

UplandsManagementGroup

SPHAGNUM TASK & FINISH GROUP

Report from visits to six moors to inspect
Sphagnum Regeneration Techniques



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1 Introduction

- 1.1 The Sphagnum Task & Finish Group was set up by the Uplands Management Group to investigate and report on examples of the range of techniques being used in England to regenerate the cover of Sphagnum mosses on deep peat, with a view to covering areas of bare peat, diversifying vegetation, where Sphagnum was absent or sparse, and restoring active bog function, biodiversity and associated ecosystem services.
- 1.2 There is scope to improve the condition of many areas of deep peat for sheep and grouse as well as biodiversity, water quality and carbon storage. One of the aims of this work is to establish whether or not it would help to produce some new, targeted guidance covering the techniques available to landowners and managers to improve peatland, based on the restoration methods outlined in this report.
- 1.3 Andrew Walker of Yorkshire Water agreed to be the Chairman of the T&F Group. A list of the members of the Group is in Appendix 1, and a list of those who took part in the visits is included in Appendix 2.
- 1.4 Attendance at the visits expanded beyond the Task & Finish Group, and as a result, the discussions extended beyond the Group's brief. The report has been confined to address the issues outlined in the brief but additional questions and issues, which were raised during the visits and remain to be considered, have been recorded in Appendix 8.

2 Visit Programme

- 2.1 This report follows the visits carried out over four days by members of the Task & Finish Group to six different moors in the Peak District, Yorkshire Dales and North Pennines. Different methods for stabilising peat and reintroducing / encouraging Sphagnum mosses were demonstrated on each moor.

Date	Moor	Host
7 Jul 15	Kinder Scout	Moors for the Future Partnership The National Trust
24 Nov 15	Derwent Moor Abney Moor	Geoff Eyre The National Trust
26 Nov 15	Broadmea Fell	The North Pennines AONB Partnership Knarsdale Estate
26 Nov 15	Geltsdale Moor	RSPB
1 Dec 15	Mossdale Moor	Yorkshire Peat Partnership Barker & Bland, Mossdale Estate

- 2.2 The visit reports are enclosed as Appendices 3-7, and all follow the same format.



The Group on location – Kinder Scout

3 Conclusions

- 3.1 'Every site is different' – there is no single solution.
 - 3.1.1 It is clear that methods that work well in one area might not be as successful in another area. Conversely, a different method might be more appropriate than one currently being used.
 - 3.1.2 The techniques that were inspected should be used as an indication of the range of available techniques that can be adapted according to the needs and uses of the peatland being considered for improvement or restoration work.
- 3.2 There is great scope for finding unique local solutions. All types of landowners and managers are adept at developing such solutions, if they understand the objectives, desired outcomes and constraints.
- 3.3 The most appropriate approach to restoration, or improved management, will depend on available resources, and other land use objectives, as much as the existing condition of the peatland and desired final condition.
- 3.4 The Group visited a range of sites, and on some of these the work had started not long before the visit. Some success had been achieved on all the sites and on the basis of what was observed during the six visits, these techniques are achieving measurable improvements.
- 3.5 Where it is difficult to specify the desired outcome exactly, it might be better, and more effective, to describe the conditions that give rise to concern, such as: bare peat, dry peat, heather (and sedge / grass) domination and eroding grips / gullies, and indicate how the condition of the peatland could be improved through changes to management or restoration work.

- 3.6 The re-vegetation of bare peat, which is eroded quickly by the effects of wind, water and livestock, should be a key issue for introducing the concept of peatland restoration to the owners & managers of land.
- 3.6.1 The choice of species used to provide the initial cover is less important than establishing cover as quickly as possible. However the proportion of individual species used should be a consideration, partly informed by the long-term desired state.
- 3.6.2 Species that can be used to provide initial cover include: less persistent grasses, such as agricultural grasses and some fescues and bents; dry heath mixes; wavy hair grass; cottongrasses; pleurocarpous mosses; and Sphagnum mosses (even if not key peat forming species e.g. *S. fallax*).
- 3.6.3 Once the peat is vegetated and stable, additional peat-forming species can be considered to both increase diversity and enhance functionality.
- 3.6.4 An alternative approach is to add a broad range of vegetation species, initially.
- Different vegetation species require different conditions to thrive.
 - Ground and weather conditions will vary in time and location and the different species will grow when the conditions are right.
 - This approach avoids the need for a return visit to apply more seed.
- 3.7 Producing a simple guide to the different techniques viewed during the visits would provide useful support for the owners, managers and advisers who want to improve the condition of the areas of their land covered by deep peat.
- 3.8 It is not always clear what the best management techniques are to achieve a shift from heather dominance on drier peats to a higher proportion of peat-forming species, especially where there is little or no under-storey of other vegetation or direct opportunities to re-wet the peat. There was a willingness within the Group to promote trials of different techniques, including monitoring, in different situations in order to address the challenge this poses. Additional work should be linked to demonstration events.
- 3.9 From the discussions that took place during the visits, enhancing co-ordination between the peat restoration partnerships and communications with land managers and advisory bodies is essential to maximise the knowledge base.
- 3.9.1 Sharing knowledge and experience openly is likely to increase the rate of progress towards better peatland condition in England.
- 3.9.2 As an aid to a better flow of information, it would be useful to have a map of the English Uplands showing where peatland restoration activity is taking place, where it has been completed and where it is required.

- 3.9.3 Better coordination of different peatland initiatives is understood to be one of the aims of the bid being developed by Defra for a LIFE Integrated Project. It is also a key function of the IUCN Peatland Programme.
- 3.10 It was acknowledged that there is commercial competition between peatland restoration contractors and this may hinder the exchange of information about techniques and experiences. Better communication would allow members of the industry to learn from each other and contribute to the overall aim of improving peatlands.
- 3.11 More effort should be directed at communicating the importance of peatlands, the need for sensitive management of peatland, and peatland restoration beyond the conservation community.
- 3.11.1 This could be addressed, at least in part, by any guidance for owners and managers of peatland that flows as an action from this report.
- 3.11.2 More workshops and on-site meetings for advisers, landowners and managers would serve to raise awareness of how a new approach to peatlands can benefit their own interests, as well as providing public goods.
- 3.11.3 Equally, the workshops and meetings should be used as an opportunity to showcase the amount of restoration work that has been completed and is already underway on deep peat.
- 3.11.4 Greater understanding of the issues, and the amount of work completed and underway, would lead to more engagement and support from the owners and managers of land, and the local communities that are within and adjoin peatland areas.
- 3.11.5 In addition to explaining the importance of peatlands, communications and events should explain the benefits for land management and cover how to:
- Avoid inadvertent damage in the first place,
 - Initiate improvement work,
 - Maintain peatland, after capital improvement works have been completed, and
 - Remove barriers to take-up and address misconceptions.
- 3.12 The brief for the Sphagnum T&F Group invited the Group to consider the work to develop vegetation proxies to indicate peat condition. It is understood that this concept is still under development at present. It may be that the relatively rapid development of remote sensing techniques for mapping vegetation could make use of vegetation proxies more viable over wider areas.



Mossdale: bare peat under water

4 Recommendations for Action

- 4.1 Present this Report to the Uplands Management Group (UMG) for discussion and adoption.
- 4.2 Consider how guidance can be prepared that will be of value to practitioners.
 - 4.2.1 The establishment of a separate T&F Group is likely to be the best approach.
 - 4.2.2 The guidance could take the form of a flow chart that would identify the best approach to use from the six different starting points identified in the ‘Strategy for the restoration of Blanket Bog in England’: afforested bog, bare peat bog, dwarf-shrub dominated blanket bog, grass and/or sedge dominated blanket bog, modified blanket bog with high dwarf shrub cover, active hummock/hollow/ridge blanket bog.
 - 4.2.3 The guidance should promote management practices that deliver improving peatland, and emphasise the importance of all peatland: for biodiversity, as a carbon store in its own right and for other outcomes.
 - 4.2.4 Consider how best to disseminate the guidance to the owners and managers of peatlands through practical demonstration.
 - 4.2.5 Consider how to monitor take up, obtain feedback and update the guidance.
- 4.3 Currently, the ‘Strategy for the restoration of Blanket Bog in England’ is not available from NE or Defra websites. It should be made available through the UMG website (www.uplandsmanagement.co.uk).

- 4.4 Consider the establishment of an annual meeting, hosted by the UMG / Uplands Stakeholder Forum to address concerns about communications between the agencies, peatland partnerships, peatland contractors and the owners and managers of land. The meeting:
- 4.4.1 Would aim to:
- Identify gaps in knowledge,
 - Share new techniques and evidence,
 - Coordinate the flow of information, and
 - Review progress towards the delivery of the ‘Strategy for the restoration of Blanket Bog in England’.
- 4.4.2 Is likely to involve a site visit and it could be hosted in turn by different peatland groups / organisations.
- 4.4.3 Should be arranged in coordination with other initiatives such as: The Defra-led application for a LIFE Integrated Project, and the Sphagnum Technical Advisory Group¹, run by the Moors for the Future Partnership (MFTF).
- 4.5 Further consideration of the questions in Appendix 8 should take place. A separate T&F Group is recommended.

5 Acknowledgements

- 5.1 Members of the T&F Group are listed in Appendix 1.
- 5.2 The T&F Group would like to express its thanks to the landowners who granted permission for the visits to take place; and to the people who hosted the visits and gave their time to explain the work that was taking place:

Kinder Scout: The National Trust and The Moors for the Future Partnership
Abney: Geoff Eyre
Derwent Moors: The National Trust and Geoff Eyre
Broadmea Fell: Knarsdale Estate and the North Pennines AONB,
Geltsdale Moor: the RSPB Reserve Staff
Mossdale Moor: Mossdale Estate, The Yorkshire Peat Partnership, Simon Bland of Barker & Bland and Andreas Heinemeyer from the University of York.

- 5.3 Simon Thorp is Chairman of the Uplands Management Group, but as Director of The Heather Trust, he provided support for the T&F Group and drafted this Report.

¹ Sphagnum Technical Advisory Group Area: South Pennines. Partners: MFTF, RSPB, National Trust and Natural England. Aim: to provide a forum for discussions and knowledge sharing to: develop application techniques, share results and build on each others knowledge and experience, develop coordinated monitoring programmes across a range of sites and application methods, and work towards comprehensive guidance on Sphagnum application on blanket bog.

- 5.4 Special thanks go to Laura King from the Moors for the Future Partnership who attended all the visits and took responsibility for taking notes, often in adverse conditions, thus proving the value of waterproof notebooks. She provided the first draft of the Report.

Andrew Walker

Chairman of the Sphagnum Task & Finish Group

18th March 2016

MEMBERS OF THE SPHAGNUM TASK & FINISH GROUP

Task Group Chairman	Andrew Walker	Yorkshire Water	
Task Group Members	David Airey	Hill farmer	
	Amanda Anderson	Moorland Association	
	John Barrett	Natural England	
	David Glaves	Natural England	
	James Mawle	Coverhead Farm	
	Mark Owen	Natural England	
	Pat Thompson	RSPB	
	Simon Thorp	Heather Trust	
	Adam Watson	Hill farmer	
	Non-members of the UMG		
	Laura King	Moors for the Future Partnership (Note taker)	
	Emma Taylor	North Pennines AONB	
	Tim Thom	Yorkshire Peat Partnership	

ATTENDANCE

Name		Organisation	Kinder Scout	Abney & Derwent	Knarsdale	Geltsdale	Mossdale
Andrew	Walker	Yorkshire Water (Chairman)	✓	✓	✓	✓	✓
Simon	Bland	Barker & Bland					✓
Tom	O'Neill	Barker & Bland					✓
Kieron	Logan	Gamekeeper for Geoff Eyre		✓			
Dave	Newborn	GWCT	✓				
Simon	Thorp	Heather Trust		✓	✓	✓	✓
Amanda	Anderson	MA	✓	✓	✓	✓	✓
James	Mawle	MA	✓				✓
Matt	Buckler	MFFP	✓				
Tia	Crouch	MFFP	✓				
Chris	Dean	MFFP	✓				
Laura	King	MFFP (Recorder)		✓	✓	✓	✓
Mike	Pilkington	MFFP	✓				
Jon	Walker	MFFP	✓				
Brendon	Whittram	MFFP		✓			
Jake	Gargett	Mossdale Estate					✓
Adam	Watson	National Sheep Association			✓	✓	✓
Matt	North	National Trust		✓			
John	Barrett	NE	✓	✓	✓	✓	✓
Mark	Owen	NE	✓	✓	✓	✓	✓
David	Glaves	NE	✓	✓			✓
David	Airey	NFU	✓	✓			✓
Rona	Charles	North York Moors NPA	✓				
Emma	Taylor	North Pennines AONB	✓		✓	✓	✓
Alistair	Lockett	North Pennines AONB			✓	✓	
Steve	Gibson	Northumberland FRS	✓				
Penny	Anderson	Penny Anderson Associates	✓				
Pat	Thompson	RSPB			✓	✓	✓
Dave	O'Hara	RSPB	✓	✓			
Steve	Westerberg	RSPB Geltsdale				✓	
Steve	Garnett	RSPB Geltsdale				✓	
Andreas	Heinemeyer	University of York					✓
Geoff	Eyre	William Eyre Ltd.	✓	✓			
Tim	Thom	YPP		✓			✓
			19	14	10	12	17

VISIT REPORT - KINDER SCOUT, PEAK DISTRICT

Host: Moors for the Future Partnership

Date: 7th July 2015

1 Description of site before management

- 1.1 The site is a typical, eroded, hagg system, with the hagg tops dominated by heather and other dwarf shrubs, and the hollows holding bare peat and cottongrasses. There is little to no Sphagnum present on site.



On top of Kinder Scout

2 Land use

- 2.1 The land on Kinder Scout is predominantly used for recreational purposes and is open access land. No grazing is permitted on the site though it was grazed in the past.

3 Aim of work

- 3.1 For the past seven years the Moors for the Future Partnership (MFFP) has been working with Micro-Propagation Services in the development and application of BeadaMoss®. BeadaMoss® is formed from small fragments of Sphagnum moss encapsulated in a gel-like bead; it has been used as an efficient way of spreading Sphagnum moss over hundreds of hectares of degraded moorland in the Peak District National Park and South Pennines.

- 3.2 Although successful in trials, the beads have not yet shown conclusive results on restoration sites. It is thought that this is due to the small size of the fragments, which need long time periods to develop. Since the development of BeadaMoss®, other micro-propagated techniques for Sphagnum moss have been developed that appear to show better initial success. A landscape trial was set up to provide a like-for-like comparison between the different micro-propagated materials. The trial also included the spreading of clumps of Sphagnum – using techniques developed by the RSPB at their Dove Stone Reserve and on restoration sites managed by the North Pennines AONB Peatland Programme (see the case study in this report).
- 3.3 The Kinder Scout plots were set up as a landscape-scale trial to compare the five different techniques in order to try and demonstrate the strengths and weaknesses of each of the application methods. Practitioners could then use these results to make informed decisions about which techniques would be best suited to their situation.

4 Description of what was done

- 4.1 The site being treated had been stabilised in the period 2009-2013 using: heather brash, amenity grasses, stock exclusion and three treatments with lime and fertiliser. This treatment had established a well-developed sward.
- 4.2 In order to look at the different techniques for introducing Sphagnum mosses into this type of sward, three replicates of four headwater micro-catchments of approximately 1 ha in size were treated with one of four different Sphagnum propagule types:
 - 4.2.1 BeadaMoss® - small (<1mm) fragments of Sphagnum (mixture of species) in a gel-like bead;
 - 4.2.2 SoluMoss® - larger fragments (1-10mm) of Sphagnum (mixture of species) in a liquid;
 - 4.2.3 Plugs – plug plants of Sphagnum (mixture of species) grown by micro-propagation; and
 - 4.2.4 Clumps – handfuls of Sphagnum collected from a nearby donor site.
- 4.3 A fifth micro-catchment was set up as a control site. The total area looked at is approximately 15 ha. These sites will also demonstrate the impact of non-intervention, as it is possible that once an area is stabilised and re-vegetated Sphagnum will naturally re-colonise, if there are nearby sources.
- 4.4 Each individual micro-catchment was allocated 10 quadrats, in which several measurements were taken. Where possible, the Sphagnum moss within the quadrats was standardised and planted by a researcher during the initial monitoring. Contractors carried out the planting in the wider areas.

5 Results of the work

5.1 The work was carried out in the spring of 2015, and there are no conclusive results at present. The quadrats will be surveyed regularly, but it is not envisaged that there will be any clear indication of the success of the BeadaMoss® and SoluMoss® for a few years, due to the initial size of each individual plant within the propagules. However, for both clumps and plugs, the survival rates so far are excellent, and they are showing good expansion rates.

6 Considerations

6.1 **Biosecurity** - For the purpose of this trial, the clumps planted were harvested from a nearby source to limit the issues surrounding disease translocation. This would need to be considered in any situation where Sphagnum was being brought in from a donor site. (see the Vegetation Transfer report produced by the UMG that is available on the website www.uplandsmanagement.co.uk)



Kinder Scout: The Ascent

DERWENT AND ABNEY MOORS, PEAK DISTRICT

Host: Geoff Eyre

Date: 24th November 2015

1 Description of site before management

- 1.1 Derwent Moor has an area of 800ha site. Before restoration work started the vegetation was dominated by Purple moor-grass *Molinia caerulea* (Molinia), Mat grass *Nardus stricta* and Bracken *Pteridium aquilinum*. It was originally included within an ESA agreement with heather restoration a key priority.
- 1.2 Abney Moor is around 100ha, and was dominated by Molinia, rushes, Bracken and Mat grass. There were some patches of Sphagnum mosses (probably *S. fallax*), which were mostly associated with pools, but these were not widespread.
- 1.3 Both moors have extensive areas of deep peat.



Derwent Moor: the challenge

2 Land use

- 2.1 The primary uses for the land are grouse shooting and sheep grazing, and but seed is also harvested from these moors for restoration. There is also a large amount of recreational access.

3 Aim of work

- 3.1 The work took place to satisfy the terms of the ESA agreement to reintroduce heather to the sites currently dominated by Molinia, Rush, Bracken and Mat grass.

- 3.2 The work also aimed to return the sites back to land suitable for sheep grazing and seed harvesting.

4 Description of what was done

- 4.1 In both cases, the sites were sprayed with Glyphosate in late Spring, then burnt and weed-wiped with Glyphosate to stop any regrowth, before being burnt again the following Autumn or Spring. They were then re-seeded with a heather-sphagnum mix.
- 4.2 On Abney Moor, sheep were introduced after burning for the second time to thin the heather, and the site was cut every two years to encourage a bushy growth of heather. Bracken was spot-treated every year.
- 4.3 On Derwent Moor, sheep were reintroduced but in reduced numbers. In one area a trial was carried out without sheep to assess the impact on heather growth. Where sheep are grazing, the areas are reseeded every year to replace the losses of heather seedlings. In more established areas, the re-seeding of heather and Sphagnum takes place every 4-5 years.
- 4.4 Since 2011, re-seeding has been carried out using seeds bound to the surface of clay or peat pellets. The pellets can carry a mix of seeds from any desired plant species. Seed from plants such as heather, crowberry and bilberry can be added, as well as other native grasses and sedges. Spores of Sphagnum are added to the pellets by mixing the hand-collected spores with yogurt and coating the pellets. The successful establishment of plants using this technique was demonstrated, during the site visit.
- 4.5 The clay pellets can be dried and stored, but the peat pellets break down and so need to be applied relatively soon after being created.
- 4.6 Currently, Geoff Eyre is running a trial that adds SoluMoss® to the pellets. This will allow the pellets to be coated with specific species of Sphagnum mosses. The pellets would need to be spread quickly after the SoluMoss® solution was added, and so it is likely that the mixing would need to take place on site.
- 4.7 The pellets are applied at a spread rate of around 10 pellets per m². The pellets can be applied using a seed catapult towed behind a Softrak at a rate of around 100 acres/day. Alternatively, a quad bike and spinner can apply the pellets at a rate of 50 acres per hour.
- 4.8 Prior to 2011, heather seed and Sphagnum was added to liquid collected from bog holes on site and sprayed onto the ground. Although cheaper to produce, this method is not as convenient and so is no longer used.

5 Results of the work

- 5.1 The vegetation on sites has been converted to mixed heath with Sphagnum mosses in wetter areas on Abney Moor and more widely on Derwent Moor. The Sphagnum cover is predominantly *S. fallax*, although other species were present especially in fen features at Abney, including *S. palustre* and probably *capillifolium*). The change has taken place over nine to ten years, with results seen within four to five years after the initial re-seeding.
- 5.2 Vegetation is coming back in the habitats to which it is suited. Sphagnum mosses are returning in wetter areas, with heather in drier areas to create a mosaic of species.
- 5.3 On Derwent Moors, once *Molinia*-dominated areas now have Sphagnum mosses, and *Nardus*-dominated areas are seeing more heather growth. Similarly, at Abney Moor, heather is forming on tussocks, and more widely across the drier parts of the site. In the wetter areas, Sphagnum is out-competing star moss.

6 Considerations

- 6.1 ***Level of intervention*** – there was some discussion about the level of intervention on Geoff Eyre’s sites, and whether this was needed. It was argued that where land is dominated by one species, as a result of intervention by man, it is very hard to use natural processes on their own to change the landscape within timeframes that are economically viable. Using a one-hit approach can create significant changes relatively cheaply and within relatively short timeframes.
- 6.2 ***Regular maintenance*** – Geoff’s sites require regular maintenance through re-seeding and burning to maintain the mosaic of mixed heath species.
- 6.3 ***Level of grazing*** – Overgrazing can lead to a landscape that is dominated by one species such as *Molinia*, while undergrazing can lead to a fire risk due to an increase in the vegetation biomass. Grazing levels therefore need to be carefully considered and managed.

BROADMEA FELL, CUMBRIA

Host: The North Pennines AONB Partnership

Date: 26th November 2015

1 Description of site before management

- 1.1 The fenced, restoration site is 14 ha, of which 4.5 ha was bare peat contained within relatively small patches. In the areas of bare peat, the landscape consists of hagg tops and hollows. The hagg tops are predominantly covered with heather, moorland shrubs such as crowberry, and a good mix of mosses. Bare peat is mainly confined to the hagg sides, with the bottom of the systems dominated by flushes of cottongrass.
- 1.2 Anecdotally, the bare peat had been caused by significant wildfires in the summers of 1941 and 1942, which were believed to be uncharacteristically hot and dry. The sides of hags exposed to prevailing winds are generally more eroded than sheltered areas, indicating that weather has a significant effect on the ability of the system to repair itself.



Broadmea: Bare peat no longer

2 Land use

- 2.1 Stock are excluded from the restoration area but grazing is still taking place on adjacent areas with stock off wintered from December to February.

3 Aim of work

- 3.1 The main aim of the work was to stabilise the bare peat so that it could re-vegetate. A secondary, later aim was to increase the coverage of Sphagnum in the area.

4 Description of what was done

- 4.1 The area was fenced off to exclude sheep. The following winter Sphagnum-rich heather brash was spread on the site at a thickness of around 5cm, which is the double the thickness applied elsewhere. The brash had been cut from a nearby site and contained a good mix of heather as well as cottongrass, mosses and Sphagnum. Prilled lime was then applied in targeted areas using a hand seed spreader. This was followed two weeks later with triple phosphate fertiliser – again applied by hand using a seed spreader. A mix of seed was then applied. The seed was a commercial mix containing 90% heather seed, plus wavy hair grass and fescue. Locally harvested cottongrass seed was added to the mix.
- 4.2 One year after the bare peat was treated, Sphagnum was redistributed around the site. Volunteers took handfuls of Sphagnum from one location and replanted them into the bare peat areas. Around 10% of material was taken from hummocks and flushes of Sphagnum in the intact areas for distribution. This amount follows the recommendations from Natural England based on the work carried out at Dove Stone (RSPB). The impact of removal is being monitored.
- 4.3 At Dove Stone, only flush-species of Sphagnum are harvested, but due to the abundance of both types at Knarsdale, hummock-forming and flush-forming species are harvested.

5 Results of the work

- 5.1 After three years, the site is recovering well with significantly fewer areas of bare peat. The site is no longer eroding and from fixed-point photography it can be seen that the majority of bare peat areas are now re-vegetated.

6 Considerations

- 6.1 ***Thickness of brash*** – In this area, the brash was spread to a thickness of 5cm. Other restoration techniques (for example, those used by Moors for the Future) use a much thinner layer of brash. Such a thick layer would not be possible on larger sites due to the amount of material that would be required, however this approach can be justified on smaller sites. Using a thick layer of brash has the benefit of forming a protective layer under which mosses can grow.
- 6.2 ***Addition of seed*** – The addition of root-forming grasses to the seed mix aimed to stabilise the peat quickly. The living mosses within the brash created a carpet that was knitted together by these roots. The seed mix only contained locally occurring species. As there was a good mix of moorland species present on the site, it was not considered necessary to add other species such as fast-growing amenity grasses. With hindsight, it might have been beneficial to add seed from Sphagnum species to the mix, but this would have increased costs. The primary objective was covering and stabilising bare peat, not re-establishing active bog capability.
- 6.3 ***Sphagnum*** – Given the abundance of Sphagnum on site and the scale of works, the low-key method of Sphagnum redistribution by hand was the most cost-effective and appropriate method.

- 6.4 ***Re-profiling*** – No re-profiling was done on site, as the site contained significant hagg systems. It was considered too difficult to get the machinery on site, and also very difficult to manoeuvre around the site.
- 6.5 ***Impact on farmer*** – It was stated that the farmer is happy with the work on the site. The cutting work that takes place provides a good mix of food for the sheep and the restricted area for grazing has had a minimal impact in the short-term as it was mostly bare peat. There is the potential of improved grazing when the fence is removed in 10 years' time.

GELTSDALE MOOR, CUMBRIA

Host: RSPB

Date: 26th November 2015

1 Description of site before management

- 1.1 The site was heavily drained and is dominated by common ling *Calluna vulgaris*, with very few other species present. Originally, the site was heavily grazed with around 800 sheep on 400 ha. It was reported that the site had been burnt on a short rotation leading to the heather monoculture and areas that had been heavily eroded. The site is all on deep peat, although some areas of the site behave like dry heath rather than blanket bog. In some areas Sphagnum mosses were present; overall it is estimated there are 15 species of Sphagnum growing on the reserve.



Geltdale: More sphagnum, less heather

2 Land use

- 2.1 The land is used for grazing. Currently there are 100 ewes on site throughout the year, and 15 cattle between April and September.

3 Aim of work

- 3.1 The aim of the work is to create a mosaic structure of vegetation (including the regrowth of Sphagnum) by managing the site through a longer rotation of cutting rather than a short burning rotation. The long-term aim is to manage the site through grazing with as little intervention as possible.

4 Description of what was done

- 4.1 The site is cut on a 14-15 year rotation with 30-35 ha cut each year. Cuts are taken quite low and are of varied shape and size. The location of the cuts is chosen to reduce wildfire risk and to encourage birds.
- 4.2 Originally, cut material was collected and used to fill the grips on site. Instead of creating dams, the whole grip was filled with the aim of raising the water table over a larger area. The grip-blocking work has now been completed and the cut material is now left on site.
- 4.3 Birds are monitored using the Brown and Shepherd bird surveying methodology. Changes in vegetation are monitored using quadrats and fixed-point photography. The data was originally collected to monitor the impact of reduced grazing, but it is hoped that the results, which date back to 1999, can also be used to establish the impact of the cutting.

5 Results of the work

- 5.1 Following the cutting, hare's tail cottongrass grows back relatively quickly. This is a natural response to cutting, which has the benefits of helping to quickly stabilise the peat surface. Due to the age of the heather it generally grows back from the seed source in the soil, so can take up to two years for seedlings to appear.
- 5.2 After three-four years a good mix of species could be seen on the cut sites, including Sphagnum mosses and a mix of heather and dwarf shrubs. All these species have grown from the seed source in the peat or through natural propagation and translocation by cattle or sheep, as no re-seeding is done on site. After ten years there is a good mix of heather and shrubs growing through carpets of sedges, bryophytes and Sphagnum, indicating that the results of the cutting appear to be promising.
- 5.3 Sites that were first cut 15 years ago had been shown to have six species of Sphagnum moss present, including hummock-forming species.
- 5.4 Results from the monitoring work are currently being analysed.

6 Considerations

- 6.1 ***Cutting rotation*** - There was some discussion as to whether a further cut would be needed on older cuts to help reinvigorate the mosses and stop the heather becoming dominant again. Consideration is also being given to whether it would be possible to cut on a longer rotation.
- 6.2 ***Grazing*** – Levels of grazing were regularly monitored, and there was consideration being given to increasing the number of sheep and cattle on the site to control the growth of heather.

- 6.3 ***Water tables*** – the water table had been raised on site through grip blocking, but it was not known whether the water table was consistently high enough to maintain the mosses over the long-term. Lowered water tables could encourage increased heather growth, further drying out the peat and reducing suitable habitats for mosses.
- 6.4 ***Bird populations*** – the cutting was structured to provide the range of environments needed by bird species throughout the year.
- 6.5 ***Level of intervention*** – an adjacent wet heath site on the reserve that was previously dominated by *Molinia* had been managed through cutting the *Molinia* once and adding cattle. No other intervention took place. The site is now moving towards Favourable Condition, 12 years after the original work was done, indicating that in the right situation, limited intervention can achieve results, albeit on a longer timescale.

MOSSDALE, CUMBRIA

Host: Yorkshire Peat Partnership and Barker & Bland

Date: 1st December 2015

1 Description of site before management

- 1.1 The site visit included areas of deep peat where cutting was taking place, or had been carried out, to harvest brash for peatland restoration work.
- 1.2 On the top of the catchment, the Group was also shown a restoration site where the cut material had been spread onto an eroded hagg system.
 - 1.2.1 The tops of the hagg system were dominated by heather and shrub species, but cottongrasses are now establishing in the hollows.
 - 1.2.2 The restoration sites had areas of bare peat.
 - 1.2.3 Other restoration sites had been re-profiled as part of the restoration work.
- 1.3 The Group also visited the Mossdale site, which is part of a Defra project that is comparing the impact of cutting and burning on deep peat. Andreas Heinemeyer, the Project Manager from the University of York, explained the work.
- 1.4 The contractor, Barker & Bland, is carrying out the cutting and restoration work, and Simon Bland discussed the work with the Group.



Mossdale: rewetting producing the goods

2 Land use

2.1 The primary objective is to manage the land for grouse shooting.

3 Aim of the work

3.1 There are two aims for the restoration work:

3.1.1 To stabilise and re-vegetate areas of bare peat, and

3.1.2 To replace rank heather with more diverse vegetation that includes peat-forming Sphagnum species.

3.2 To date, an area of 500 ha of degraded moorland has been treated.

4 Description of what was done

4.1 Barker & Bland are cutting the vegetation on a large-scale in accordance with the requirements of the Estate's HLS agreement. As part of the arrangement between the Estate and Barker & Bland, the sites were re-seeded with heather after the cutting had taken place.

4.2 The cuts are taken as low as possible to increase the amount of mosses in the brash. Cuts for Sphagnum are taken slightly higher to just remove the Sphagnum tip.

4.3 Cutting sites were chosen that had a good mix of heather, shrubs and dry heath mosses to produce bryophyte-rich brash. Other sites were chosen specifically for Sphagnum. The cuts were then mixed so that the mulch spread on restoration sites had a balance of heather brash, cottongrass and the living mosses including Sphagnum.

4.4 The mulch can be harvested, mixed and spread on restoration sites at a rate of 0.4–1.0 ha per day. All work is carried out by low ground pressure machines and by using bog mats where necessary. In the bryophyte-rich brash, between 40-100 Sphagnum plants are spread per square metre.

4.5 The mulch spread on the restoration sites works by allowing the living mosses to create a skin over the bare peat, stabilising the surface and allowing vegetation to grow. The cottongrasses in the mix act as a coloniser to provide initial protection for the mosses. By using brash with a mix of species, re-vegetation on degraded sites is more likely, as there are species present in the mix suited for a wide range of micro-habitats. No lime was required on the restoration sites.

4.6 Additional work on the restoration sites includes re-profiling and raising the water table through grip blocking. Due to concerns about the release of methane from re-profiling, this is no longer used as widely, despite it having the potential to achieve better restoration results and better land for gamekeepers.



Mossdale: harvesting vegetation



Mossdale: after harvesting

5 Results of the work

- 5.1 The cut sites appear to recover quickly and after three to four years the sites have a good mix of heather, shrubs and mosses. Notably, the gamekeeper is happy with the results following cutting – in this instance the combination of cutting and seeding produces a result that is considered to be better than burning for grouse. The cut sites were also considered suitable for grazing with a good diversity of mosses alongside young heather.
- 5.2 Two years after the mulch was applied, the restoration site showed variable results. Sphagnum was seen to be growing at the restoration sides – both on the hagg sides and bottom of the hollows. However, there was still a proportion of bare peat on the hagg sides that had not fully vegetated, although it is possible

that this could be due to the short timeframes between the work and the site visit. Consideration is being given to re-seeding with some native grasses.

6 Considerations

- 6.1 ***Spreading rate of Sphagnum*** – It is not known how much Sphagnum needs to be added to the restoration sites for the Sphagnum to establish.
- 6.2 ***Presence of dry heath mosses*** – it is not known whether the dry heath mosses will out-compete the Sphagnum mosses, or what the ideal ratio of dry heath moss to Sphagnum is. However, in the initial restoration stages, the dry heath mosses are important to increase humidity on the peat surface and to create a stabilised surface on which Sphagnum can colonise.
- 6.3 ***Use of seed*** - Mosses are used instead of rooted plants to stabilise the peat surface. This method was chosen as initial attempts to stabilise the peat using grass seed were failing due to frost heave damaging the plants.
- 6.4 ***Impact of machinery on sites*** – the machines all operated with low ground pressure and although there was an immediate effect on site, the sites appeared to recover well. Research from the Defra project, managed by the University of York, indicated that within six months, any depression caused by short-term operations, such as harvesting seed, was no longer measurable on the study sites. The main issue was the impact on micro-topography – particularly if machinery has an impact on hummock-forming species, though it was suggested that this might not be a long-term effect.
- 6.5 ***Re-seeding after cutting*** – consideration was being given as to whether the cutting sites should also be inoculated with Sphagnum.
- 6.6 ***Resilience of Sphagnum to cutting*** – initial observations from cutting sites shows that Sphagnum recovers well after cutting. However, research needs to be done into whether some species are more resilient than others.

QUESTIONS FOLLOWING THE SITE VISITS

1 Overall aims

1.1 What are we are restoring to?

Clarity is needed on what the objectives are for peatland restoration, and what is expected as part of any changes in management techniques. This should be developed taking account of the individual requirements of each site.

1.2 How do we balance the cost of restoration against the benefits?

The cost of that restoration needs to be balanced against the benefits. This leads to a wider question of how you value the benefits of the work undertaken, and over what time frame these benefits are calculated.

1.3 How do we balance the benefit of restoration against the level of intervention?

The impact of management techniques (such as cutting, burning, use of machinery, spraying and grazing) needs to be considered and balanced against the benefits. Similarly, the consequence of making mistakes needs to be looked at practically – learning from interventions that did not work can be as valuable as learning from interventions that did work.

2 Monitoring

2.1 How do you attribute what has been done to the results seen on the ground?

Many sites are only monitored through the observations of land managers. Often there are several factors that have changed on the site (for example levels of grazing, hydrology and cutting regime) and it is difficult to attribute changes in vegetation to any one factor.

2.2 How do you know what is the best method to use?

In many cases the techniques being used are experimental in nature and more work, trialling, monitoring and guidance is needed on how to best apply the techniques being developed. It is important that the experiences of the restoration partnerships are shared.

3 Ecology

3.1 What species of Sphagnum should be reintroduced?

Do we need to focus only on the hummock-forming species, or should all species of Sphagnum be encouraged in order to create a habitat suitable for further Sphagnum colonisation? If one species of Sphagnum becomes dominant, will it out-compete other species? What is the best way to create a diverse mix of Sphagnum?

3.2 What is the impact of restoration on livestock/key species?

Changes to sites could have wider implications – such as the tendency of heather in re-wetted areas to be susceptible to heather beetle, and the presence of Bog asphodel *Narthecium ossifragum*.

3.3 Is the ‘hummock and hollow’ structure varied enough for birds?

Does the ‘hummock and hollow’ structure provide a diverse enough habitat for birds? Does it give a similar structure as that provided by managed cuts and burns? What is the impact of restoration on birds?

3.4 What are the best conditions for Sphagnum to grow in?

How do we create the conditions for Sphagnum to grow and what are those conditions?

4 Carbon sequestration

4.1 Rate of carbon loss from untreated areas

Do we have an accepted rate of carbon loss from an untreated area of bare peat for the peatland code?

4.2 Does re-vegetated peat lose carbon?

Do we have an accepted rate of carbon loss from re-vegetated peat?

4.3 Carpet vs hummock-forming species

What are the differences between carpet and hummock-forming species when considering carbon sequestration?

5 Economic viability

5.1 When is land considered too wet for grazing?

If land becomes too wet for grazing could it be considered ineligible for payments by the RPA. Clarity is needed on the difference between a blanket bog and ineligible area for grazing?

6 Management tools

6.1 How can fire be used as an effective management tool?

How can we best use fire as a management tool – can cool burns be used to reduce the damage to mosses and Sphagnum? How do we balance this against the impact of badly managed burns and the impact that that ash from burns has on the drainage of water from the surface of the peat?

6.2 What are appropriate grazing levels?

What is the right level of grazing to maintain land, manage fire risk and allow for a mosaic of mixed heath?

6.3 What are the options if machinery cannot be taken onto site?

What are the options if you cannot get machinery on site for cutting, or if you cannot get cut brush removed from the site? In these cases is burning the right option?

6.4 Can we re-create agricultural seeding rates for Sphagnum?

How much Sphagnum needs to be reintroduced to a site for effective re-colonisation?

6.5 Shallow Peat

The techniques for peatland management and restoration have been developed for deep peat (>0.4m). How should we manage shallow peat to keep these areas in good condition and conserve their carbon stocks?

7 Impact of cutting

7.1 What happens to the site after cutting?

When a site has been cut, what is the impact on the site? There were several questions within this:

- Does the balance of vegetation shift, and if so, how?
- What is the impact of taking Sphagnum from a cutting site?
- Does cutting arrest the development of hummock and hollow forming topography?



*An alternative approach to peatland management
(Seen in Dumfries on the way back from Mossdale)*