9 Drainage and burning management on moorlands

Context

9.1 Moorland is a cultural landscape that is at least partly anthropogenic in origin as a result of forest clearance and grazing. It is also a product of the climate and underlying soils and geology. Open moorland landscape is typical and characteristic in upland England. It covers a variety of different habitats and soils - including blanket bogs, heaths, grasslands and rocky outcrops. These can frequently occur together in a mosaic but their management requirements and the impacts of management will be widely different. Approximately 773,000 ha of land in England are currently within the Moorland Line, which comprises "*Land with predominantly semi-natural upland vegetation, or comprised predominantly of rock outcrops and semi-natural upland vegetation, used primarily for rough grazing; including enclosed land such as allotments, ffridd or reverted in-bye.*"[1]

9.2 Past land management practices undertaken on moorlands have been dominated by drainage to reduce or remove waterlogged conditions, with the intention of increasing 'productive' vegetation. This was carried out with the intention of increasing livestock production as well as of improving conditions for grouse. Burning is a major habitat management tool on many moorlands, contributing to the value of the area in terms of grouse production, and in terms of its distinctive landscape.

9.3 The major socio-economic activities on moorland in England are: livestock production; game shooting (mainly for red grouse); recreation and tourism. Moorlands are also important areas for the supply of drinking water and increasingly identified for the generation of wind energy. In the future, the ability of certain soils and vegetation types to store carbon may also have an economic value.[2] In the past, drainage was also carried out on moorlands for the establishment of forestry stands and improved grazing. This practice has been discontinued.

9.4 Grouse moor management is a substantial source of income to some areas of the uplands: estimated net income on grouse moors from shooting is approximately £67/ha - not taking into account likely income to service industries in the area. Nationally this is worth £12 million.[3] Sheep grazed at a low level (one ewe per hectare) on a similar area might be expected to yield a net income of around £25/ha, excluding any agri-environment payment.[4] Research has shown that lower stocking rates (down to 0.25 ewes per ha) could be more profitable.[5]

9.5 Around 80,000 ha[6] of moorland SSSI is classified as being in unfavourable condition as a result of burning. Approximately 10,000 ha of SSSI moorland is in unfavourable condition due to inappropriate drainage. There are approximately 283,000 ha of moorland managed for grouse in England,[7] of which 180,000 ha are SSSI.[8]

Current practice

9.6 Active drainage ('gripping') of moorland areas is now a relatively minor activity. Whilst some grips are maintained (for example in the north Pennines), more conservation effort is being put into grip blocking, to prevent erosion, to prevent degeneration of peat, and to restore upland wetland habitats. Burning is carried out to improve palatability of the vegetation for grouse and livestock, and to provide a variety of heather age and structure for red grouse to feed, nest and shelter. Grazing by livestock and game species is the third key management activity. This is discussed in more detail in the chapter on 'Grazing management in the uplands'.

Heather and grass burning trends and pressures

9.7 Adequate areas of heather which have been burnt and have regenerated are vital to grouse management. Without large areas of fresh growth and cover in which to nest, the grouse will not be productive enough to warrant driven shooting.[9] Burning of heather moorland is predominantly carried out to provide a mixture of heather ages and structure for supporting grouse for game shooting - young shoots for feeding and deep heather for nesting cover and shelter. The frequency and extent of heather burns nationally is currently being researched using satellite imagery. Current research shows that approximately 23% of upland heath and 11% of bog in England has been burnt within the last 7.7 years.[10] This can be extrapolated to approximately 114 km^2 of dwarf shrub heath burnt annually, with the average period between burns on all such habitat at 20 years.[11]

9.8 Other vegetation, for example coarse grasses such as Purple Moor Grass, is burnt by moorland managers to remove litter and encourage fresh growth for grazing livestock.[12] This can increase the dominance of the coarse grasses in the long term, especially if the burns are hot and if the ground is burnt frequently.[13] The area covered by this activity is being researched but is not yet known.[14] The legal period for burning vegetation in the uplands is 1 October - 15 April. Within this period, gamekeepers and livestock managers burn heather and grass as part of the management of the moor. In addition to the legal burning season, the Regulations also prohibit various types of burning which may create a high risk of soil exposure and erosion.

Moorland drainage trends and pressures

9.9 The digging of drainage channels (grips) in upland peat in an attempt to dry out the land is now uncommon, but government grants from the 1950s to the 1980s provided funding for the use of grip-producing machinery on a large scale.[15] There are no accurate figures for the full extent of moorland gripping in England, although regional data taken from aerial photographs of upland areas in England and Wales indicate that over 50% of the land had been drained in some areas. Approximately 1.5 million hectares of upland blanket peatland have been drained since the 1930s.[16] It has been estimated that within the North Pennines AONB there are 9300 km of grips.[17]

9.10 There is little evidence that gripping was of much value agriculturally and it is seldom carried out today. Current practice is largely centred on the blocking of grips, to recreate wet areas and to control soil erosion by rewetting peatlands and restoring vegetation.

9.11 Currently, a number of important projects are under way throughout England and the rest of the UK to block existing grips, to restore the soil wetness and create conditions to allow peat forming species to thrive and return to a situation which captures and stores carbon. In some very degraded areas significant restoration activities have been required, including grip blocking at a landscape scale, along with stabilisation and re-seeding of bare soils, for example the Sustainable Catchment Management Programme.[18]

9.12 For current incentives, advice and regulation for moorland managers, see Annex I to this chapter.

Key impacts

9.13 Moorland habitats are varied and will be impacted differently by management. There are strong links between different economic activities, with some land management practices impacting on others. For example, management for grouse will also affect grazing use of the moor by livestock, and both have an effect on water quality.

9.14 Unless carefully managed, drainage, burning and grazing on moorland areas can all reduce the diversity of the vegetation and the associated fauna, although in different ways. Drainage and burning may affect *Sphagnum* communities, and these activities can also allow heather to dominate at the expense of other species.[19] Grazing can suppress dwarf shrub cover, allowing coarse grasses to predominate where heather stands become fragmented. Research suggests that where heather is restored from grass-dominated moorland, there can be an increase in invertebrate abundance and diversity.[20] Changes in bird populations may result, but these are also closely linked to other moorland management practices such as predator control.[21]

9.15 Recently, there has been considerable concern that the gripping and burning management of peat moorlands has contributed to large-scale degradation and drying of peatlands.[22] The drier conditions have led to the loss of peat forming plant species such as *Sphagnum* mosses. Where the peat surface is exposed, such as through excessively hot burns, desiccation and erosion can result, with associated water sediment and colouration problems. Research has shown a correlation between an increased frequency of soil piping within peat soils on peatland with grips and on areas dominated by heather. This produces more rapid subsurface erosion and carbon loss.[23] Where grips have been blocked, there is some evidence that this slows water release into the catchment. Depending on where this occurs, it can mitigate flooding further downstream.[24]

9.16 The cost of removal of peat colouration from water for domestic use is currently borne by water companies and, ultimately, consumers.[25] Drainage can also cause direct damage to archaeological sites and can alter the hydrology leading to a loss of peat and palaeological deposits.[26]

9.17 Peat oxidation and the consequent release of carbon to the atmosphere has been strongly associated with moorland gripping. As peat dries out, so it is able to decompose; this releases CO_2. There have been estimates of carbon losses of 3-10 t C/ha per year where peat has been drained.[27] The blocking of grips is a necessary and critical precursor of restoring the hydrology and functioning of these peatland systems.[28] Grip blocking is effective in rewetting peat soils in the long term, although it is calculated that there is some time lag before the peat reverts from greenhouse gas source to greenhouse gas sink, and the rewetting can result in increased methane emissions.[29]

9.18 Extensive grazing, cool, managed burns on longer rotations, limited or no burning on blanket peats and a reversal in the drainage of moorland areas can lead to landscapes which are richer in biodiversity.[30] They can also make a significant contribution to better water quality,[31] and climate change mitigation.

9.19 For further factual background to this section, see Annex II to this chapter.

Summary of impacts

Biodiversity

9.20 Drainage and burning both have high potential for impact on biodiversity, either as individual activities or in combination.

9.21 Burning alters the vegetation composition and structure of moorland habitats and, where intensive, can significantly reduce biodiversity interest and species diversity. Where associated with drainage on peat, it can remove peat forming vegetation and prevent further accumulation of peat.

9.22 A variety of vegetation species and structure favours a wider range of invertebrates, birds, mammals and reptiles and amphibians. Sustainable burning of heather on mineral soils can increase plant species diversity, providing the burning regimes are not intensive. Where intensity is not severe, it is also associated with creation of patches which are favoured by some Biodiversity Action Plan (BAP) priority species, for example golden plover and curlew. Management for red grouse can lead to significantly improved chances of having black grouse, and some species of breeding waders on the moor[32], though current evidence does not differentiate between the effects of habitat management and predator control.

9.23 An increase in the frequency or intensity (temperature) of the burn is likely to result in greater negative impacts on biodiversity. Where there are large-scale fires and hot temperatures, all vegetation can be destroyed, soils (especially peat soils) can be badly damaged and animal life may be affected.

9.24 Burning carried out in March and April has the potential to destroy nests and nesting birds, even during the legal burning period.

9.25 Drainage of moorland, especially blanket bog, has significant impacts on the biodiversity through altering hydrology, reducing soil wetness and, consequently, vegetation composition and structure. These impacts can be exacerbated by burning and inappropriate grazing.

Resource protection

9.26 Peat soils can be destabilised through drainage and burning. Exposed peat soils can be broken down, contributing to colouration and sediment in the water run-off.

9.27 Poorly functioning blanket bogs and peats lose their ability to hold up water within the catchment. Where little or no vegetation is present, there is also little impediment to surface water flows following periods of rain. These surface flows can be significant.

9.28 Managed burning along with other fire prevention measures can reduce wildfire risk (through, for example, fuel load reduction), potentially minimising the damage caused by very hot burns. Whilst burning over peat soils carries a relatively high risk, increasing soil wetness and reduction of heather cover on peat soils can reduce wildfire risk.

Greenhouse gases

9.29 Moorland drainage (or ‘gripping’) at regular intervals dries out peat soils allowing oxidation, which releases large quantities of stored carbon in the form of CO_2, potentially turning a substantial carbon sink into a major carbon emitter. The drying of the peat is unsuitable for the survival of peat forming species, most notably *Sphagnum* mosses, which need waterlogged conditions. The loss of Sphagnum mosses therefore reduces the carbon storage function of peats.

Landscape and recreation

9.30 Regular burning (in combination with grazing) creates or maintains spatial, compositional and structural diversity of the open heathland element of our upland landscape.

9.31 Drainage and burning affects both landscape (through removal of trees and scrub) and the recreational use of that resource.

9.32 When burning and drainage activities impact on peat they can also cause the loss of historic information such as the pollen record (sometimes going back thousands of years) and archaeological remains that are preserved either above or below the soil surface.

Annex I Current incentives, advice and regulation

Management incentives

- There are capital grants to aid grip blocking where rewetting is considered favourable to enhance agri-environment objectives such as biodiversity and the historic environment.
- Similarly, agri-environment payments can be made to fund burning management where it is considered of benefit, particularly for biodiversity or the historic environment. This requires the production of burning plans, which may also identify areas to be excluded from burning management.
- Graziers on grouse moors can benefit from payments under the Single Payment Scheme, and from Hill Farm Allowance and Upland Entry Level Stewardship. Moorland owners can be recipients of Entry Level Stewardship, Higher Level Stewardship and Wildlife Enhancement Scheme payments.
- Agri-environment payments may also be available to fund other restoration works such as soil/peat stabilisation and revegetation.

Regulatory

- *Heather and Grass etc (Burning) Regulations 2007 (No.2003):* primary legislation governing moorland burning. The Heather and Grass Burning Code[33] (which is voluntary) outlines good practice on planning where to burn and how to burn safely and responsibly.
- *Wildlife and Countryside Act 1981*: moorland burning and drainage on SSSIs requires consent from Natural England.
- *Wildlife and Countryside Act 1981, and Conservation (Natural Habitats etc.) Regulations 1994*: regulate against destruction of protected animals, plants and habitats.
- *Ancient Monuments and Archaeological Areas Act 1979*: Scheduled Monuments must not be damaged by burning activities.
- *Highways Act 1980*: burning must not cause interruption or danger to road users.
- *Health and Safety at Work etc. Act 1974, and Management of Health and Safety at Work Regulations*: burning operations must not endanger anyone, including the public.
- *Environmental Protection Act 1990*: smoke emissions must not cause a nuisance, or be prejudicial to health.
- *Cross Compliance - GAEC 9* conditions,[34] in particular those relating to soil protection may be applicable.

Annex II Impacts of moorland habitat management on environmental sustainability

Table 11 Impacts of moorland habitat management on environmental sustainability

Habitat quality and diversity	• Routine burning reduces the botanical diversity of the moorland being burned. Regular burning can particularly favour heather and Purple Moor Grass over other species such as *Sphagnum* mosses and woody species. For Red Grouse, the purpose is to maintain a heather dominated moorland, while burning for grazing livestock - previously practised on a much larger scale, can lead to a grass dominated landscape.[35] • Burns that become uncontrolled covering large areas increase habitat homogeneity, by reducing age diversity in the heather. They may also burn into non-target areas, such as bracken, affecting the breeding habitat of such Red-list birds as Twite, Ring Ouzel, Whinchat and Merlin.
Species abundance and diversity	• Some species of bryophytes are thought to be uncommon as a result of their sensitivity to burning, for example *Sphagnum fuscum*.[36] • Burning on moorland is permitted at a time when potentially substantial numbers of ground-nesting birds may already be nesting, for example golden plover, hen harrier, redshank, short-eared owl.[37] • Insects that normally thrive in pools and boggy wet ground, can no longer survive when these are affected by drainage schemes. This has had a consequent impact up the food chain on birds and small mammals that feed on these insects.[38] • Data suggests that the habitat conditions created by blocking grips can be of high value to grouse chicks and upland wader populations by providing an important invertebrate food source.[39] • A wide variety of different moorland habitats and vegetation structure has been shown to favour a greater range of birds and invertebrates.[40]
Water level control	• Draining has been shown to increase the sensitivity of blanket bog to rainfall with earlier and higher peak flow rates per unit.[41] • Some research suggests that selective grip blocking can reduce some flood risk but in some places can increase it, depending on which grips are blocked and the balance between connectivity and storage.[42,43]

Table continued...

Sediment load in water	• Where burns have removed too much surface vegetation, or where they have been carried out on steep ground, there is a high risk of erosion.[44] • Artificial drainage of moorland can generate large quantities of eroded material (up to 5.8×10^3 kg carbon per km^2 in addition to any erosion related to the ditch channel incision).[45] • There is some evidence that changes in wind velocity over the moorland following burning plays a role in soil erosion.[46]
Pesticide control in water	• Bracken spraying on moorland using Asulam has been closely controlled by the Environment Agency, due to the high risk of spray residues entering watercourses. The use of Asulam in this context is currently under review.
Other pollutants	• Eroded peat can cause discoloration of water, the removal of which is a major cost to the water utilities. One water utility has estimated that a catchment management programme to address moorland erosion, largely caused by inappropriate drainage and peat degradation, would reduce water colouration to acceptable standards, saving approximately £800,000 p.a.[47]
Greenhouse gases	• Recent research has shown that the proportion of exposed peat surface resulting from new heather burning was consistently identified as the most significant predictor of variation Dissolved Organic Carbon concentration.[48] • Over half the carbon within *Calluna* which is burnt is lost into the atmosphere.[49] • Active peat moorland (fully vegetated) can sequester carbon at rates between 0.2 and 0.7 t C/year.[50] • Degraded peat, and peat which is drying out, becomes mineralised, and is a major source of carbon released into the atmosphere (up to 100 t C/km^2 per year in the Peak District).[51]
Soil stability (erosion)	• Burning of gullies leads to a high risk of formation of erosion features.[52] • Burning is closely associated with erosion of peat soils, in particular through the exposure of burnt areas to the atmosphere and rainfall.[53,54] • Gripping is directly related to high levels of peat and mineral soil erosion in the uplands. In some areas this has led to substantial loss or destabilisation of peat 'caps'.
Soil structure	• Increases in the numbers of sub-soil pipes has been associated with gripping, with these contributing to the loss of particulate organic matter. The older the grips, the greater the number of soil pipes.[55]

Table continued...

Landscape character		• Controlled burning leaves a very obvious and recognisable signature on the landscape. • Grips form an obvious feature in the landscape, particularly when they have been dug in the standard 'herring-bone' fashion spaced at 22 m intervals. • Archaeological evidence within the peat such as pollen records and other carbon-based material can be destroyed where desiccation and erosion take place.[56] • The construction of tracks to aid moorland management can have significant impacts, not just on biodiversity, but also have a detrimental impact on wild moorland landscapes.[57] They may also open up access to sensitive parts of the moor, possibly increasing fire risk.

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Case study: Bracken

Bracken is seen by most land managers as an invasive weed. In fact it can be an important habitat, and has become a strong landscape component in some areas (such as the Lake District), particularly for its colour as it dies back in the autumn and early winter.

Originally bracken was a predominantly woodland species,[1] but in England it has become a vigorous and invasive competitor on uncultivated ground. It can have strong negative impacts where it encroaches on vegetation such as semi-natural grasslands and heathlands. Its rhizomes can also disrupt below-ground archaeological deposits, and obscure sites.[2]

Bracken also has some biodiversity value: the high brown fritillary,[3] and the pearl-bordered fritillary,[4] use bracken litter for overwintering their eggs; both are Biodiversity Action Plan priority species. It is also an important habitat for ground-nesting Twite, Ring Ouzel, Whinchat and Merlin, four Red-listed birds of conservation concern, and BAP priority species.

Where bracken grows in dense beds, it smothers ground vegetation, and forms a deep litter layer, which is not populated by other plant species. It is toxic to livestock: cattle can develop internal haemorrhaging, associated with bone-marrow damage,[5] and is not usually grazed. Key livestock impacts on it are: increase of extent by suppressing other vegetation (through grazing), or decrease of extent by trampling and exposing the rhizomes to frost - this is generally only effective in small areas such as feeding sites, where the effect can be concentrated. There is no conclusive research to show that reduction of grazing pressure causes an increase in bracken spread, despite common belief.

The Countryside Survey in 2007 indicates that between 1998 and 2007 there was a reduction in bracken 'broad habitat' cover in Great Britain, from 318,000 ha to 263,000 ha. This does not necessarily reflect eradication of bracken over 55,000 ha - rather a change in the overall bracken cover in that area.[6]

Land managers are often keen to treat bracken . Its invasive habit means it can hinder heather growth and thus reduce grouse habitat, it can reduce the area available for grazing, and it can make good habitat for ticks, providing a potential reservoir of Lyme disease, and Louping Ill. Most treatments involve spraying with asulam or glyphosate, with follow-up treatments, though there is some evidence that regular cutting (twice a year) is effective.[7] Spray treatment is relatively expensive (up to £280/ ha),[8] and involves vigilance in subsequent years - requiring regular follow-up treatments. It is now likely that Asulam will be withdrawn from the market for use on bracken, removing a key tool in its control.

The regeneration of vegetation after bracken eradication can be problematic, particularly where there is a deep litter layer. Here the soil is unstable, and the establishment of other vegetation may take some years. In the intervening period it is prone to erosion, and has little habitat value.

A number of small enterprises have been set up to compost harvested bracken for use as a garden soil conditioner, potentially replacing the unsustainable use of peat.[9]

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