographical range over which grouse now show symptoms since 2010.
- The interactions between this disease and other red grouse management techniques.
- The apparent challenges of reducing the effects and impacts of the disease, particularly when grouse densities are low.

We have developed a joint research programme with veterinarians from the Animal and Plant Health Agency (formerly AHVLA) and in private practice who are assisting us with clinical analysis and diagnosis. We are still establishing how many grouse survive the disease, so we have invested in a project to radio-tag infected and uninfected birds and track their fate. Initial monitoring of infected birds has shown that despite hatching similar numbers of chicks as uninfected birds, survival amongst infected clutches is often lower. Infection was also associated with a weight loss in both adult male and female birds of 5% and 7% respectively and more infected birds died over a three month period, compared to healthy grouse.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none">Follow best practice guide on disease control.Support research into ways of minimising the use of medication and the impacts of disease control methods.Develop sustainable wild tick host control programmes.	<ul style="list-style-type: none">Action to reduce the impacts of tick numbers on the public and rural areas.Financial support for tick control programmes.Endorse best practice guidance.

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Predation control - its techniques and contributions to upland conservation

Predator control to improve the breeding numbers and productivity of red grouse can also benefit ground-nesting birds that share the grouse's moorland habitat. Many increasingly rare birds such as golden plover, curlew, black grouse and lapwing nest on the ground making them particularly vulnerable to predation. Legally controllable predators such as foxes, crows and stoats can take eggs from a nest, kill the sitting female or take the young. These direct impacts on productivity (ie the number of young that are successfully reared) can reduce the ability of a population to maintain itself. Significantly research has shown that the underlying populations of managed predators are not significantly impacted through predation management¹.

Where habitat quality has been addressed, predation pressure is high and the management tools chosen are effective in removing enough predators, we believe that predator control can be a cost-effective approach to improving the survival and recruitment of grouse. It is also likely to stimulate interest in wider landscape conservation from land managers who see cultural and economic value in game and wildlife².

Since the early 1980s, the GWCT has published over 150 papers considering the effects of predation. This research shows that predation can be a common factor limiting the breeding success of many species in the UK, particularly ground-dwelling birds with limited habitat extent, quality and connectivity^{3,4}. The implications for conservation and investment in sporting management are clear. High predation pressure can halt sustainable driven wild game shooting⁵ and by extension prevent the recovery of declining species of wildlife⁶. In the uplands, black grouse ranges would contract further if predation pressure increased^{7,8}. Birds such as curlew are now typically restricted not just to upland areas, but to sites where predators are controlled to benefit red grouse⁹.

Though currently under-researched, it seems likely that predator control undertaken over larger areas will be more effective in reducing and maintaining lower predator densities¹⁰. In this way moorland managers working together at a landscape scale can have a positive effect on upland birds, many of which are in serious decline.

Research by the GWCT and others has shown not only that predation can cause local species decline, but that targeted predator control can reduce this impact to the point where effective species recovery may be achieved¹¹. The value of predator control is now widely recognised by policymakers and practitioners in a variety of fields⁶. Thus predator control is practised not just by farmers and gamekeepers on private land, but on a wide range of designated sites and nature reserves around the country. Furthermore, it is also supported by public funding in the Scottish Rural Development Programme (SRDP)¹².

The importance of breeding success to conservation

Policymakers and conservationists measure upland bird assemblages to assess conservation success¹³. The sustainability of each population, critical to maintaining diversity in the assemblage, will be in doubt if conditions are unsuitable for the recruitment of young into the population and maintenance of breeding productivity.

The importance of maintaining breeding productivity was demonstrated by modelling the data gathered during GWCT's Upland Predation Experiment (UPE). Previous research suggests that to maintain a stable breeding population, lapwing and curlew need to produce on average around 0.9 young and 0.5 young per pair per annum respectively^{14,15}. The UPE showed that without predator control only 19% of lapwing and 15% of curlew pairs produced young. This means each successful pair would have to produce an unrealistic number of young for species that typically lay four eggs and rear one brood per year.

In contrast, the UPE showed that where predator numbers were controlled, lapwing fledged 3 times more young (57% fledging young), and curlew 3.4 times more (51% fledging young). Such productivity, averaged across the population, would allow populations to recover within similar environmental conditions¹¹.



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Predator and habitat management

Good-quality habitats, supported by farming and sporting management, are essential if predator control is to be justified. The demand for food, fuel and fibre from a small, finite land area has led to declining extent, quality and connectivity of existing wildlife territories. This in turn has often led to poor integration and thus low population resilience. Having suitable habitats in adequate amounts for reproduction and survival is crucial for all species. However, habitat management is not always enough on its own to improve conservation¹⁶.

Predator conservation

The benefits of predator control can extend beyond game species, waders and songbirds. Reducing numbers of some of the common generalist predators can benefit some rare predators. Ground-nesting hen harriers do well on virtually fox-free islands, e.g. the Orkney Islands, and have been found to decline sharply on islands and moors when fox control stops¹⁷.

Where contiguous properties are managed principally for grouse, the combined predator control effort can result in some predators becoming locally scarce. We see nothing intrinsically wrong in this, provided it is offset by good numbers of the same predators in other regions, the conservation status of the predators is secure, and other important ecosystem services are being delivered in these areas as a consequence.

Trapping and snaring in Scotland

Snaring, cage and spring traps are modern, effective and humane techniques for locally limiting predation pressure from foxes, crows, magpies, stoats and weasels. Our research into the trapping of crows and snaring of foxes has improved the specificity of predator control and the welfare of trapped predators^{18,19}. Historic poor practice by some wildlife managers has led to the snare being viewed as a killing rather than a restraining device and to repeated calls for a ban in the use of snares.

Given increasing public connection with the countryside through recreation and wildlife interests, the grouse sector (indeed the land management industry as a whole) would be unwise not to respond to concerns about welfare standards and non-target issues. Calls for a ban on snaring resulted in the land management industry developing a code of practice supported by compulsory training and Government accreditation to ensure best practice across the industry.

Industry and researchers now need to address concerns which have been expressed over the mis-use of corvid traps and develop a sector-led initiative to educate the minority who undertake poor practice; otherwise, the general licence provisions could be used to severely restrict their practicality. Eradicating poor practice through sector-led training initiatives is in our view the best way forward, ensuring practitioners lead the way in terms of compliance and support research into improving techniques.

Whilst there is ongoing support for GWCT research into welfare-friendly snaring techniques, trapping hardware and refining best practice predator management, it is essential that the Scottish Government is encouraged to endorse guidance and research, as well as publically supporting predator control as a legitimate conservation tool.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none">• Eliminate illegal persecution.• Develop codes of practice and training.• Support research into improving the welfare standards of current techniques.	<ul style="list-style-type: none">• Endorse grouse sector-led codes of practice and training.• Identifying predator control as a legitimate conservation tool.

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Mountain hares

Critics of mountain hare control have been quick to call for an outright ban on culling and have pointed to high bag numbers threatening individual populations. The reality is that high bag numbers do not necessarily equal high cull rates in population terms, but appear to be indicative of a high level of abundance. Policymakers should recognise that mountain hares benefit from moorland management and that, besides culling, both disease and loss of habitat can have an impact on their overall status.

Nonetheless, the grouse moor community should not ignore public concerns about the culling of wild hosts such as mountain hares. Grouse moor owners and managers are well advised to address such concerns by ensuring, through coordination at a regional level, that a combination of shooting and natural declines does not lead to local over-exploitation.

The Law

EU legislation seeks to promote sustainable management of mountain hares, not protection per se. The EU requirement to monitor hares, which is now transcribed into Scottish law, was designed to track the status of fragile low-density mountain hare populations in continental Europe. In Scotland, a closed season has recently been introduced in line with other mammalian species.

Current status

Through the GWCT's National Gamebag Census (NGC) we can evaluate trends in mountain hare bags. Since the 1950s, when keeping increased again after World War II, the bags show a clear cyclical pattern of peaks and troughs. Natural declines of 5-100 fold followed by recovery are a feature of bag records, with densities naturally reaching in excess of 250 per km² at cycle peaks.

Despite these large short and medium-term changes, there is no discernible long-term trend in numbers of hares in the NGC. In 2008, GWCT established that the Scottish range of mountain hare is not shrinking (range contraction is often the first sign of a population in trouble); in fact we found that over 80% of the UK's mountain hare population is in Scotland and most of these are on grouse moors¹. Scottish mountain hare densities are regularly ten times higher than are typical in other European countries². GWCT is currently working with SNH and the James Hutton Institute to assess hare densities more accurately and establish a reliable methodology for counting mountain hares.

Mountain hare management

Mountain hares are part of the sporting interest on many upland Scottish estates, benefiting from grouse moor management with the production of cover, young heather and few predators³. Hares can sustain high levels of ticks, thus supporting ticks in completing their life cycle and perpetuating tick transmitted diseases (eg Louping-ill and Lyme disease), which can be detrimental to grouse populations⁴. Mountain hares are also affected by a gut parasite, *Trichostrongylus retortaeformis*, which causes similar cyclical effects on population numbers as strongyle worms in red grouse.

Culling hares to manage disease

Louping-ill virus (LIV) which is transmitted by ticks can cause up to 80% mortality in grouse chicks, whilst tick burden alone can cause stress and mortality in both adult grouse and chicks⁵, as well as other upland species. In addition to the vaccination of sheep, an effective way of controlling louping-ill is to reduce the number of ticks on the moor. This is likely to involve, in one form or another, the management of tick hosts such as sheep, deer and hares. The GWCT's prescription for reducing tick abundance and limiting LIV prevalence in Scotland advocates, as a first step, the introduction of a comprehensive acaricide (tick-killing pesticide) regime for sheep flocks. In the event that sheep management alone does not work, and on moors where there is a population of deer, we recommend a reduction in deer numbers. Only after both these options have been explored, should culls of mountain hares be considered.

In such cases, the GWCT believes that culls should not lead to regional declines in mountain hares provided that an effective and balanced management plan is in place.

In any event, it is important to carry out regular tests for the presence of LIV.



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Sustainable management

The fact that we still commonly see hares, even in areas where there are intensive culls suggests that the population may be more robust than some think. However, this cannot be taken for granted, and sustainable management of hares must go hand in hand with sustainable management of grouse. Hare populations are regionally at risk when shooting is carried out on populations that are already declining, either due to natural causes or as a result of a disproportionate programme of control. We would encourage land managers to consult their neighbours to make sure that shooting and natural declines do not occur together across large landscape areas.

Ongoing research into improved monitoring methods will help both policymakers, such as SNH, and moorland managers understand the effects of culls, and enable the latter to put in place sustainable disease management plans based on sound science. Additionally, the NGC will provide a historical perspective so that current bags can be seen in the context of past changes in bag numbers.

Actions

Actions for moorland managers	Actions for policy and delivery
<ul style="list-style-type: none">Follow best practice guidance on disease control.Support research into appropriate counting methodology.Development of sustainable wild tick host control programmes.	<ul style="list-style-type: none">Action to reduce the impacts of tick numbers on the public and rural areas.Financial support for tick control programmes.

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The Game & Wildlife Conservation Trust, which produced this document, conducts research into Britain's game and wildlife.

We advise farmers and landowners on improving wildlife habitat and seek to improve agricultural and conservation policies with our science. Our research into best practice grouse moor management has demonstrated that this form of management can deliver a number of public goods and services, contributing a net benefit to biodiversity.

Through our continued research and demonstration we aim to help maximise the delivery of multiple benefits from moorland management.

Our emphasis on turning science into both good practice and policy means we are well placed to help find solutions to problems or conflicts, as well as inform evidence-led policy decisions.

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