UplandsManagementGroup

MOORS FOR THE FUTURE PARTNERSHIP

BLANKET BOG

Frequently asked questions

LAND MANAGEMENT GUIDANCE

STATE 1 AFFORESTED BOG

STATE 2 BARE PEAT BOG

STATE 3 DWARF SHRUB DOMINATED BLANKET BOG

STATE 4 GRASS AND/OR SEDGE DOMINATED BLANKET BOG

STATE 5 MODIFIED BLANKET BOG WITH DWARF SHRUB

STATE 6 ACTIVE BLANKET BOG

INTRODUCTION – WHERE DID THIS GUIDANCE COME FROM?

The importance of upland peatlands to society has become more prominent over the last decade. This was highlighted in a joint publication 'National Upland Outcomes Framework' prepared by Defra and Natural England and published in December 2013. Subsequently Defra's Uplands Stakeholder Forum (USF) were challenged to provide support to deliver better outcomes in the uplands.

At the same time there was interest from the EU Commission over the management of UK blanket bog and a series of questions were posed to the UK Government over the condition of the habitat and measures being taken to improve the condition of blanket bogs. As a result of this challenge Natural England in consultation with the USF developed a high level strategy 'A Strategy for the Restoration of Blanket Bog in England – An Outcomes Approach' published in June 2015.

Over many years a number of partnerships have evolved to specifically help improve the condition of peatlands in the uplands. These have tended to focus on specific restoration activities in defined geographic areas and with considerable success. However, an approach was required which considered the whole extent of England's blanket bog and embraced the day to day management activities of land owners and managers.

To facilitate this, the Uplands Management Group (UMG, a group of land management practitioners, statutory and voluntary groups) were requested by Defra's USF to work with Natural England to develop a programme of awareness raising on best practice management of blanket bog.

Led by the Uplands Management Group working closely with Natural England, a range of activity that has focussed attention on the requirements of the day to day management of blanket bogs and what is required to improve the condition of those that are in a degraded state. 'Bogathon' helped develop consensus on the importance of blanket bogs, 'what good looks like' and how this then contributes to delivering the range of agreed outcomes.

'Sphagathon' subsequently looked at the importance of sphagnum mosses and the range of techniques that are available to use sphagnum in restoration. It also considered how restoration could be achieved over a larger geographic scale and how it could be delivered as part of day to day management by land managers. The practicalities were then discussed at a series of events for land managers during which considerable support was expressed for improving blanket bog management and active engagement in restoration.

The principles, land management guidance and FAQ included in this pack have been prepared to reflect those various discussions. They represent a broad consensus over the need to take proactive action to restore and provide sustainable management of blanket bogs. They are aimed at three main audiences; land management practitioners who may be able to deliver restoration and sustainable management as part of securing their own outcomes, peatland restoration partnerships and Natural England advisers. The outcomes-led approach aims to bring a common understanding and consistency to discussions on the ground. This guidance should be used to inform individual decision making on the ground, based on agreement at a local level on the actions required.

Different decisions may lead to different actions in different situations. These may take place over different time scales dependent on a range of factors including the current condition of the habitat, the range of outcomes to be delivered (including the desired condition of the habitat) and the skills and resources available. Ultimately, locally tailored actions following this guidance will deliver improving and maintained structure and function of blanket bog and fulfil the socio-economic objectives of the local land use.

Q1 WHAT IS BLANKET BOG?

The term blanket bog describes the extensive rain fed, deep upland peatland over 40cm in depth on flat or sloping ground and the range of vegetation types it can support. Blanket bog is a nationally important store of carbon and the water source for millions of people. Less modified blanket bogs support a range of sphagnum mosses, cotton grasses, dwarf shrubs, sedges and other wetland plants. They have a high water table that fluctuates in a zone close to the peat surface. These systems form peat by the compression of plant material into their waterlogged lower layers where it accumulates because decomposition is very slow in the anaerobic conditions. More modified blanket bogs may have lower water tables and vegetation dominated by dwarf shrubs (especially heather), cotton grasses, deer grass or purple moor grass depending on the location and management practices.

Q2 HOW IS BLANKET BOG DEFINED?

Blanket bog habitat includes all vegetation types over deep peat. Six 'states' are summarised in the Blanket Bog Restoration Strategy: http://publications.naturalengland.org.uk/publication/5476256970702848

1. Afforested bog (inactive) Bogs which have been planted with trees, usually for commercial reasons, and are not functioning as blanket bog.

2. Bare peat bog Little or no vegetation with areas of exposed bare peat and extensive gullying and hagging. Unlikely to support representative peatland communities. Small patches of dwarf shrubs (heather) or cotton grass may exist.

3. Dwarf shrub dominated blanket bog with other species scarce or absent (largely inactive) Largely inactive, severely modified bogs where dwarf shrub cover exceeds 75% of the canopy and other typical mire species such as bog mosses and cotton grass can be rare or absent. It may have moderate to severe gullying and hagging. Occurs often on 'drier' peats and the more easterly moors where there is less rainfall.

4. Grass and/or sedge dominated blanket bog (potentially active) May be active or have potential to become so. Vegetation is dominated by graminoids such as purple moor grass, cotton grass or deer grass with sphagnum bog mosses scarce or absent. Does not include the post-burn grass or sedge dominated areas of modified bogs of State 5 below. Unlikely to be extensively drained and usually with few gullies or haggs.

5. Modified blanket bog with high dwarf shrub cover but with sphagnum and other mire species (active) Dwarf shrub cover is high, often reaching 50–75%, and sphagnum cover tends to be lower. Cotton grass is abundant or frequent as an understorey and becomes dominant in the years following fire. Moderately active, with peat formation likely to be slower than in State 6. It may be drained, but usually with few gullies or haggs. Characteristic of much of the Pennines for example.

6. Active hummock/hollow/ridge blanket bog (active) This is un-modified or little modified, sphagnum-rich blanket bog, which is peat-forming (active) often with hummocks and hollows. There may be basin or valley mire components. Typically neither heather nor cotton grass achieve high abundance and there is usually a good sphagnum understorey. It meets, or is close to meeting favourable condition attributes.

Q3 WHAT IS DEEP PEAT?

Deep peat is defined as peat in excess of 40cms. 40cms has been used as a definition following that used by the Soil Survey of England.

Q4 DOES THE APPROACH APPLY TO PEAT LESS THAN 40CMS IN DEPTH?

40cms is an arbitrary value. On deeper peats with a high water table, functioning of blanket bog habitat is more likely than on shallower peat. Though all peat is important and should be protected we are likely to see greater gains on deep peat simply because of the volume of peat present in such areas.

Q5 WHY IS THERE SO MUCH INTEREST IN BLANKET BOG AND DEEP PEAT?

The UK's uplands are home to a range of rare and important habitats and species and are internationally important for their peatlands, holding between 9–15% of the total peatland area in Europe and about 13% of the global blanket bog resource. Peatlands – defined as areas with peat soil – cover much of the English uplands. The most extensive type of peatland is blanket bog and upland valley mire. An estimated 70% of the UK's drinking water is collected from upland catchments. Well-functioning blanket bog reduces the risk of dissolved organic carbon passing into water courses and the subsequent costs of clean-up downstream. English peatlands are a significant carbon store, holding an estimated 584 million tonnes of carbon, equivalent to 2.14 billion tonnes of CO_2 or approximately five years of England's total annual carbon emissions. Restoration of blanket bog safeguards this important function and turns degraded bogs which emit CO_2 into healthy bogs which capture and store CO_2.

Peatlands are sensitive habitats and little of the peatland in England is in good condition. Many have been subjected to factors which have reduced their functionality. Impacts include atmospheric depositions which have reduced sphagnum cover, fire, peat cutting and drainage which have impacted on water tables and caused erosion, and grazing which may have modified the vegetation type. Peatlands are now known to be important for a range of outcomes:

- flood management, and water supply
- carbon storage and climate regulation
- driven grouse shooting
- agricultural grazing and livestock breeding
- biodiversity

Peatlands in poor condition cannot deliver the full range of outcomes, are a net source of carbon and are a cost to society. Developing restoration plans and sustainable management techniques that allow current land use practices to continue whilst eliminating or greatly reducing these wider negative impacts is a priority.

Q6 WHAT AM I AIMING FOR, WHAT DOES GOOD LOOK LIKE?

A good blanket bog is functioning and actively accumulating carbon. It will be identified by having a high water table (within 10cm of the surface for most of the year) and the presence of a range of species which should include abundant sphagnum species, cotton grasses and a range of dwarf shrubs, including heather. The peat is generally wet at the surface. There should be no large scale bare peat surfaces.

The ultimate aim, where climatic and topographical conditions allow, is for the vegetation to be in balance, where the growth of the heather is healthy but not rooting deep into the peat, which would cause the bog to dry leading to carbon loss, water discolouration and other negative impacts. In this state growth of heather and other dwarf shrubs is controlled by peat wetness and abundant sphagnum mosses but heather will be growing up through the sphagnum, constantly producing new shoots for sheep and grouse. Variable growth of sphagnum will create hummock and hollow habitats providing key habitat niches for many moorland birds. In this state, the moors will also retain and capture carbon, be biologically

An example of what 'good' looks like

diverse and be good for water quality, supporting the delivery of the five key outcomes. Heather is a normal component of blanket bog vegetation but in an active bog it does not assume dominance and it is this that we need to avoid. It is generally agreed that for a moor to be productive for grouse no more than 50% healthy heather in the sward is required. Too much heather will shade more sensitive vegetation and contribute to drying out the peat through its extensive root structure.

Q7 WHY IS 'GOOD' GOOD?

Good is 'good' for the following reasons:

- The varied structure and availability of food in the form of insects, young heather shoots, and plant diversity is good for grouse health and nutrition, cover and chick survival. A higher water table delivers more chick-food insects, particularly tipulid species (crane fly) and has a significant positive impact on chick survival.
- It provides a wider range of forage and availability of grazing through the year for livestock.
- A high water table and presence of sphagnum means that conditions are suitable for peat formation. The peat surface is protected from erosion and oxidation preventing carbon loss and more carbon is being locked up helping combat climate change.
- The layer of mosses and surface roughness helps filter drinking water so that it needs less treatment. The peat is not being dried out under the surface from a large heather root mass, the peat is not oxidising and carbon is not being released as dissolved organic carbon into the water courses. It is expensive to remove high levels of dissolved organic carbon (DOC) in water treatment and the by-products of the process are carcinogenic.
- Good quality bog is more resistant to wildfire as it will have a high water table and lower fuel load.
- Good blanket bog habitat supports globally rare species of plants and animals.
- A healthy moor with a diversity of species is much more likely to be resilient and adaptable as climate change occurs.

Q8 WHAT DO YOU MEAN BY HYDROLOGICAL FUNCTIONALITY?

The hydrological functionality of a blanket bog is the impact peat has on the water that flows through it and over it and vice versa.

A moor with good hydrological function will act like a sponge, holding water on the top of the hill. The water held in the upper layer of the peat flows very slowly. In times of high rainfall, mosses and rough vegetation on the surface of the peat slow down surface flow and so affect how quickly water enters water courses, reducing peak flood levels and helping to filter water so that it is cleaner.

Peat that is wet is less likely to burn during a wildfire, builds new peat and loses less carbon through oxidation, protecting the stored carbon of old peat and ensuring that the habitat persists.

Q9 WHAT ARE THE CHANGES I'M BEING ASKED TO IMPLEMENT? HOW IS THAT DIFFERENT TO WHAT I CURRENTLY DO?

Land managers already assess each part of their land before deciding what management is needed but may not be fully aware of the wider impacts of their management decisions. Land managers are being asked to consider a wider scope of factors so that they may continue with their activity or business whilst eliminating or significantly reducing unintended adverse impacts. For each area of land a check list can help:

- Is my peat deep or shallow? Use a stick to test the peat depth.
- Is the peat wet or dry, can I do more to make it wetter e.g. block drains/gullies? Does your stick come out clean closest to the top end? This suggests a high water table and active top layer of peat.
- Are there bare peat surfaces which need revegetating?
- Is there the right mix of vegetation for blanket bog, if not what is missing and what might need adding, especially sphagnum mosses?
- Is one species, often heather, over-dominant? If so, think about how you can reduce the dominance (cutting/burning according to site)
- What is the contribution of grazing management? Consider stock numbers and timing.

All these pieces of information will help you make decisions about how to assess and improve (if needed) the blanket bog in your care and improve the environmental services it provides.

The higher, wetter, western blanket bogs will be easier to restore than the lower, drier eastern sites. Decisions over management steps will need to be taken on a moor by moor basis with flexibility to account for the natural diversity encountered.

There are limited situations where doing nothing might fulfil all the outcomes but people have had an influence on most of our blanket bogs and reversing the impact will probably require a change. This may be a one-off action or changing on-going management to get to 'good'. All land managers will play a vital role in this, bringing their own knowledge and experience to bear. There are specialists in peatland restoration and peatland restoration partnerships. Collectively there is a wealth of experience to help improve blanket bogs.

Q10 WHAT MANAGEMENT TOOLS ARE IN THE TOOLBOX?

All tools are in the toolbox. The approach aims to make blanket bogs more active whilst phasing out the need for routine, regular vegetation management on deep peat where conditions allow. It is not a ban on burning and we are still learning about the most appropriate way to restore blanket bog. This will involve new techniques, experimentation, trial and monitoring. Where restoration is undertaken it should be informed by evidence

and followed up by monitoring and review of the results to determine whether further action is needed.

We know much about the impact of regular fire on blanket bog ecology and hydrology. Cutting is a relatively new tool and long-term effects are less well understood but it may have significant potential in managing the over-dominance of heather. There are well established techniques for blocking grips, addressing eroding gullies and for revegetating bare peat and there is a growing interest in a range of techniques for introducing blanket bog species such as sphagnum and cotton grasses. When thinking about vegetation management followed up by inoculating these species, you can also consider whether species could be introduced retrospectively. You may have created good conditions for inoculation on burns or cuts created over the last few years. These may offer a good opportunity to achieve more over a shorter period of time.

Remember to assess all the tools available, such as inoculation and cutting, and move away from thinking that routine burning is the only way to manage vegetation. The long-term aim is an active, functioning bog that is good for grouse, grazing, carbon storage, water and biodiversity.

Q11 WHAT IS THE EFFECT OF MANAGED BURNING ON BLANKET BOG?

The effect of burning is variable depending on a range of factors which include location, height, climate, aspect, state of the blanket bog and peat, timing and frequency of burning and the weather at the time of burning. Some effects are very visible, for example the changes that take place to vegetation immediately following a burn. Others, for example the impact on carbon and water quality, are much less obvious and can be easily overlooked but nevertheless are important considerations in terms of the functionality of the peat. Burning is currently the primary tool for controlling the fuel load on blanket bog. This is a vital task but the potential adverse impacts of burning must be understood by those employing it so that those adverse impacts can be avoided.

The following summary describes some of the observed impacts from routine, regular burning. How these are manifested will vary from site to site:

- A change in the species composition of blanket bog, at least for a period of time. This may include an initial period of graminoid (grasses, rushes and sedges) dominance, in particular of hare's-tail cotton grass, purple moor grass or deer grass (especially on the wetter peats), typically lasting 10–20 years, and with an initial decline in dwarf shrub cover and in some cases diversity. Heather and some other dwarf shrubs tend to be sparse during the initial graminoid dominant phase, but typically then increase, especially on drier sites, and may become dominant. On sites where much of the typical blanket bog vegetation has been lost or is sparse and where heather is dominant, continued regular burning is likely to perpetuate heather domination and reduce the opportunities for successful restoration;
- Sphagnum bog-mosses as a group have shown mixed responses to burning, in some cases increasing in the early post-burn stages, sometimes declining or being killed and sometimes then increasing or recolonising after varying periods. Anything which reduces the wetness of the surface in the long term will reduce the amount of sphagnum present. Burning may impact the hummock and hollow structure formed by sphagnum mosses;
- Burning can be associated with the creation of bare ground at least at a fine-scale and can result in the removal of the protective litter or moss layer;
- At Moor House (see Q36) the impact on the composition of blanket bog vegetation continues to show change more than 80 years after the last burn. This means that frequent burning may arrest the full development of blanket bog vegetation as it may never fully recover to the previous state;

- Burning can lead to the creation of relatively flat, unpatterned bog surfaces (this can be an issue with cutting too). This may be followed by the re-establishment of hummock-hollow topography following gradual recovery or recolonisation of sphagnum mosses over long time frames. Frequent repeated burning will arrest this development if it damages the sphagnum mosses;
- Changes in vegetation composition and structure may affect the functioning of the peat and hence have effects on associated ecosystem services;
- Studies show correlations between moorland habitat types, their vegetation composition and structure and densities of some moorland breeding birds, particularly waders. However, in few studies has this been related directly to peatlands, rather than moorland in general, or specifically to burning. Other factors such as predator control are also likely to influence bird abundance;
- Burning lowers the water table. There is evidence that burning lowers the water table in blanket bog affecting flow of water in the peat and allowing decomposition of the upper peat layers;
- Burning affects various components of the carbon cycle of upland peatlands. Only relatively recently have attempts been made to estimate complete carbon budgets that consider the overall impacts of burning. So far, these have produced inconsistent evidence, with predictions of both positive and negative overall effects of burning but it may result in the following:
  – increased dissolved organic carbon (DOC) in peatland watercourses;
  – reduced peat accumulation;
  – reduced carbon storage compared to unburned areas;
  – reduction in the level of the soil surface;
  – increases in transfers of CO_2 from vegetation to atmosphere through respiration and photosynthesis;
  – losses of carbon through burning and in conversion to char.
- Burning can have a range of impacts on water quality either directly or indirectly through changes in vegetation structure and composition. These may include:
  – increased water colouration and/or dissolved organic carbon (DOC) in watercourses;
  – a correlation between heather-dominated vegetation on deep peat and an increase in water colouration and/or DOC, in soil water and in watercourses draining peatland catchments;
  – evidence from laboratory studies that burning is associated with an increase in water colouration and increased pH (which are likely to be related as pH controls solubility of DOC);
  – shallower water tables initially after burning;
  – increased surface runoff after recent heavy rain;
  – changes in aquatic invertebrate assemblages in watercourses draining upland peatland catchments. These changes reflect declines in certain groups, especially those characteristic of unpolluted water, and increases in groups associated with water of lower quality.

Q12 CAN I STILL USE BURNING AS PART OF THE TOOL BOX FOR THE MANAGEMENT OF BLANKET BOG VEGETATION?

As part of moor management planning, burning is seen as a legitimate tool where it helps facilitate restoration ('restoration burning') and where it does not lead to deterioration of the blanket bog or impede restoration.

With respect to rotational burning (regular, repeated burning over the same area of ground) Natural England will not issue new consents on blanket bogs. Such burning is likely to encourage heather dominance and may lead to a drying out of the peat and loss of carbon. Note this does not apply to burning on dry, mineral soils where there is dry heath. It only applies to vegetation over deep peat.

Q13 WHAT IS RESTORATION BURNING?

'Restoration burning' should be viewed as one element of a suite of measures to be used in conjunction to start or accelerate improvement, where the aim is to reduce the cover of over dominant and shading vegetation, particularly heather, in preparation for planting or inoculation with target species such as sphagnum. Burning in isolation of other measures such as grip blocking or sphagnum inoculation is unlikely to be considered 'restoration burning'. The areas subject to restoration burning should be defined in advance. This will normally be followed up by further restoration techniques to facilitate improvement to the vegetation of the site. This type of burning should be agreed as part of a restoration plan to improve the condition of the blanket bog in specific areas. Restoration activity will vary between sites. Where cutting is practical and can be undertaken without causing significant damage to the peat surface it should be considered as an alternative that may have less impact than burning.

Q14 WHEN CAN I BURN?

When vegetation is not meeting management objectives, it should be managed to improve it, but taking into account all the other relevant outcomes from blanket bog. There is perhaps a need to rephrase this question. It should be 'When do I need to manage the vegetation?' If necessary this could be through burning and/or cutting. Management on blanket bog should aim to improve the condition of the blanket bog. Doing this will also help deliver all the outcomes. If heather is increasing to the point where it regularly needs to be managed then it probably reflects that not all the conditions for good blanket bog are in place (e.g. water table too low, not enough bog forming plants present, canopy shading out mosses and preventing rain water reaching the soil). Management should be directed towards addressing the conditions. Management of heather is part of the consideration but as part of a restoration plan, not in isolation.

Q15 WHY THE CHANGE FROM ROUTINE, REGULAR BURNING OF BLANKET BOG?

Depending on the conditions, by repeatedly burning we may be perpetuating a process which encourages a move to heather dominance and the requirement to intervene again and again on the same patch of land. The new approach aims to break this cycle so the need to manage the vegetation is reduced or is no longer necessary as peat becomes wetter and the blanket bog becomes more active, by restoring the blanket bog's natural function. If burning is undertaken, it will be part of a management regime that delivers restoration, such as reducing the heather canopy prior to sphagnum inoculation. The aim is to promote an increase in bog species and wetness of the peat. When used in this way, burning can be considered to be a restoration tool.

Q16 IN SOME SITUATIONS BURNING APPEARS TO MAINTAIN A 'GOOD' BLANKET BOG; WHY DO WE NEED TO CHANGE ANYTHING?

The monitoring and assessment of habitat condition looks at very visible attributes such as the diversity and abundance of certain indicator species. These include sphagnum and cotton grasses, typical species of a blanket bog. However, we cannot easily see what is going on in the peat itself. Is the water coming off the peat of good quality? What is the water table height? Is carbon being absorbed rather than being released? Have we got species of sphagnum present which contribute to building an active bog and functioning peatland? Research has shown that there are less obvious consequences of burning particularly in relation to carbon and water quality (see Questions 7, 8 and 11).

Sphagnum mosses are the key species but not all sphagnum contribute significantly to peat accumulation. Being able to identify the different species is critical. Generally those that form hummocks (such as *S. papillosum*, *S. capillifolium* and *S. magellanicum*) are most important, those that form shallow carpets or loose clumps in pools (such as *S. fallax* and *S. cuspidatum*) less important.

Too frequent or too hot burning can damage the hummock forming species. A burnt surface tends to be less structurally diverse with a loss of the hummock/hollow topography found on a very active bog where there is no need for vegetation management. (It is important to acknowledge that repeated mowing will create an even flatter topography). There is evidence of change in the composition of sphagnum species over the last few centuries for reasons that are not fully understood, but managed burning may have been a contributing factor.

Q17 WHAT IS THE IMPACT OF TOO MUCH HEATHER?

Heather is a natural component of healthy blanket bog. However, when conditions encourage very vigorous growth it assumes increased dominance over and above what might be expected in an active bog and it can act to impede the restoration process. It does this in four main ways:

- A dense heather canopy will shade out many of the other blanket bog species and its shed leaves provide a dry surface inhospitable to wetland species.
- It can result in lowered water tables, partly through the deep root system which transfers water to the atmosphere, thus drying out the surface peat layers and reducing opportunities for restoration.
- Peat pipes are associated with dominant heather cover, although the mechanism is not fully understood. Peat pipes can act to channel water away from the surface of the peat and in doing so release dissolved organic carbon.
- The dense canopy itself will prevent rainwater from reaching the lower vegetation layers and bog surface which will hinder restoration.

Laboratory studies also show that heather dominated vegetation has higher methane and carbon dioxide emissions than sphagnum or cotton grass dominated vegetation. Indirectly, over dominance of heather increases the severity of impact from wildfire and presents a greater risk of fire starting. This perpetuates a view that long heather needs to be burnt to reduce the risk. Inadvertently this cycle results in consolidating the heather cover into the future. Reduction in heather cover and restoration towards a fully active blanket bog will increase the resilience to wildfire and mitigate the impact by reducing the fuel load.

Q18 HOW DO YOU CHANGE THE VEGETATION TO MAKE IT MORE DIVERSE?

Heather is a competitive plant in the right conditions. It can shade out other species if it becomes dominant. Drainage and burning of blanket bogs has encouraged it to become more dominant in places. Cutting or burning will reduce competition in the short term and rewetting of the peat and raising the water table will reduce its competitive effect in the longer term, especially if accompanied by introduction or colonisation of wetland species such as sphagnum. There is evidence that heather regeneration after cutting may be slower than following burning and hence cutting may create a longer opportunity for bog plants to establish. Each bit of moor needs to be assessed to decide on the best method to use to rebalance heather growth so that it remains a healthy but not dominant component of the vegetation. Trialling different techniques followed by monitoring to judge results would be ideal.

Q19 WHAT IS THE IMPACT OF CUTTING?

Cutting can also be used to remove the heather canopy. If chopped finely and left, the brash can create a mulch to provide a damp seed bed ideal for sphagnum and other mosses to take hold if there is a dry bare peat surface. Leaving the brash does not reduce fuel load. Brash can be removed instead and used to regenerate areas of bare peat especially if moss is harvested with the brash but this requires that rainfall will be enough to keep the surface wet enough for introduced mosses to take a hold.

Cutting also has the following benefits:

- it should not expose any bare peat if the cutting bar is set high enough and the land is smooth enough
- it will not remove the bryophytes
- it can be used to spread existing sphagnum mosses
- regeneration of heather, particularly from older heather stands is likely to take longer
- it is not dependent on the weather and has a less restricted management season

The full impacts of cutting are not yet known. In some cases, cutting may lead to quicker heather growth – especially if younger heather is cut. Cutting should also be sympathetic to the structure of the peat surface so that it does not remove the hummock and hollow structure. There is also the need to consider any archaeological interest as machinery can potentially damage features and on sites which are protected for their cultural heritage (e.g. Scheduled Ancient Monuments), further consents will be required. Low ground pressure machinery and the cutting bar set at an appropriate height are key.

Q20 IS THERE A PREFERENCE OF CUTTING OR BURNING?

The most recent preliminary results from the Defra funded project comparing cutting and burning, undertaken on three sites in the north of England (Whitendale, Mossdale and Nidderdale) and reported in the Heather Trust's 2016 Annual Report show:

- less water loss from cut compared with burned catchments.
  water tables remained higher in cut catchments compared with burned ones.
- quicker revegetation of sphagnum and cotton grass in cut areas but after four years cover was similar in cut and burned areas.
- heather germination and seedling growth were more vigorous on the burned areas over the first two years following treatment.
- similar increases in nutrition levels in new shoots from both cut and burned areas
- after three years of management uncut areas stored on average 350g of carbon per square metre. Burning lost 350g from the peat and an additional 560g from the vegetation. Cutting lost only 350g as it stored carbon in the brash layer and decomposition losses were reduced due to initial faster regrowth of vegetation. Note this only shows the initial responses, the burned areas could catch up over a full management cycle.
- the higher soil moisture on cut plots increased crane fly abundance.

This provides useful information to support the benefits of cutting at least in the short term as a restoration tool. These results are early responses to management action and may not tell the full story over a longer period.

Q21 CUTTING IS NOT AS PRACTICAL AS BURNING, WHY ARE WE BEING ASKED TO CONSIDER IT AS A MANAGEMENT TOOL?

Cutting has benefits. It is an especially useful tool when the peat surface is dry and there is less chance of the surface rewetting through rainfall. In these cases cutting and leaving the brash may protect the surface from further drying and create damp conditions for introduced mosses to take hold.

In some cases, cutting will not be practical due to lack of access, if the ground is stony, too wet and fragile, or if the topography of the land is too varied.

Cutting is not so dependent on the weather as it can be done at any time of the year (excluding the bird breeding season).

Gearing up with kit for cutting on a large scale is likely to be more expensive than burning with low ground pressure, high torque tractor being the greatest outlay. Many land

managers already have smaller ATV towed cutting kit as it is part of the toolkit for burning management and trial plots could be created to compare methods. If full sized kit is purchased a greater area can be potentially managed in a year and operated by a single person.

Q22 HOW CAN WE CHANGE THE VEGETATION ON AN AREA OF MOOR?

Use the Decision Making Toolkit to decide what 'state' the moor is in. The main aims are to:

1. Rewet the land by blocking gullies or grips if these are present
2. Revegetate any bare peat surfaces
3. Modify the vegetation to enable the development of active blanket bog. This may include reducing the dominance of heather and slowing down its growth and introducing sphagnum mosses, ideally hummock-forming species that are the best peat-formers

The speed of recovery will vary between sites but may take many years, and might require a number of interventions. Monitor progress on steps 1–3 above, using the methods described in Question 30.

Q23 WHY DO WE WANT TO HAVE SPHAGNUM? WOULD SPHAGNUM HAVE BEEN HERE ORIGINALLY?

Peat is formed from plant material that cannot fully decay due to acidic, wet, anaerobic conditions. The species that form peat most often are sphagnum mosses and cotton grasses. Sphagnum mosses are particularly important alongside wet conditions in providing the acidic environment needed to arrest the decomposition of other plant matter. Where there is deep peat, sphagnum would have been present historically and for continuing peat formation sphagnum is essential.

The English peatlands are a significant carbon store, holding an estimated 584 million tonnes of carbon which is equivalent to 2.14 billion tonnes of CO_2 or approximately five years of England's total annual carbon emissions. Worldwide blanket bogs hold over 550 billion tonnes of carbon, over twice as much carbon as contained in the world's forests. By creating conditions where sphagnum is growing and peat can form, blanket bogs can be more resilient to climate change and can also lock up carbon but modified peatlands without sphagnum are net exporters of carbon. The re-establishment of sphagnum on modified peatlands is key to eliminating current negative environmental impacts.

Q24 WHAT IMPACT DOES SPHAGNUM HAVE ON THE HEATHER?

A good cover of sphagnum can be indicative of a high water table and sphagnum will help maintain a high water table and surface wetness. This won't kill the heather but will affect its growth rate. The aim is to have the heather growing in balance with the sphagnum, growing up through the sphagnum and providing new shoots each year. A healthy bog will have both sphagnum and heather and if this steady state can be reached, the heather should require no long-term management to deliver grouse objectives.

Q25 WHAT CONDITIONS DOES SPHAGNUM NEED TO GROW?

Because sphagnum moss has no roots and gets all of the water that it needs through its stem, it needs wet conditions to grow. It thrives in areas with high rainfall and where the atmosphere is saturated with moisture for many days of the year. It also needs a wet substrate, often provided by a water table at or near the surface. It can grow on slopes as well as on the flat and in very undulating conditions will grow in the damper hollows. There is no minimum depth of peat needed for sphagnum growth. Indeed, in the tropics it can grow on gravelly substrates provided there is high humidity.

There is much still to learn about how to reintroduce sphagnum and the range of conditions required. Not all our peatlands are wet and we need to find new ways to assist the establishment of sphagnum on the drier peats. If we can restore sphagnum to the drier peats its presence will itself help water tables recover. We still need to learn how to do this effectively. Providing increased humidity at the soil surface may be the best way. This could be achieved in a number of ways, including cutting vegetation and leaving the brash or introducing feather mosses as an initial nursery crop. These will help increase humidity at the surface and this may act as a precursor to sphagnum taking advantage of better conditions in time.

Q26 HOW IS SPHAGNUM INOCULATED?

The mechanics of how to inoculate will vary from area to area and will depend on what mosses and plants are already there, the age of the heather, the hydrology, slope, aspect and rainfall. As this is a new approach we are still learning about the techniques and it may be best to experiment with a range of techniques to find the one that suits the conditions on each moor. We can say that sphagnum requires light and wet conditions to establish. There are a number of ways in which sphagnum can be added including:

1. Spreading of pellets, inoculated with sphagnum spores
Pellets can be created to a moor-specific recipe or more standard mixes can be produced. Seeds of other species can be added. Natural England can advise on the species that may be required.

- How are pellets spread?
  The pellets can be spread by hand or using a spinner towed by an ATV dependent on the scale of application required.
- How many pellets do you require per acre?
  This will vary from site to site but you should aim for around 36 pellets per square metre. Lower rates would be acceptable where there is already some moss cover. Suppliers will be able to advise based on their experience.

2. Direct transplanting of sphagnum harvested on the site and moved to an area where it is needed
This can be done by hand and is likely to be the most successful means of establishing sphagnum quickly. This method allows you to be very selective of the species and gives much quicker responses. However, it depends on having enough sphagnum available and it is labour intensive but also potentially cheaper as it is using existing natural material. Avoid taking too much from the donor site, generally it is safe to harvest 10% from any area. Collection of sphagnum would need approval from Natural England on a SSSI.

3. Cutting of brash containing sphagnum material and spreading on the required areas
This is particularly useful in the treatment of bare peat surfaces where a mix of vegetation is required.

- Is it best to inoculate before a cut or after? Inoculating before may give the material a better chance of being in contact with the peat surface and then the cut brash provides increased humidity and protection, which may be important on dry or exposed areas. Leaving the brash will provide increased humidity and protection. Brash can be removed if sphagnum is already present and used elsewhere on site for restoration.

4. Using material supplied through micro-propagation techniques
This can be in the form of beads, slurry or small plugs. This technique allows the supply of any species required. The speed of recovery and successful establishment of sphagnum may take longer compared to other methods. As the material is grown in sterile conditions there is less concern about spreading disease.

Q27 ARE THERE DIFFERENT TYPES OF SPHAGNUM SUITABLE FOR DRY AREAS AND HOW LONG DOES IT TAKE TO GROW?

We are still learning about the use of different types in different situations. *Sphagnum fallax* is generally the most common species and occupies a range of habitats. This is likely to be the best species to use as a first attempt.

The time taken for sphagnum to establish depends on the type of material being used. Spores and propagules generally take much longer than fresh material. Brash containing cut sphagnum can show good colonisation after two years. Plugs give an immediate response and can double in size within a year. Plants applied as fragments in pellets and solution are very small and may take 4–5 years to grow into recognisable plants.

Q28 HOW WILL WE KNOW IF THE RESTORATION ACTION IS WORKING? WHY MONITOR?

Unless we monitor to track progress we will not know if restoration is working. Monitoring is essential to help you understand what changes happen after restoration management and whether further action may be necessary. For example, is sphagnum increasing? Has the heather come back too quickly to allow other bog plant species to get a hold and flourish? Are initial beneficial changes maintained over time?

The changes and their causes should be considered and used to inform a next step which may be a further burn and/or cut followed by other action to put the restoration back on track. Estate staff and Natural England advisors would work together to agree flexible next steps dependent on the results. It is hoped that further inoculations of peat forming species would not be required if they have successfully established, but fine tuning to deliver an active bog surface with abundant sphagnum mosses and a naturally controlled dwarf shrub heath component providing food for grouse and sheep is the aim.

Monitoring does not need to be complicated. It can be as simple as a photograph of vegetation taken periodically (e.g. every 3–5 years) from the same spot using GPS.

Q29 HOW DO I ASSESS THE LAND?

There is no one-size-fits-all formula for what 'good' will look like. However a peatland will be moving towards 'good' if it has the following characteristics:

The water table is high (within 10cm of the surface most of the year) and the surface peat feels wet throughout the year – kneel on it, ideally your knees should get wet;
Limited areas of bare peat showing signs of continuing erosion;
A wide variety of bog species present – at least six of the following bog indicator species:
Heather *Calluna vulgaris*
Sundews *Drosera spp.*
Heaths *Erica spp.*
Crowberry *Empetrum nigrum*
Cotton grasses *Eriophorum spp.*
Bog asphodel *Narthecium ossifragum*
Non-crustose lichens
Feather mosses (Pleurocarpous mosses)
Reindeer moss (various *Cladonia* lichens)
Woolly hair moss *Racomitrium lanuginosum*
Cloudberry *Rubus chamaemorus*
Sphagnum spp.
Deer grass *Trichophorum cespitosum*
Bilberry, cranberry, cowberry *Vaccinium spp.*

- A good balance of vegetation types. As a rule of thumb, you should be able to see approximately 1/3 heather; 1/3 cotton grasses and at least 1/3 sphagnum with a range of other wetland species present. The more sphagnum the better; it should be ideally forming an understorey beneath the other species.
- The presence of hummock forming sphagnum mosses (e.g. *S. papillosum, S. capillifolium* and *S. magellanicum*).
- If burning or cutting management has taken place there should be no exposure of the peat surface or lasting ruts caused by vehicles.
- The presence of small pools of open water formed by pooling where the water table is high.

Using the above criteria will help determine the state of the blanket bog and whether there is a need to do something different. The accompanying Decision Making Toolkit will help determine what management may be required. However it is important to continually assess the land to determine change on the ground and whether the change is on a positive trajectory. This can be done simply through the use of GPS and fixed point photography and observations at the same point. Each piece of land will differ in terms of the starting point so select the most relevant to monitor for the area. Examples might include:

- Heather dominance – is it increasing or decreasing? Too much heather is negative for all the outcomes. Aim for no more than 50% cover. More than 75% signifies inactive blanket bog.
- Sphagnum cover – is it increasing or decreasing? The more sphagnum the better. If the monitoring shows it is declining we need to think about why this might be the case.
- Sphagnum species – are hummock forming/peat forming species present? If not we may need to add them.
- Species diversity – there should be a range of species present from the above list. If there are less than six and this is consistent across the moor some may need to be added.

Consider also the water table. A high water table means that the conditions are present to support an active bog. After a few days without rain does the surface layer of peat remain wet or is it dry and crumbly? When you push a stick into the peat does the top part of the stick come out clean and moist relative to the lower part?

A reliable way of actually measuring the water table depth is through using manual dipwells. These can be made simply from 1m lengths of 34mm diameter polypropylene waste pipe and drilling perforation holes at 100 mm intervals, with the first perforation holes located 100 mm below the position of the ground surface after installation. The base of each dipwell is sealed with a waterproof tape. The piping is installed by coring out peat, using the same diameter pipe to the dipwell. The dipwell is then pushed into the hole with approximately 100mm of pipe protruding above the ground surface. The dipwells are normally checked manually, by blowing down a tube which is lowered into the pipe. When the tube reaches water, bubbles are produced and the resulting depth can be measured and recorded.

Q30 CAN MOORS BE REWET IN A WAY THAT DOES NOT NEGATIVELY IMPACT ON GROUSE?

Rewetting does not mean there are large areas of standing water that kills all heather, or provides no open areas for birds to dry out.

In a balanced state, a rewet moor will have water that flows slowly through the surface layers of vegetation and peat. The vegetation will be mixed, including plants that are wet-loving such as mosses and cotton grass and other species such as heaths, berries and lichens which often occur on drier hummocks. On flatter areas, there may be small pools. This mix is typical of an active bog and provides conditions required by grouse and other birds

including permanently wet areas important in dry conditions, drier raised areas that birds can dry out in and use to scan the horizon.

In such an environment, heather will have to compete with the mosses and cotton grass, but should not be so stressed that it succumbs to disease or pests such as heather beetle, or loses its nutritional value. Although heather beetle may be becoming more widespread it is equally prevalent on dry and wet moors.

Blocking grips or gullies is simply returning the moor to its previous state – pre-1950-70s. Pre-war game bags were higher than now! It should not make them wetter than they once were. Blocking should be done where the grips or gullies have flowing water or are eroding and showing no signs of naturally revegetating. These should be blocked in an appropriate way so that they do not flood the moor. Advice should be sought from Natural England, the peatland restoration partnerships and experienced contractors about what the best techniques and plan might be for a particular area.

Rewetting should then help raise the water table and allow the natural bog vegetation to recover – especially where a dominant shrub canopy is removed. In some situations, like bare or eroding peat or grass/heather dominated moors, the natural bog vegetation may not be present. In these situations a restoration plan will need to also include revegetation and introduction of bog species such as sphagnum and cotton grass, which will help to reduce the risk of any erosion from excessive water movement on the bog surface.

Q31 HOW DOES NATURAL ENGLAND WANT TO WORK WITH LAND MANAGERS?

Natural England are looking to work with land managers using an outcomes based approach. This involves mutual understanding and trust on both sides. The aim of this way of working is to remove the very rigid prescription led approach and move to one whereby land managers use their own skills and judgement and knowledge of their land to put in place management techniques that will deliver improving blanket bog.

As part of this land managers should be able to do some simple monitoring (for example, photos at fixed points, and possibly dipwells) to show how the land is changing. This will require co-operation and building new relationships whereby each party learns from each other. Natural England will work with land managers to develop new ways to improve the blanket bog and find the best ways for each area across each moor. Land managers will need to think about using all available tools and using burning in a more informed way for all outcomes.

Natural England advisors and land managers are all being briefed on this new way of working and getting everyone up to speed will take time – especially with unknown responses from restoration techniques across moors which are all different. Working together and pooling knowledge, experience and results is what is needed.

Always try and resolve any issues at first with your Natural England advisor. If there are disagreements then there is a route within the Area Teams to help resolve these. This new way of working will rely on trust and co-operation between land managers and Natural England and most importantly relationship building.

Many land managers have existing agreements with Natural England. These remain in place until their expiry. During the remaining period Natural England advisers will discuss with land managers the states of peat that exist on their land and the options for restoring blanket bog. The aim is to develop a restoration plan in time for transfer to the next scheme. Existing 'rotational' burning consents will be withdrawn in this process and replaced with restoration plans with vegetation management as an integral and vital part – for both blanket bog

restoration and wildfire mitigation. If there are a significant number of years left with an existing agreement the intention would be to help use the existing terms of the agreement to support restoration. If the agreement expires shortly the restoration plan will be an integral part of a new agreement. The new Countryside Stewardship scheme may be a mechanism for delivering moorland restoration. This is a Defra scheme operated by Natural England and requires agreement holders to follow prescriptions.

Q32 HOW CAN THESE CHANGES BE FINANCED?

There are a range of potential funding mechanisms to support restoration of blanket bog. There are uncertainties as a result of Brexit as the two main funding programmes are supported via the EU Commission. Countryside Stewardship (CS) currently provides the main mechanism to support environmentally focussed land management. This scheme is administered by Natural England. CS agreements may include capital payments for restoration alongside annual payments for moorland management. It is likely that emphasis will be given to restoration when CS schemes are worked up. It may also be possible to use capital payments in existing Higher Level Scheme agreements to support restoration works. The EU LIFE programme supports major restoration projects. Currently there is a major programme operating in the Peak District and South Pennines administered by Moors for the Future Partnership. Other peatland partnerships operate in other upland areas and are funded by a variety of sources including charitable trusts, landfill tax and water companies. A list of the key peatland restoration partnerships is provided at the Appendix.

There is also a developing concept around payment for ecosystem services, recognising and rewarding those who provide a service. One example for upland moorlands might be the provision of fresh water and flood regulation. Those that benefit from these services would then help pay for the management of the land so that these services continue. There are examples where this exists already, for example, water companies will often spend significant amounts of money on projects to restore areas of moorland with bare peat as they benefit from moors that provide clean water.

Another mechanism whereby services can be paid for is carbon trading where the carbon captured in the peat is given a value and payments are made by those that use significant amounts of carbon. Payments might be made to ensure ongoing management that keeps the carbon there, and traps more carbon (by having an environment in which peat is actively growing). The IUCN Peatland Code is a possible mechanism that links funding to restoration.

All these concepts are in development. However a resilient moor that does not lose carbon could attract some form of alternative funding in the future.

Q33 HOW WILL BREXIT AFFECT HOW WE MANAGE LAND?

Natural England and land managers working together towards 'good' is an agreed policy regardless of what happens before or after the UK leaves the EU. Brexit may have an impact on what payments are available, but this should not impact on how land now needs to be managed with other outcomes in mind.

Q34 WHAT ABOUT GRAZING?

Grazing at an economically viable level that works in conjunction with farmers' available in-bye land is a key outcome of a healthy moor delivering multiple outcomes. Grazing is one of the tools for managing a moor. Grazing in the right place, at the right time and with the right number of suitable animals can help manage heather, and other moorland vegetation, and reduce the need for burning or cutting. Natural England recognises that these levels and timings may vary year on year and will endeavour to work with land managers to make stocking regimes fit for purpose.

However, it is recognised that this is a real challenge, particularly on blanket bog where grazing may only be required for short periods and with relatively small numbers of livestock. Most moors have a mix of vegetation types which may require different grazing regimes and defining a grazing regime in such cases is not simple. We do need to learn from the past 25 years of agri-environment agreements as they provide some valuable evidence to help in the future. In some cases stock may have been reduced to support heather restoration. This has been successful in many areas to a point where the heather is now vigorous and requires more regular management to deliver all of the outcomes. There are particular challenges in some areas where changes in farming practice and the requirements of previous agri-environment schemes mean that suitable grazing stock may no longer be readily available. Natural England is keen to develop long-term plans which factor in the wide variation in experiences and which allow multiple key outcomes to be delivered. This can only be achieved through an open dialogue with all concerned in managing the land. These plans need to account for the year round management requirements of livestock not simply the period that the animals are on the moor. Such collaborative working will be especially important where the land is a registered common or shared grazing, and where agri-environment agreements are often with the common or graziers association.

Temporary removal or reduction of grazing may be necessary to facilitate vegetation recovery and to enable the revegetation of bare peat, helping nurse crops to establish and avoiding erosion through trampling.

Other management activities such as blocking grips and gullies, increasing diversity of species and increasing sphagnum can be undertaken alongside livestock grazing. Management tools such as cutting can open up new areas for grazing leaving some areas of taller vegetation could remain for foraging during snow cover.

Q35 WILL THE BLOCKING OF GRIPS/GULLIES BE A DANGER TO MY LIVESTOCK?

Pools, boggy areas and blocked grips/gullies can provide drinking water all year round which in turn reduces grazing pressure lower down the water system in summer. Livestock may take time to get used to where these pools are located and care will need to be taken when sheep are being gathered to ensure that they have time to negotiate wetter areas.

Grip and gully blocking can be planned and delivered in such a way as to create grip/gully crossing points for livestock and also small farm vehicles. A study in Wales (Wilson *et al.*) showed numbers of sheep being lost in grips decreased after grip blocking, due to the increased number of crossing points (dams) available. The study presented evidence that restoring a peatland through drain blocking is likely to have at least a neutral influence on sheep farming, and potentially of positive benefit. Restoration does not reduce the amount of grazing available, and appears to both increase access to wetter areas and decrease the hazard represented by drains.

Q36 IS BOG ASPHODEL LIKELY TO INCREASE WITH REWETTING AND WILL IT AFFECT MY ABILITY TO GRAZE?

Bog asphodel is known to be toxic to some livestock and is often present in blanket bog vegetation. It is known to prefer places where there is some lateral flow of water so in blanket bog areas tends to pick out valley mire systems, runnels etc where it can become concentrated, forming patches by vegetative, rhizome spread. It is probable that raising water tables allows the plant to spread but there may be effects of reduced grazing pressure too – ungrazed plants may be more vigorous, flower more and so are obvious. The increased abundance or vigour of bog asphodel poses problems where livestock, especially lambs, graze it in the summer.

Bog asphodel causes symptoms in sheep that have been known to the farming community for many years but there have been a number of cases in recent years where there have been significant problems, attributed to rewetting or changes in grazing arising from moorland restoration projects. The development of areas that cannot be grazed either due to extreme wetness or poisonous vegetation is of concern to farmers and does not fulfil the grazing outcome.

Whether bog asphodel affects the suitability of land for grazing probably depends on a range of site-specific factors such as the vegetation conditions, alternative grazing opportunities and the characteristics of the grazing animals.

The main management responses are to exclude grazing or avoid grazing at key times where farmers have the land and flexibility to do so. Other options to explore are grazing with less susceptible (or maybe less obviously affected) older stock such as wethers, older hoggs/shearlings, while still keeping an eye out for signs of photo-sensitisation. Where farmers have limited options a more flexible approach to grazing could be explored, allowing some earlier or heavier grazing in late winter/early spring to perhaps reduce plant vigour, with reduced or no grazing in the risk period.

It is not known whether the increase in bog asphodel is a short-term response, with the plants reducing in vigour over time as competition from other species increases, or whether these are long-term effects.

Q37 DOES WETTER MOORLAND INCREASE THE RISK TO SHEEP OF INFECTION BY LIVER FLUKE?

Evidence suggests that rewetting blanket bog will not increase numbers of liver fluke. The liver fluke's intermediate host, the snail *Galba* (formerly *Lymnaea*) *truncatula*, cannot survive where the water has a pH lower than 5.4, and ideally needs a pH of between 7.0 and 9.7, with a high dissolved calcium level. These conditions are not found on areas of blanket bog. (The pH of blanket bog waters range between 2.0 and 5.0, with an average soil pH across the Pennines of less than 4.0).

Whilst the pH of the bog is raised, by the application of granulated lime, during a bare peat revegetation phase, it only goes up to approximately 5.5, declining over a period of about 18 months. This is not long enough for a population of snails to establish and generally, stock will be excluded from the bog during this period as the grasses that are sown are preferentially grazed by sheep. These changes to pH do not occur where the only action is rewetting, using grip and gully blocking.

Furthermore, the snail favours areas of variable wetness, rather than the stable wetness of a blanket bog, and favours nutrient rich soils supporting algal growth on which it feeds. A study of the rewetting of blanket bog in Wales found no snails in a rewetted bog. Work on a restored site on Exmoor found snails in the valleys, where the soil chemistry will be very different, but no snails on the bog itself.

It is recommended that sheep are routinely dosed for liver fluke if they run on pasture that could be infected, and it is considered more likely that fluke are prevalent on intensively managed in-bye with a more optimal pH for the snails.

There is useful information available from AHDB http://beefandlamb.ahdb.org.uk/wp-content/uploads/2013/06/Leaflet-Reducing-liver-fluke.pdf or consult your veterinary surgeon for advice tailored to your moor and livestock.

Research into the effects of rewetting blanket bog on parasites continues. If you would like further information please contact the Moors for the Future Partnership.

Q38 WHAT DOES THE EXPERIMENT AT MOOR HOUSE NATIONAL NATURE RESERVE SHOW?

The experiment was established in 1954 on Hard Hill by the then Nature Conservancy and is the only long-term replicated study on rotational burning in the UK. Four experimental blocks were established at intervals up the hillside in 1954. Each block was burned at the start of the trial and is subdivided so that there are two grazing treatments (grazed, ungrazed) and three burning treatments (10-yr, 20-yr and 'unburned' control) in plots within them. The treatment burns are of individual 'sub-plots' so are much smaller and fires are probably less severe than the original burn. Longer-unburned (at least 30 years prior to 1954) 'reference plots' were established adjacent to each block and have remained unburned for over 90 years.

Summary of main vegetation monitoring results to 2001
(2011 for 'reference plots') based mainly on Lee *et al.* (2013a)

- An initial post-burn increase in cotton grasses, an acrocarpous moss *Campylopus flexuosus* and bare ground.
- An initial decline in heather which then increased in the longer (20-yr) rotation and especially the control (and longer-unburned 'reference plots', see below), as did the pleurocarpous mosses *Hypnum jutlandicum* and *Plagiomnium undulatum* and bryophytes in general. The increase in heather was not associated with a decline in species-richness (which was highest in the control treatment).
- *Sphagnum* species occurred at relatively low frequency in all treatments, though *S. capillifolium* showed a greater frequency in the 10-yr burn treatment. However, the number of spp. (and probably cover) was greater in the longer-unburned 'reference' plots. There is also an increased frequency of sphagnum propagules in the peat with increased time since burning.
- Some spp. showed consistent changes over time across treatments, e.g. an increase in heather, suggesting that some of the change may reflect factors other than just burning.
- The longer-unburned 'reference plots' continued to show change >80 years after the presumed last burn, with an increase in moss species-richness, heather and the mosses *Aulacomnium palustre* and *Plagiothecium undulatum*, and the addition of 24 new spp. including six *Sphagnum* species and the relatively scarce orchid *Listera cordata*, (but a loss of eight species) between surveys over a 48 year period. Thus, despite an increase in *Calluna*, cessation of burning has not been associated with a decline in vegetation diversity, but more a progression towards a 'steady state' where heather is rejuvenated by layering and growing through sphagnum hummocks representing gradual restoration towards favourable condition.

The experiment results relate to vegetation composition and provide little information on vegetation biomass and structure, nor on bog surface structure/micro-topography, which are key characteristics of functioning blanket bog (though there are several separate studies that provide some information on this). A recent initial survey of micro-topography showed some differences between blocks and sub-plots which are visible on the ground, especially in the top block, which are currently being studied in more detail.

It should be noted that Moor House is an example of a blanket bog that has not been managed intensively for the past 60 years. There has been no burning except for the experiment and grazing pressure has been generally light. Since foot and mouth disease in 2001 very limited grazing occurs on the blanket bog areas. It therefore cannot be compared directly with blanket bog that is managed for both grouse and sheep. The intention of the experiment is to see what happens when land is left unmanaged and how things change naturally rather than through interventions such as burning and grazing. It is a long-term experiment that is not constrained by the need for the land management to be commercially or economically viable. In these climatic conditions, however, the heather presents fresh shoots pushing up through the moss at head height for grouse and does not demonstrate an obvious or alarming fuel load because growth is slow and the heather layers in the moss carpet.

Q39 WHAT ABOUT WILDFIRE?

Wildfire is a risk on open moorland and on some sites has contributed to significant environmental damage. The protection of economic activity, habitat and the carbon stored in the peat is an important consideration and should be tackled by a holistic approach to wildfire risk management. The requirement for wildfire prevention activity will vary from place to place and in the long-term restoration of blanket bog will make it more resilient and will result in lower fuel loads. There is recognition that the risk of severe damage by wildfire on a wet, well-functioning blanket bog is relatively low. Burning or cutting firebreaks may still be necessary to reduce the risk of fires starting and reduce the spread of fire around likely ignition points. While moors are undergoing restoration wildfire is a risk that needs to be managed based on a fire risk assessment that considers factors such as vegetation type, fuel load, public access, strategic access and proximity to infrastructure and settlements.

Q40 WILL THIS APPROACH CHANGE?

To ensure this document remains useful, it will be revised so that it continues to be relevant to all stakeholders taking account of changes in practice, new techniques and situations and addressing questions as they arise. Equally, as more research is concluded the evidence base will be updated and management practice informed accordingly.

To submit comments and questions on this guidance, **e-mail moors@peakdistrict.gov.uk** with the heading 'Blanket Bog – Outcomes Approach – Land Manager Guidance.'

To see the most up to date version of the guidance go to:

www.moorsforthefuture.org.uk/blanket-bog-guidance

APPENDIX

Contact details of peat restoration projects:

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To give feedback or ask questions please e-mail moors@peakdistrict.gov.uk
To download the latest version please go to
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