Yorkshire Peat Partnership

WORKS MONITORING REPORT

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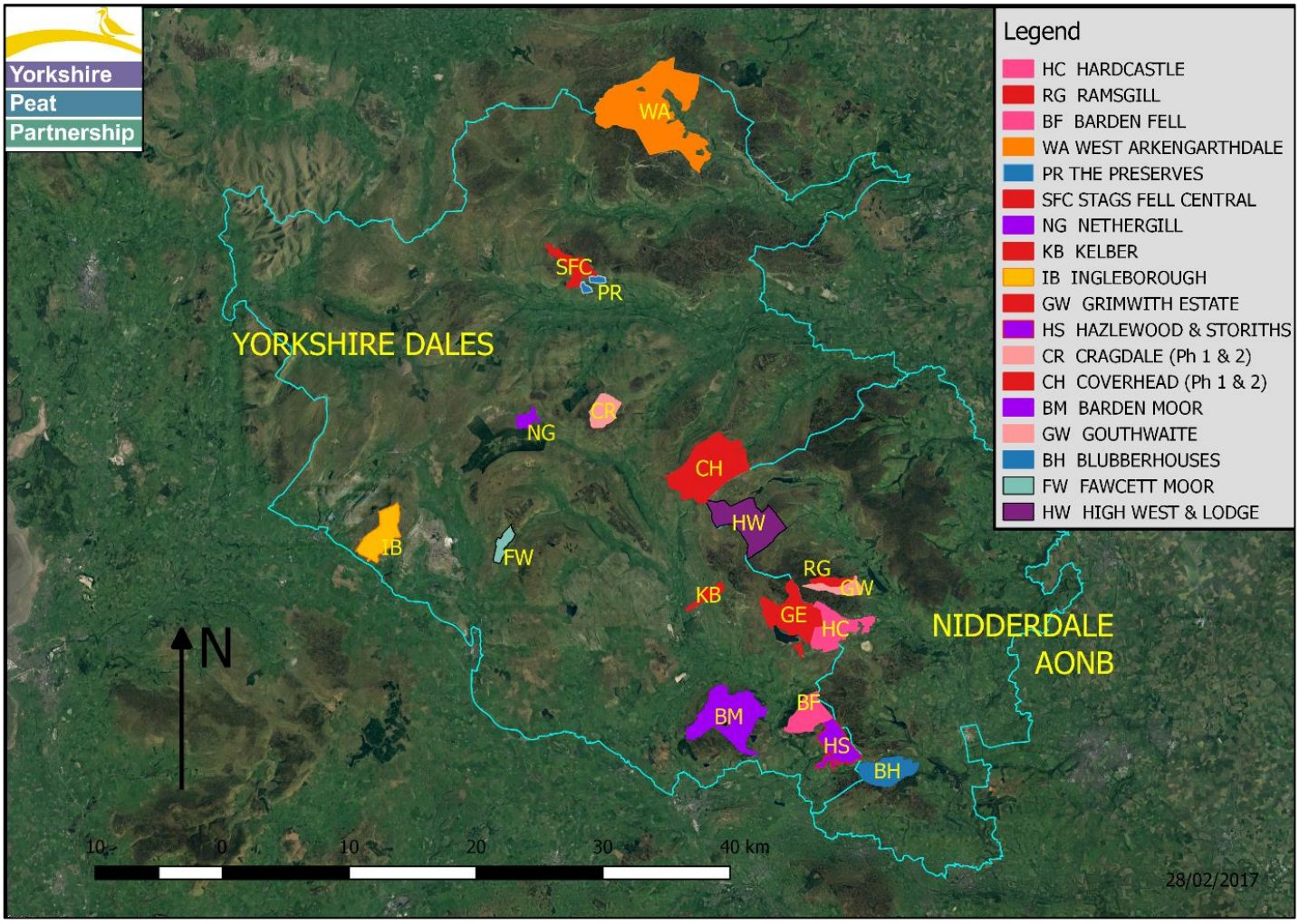
The Wildlife Trusts
Yorkshire Wildlife Trust

Yorkshire Peat Partnership

1.0. INTRODUCTION

The following document details the works monitoring that has been undertaken by the Yorkshire Peat Partnership (YPP) on 20 sites that have undergone restoration works in the Yorkshire Dales and Nidderdale AONB over the past six years (Map 1 & Table 1).



Map 1: Yorkshire Dales and Nidderdale AONB showing the location of sites monitored by YPP in 2016/17

Table 1: Yorkshire Dales and Nidderdale AONB: Sites, restoration work and dates monitored.

Area	Site	Restoration Works Timing	Types of Restoration Works Monitored				Dates Monitored previously	Dates Monitored 2016-17
			Peat Dams	Bare Peat	Reprofiled grips	Reprofiled hags/gullies		
YD	Barden Fell	Mar-15	Y	Y	N	Y		Mar-17
YD	Barden Moor	Mar-15	Y	Y	Y	Y		Mar-17
YD	Coverhead (Ph 1)	Mar-11	Y	N	N	N	Jan-15	Mar-17
YD	Coverhead (Ph2)	Mar-12	N	Y	Y	Y		Mar-17
YD	Cragdale (Ph 1)	Mar-15	Y	Y	N	N		Feb-17
YD	Cragdale (Ph 2)	Mar 16	Y	Y	N	N		Feb-17
YD	Fawcett	Mar-16	Y	N	N	N		Mar-17
YD	Grimwith	Mar-11	Y	Y	N	N		Feb-17
YD	Kelber	Mar-14	Y	Y	N	N	Nov-14	Mar-17
YD	Nethergill	Mar-16	Y	N	N	N		Feb-17
YD	Stags Fell Central	Mar-13	Y	N	Y	Y	Aug-15	Mar-17
YD	The Preserves	Mar-15	Y	N	N	N		Mar-17
YD	West Arkengarthdale	Mar-14	Y	N	N	N	Nov-14	Mar-17
YD	Ingleborough	Oct-14	Y	N	Y	N	Nov-14	July-16
YD	Hazlewood & Storiths	Mar-15	Y	Y	N	N		Mar-17
NDD	High West & Lodge	Mar-15	N	Y	N	Y		Mar-17
NDD	Blubberhouses	Mar-15	Y	Y	N	N		Dec-16
NDD	Gouthwaite	Mar-16	Y	N	N	N		Jan-17
NDD	Hardcastle	Mar-14	Y	N	N	N	Nov-14, Feb-16	Jan-17
NDD	Ramsgill	Mar-16	Y	N	N	N		Jan-17

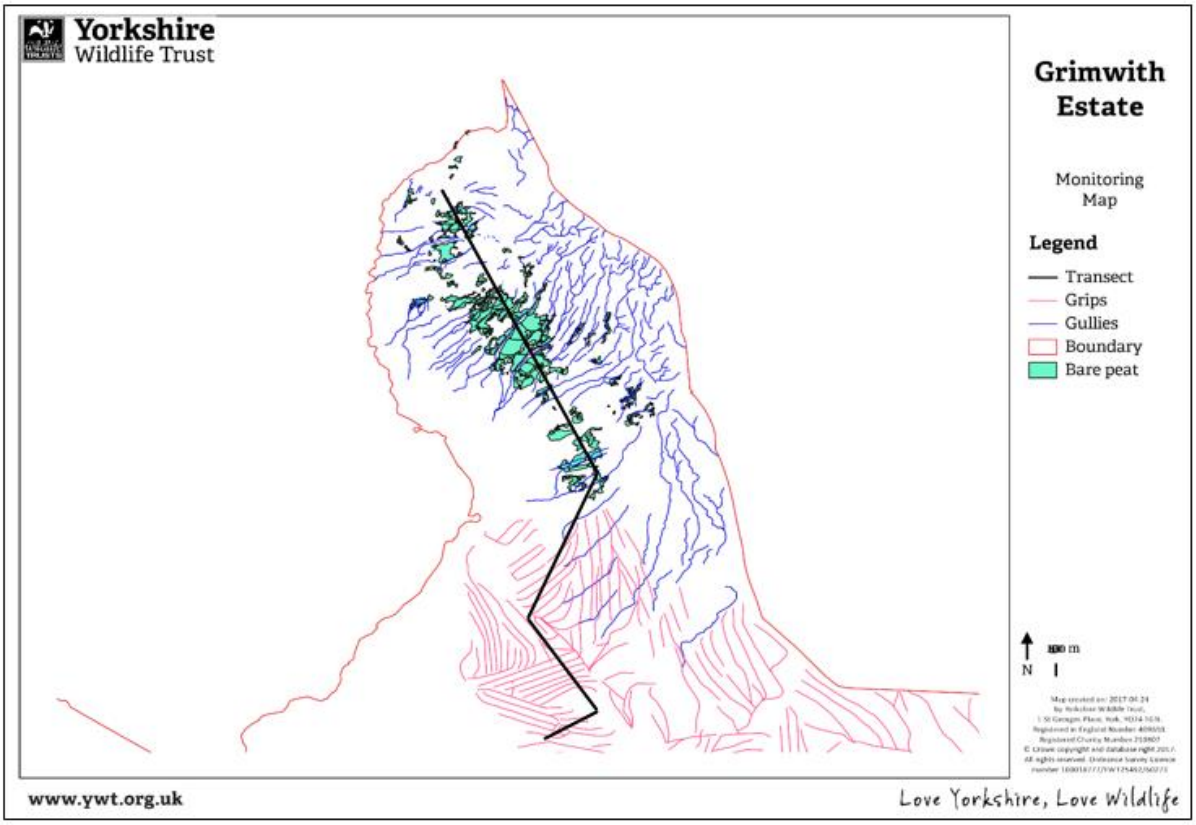
2.0 AIMS

The overall aims of the study were to determine the success of:

- Peat dam installation
- Bare Peat revegetation
- Reprofiling of hags and gullies
- Revegetation of reprofiled hags and gullies

3.0 METHODOLOGY

A series of transects were set up across the areas of each site that have undergone different types of restoration intervention (Map 2).



Map 2: An example of a monitoring transect over grips, gullies and bare peat. Grimwith Estate, 2017

A number of different measurements were recorded using GPS units at 30-40 sample points along the transect to assess the status of the specific type of restoration intervention. (For a full description of recorded variables see Appendix 1).

3.1 Peat dams

The integrity of the dam was determined, recording whether it was entirely intact, whether it showed signs of erosion and whether there was water at its base. In addition, an area of 5 x 2 metres was assessed directly upslope of the dam recording percentage of overall revegetation and percentage of each species present.

3.2 Reprofiling

A 2 x 2 metre quadrat of the reprofiled gully or hag was used to determine whether or not the feature was still intact, whether there were signs of erosion, the percentage of the area showing signs of revegetation (from turves or treatment with brash and seed), and percentage cover of different species.

3.3 Bare Peat revegetation

A 2 x 2 metre quadrat on the bare peat was examined at every 10 or 20 metres (dependent on the size of the bare peat) to determine percentage of vegetation cover and percentage cover of different species. Readings were taken from the South West corner of the quadrat where the GPS point was recorded (Figure 1).

Figure 1: A 2 x 2 metre quadrat for assessing revegetation cover and species on bare peat, Ramsgill 2017

4.0 RESULTS AND DISCUSSION

4.1 Peat dams

Figure 2: Peat dam on Hardcastle Moor, 2017

Overall the results were very encouraging with an average of 94% of all the 763 dams assessed being intact; only 12% showing signs of erosion; and an average of 72% of the surface area having successfully revegetated (Table 2).

Table 2: YPP monitoring results on grip restoration work, 2017

Site	Number of dams	% dams intact	% dams showing erosion	% dams with water retained	% dams with water dispersal	% revegetation
Barden Fell	5	100	0	40	60	69
Barden Moor	23	100	9	39	43	71
Bubberhouses	47	100	43	96	91	44
Coverhead ph1	78	92	1	34	6	88
Cragdale ph1	36	94	6	22	92	87
Fawcett	50	100	8	40	80	70
Gouthwaite	68	100	24	100	94	29
Grimwith	29	93	7	72	100	69
Hazelwood Storiths	14	86	43	57	57	76
Hardcastle	112	98	4	81	98	73
Ingleborough	22	100	4	18	81	96
Kelber	29	79	0	14	83	94
Nethergill	30	93	13	10	93	81
Ramsgill	54	96	15	65	83	61
Stags Fell Central	27	96	7	11	89	77
The Preserves	57	77	18	5	68	58
West Arkengarthdale	82	96	8	5	88	87
Total	**763**	-	-	-	-	-
Overall average	-	**94**	**12**	**42**	**77**	**72**

4.2 Reprofiled versus non-reprofiled grips

In addition to peat dams, some of the restored grips had been reprofiled, narrowing the grip channel and reducing the angle of the grip's side (Figure 3).

Figure 3: Gouthwaite Moor, 2015: a reprofiled grip (left) and a non-reprofiled grip (right).

The practice of reprofiling was common in the early years of YPP's restoration work but was recently discontinued following evidence that it may increase the release of methane (Green, S., Boardman, C., Baird, A., 2011). However, through the monitoring process a number of interesting differences between reprofiled and non-reprofiled grips began to emerge which may benefit from a more detailed investigation. Visually, the reprofiled grips appear to have revegetated faster and are potentially less vulnerable to erosion than their non-reprofiled counterparts (Figure 3 & 4).

Table 3a and 3b show the relative merits of both types of restoration work on grips.

Table 3a. Monitored peat dams on reprofiled grips, 2017

Site	Number of dams	% dams intact	% dams showing erosion	% dams water retained	% water dispersed	average revegetation % cover
Coverhead (Phase 1)	78	92	1	34	6	88
Stags Fell central	27	96	7	11	89	77
Barden Moor	23	100	9	39	43	71
Ingleborough	22	100	4	18	81	96
Hazelwood Storiths	14	86	43	57	57	76
Kelber	29	79	0	14	83	94
West Arkengarthdale	82	96	8	5	88	87
Grimwith	29	93	7	72	100	69
Total	**304**	**-**	**-**	**-**	**-**	**-**
Overall average	**-**	**93**	**10**	**31**	**68**	**82**

Table 3b. Monitored peat dams on non-reprofiled grips, 2017

Site	Number of dams	% dams intact	% dams showing erosion	% dams water retained	% water dispersed	% revegetation
Barden Fell	5	100	0	40	60	69
Bubberhouses	47	100	43	96	91	44
Cragdale ph1	36	94	6	22	92	87
Fawcett	50	100	8	40	80	70
Gouthwaite	68	100	24	100	94	29
Hardcastle	112	98	4	81	98	73
Nethergill	30	93	13	10	93	81
Ramsgill	54	96	15	65	83	61
Stags Fell Central	27	96	7	11	89	77
The Preserves	57	77	18	5	68	58
Total	**486**	**-**	**-**	**-**	**-**	**-**
Overall average	**-**	**95**	**14**	**47**	**85**	**65**

The visual evidence is backed up by the data, which shows that individual dams on reprofiled grips are less likely to be eroded than those that have not been reprofiled. The major exception to this, which has the effect of negatively skewing the overall data, is Hazelwood Storiths. Here 43% of dams were recorded as displaying some form of erosion (well above the average of 10%). Further investigation is needed to determine the cause of this issue, but it was noted that the affected grips were located at a lower level than the land immediately surrounding the grip, making it impossible to place dispersal channels to divert the water onto the moor. At times of heavy rainfall this will have the effect of channelling water directly at, and around, the dam, resulting in erosion.

What is very apparent is that reprofiled grips had a much higher percentage of vegetation cover (82%), compared with that of non-reprofiled grips which had an average of 65%. This was even the case for grips completed at the same time (Figure 4).

Figure 4: A reprofiled grip on Kelber moor (left) and a non-reprofiled grip on Hardcastle moor (right), both completed in March 2014.

4.3 Erosion of Peat Dams

Erosion of peat dams and restored grips was found to be a particular problem on sites with steeper gradients and higher run-off such as The Preserves (Figure 5 & 6).

Figure 5: Erosion of previously restored grip and peat dam, The Preserves, 2017

Here only 77% of peat dams were intact compared with an overall average across the sites of 95%. At the time of the site visit water run-off was high and flowed unimpeded across the steeper parts of the moor, subjecting dams lower down to a great deal of force. Clearly, over time this has led to problems including dams being undermined by flowing water (Figure 6).

Figure 6: Eroded peat dam on The Preserves, 2017

4.4 Data Comparison from monitored sites, 2014-2017

Five of the sites monitored this year had been monitored in previous years. Comparisons were made with the most recent data to determine changes in vegetation and the species present (Figure 7-11).

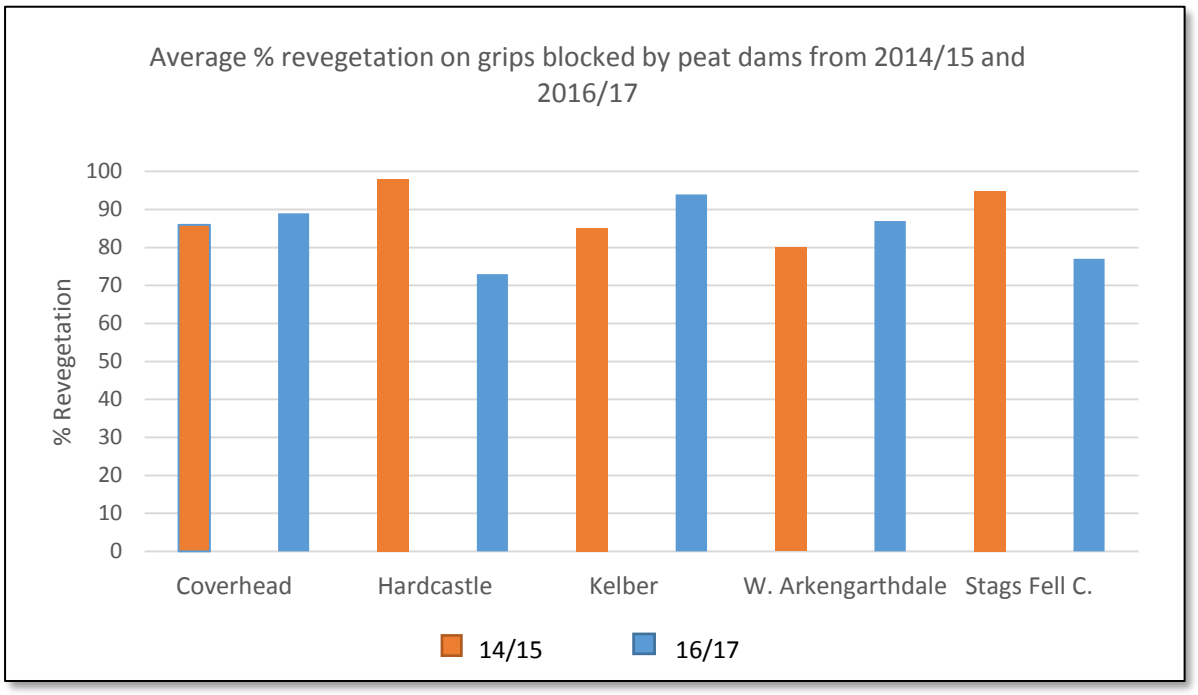


Figure 7: Data comparing vegetation cover from sites monitored in 2014/15 and 2016/17.

Out of the five sites average vegetation cover has gone up on three (Coverhead, Kelber and West Arkengarthdale) but down on Hardcastle and Stags Fell Central (Figure 7). Part of the decline on Hardcastle could have been due to recent burning over the features being monitored. Also, the data from 2014/15 for Stags Fell had been gathered after heavy snow, so may have been less accurate.

What is of greater interest is the change in the species recorded on these sites. (Figures 8-11)

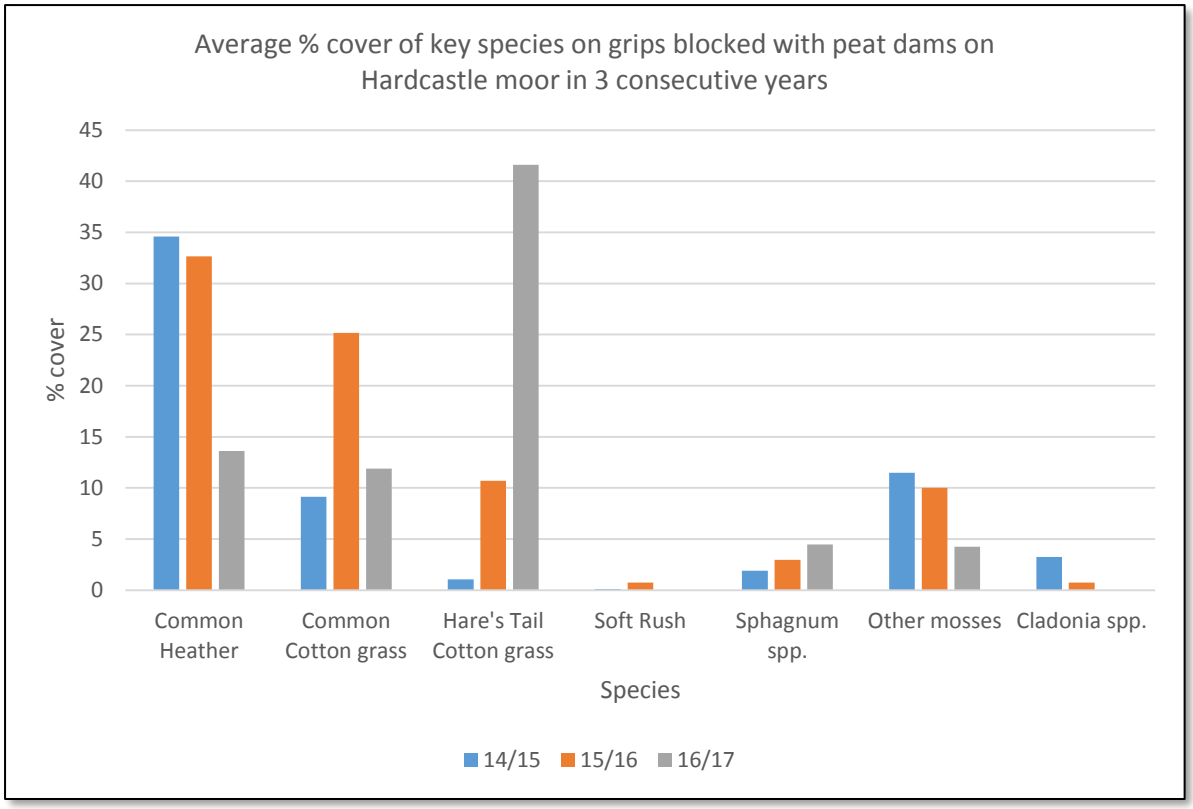


Figure 8: Data comparing percentage of species cover on Hardcastle moor monitored in 2014/15, 2015/16 and 2016/17.

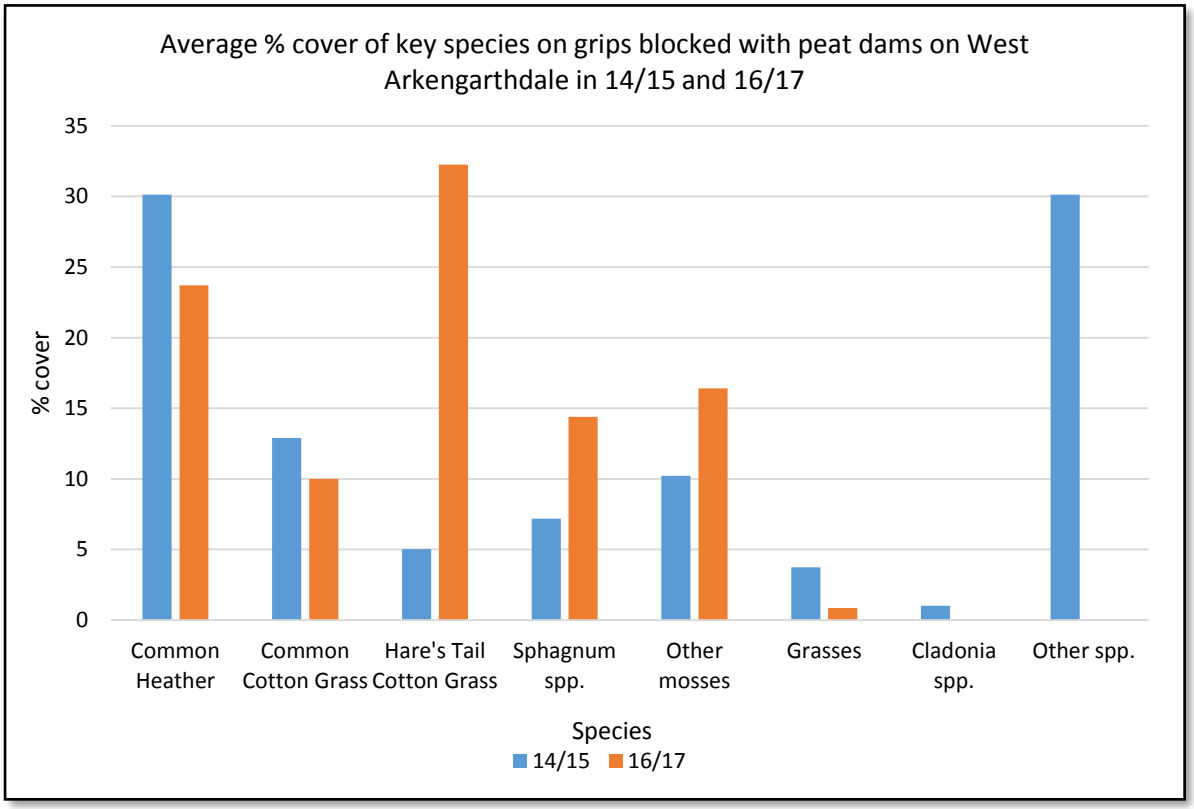


Figure 9: Data comparing percentage of species cover on West Arkengarthdale monitored in 2014/15 and 2016/17.

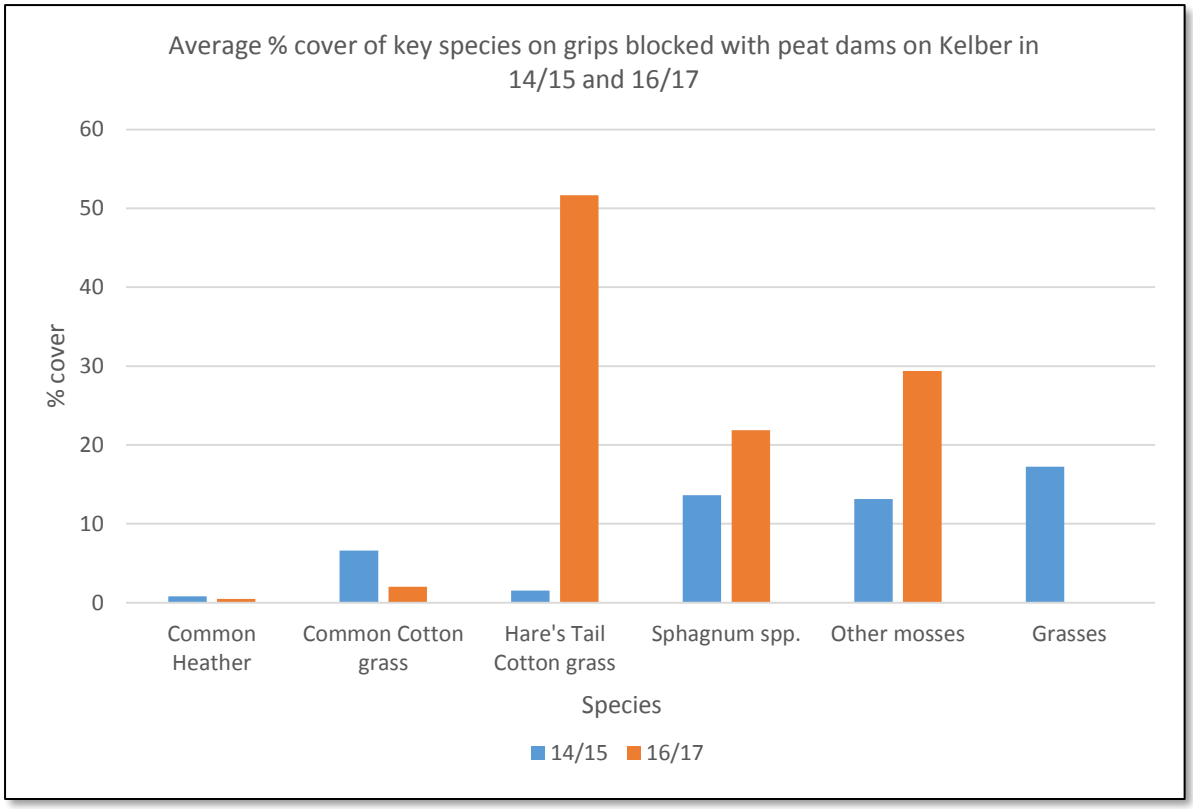


Figure 10: Data comparing percentage of species cover on Kelber moor monitored in 2014/15 and 2016/17.

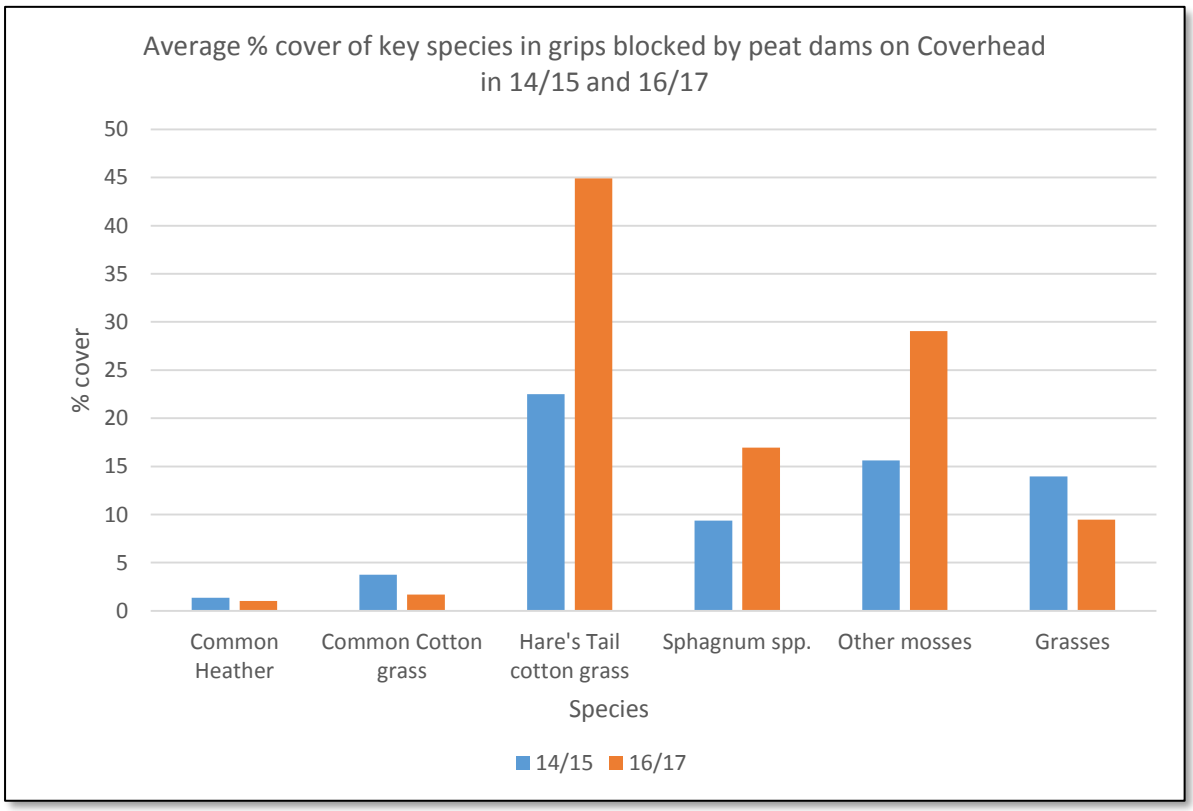


Figure 11: Data comparing percentage of species cover on Coverhead monitored in 2014/15 and 2016/17.

There was no data for species on Stags Fell Central due to the snow cover at the time of monitoring in 2015, but on the other 4 sites percentage cover of Common Heather *Calluna vulgaris* has decreased; Hare's Tail Cotton-grass *Eriophorum vaginatum* has increased substantially and sphagnum species have also shown a steady rise.

Hardcastle (Figure 8) has particularly interesting changes with no records of Soft Rush *Juncus effusus;* a decline in grasses, mosses, *Cladonia, Sphagnum palustre and S. fallax.* This all points to a reduction in water flow and an increase in acidity. To substantiate this trend, these species are being replaced by new blanket bog species including cranberry *Vaccinium oxycoccos*, and several sphagnum species including *S. subnitens and S. magellanicum.* All of this is showing a very positive shift to blanket bog communities.

4.4 Reprofiled and revegetated gullies and hags

Although the number of sites visited was low for this section (*n= 5*), 90 points were recorded overall backed up by a great deal of observational evidence from other sites. Despite largely being intact, reprofiled gully sides and hags revegetated with turves often showed signs of slipping and erosion around turved edges. Often on turves that had become dislodged, vegetation was dead or dying. This may be a problem resulting from poorly keyed-in turves where the erosion and slippage was preventing the vegetation from taking root. Of the 90 slopes monitored 73% showed signs of erosion and the average percentage vegetation cover was only 55% (Table 4). Vegetation cover was particularly low on slopes that had been revegetated using seed and moss rich brash. Slopes facing in a south-westerly direction were noteably poorly revegetated. This could be due to a number of factors including aspect, exposure, slope angle and quantity of brash and seed used.

Table 4. Monitoring results on reprofiled and revegetated gully sides and hags, 2017

Site	Number of areas monitored	% areas intact	% areas showing erosion	% average revegetaion cover of area
Barden Fell	19	74	74	49
Barden Moor	45	91	60	62
Coverhead (Phase 2)	3	100	67	82
High West & Lodge	17	47	82	31
Stags Fell Central	6	50	83	49
Total	**90**	**-**	**-**	**-**
Overall average	**-**	**72**	**73**	**55**

4.5 Bare Peat

Results from monitoring the success of revegetating areas on bare peat were very mixed. Within one site the range of revegetation cover varied from 0-100% (Figures 12a. & 12b).

Figure 12a. Bare peat on Grimwith Estate (2017) showing an area with no revegetation

Figure 12b. Bare peat on Grimwith Estate (2017) showing an area with 100% vegetation cover

The results are similar to those of the reprofiling with average vegetation cover at only 47% (Table 5). Again, south-west facing slopes fared particularly badly, with more sheltered areas showing a greater level of success.

Table 5. Average percentage revegetation recorded for treated areas of bare peat (2017)

Site	Number of areas	Average % revegetation
Barden Fell	36	30
Barden Moor	6	48
Blubberhouses	10	53
Cragdale ph2	21	56
Grimwith	22	39
Hazelwood Storiths	17	44
High West Lodge	28	26
Ramsgill	2	23.5
Overall	**163**	**42**

Many of the revegetated sites where low vegetation cover was recorded were restored using techniques that have since been modified. Applications of brash, dwarf seed and 'nurse' grasses have been increased and less suitable lowland grass species have been replaced by upland varieties better adapted to local conditions. Cotton grass plugs were also introduced last winter, targeting wetter areas. Although it is not possible to predict the success of the revegetation from recent work using these updated techniques, the first signs are promising (Figure 13).

Figure 13: Ramsgill (2017) reprofiled and revegetated gully sides, one year after works completion.

It is also encouraging that Cragdale, only a year after restoration works were completed, has one of the highest average percentages of revegetation (56%). This may be attributable to the use of heather

bales to slow run-off, trap sediment and provide shelter, reducing erosion and allowing new seed and cotton grass plugs to establish (Figure 14a & 14b).

Figure 14a & 14b. Cragdale (2017) showing the use of heather bales to help with revegetation

5.0. SUMMARY

Overall the results of the 2016/2017 monitoring project were positive. Grip blocking with peat dams has been particularly successful with the majority of dams remaining intact with a high average percentage vegetation cover. This reflects the quality of work carried out by contractors on this feature. Additionally grips with reprofiled edges appeared to be more successful than non-reprofiled, with less erosion around the dam and a higher percentage of vegetation cover.

The success of reprofiling hags and gullies and revegetating using turves or seed and brash is less apparent. Revegetation was relatively low in both techniques and erosion was high on slopes revegetated with turves. The story is similar on bare peat areas revegetated with brash and seed. However many of the sites we monitored had been completed prior to current improvements on technique.

Analysis of longer term data shows encouraging changes in cover of key species. Common Heather *Calluna vulgaris* appears to be decreasing along with Hare's Tail Cotton Grass *Eriophorum vaginatum* and more base tolerant species such as *S. palustre* and *S. fallax*. Conversely, on the increase are more acid tolerant Sphagnum species. The positive indicators are that on these sites water is being retained by the grip blocking, creating conditions better suited to blanket bog community species.

REFERENCES

GREEN, S.,BOARDMAN, C.,BAIRD, A. 2011. Investigation of peatland restoration (grip blocking) techniques to achieve best outcomes for methane and greenhouse gas emissions/balance. Controlled Environment (Mesocosm) Experiment. Final Report to DEFRA. SP1202. Leeds.

Appendix 1

YPP WORKS MONITORING SPECIFICATION

A. Grip Blocking with Peat Dams

Record an area within 5m of the nearest dam to the transect:

Dam intact	YES/NO
Signs of erosion around dam	YES/NO
Water retained to base of previous dam	YES/NO
Excess water dispersed without erosion	YES/NO
Grip surface revegetating	% cover
Species revegetating grip surface	% cover

B. Grip / Gully Blocking with Timber / Heather Bale Dams

Record an area within 5m of the nearest dam to the transect:

Dam intact	YES/NO
Signs of erosion around dam	YES/NO
Water retained to base of previous dam	YES/NO
Sediment retained to base of previous dam	YES/NO
% of water surface revegetated (viewed from above)	% cover
% of sediment surface revegetating (viewed from above)	% cover
Species revegetating grip/gully surface (Table 1)	% cover

C. Reprofiling

Record in 2m x 2m quadrats for reprofiled areas on the transect:

Area surveyed:	Quadrat, 5m of transect or entire feature
Reprofiled area intact (assess whole patch)	YES/NO
Signs of erosion to reprofiled area (assess whole patch)	YES/NO
% of reprofiled area revegetated (viewed from above)	% cover

% cover of grass nurse in quadrat (viewed from above)	% cover
Species re-vegetating quadrat surface (Table 1)	% cover

If area is too small/steep then record the entire feature or an area within 5m of the transect.

D. Bare Peat Treated Areas

Record in 2m x 2m quadrats for bare peat areas on the transect:

% of bare peat area revegetated (assess whole patch)	% cover
% cover of grass nurse within quadrat	% cover
Species revegetating quadrat surface (Table 1)	% cover

If possible, set up 3 quadrats per area, one near the edge and 2 others more centrally. If area too small, reduce number of quadrats accordingly.

Quadrat orientation

If possible orientate the quadrat sides with the cardinal axes. Record the GPS location at the *south west* of the quadrat with a mean of 30 satellites.

Table 1: Species codes

Cv	*Calluna vulgaris*
Ea	*Eriophorum angustifolium*
Ev	*Eriophorum vaginatum*
Sc	*Scirpus cespitosus*
Et	*Erica tetralix*
Em	*Empetrum nigrum*
Vm	*Vaccinium myrtillus*
Vv	*Vaccinium vitis-idaea*
Vo	*Vaccinium oxycoccos*
Rc	*Rubus chamaemorus*
Ap	*Andromeda polifolia*
No	*Narthecium ossifragum*
Do	*Drosera rotundifolia*
Da	*Drosera anglica*
Mc	*Molinia caerulea*
Je	*Juncus effusus*
Ja	*Juncus acutiflorus*
Js	*Juncus squarrosus*
Df	*Deschampsia flexuosa*
Ac	*Agrostis canina*
As	*Agrostis stolonifera*
Pc	*Polytrichum commune*
Sph	*Sphagnum* spp.
Sfa	*Sphagnum fallax*
Spp	*Sphagnum papillosum*
Scp	*Sphagnum capillifolium*
Sm	*Sphagnum magellanicum*
Scu	*Sphagnum cuspidatum*
Spu	*Sphagnum palustre*

Ss	*Sphagnum subnitens*
St	*Sphagnum tenellum*
Saf	*Sphagnum affine*
Sau	*Sphagnum austinii*
Si	*Sphagnum inundatum*
Sfu	*Sphagnum fuscum*
Sq	*Sphagnum quinquefarium*
Sd	*Sphagnum denticulatum*
Sfl	*Sphagnum flexuosum*
San	*Sphagnum angustifolium*
OTHER_MOSSES	Non listed mosses
GRASSES	Unidentified grasses
Cl_spp.	*Cladonia* lichens
OTHER_spp.	Non listed species