Yorkshire Peat Partnership

10 years of restoring Yorkshire's upland peatlands

July 2009 to March 2019

Full Report

By

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November 2019

HEADLINES

This is a report on the considerable achievements of the first 10 years of the Yorkshire Peat Partnership up to March 2019 a summary version is available for download from the Yorkshire Peat Partnership website www.yppartnership.org.uk

Landscape-scale Action

The Yorkshire Peat Partnership completed a remarkable 32,343ha* of peat restoration work by the end of March 2019 which is 37% of the estimated 86,377ha* of blanket bog in Yorkshire.

*this is defined as upland management units containing peat.

Key highlights included:

- **Securing £2,683,546 to cover core costs (e.g. staff, vehicles, equipment and office costs)**
- **Securing £16,760,543 of capital funds to carry out direct peatland restoration.**
- **Completing surveys of 50,403ha of the estimated 86,337ha of peatland units (101 sites covering 29,524ha of actual peaty soils) in Yorkshire plus an additional 392ha in the Forest of Bowland.**
- **Completing 48 archaeological assessments of potential restoration sites**
- **Carrying out Unmanned Aerial Vehicle (UAV) surveys of over 10,000ha of peatland in Yorkshire and under contract elsewhere.**
- **Completing restoration plans for 46,545ha of peat units (54% of the estimated total for Yorkshire) plus an additional 366ha in the Forest of Bowland.**
- **Completed restoration works on 32,343ha (37% of total estimated area) of peat units in Yorkshire by:**
    - **blocking 1844km (38%) of eroding grips and begun blocking of 181km (7%) of eroding gullies**
    - **Re-profiling and re-vegetating 1682km of grips and 1497km of gully edges and hags.**
    - **Re-vegetating 108ha of bare peat & micro-erosion.**
    - **Restoring 58ha of dendritic gullying.**
    - **Sowing heather seed across 124ha of bare peat, hags, dendritic areas and micro-erosion.**
    - **Planting 124,775 cotton grass plugs in bare peat**

    - **Inoculating 404ha of bare peat, dendritic areas and gully and hag sides with 93,850 harvested Sphagnum clumps, harvested Sphagnum fragments, BeadaMoss beads® and BeadaGel™**
    - **Re-establishing Sphagnum in 58ha of existing degraded blanket bog vegetation by Spreading 20ha of BeadaMoss beads® and planting 50,018 BeadaHumok™ plugs.**

- **Supported the establishment of a long-term research programme with the Stockholm Environment Institute into the relative merits of burning versus cutting and stablished a long-term *Sphagnum* and ecosystem services study Funded by Yorkshire Water in partnership with University of Manchester.**

- **Established a project under the University of Leeds led iCASP programme to develop a hydrological modelling package Digibog-Hydro and methods for assessing the socio-economic benefits of peatland restoration.**

- **Estimated that Yorkshire's peatlands currently store 38,101,767 tonnes of carbon.**

- **Towards the end of the period YPP directly employed a communications officer leading to a considerable uplift in promotion of peatlands through a revamped website and social media presence. Significant coverage on traditional media culminating in Look North and BBC Radio 4 coverage.**

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1 What is the Yorkshire Peat Partnership?

The Yorkshire Peat Partnership (YPP) began in 2009 as an umbrella organisation to try to coordinate the restoration of the badly degraded peatlands in the uplands of northern Yorkshire.

Since 2009 YPP has developed into the primary organisation coordinating the delivery of upland peatland restoration across the Yorkshire Dales National Park, Nidderdale AONB, North York Moors National Park and northern parts of the South Pennines.

Back in 2008 peatland restoration work was already underway In the Peak District and South Pennines under the coordination of the Moors for the Future Partnership and in the North Pennines under the management of the north Pennines AONB Partnership. This left a big gap in between the two in northern Yorkshire and there was growing recognition that there was an urgent need to develop a more coordinated and strategic approach to the restoration of the peatlands in this area in order to reverse the decline in this increasingly precious resource. In 2008, in response to this need, a consortium of stakeholders funded by the Yorkshire Dales National Park Authority (YDNPA) and the Yorkshire Wildlife Trust (YWT) commissioned Tim Thom (YDNPA) and Astrid Hanlon (YWT) to scope out the potential for a peatland restoration project across the Yorkshire region. This scoping assessment concluded the following.

- There was a need for a targeted effort to tackle moorland drainage and bare and eroding peat. Grazing and burning was already being tackled through the implementation of the Environmental Stewardship Scheme.

- Some restoration work was already underway but it was patchy with Natural England and individual private landowners doing excellent work to block grips in some areas of the Yorkshire Dales National Park and the North York Moors National Park Authority coordinating some bare peat restoration activity in the North York Moors. However, there were still significant areas of peatland that remained heavily drained, with areas of eroding gullies and bare eroding peat.

- At the time of the scoping report a large amount of capital funding was available through the England Rural Development Programme (ERDP) for peat restoration through the Environmental Stewardship Scheme (unfortunately this situation changed rapidly as a result of the public sector spending cuts in 2010).

- Natural England's staff were already stretched in delivering the Environmental Stewardship Scheme and asked partners to assist in the delivery of peat restoration works.

- All partners recognised the need for a coordinated and targeted programme of peat restoration works but there was no appetite to create a new independent organisation to do this.

- The preferred option was to have a branded Yorkshire Peat Partnership "umbrella" that staff from the partner organisations would deliver under. The "umbrella" would:

    - Provide a focus and secretariat for the partnership

- coordinate practical restoration programmes channelled through existing organisations
- Develop and coordinate an ecosystems research programme
- Develop a communication and awareness raising programme

This then led to the establishment of the Yorkshire Peat Partnership (YPP).

Yorkshire Peat Partnership's mission is to substantially increase the amount of peatland restoration activity in northern Yorkshire's uplands through a combination of practical restoration work, monitoring and research.

- Through its restoration work YPP preserves the peat that remains and helps to reinstate functioning, peat-forming ecosystems that will restore hydrological processes, increase biodiversity, reduce flooding impacts and decrease the amount of carbon loss.
- Through its monitoring and research YPP is contributing to the development of peatland restoration science and guiding future restoration techniques.

2 Background

2.1 Global extent of peatlands & blanket bog

The global rarity of blanket bog and concerns over its current condition in the UK have led to it being included in protective legislation and in national conservation strategies. Blanket bog condition in the UK has been impacted by multiple-pressures including drainage, afforestation, atmospheric pollution and burning. The most intensely impacted areas are severely eroded with large areas of bare peat and erosion gully networks, and artificial drainage has affected over 1.5million hectares of blanket bog.

- Peatlands cover around 4 million km^2 or 3% of the world land area, and are found from the tropics to circumpolar regions. In Europe, there are approximately 515,000km^2 of peatland.
- Blanket bog is a rare resource representing less than 3% (120,000km^2) of global peatlands. The largest concentration of blanket bog occurs in the uplands of the UK and Ireland (approximately 20% of global blanket mire).
- The United Kingdom is in the top 20 countries that contain 92% of the world's peatland soils. At 244,214km^2 the UK contains 0.6% of the global peatland resource.
- The blanket bog that covers the majority of this peatland in the uplands of the UK is internationally important with 85% (22,086km^2) of the EU25 blanket bog resource.

Although the extent of erosion of blanket bog in the UK and Ireland is not widely replicated elsewhere in the world, analogous peat erosion has been reported from North and South America, Asia and Australia. For example, increasing levels of erosion of sloping mires in Tibet demonstrate that the requirement to manage upland peat is not just a UK concern.

The current condition of blanket bog in the UK

- Only 20% of blanket bog is in a natural or near-natural condition.
- Only 58% of the blanket bog in protected sites is in favourable condition. Of the remainder only 15% is recovering.
- Reported peatland erosion across the UK varies from 10-30 %.

2.2 Ecosystem services from blanket mire

Blanket bogs contribute a range of ecosystem services.

2.2.1 Rearing animals (sheep and deer farming)

The low fertility of blanket bogs limits agricultural activities to grazing, predominantly with sheep across the UK. Grazing rates increased steadily from the early 1700s peaking at the end of the 1980s. From the 1990s this increased grazing pressure was reduced through agri-environment schemes.

2.2.2 Drinking water supply

Blanket bog catchments are important for water supply, particularly in the uplands of the UK. Peatlands leach dissolved organic carbon (DOC) giving downstream rivers, lakes and reservoirs characteristic brown coloured water which has to be treated prior to chlorination by water supply companies at high cost. DOC leaching, however, is higher in damaged blanket peat catchments than in intact catchments, and treatment costs are significantly higher.

2.2.3 Climate regulation

Intact peatlands in the UK perform two globally important climate regulation functions; (i) they store over 3,200 million tonnes of carbon, the majority of which is in blanket bogs and (ii) they may also sequester 30-70tCkm^{-2}yr^{-1} carbon from the atmosphere in the form of CO_2 through photosynthesis.

2.2.4 Water quality regulation

Blanket bogs buffer against acidification and eutrophication by locking up nutrients and other elements (e.g. sulphur, nitrogen and heavy metals from atmospheric deposition) and therefore buffer downstream surface waters against pollutants. The loss of peat forming species may cause leaching of acidity, metals and nitrates into watercourses. Blanket bogs also act as sources of dissolved organic carbon (DOC) which is considered detrimental to drinking water supplies.

2.2.5 Flood risk regulation

Intact blanket bogs are saturated systems with little fluctuation in the water table which is generally close to the surface and have little capacity to store significant additional water. However, surface flows in *Sphagnum* spp. dominated mires are lower than in mires dominated by other vegetation types or degraded mires, and the loss of *Sphagnum* cover and increases in bare peat can increase peak flow and reduce runoff lag times. Runoff from blanket bogs can become more “flashy” after peat drainage.

2.2.6 Recreational and community activities

Many peatlands are in remote areas and offer experiences of wilderness and solitude, physical challenge and inspiration. The peatland dominated upland English National Parks, for example, receive close to 60million day visitors a year. In the English uplands blanket bogs form parts of an estimated 4,428km^2 (56%) of privately owned estates managed for recreational shooting of Red grouse (*Lagopus lagopus* subsp. *scotica*) providing 120 fulltime jobs and 5,700 shoot days per year.

2.2.7 Scientific and cultural heritage

The anaerobic conditions in peat make it an excellent preservative of archaeological artefacts which provides a detailed record of environmental change through the preservation of pollen, plant remains, insect fragments, fungal spores and testate amoebae.

2.2.8 Biodiversity

Blanket bogs are priorities for conservation under the EC Habitats Directive and are designated as Special Areas for Conservation (SAC) and/or as Sites or Areas of Special of Scientific Interest (SSSI/ASSI) in much of the UK. Blanket bogs support a range of rare, threatened or declining species which are adapted to waterlogged, acidic and nutrient-poor conditions such as *Sphagnum* species (e.g. *Sphagnum austinii*) and the Bog hoverfly (*Eristalis cryptarum*). UK blanket bogs are especially important for breeding waders such as Golden plover (*Pluvialis apricaria*), Greenshank (*Tringa nebularia*) and Dunlin (*Calidris alpina*), as well as other species such as Red-throated diver (*Gavia stellata*), and Common scoter (*Melanitta nigra*).

2.3 Drivers for the current condition of blanket bogs in the UK and their impacts on ecosystem services

The drivers for the current condition of blanket bogs in the UK can be either *indirect* or *direct*. As summarized below.

2.3.1 Direct drivers

The source of direct drivers is within the blanket bog management unit itself with the main ones being:

- **Grazing**
- **Peat harvesting**
- **Forestry**
- **Fire**
- **Drainage**

2.3.2 Indirect Drivers

These are unrelated to local blanket bog management but can still have a direct physical impact on the blanket bog. The most significant indirect drivers are:

- **Policy Change**
- **Atmospheric deposition**
- **Climate Change**

2.4 Extent of upland peat soils in Yorkshire

14% of the UK's upland peat soil is in England (3553km^2). The majority of this occurs in the hills of the Pennine chain stretching from the Peak District in the south to the English/Scottish border in the north with other significant areas in Dartmoor and Exmoor in the southwest.

In 2008 the Soilscapes Map for England & Wales developed by Cranfield University was used to map the extent of peat soils in the YPP target area which, at the time, was the Yorkshire Dales National Park, the Nidderdale Area of Outstanding Natural Beauty and an area of the south Pennines sandwiched between the Yorkshire Dales and Peak District National Parks with additional areas in the North York Moors National Park (see Figure 1). This map suggested that the target area contained about **70,000ha of peat "soil" (20% of England's upland peatland).**

In 2016 YPP used a combination of Ordnance Survey, agri-environment agreement boundary maps from Natural England's website MAGIC and local knowledge to map "Management Units" that contained peat soils identified from the Soilscapes Map. In some cases this will be reasonably accurate representations of a peat area but in many cases will be an estimate of the likely ownership or management boundary. This produced a total of **86,377ha containing upland peat in Yorkshire (23% of England's upland peatland)** (see Figure 2 and Table 1).

To try to get a better estimate of actual extent of peaty soils within these Units, YPP carried out an analysis of the 106 units (50,796ha) it had surveyed so far to extrapolate to the whole of the Yorkshire area.

According to this more detailed assessment (see Section 5.1) there are an estimated **50,957ha of peaty "soils" in Yorkshire.**

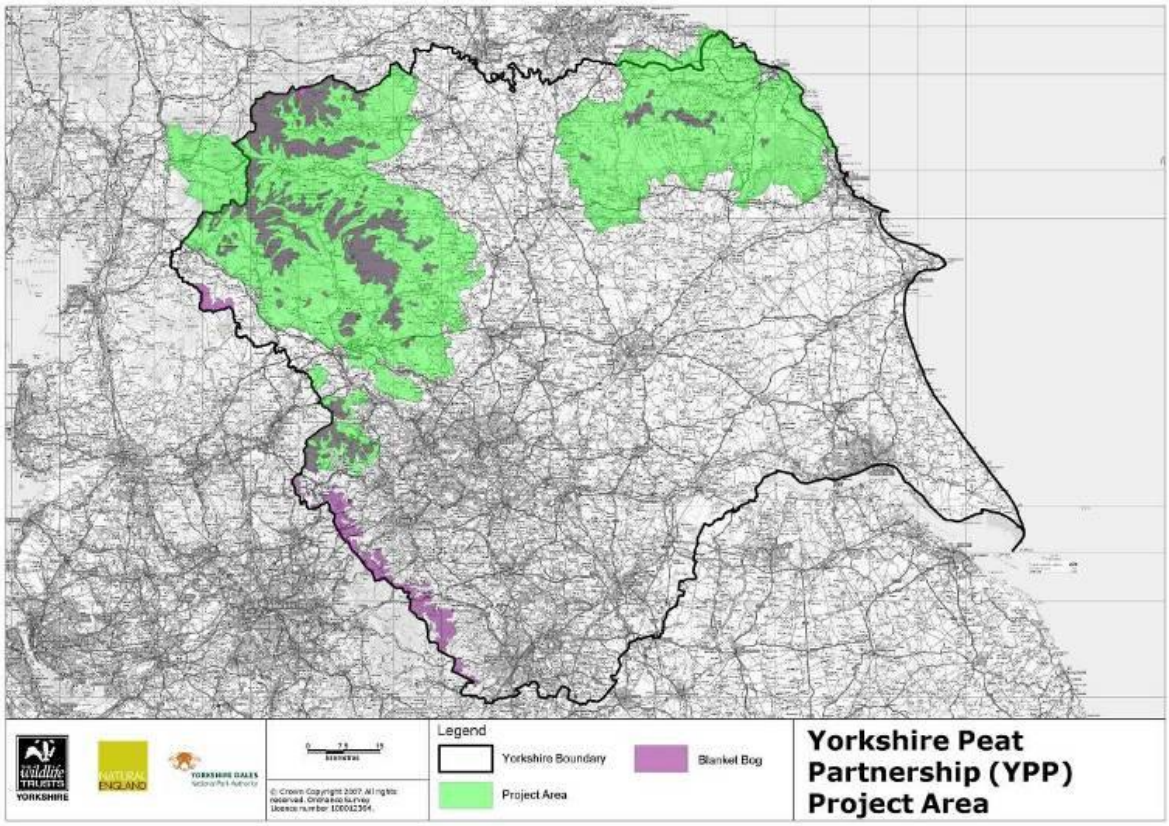
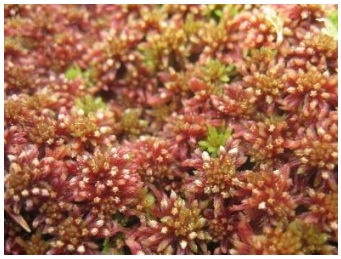


Figure 1: Original 2008 map of the Yorkshire region showing the original extent of the YPP project area (green) and the extent of blanket bog "soil"(purple) as determined from the Soilscape Map of England and Wales (Cranfield University).

Table 1 Estimated area of "Management Units" in the YPP project area containing blanket bog peat soils as defined by the Soilscapes map.

Location	Provisional Unit Area (ha)
Yorkshire Dales National Park	**56,924**
Nidderdale AONB	**19,825**
North York Moors National Park	**6,541**
South Pennines	**2374**
Other Areas of Yorkshire (east and south of Yorkshire Dales National Park)	**713**
Total Yorkshire	**86,377**
Forest of Bowland AONB (Pennine PeatLIFE area)	**2,720**
North Pennines (small extension to East Arkengarthdale)	**244**
Total Project Area	**89,341**

3 Yorkshire Peat Partnership Aims & Objectives



YPP's original aim as set out in its updated 2010 Business Plan was:

To restore 50% (35,000ha) of Yorkshire's blanket bog through a programme of grip blocking, gully restoration and bare peat re-vegetation by March 2017.

This was to be achieved through the following original objectives which related to a shortlist of sites with existing Higher Level Scheme funding and a longer list of sites identified in conjunction with Natural England and National Park staff. Initial funding was only available until March 2013:

Objectives	Target Date
1. Restore 21,262ha of degraded peatland using existing HLS committed funds. This will include: ➢ **Blocking 2085km of grips** ➢ **Reducing erosion from at least 616km of eroding gullies & hags** ➢ **Revegetating at least 139ha of eroding bare peat**	**March 2017**
2. Complete a programme of desk based surveys of 45 individual peatland sites to provide restoration plan estimates and costs for sites on a long-list for restoration.	**March 2012**
3. Secure funding and implement a works programme to restore at least an additional 13,738ha of degraded peatland from the long list to bring the total restored to 50% of the blanket bog in the Yorkshire Region. This should include: ➢ **Blocking at least 500km of grips** ➢ **Reducing erosion from approximately 200km of eroding gullies & peat hags** ➢ **Revegetating approximately 30ha of eroding bare peat**	**March 2017**
4. Establish long-term research & monitoring at a minimum of 2 sites to assess the benefits of peatland restoration to a range of ecosystem services including flood reduction, water supply, water quality, biodiversity, grouse populations and carbon budgets	**March 2013**
5. Complete a research programme to model the benefits of grip blocking in reducing the flood hydrograph	**March 2013**

6. Produce an estimate of the carbon storage and sequestration potential of the Yorkshire region's upland peat.	**August 2011**
7. Develop and secure funding for a communications and raising awareness programme to promote the importance of Yorkshire peatlands.	**March 2012**
8. Seek and secure funding to enable the continuation of the Yorkshire Peat Partnership core team beyond March 2013 enabling the restoration of the remaining peatland sites and continuation of research programmes.	**March 2013**
9. Develop a plan for restoring a significant proportion of the remaining 50% of degraded blanket bog and other peatlands within the Yorkshire Peat Partnership area	**March 2015**

4 YPP Management

4.1 Steering Group

YPP is overseen by a Steering Group consisting of Yorkshire Wildlife Trust (YWT), the Yorkshire Dales National Park Authority (YDNPA), Natural England (NE), Environment Agency (EA), the North York Moors National Park Authority (NYMNPA), Yorkshire Water Services (YWS), the Nidderdale AONB Partnership (NAONB), the National Trust (NT), the Moorland Association (MA) and the National Farmers Union (NFU).

4.2 Staff

The Partnership was established and then managed by its current Programme Manager Tim Thom, initially on secondment from YDNPA to YWT then fully employed by YWT. The majority of the remaining staff were employed by YWT together with a seconded Natural England officer on two separate occasions (see Appendix 1 for a list of current and former YPP staff).

4.3 Landowners & managers

As the majority of YPP's work is on private land, owners and managers are also an integral part of the Partnership. Without the cooperation of landowners, gamekeepers, farmers and their agents YPP would not be able to carry out its work.

4.4 Contractors

The majority of the groundworks coordinated by YPP are carried out by local specialist contractors with whom YPP has developed strong working relationships. These contractors have helped YPP to develop new and innovative peat restoration methods over the years so they are also considered to be an integral part of YPP's work.

4.5 Funding for YPP's core costs

Since 2009 funding for the YPP's core costs (e.g. staff, vehicles, equipment and office costs) has come from a wide range of partners. These contributions are described in more detail in section 6 but the main funders are Yorkshire Wildlife Trust, the Peter de Haan Charitable Trust (PDHCT) the Yorkshire Dales National Park Authority, Natural England, Environment Agency, North York Moors National Park Authority and Yorkshire Water.

Yorkshire Peatland landscapes, YPP

5 YPP Achievements

5.1 Assessing the state of North Yorkshire's blanket bogs

5.1.1 Initial estimates

Back in 2008 there was very little detailed or coordinated information on the state of Yorkshire's blanket bogs. YPP's initial targeting was based on maps of excavated drainage ditches (grips). Moorland drainage for agricultural improvement between the 1950s and the 1980s was one of the most damaging and widespread activities affecting the regions peatlands and in many cases will have destroyed the hydrological balance of the region's moorlands. In 2008/09 David Higgins of Durham University used aerial photographs to map the locations of grips across the peatlands in the catchment of the River Ouse. This was supplemented with additional funding from the Yorkshire Dales National Park Authority to cover other catchments within the National Park. The North York Moors National Park Authority also supplied YPP with Geographical Information System (GIS) layers of grips in their area. YPP obtained aerial photographs of the south Pennines area and Astrid Hanlon mapped the grips for here. As a result all of the drainage grips in peatland in the Yorkshire region were mapped into a GIS layer.

This aerial photography mapping exercise revealed that there were **over 5800km of grips in the original YPP target area**. Virtually all of the peatland sites in the area had some form of historical drainage. **90% of the grips were in the Yorkshire Dales National Park and the Nidderdale AONB**.

However, drainage from grips is not the only problem facing blanket bogs in Yorkshire. In 2008 it was also understood that significant parts of the blanket bog resource was also eroding creating large eroding gullies and peat hags and exposing large areas of bare peat. After completing restoration work on a handful of sites YPP reviewed its business plan in 2010/11 and estimated that there were **1768km of eroding gullies and hags and 340ha** of eroding bare peat in the target area.

All of the above figures were the best estimates at the time but were based predominantly on analysis of old aerial photographs without any ground-truthing. Since then YPP has surveyed 106 Blanket Bog units covering 50,796ha including some areas in the Forest of Bowland in Lancashire as part of the Pennine PeatLIFE project. These surveys used accurate (to 1cm) GPS enabled field computers to record a wide range of information (see Appendix 2 for YPP's survey specification) along transects traversing each site and, after correcting for errors, removal of all survey points that were <15cm "peat" depth (assumed not to be peat) and quality control assessment, YPP now holds a dataset of **nearly 30,500 individual records together with GIS maps of classified grips, gullies, bare peat and other erosion features**.

Using all of these data a more accurate assessment of the state of blanket bog in the project area is now possible. The next sections report on the results of those surveys and uses the information to extrapolate the condition of blanket bog across Yorkshire part of the project area.

5.1.2 Quantifying Survey areas within each Unit.

The Units do not always reflect the exact area YPP staff actually surveyed within each Unit. YPP has developed a method to determine the extent of the area surveyed.

Each individual survey point is captured using a GPS enabled field computer so YPP has a digital record of the exact location of the survey points. We can analyse these locations in a Geographical Information System (GIS) to approximate the area that had been surveyed at each of our restoration sites.

Using this method on the 106 sites surveyed by YPP the total **Survey area was calculated at 39,296ha** (Table 2) which is 77% of the Unit area for these sites (50,796ha). This figure can be used to determine the estimated area left to survey as follows:

Total estimated survey area = Total area of YPP Units (86,367ha) x 77% = 66,503ha

Total estimated unit area left to survey in Yorkshire = 66,503 - 39,296ha = 27,234ha.

5.1.3 Quantifying Peat depth, area, volume, mass and the carbon store.

It is even more important in assessing the impact of YPP's work to determine the extent of peat within each Unit and/or Survey area.

5.1.3.1 Peat depth

Peat depths for each site were obtained in accordance with YPP's survey specification. Locations with zero peat depth were removed from the analysis. In addition, it was assumed that depths of <15cm were not considered to be peat and were also removed. The whole dataset was then quality control checked to remove any errors or duplicate entries (which sometimes happened with the earlier versions of the field computers).

Table 2 gives the mean peat depths for each site divided by administrative area for all sites surveyed by YPP. Four sets of figures are given for each site. The >15cm depth data provides an assessment of the depth of all peat across the site, the >30cm depth is the ecological definition of peatland where, in general, vegetation roots can no longer reach the mineral layer below so obtain all their nutrients from rainfall, while the >40cm depth data provides an assessment of the mean depth of "deep" peat as defined in England.

Overall the mean depth of peat >15cm across the project area surveyed is 0.96m. Overall the largest mean depths are in the Forest of Bowland (1.50m) followed by the Yorkshire Dales (1.02m) then by Nidderdale (0.99m) and the North York Moors (0.92m).

Overall the mean depth of peat >30cm across the project area surveyed is 1.09m. Overall the largest mean depths are in the Forest of Bowland (1.54m) followed by the North York Moors (1.12m) then by Yorkshire Dales (1.10m) and Nidderdale (1.02m).

The overall mean depth for deep peat (>0.40m) across the project area surveyed is 1.17m. Forest of Bowland has the deepest peats (mean of 1.59m for deep peat), followed by the North York Moors (1.24m), Nidderdale (1.17m) and then the Yorkshire Dales (1.16m).

The **maximum site mean depth was 2.84m at May Moss in the North York Moors** although this site is more typical of a raised bog than a blanket bog.

None of the Units surveyed by YPP had mean peat depths less than the 40cm deep peat definition.

5.1.3.2 Peat area

The method employed by YPP for obtaining peat depths is probably one of the most comprehensive assessments used in any peatland restoration programme but it is nonetheless just a sampling approach and gives a peat depth for point locations only. YPP have used further GIS and geospatial modelling tools to turn these point locations into maps showing the area of Peat in a Unit.

YPP used a method using Thiessen (or Voronoi) polygons to estimate peat depth area using the peat depths collected during field surveys. Creating Voronoi polygons is a systematic way to divide spaces into a number of regions using a set of points specified at the beginning. For each point there will be a corresponding region that consists of the points closer to that point than any other.

The Voronoi polygons are then separated into peat depths of > 15cm, > 30cm, >40cm and >50cm to represent all peat, peat of "ecological depth", deep peat and peatland that might currently be eligible for the Peatland Code respectively.

Using this method on the 106 sites surveyed by YPP the total **Peat area (>15cm) was calculated at 29,898ha** (Table 2) which is 59% of the Unit area for these sites (50,796ha). This figure can be used to determine the estimated peat area for Yorkshire as follows:

Total estimated Yorkshire peat area = Total area of YPP Units (86,367ha) x 59% = **50,957ha**

5.1.3.3 Peat volume & mass, Carbon store

Using the peat depth area previously calculated, an estimate of the volume of peat in each polygon can then be calculated by multiplying the area of the polygon by the peat depth recorded at the point location. The sum of all volumes for all the polygons gives a total for each site.

The mass of peat can also be estimated by multiplying the volume by density. Peat density varies considerably within blanket bogs so, unless it has been measured on site (and there are few blanket bog studies that have done this), estimates of peat mass using a literature derived standard density estimate should be treated with caution. For the purposes of this report YPP has used 0.15gcm^{-3}. Carbon mass is calculated based on the assumption that peat mass is 50% carbon.

This gives an **estimated total stored carbon mass of 38,256kt across Yorkshire's peatlands**.

Table 2: Unit area, Survey area and peat and average peat depths across blanket bog sites surveyed by the Yorkshire Peat Partnership.

NYM = North York Moors National Park; NID = Nidderdale AONB; YD = Yorkshire Dales National Park; SP = South Pennines; FOB = Forest of Bowland AONB).

Admin Area	Site	Unit Area (ha)	Survey Area (ha)	Peat Area (ha)				Survey points (n)					Peat depth (cm)		
				15cm	30cm	40cm	50cm	all	15cm	30cm	40cm	50cm	15cm	30cm	40cm
NYM	Arden Great Moor	267	218	164	154	146	141	88	63	59	54	52	95	100	106
NYM	Arnsgill Ridge	2	2	2	2	2	2	40	6	2	2	2	37	77	77
NYM	Black Hagg	396	284	205	178	142	116	237	179	162	138	117	77	83	92
NYM	Bransdale	397	393	181	125	96	69	527	262	190	143	104	48	58	67
NYM	Cockayne Head	41	32	8	6	4	3	102	63	43	43	43	62	80	80
NYM	Glaisdale Phase 1	356	331	207	189	172	157	307	188	141	134	128	122	155	161
NYM	Greenhow Moor	53	48	42	40	35	30	103	92	89	79	66	75	77	83
NYM	High Farndale	313	240	146	75	44	33	115	70	38	25	18	37	52	63
NYM	Ingleby Moor	113	99	68	47	44	39	102	77	58	51	45	62	76	83
NYM	Kempswithen	436	343	43	24	9	5	247	20	12	5	3	45	62	108
NYM	May Moss	72	72	65	64	64	62	84	76	75	75	73	280	284	284
NYM	Nab Farm Bog	25	25	21	19	19	18	111	82	77	75	71	187	197	202
NYM	Rosedale Moor, Middle Head	175	136	124	90	69	44	41	36	26	20	14	59	74	87
NYM	Slape Wath	152	152	77	60	54	44	241	143	117	111	96	83	98	101
NYM	Westerdale Common	705	614	473	316	218	179	319	198	114	78	60	40	56	67
NYM	Yarsley Moss, Egton Moor	43	42	39	37	37	36	89	79	76	76	75	219	227	227
NYM	**All sites (n = 16)**	**3548**	**3032**	**1864**	**1427**	**1153**	**978**	**2753**	**1634**	**1279**	**1109**	**967**	**92**	**112**	**124**
NID	Askwith	352	307	199	84	57	39	86	56	24	16	11	33	52	63
NID	Blubberhouses	738	668	542	429	318	234	172	139	107	79	58	58	69	83
NID	Colsterdale (Swinton)	2446	2064	1461	948	765	638	552	389	251	204	170	70	98	114
NID	Dallowgill common	1389	1329	947	555	351	233	346	244	144	89	59	38	51	64
NID	Dallowgill non-common	436	401	277	150	120	78	225	144	80	59	38	43	62	73
NID	Gouthwaite	293	253	205	165	155	134	69	56	46	43	37	129	153	162
NID	Great Stray (High Moor, Low Moor &Hard Pits)	1045	956	806	503	394	316	456	382	231	182	146	50	71	82
NID	Hardcastle	694	528	392	319	284	255	507	419	380	354	335	174	190	202
NID	Heathfield	698	628	525	406	374	344	162	134	102	94	86	122	155	166
NID	Heyshaw and Flat Moor	844	762	515	286	194	137	198	134	74	51	36	39	55	67

NID	High West	632	391	371	344	314	296	243	211	187	172	160	127	141	150
NID	High West (Pennine PeatLIFE)	87	83	79	79	75	72	22	20	20	19	18	204	204	213
NID	Humberstone Bank	653	650	543	436	373	306	693	563	455	391	324	79	93	103
NID	Ilton (Swinton)	1330	1093	640	389	291	230	293	172	105	79	64	47	65	76
NID	Jervaulx	185	185	60	40	24	17	843	311	155	97	71	36	54	68
NID	Kex Gill and Hall Moor	295	230	210	162	115	78	64	58	45	32	21	56	67	82
NID	Lamb Close Moor	268	201	119	80	62	38	173	106	73	57	36	54	70	82
NID	Little Whernside	429	65	62	61	57	54	18	17	17	16	15	108	108	113
NID	Lodge Moor	674	458	361	287	261	233	117	92	74	68	61	102	122	130
NID	Lodge Moor PeatLIFE	18	18	18	18	18	18	6	6	6	6	6	175	175	175
NID	Middlesmoor	362	279	215	160	140	128	75	58	43	38	35	94	121	133
NID	Ramsgill	953	880	737	647	571	506	1449	1286	1157	1022	901	102	112	122
NID	Sigsworth Moor	172	46	27	6	5	3	34	20	4	3	2	24	50	56
NID	Somerset House	139	72	35	18	12	6	58	31	17	12	7	34	47	53
NID	Summerstone	277	276	170	108	79	60	1066	665	424	307	235	51	69	83
NID	The Guides	171	111	107	95	84	78	28	27	25	22	21	82	87	95
NID	Woodale	510	335	315	264	231	217	85	81	68	59	56	99	114	126
NID	**All sites (n = 27)**	**16117**	**13298**	**9939**	**7042**	**5725**	**4749**	**8040**	**5821**	**4314**	**3571**	**3009**	**80**	**102**	**117**
YD	Apedale	1371	1296	1034	900	838	769	1144	929	788	736	662	102	116	122
YD	Barden Fell	612	403	278	172	118	75	104	71	43	29	18	43	59	72
YD	Barden Moor	1621	1333	822	521	417	312	335	202	126	100	74	52	72	82
YD	Beamsley	283	100	86	49	30	23	30	26	15	9	7	37	51	65
YD	Birkdale Area 1	1247	187	163	154	143	128	140	112	107	101	91	104	108	113
YD	Conistone Moor	1139	725	628	558	534	506	271	232	196	186	172	102	117	122
YD	Coppergill	136	65	24	4	4	0	17	6	1	1	0	22	40	40
YD	Coverhead	1716	604	502	466	427	396	507	438	415	389	361	89	93	97
YD	Cragdale	429	331	296	228	170	155	96	84	66	51	47	71	85	100
YD	Cray Moss	231	185	155	152	146	144	253	150	143	130	121	111	115	124
YD	East Arkengarthdale Area 1	676	462	336	290	262	239	555	482	461	446	426	137	142	146
YD	East Arkengarthdale Area 2	1328	1108	779	614	530	467	868	702	612	558	506	103	115	124
YD	Embsay Moor	811	520	360	201	136	94	135	94	53	35	24	39	55	67
YD	Fawcett Moor	232	169	171	171	171	156	49	49	49	49	45	126	126	126
YD	Fleensop	265	207	137	92	73	54	63	40	28	23	18	58	75	84
YD	Fleet Moss	327	307	268	247	223	211	222	187	170	158	151	144	157	166
YD	Gayle Ings	27	19	10	5	4	2	6	4	3	2	1	42	50	60

YD	Grimwith	414	338	288	269	257	249	311	236	214	203	193	128	140	146
YD	Grimwith DEFRA	75	73	72	68	68	63	45	44	41	41	38	152	162	162
YD	Grinton Moor	280	182	103	71	51	38	166	100	71	54	41	50	62	72
YD	Gunnerside Moor & Pasture	830	651	544	463	424	346	777	701	639	595	526	95	102	107
YD	Harkerside	243	241	157	140	128	116	300	172	152	139	126	96	106	113
YD	Hazelwood and Storiths	531	429	266	166	122	48	141	79	46	35	15	35	47	52
YD	Henstones	251	152	152	152	152	148	41	41	41	41	40	173	173	173
YD	Henstones Allotment	81	81	62	42	28	21	78	61	41	29	21	55	73	89
YD	Ingleborough	755	373	252	166	133	86	124	84	53	41	26	44	59	67
YD	Ingleborough Allotment	122	115	112	108	95	80	40	38	32	27	21	55	62	68
YD	Ivelet Moor Area 1	216	155	152	151	147	141	283	276	272	265	256	110	112	114
YD	Ivelet Moor Area 2	216	202	161	135	117	100	317	272	237	209	180	81	90	98
YD	Kelber	66	44	31	11	11	5	13	8	3	3	1	30	46	46
YD	Melbecks	1213	1020	695	590	537	487	1259	799	666	603	536	108	125	135
YD	Mossdale Area 1 Phase 1	206	202	193	190	185	179	377	364	362	353	338	106	106	108
YD	Mossdale Area 1 Phase 2	272	256	244	229	209	177	508	491	472	437	391	82	85	89
YD	Mossdale Area 2	944	878	788	751	715	663	1341	1292	1254	1198	1126	99	101	104
YD	Mossdale Area 3	273	210	163	153	138	102	442	350	329	293	230	61	64	68
YD	Muker Common	498	332	319	307	298	284	677	660	645	629	602	119	122	124
YD	Nethergill	105	86	86	86	86	83	26	26	26	26	24	113	113	113
YD	New House PeatLIFE	182	171	140	101	98	91	50	39	28	27	25	118	158	163
YD	Oughtershaw	16	16	15	14	12	12	16	15	14	12	12	126	134	151
YD	Raydale	453	346	321	261	233	186	95	88	71	63	51	81	95	103
YD	Reeth High Moor	429	254	205	178	159	138	227	183	161	147	129	84	93	99
YD	Scrafton	316	278	206	176	151	140	81	60	51	44	41	111	128	143
YD	Shaking Moss DEFRA	3	3	2	2	2	2	4	3	3	3	3	207	207	207
YD	Sleets	343	340	277	260	240	218	363	308	295	270	243	91	94	100
YD	Stags Fell Phase 1	634	244	233	220	202	177	377	369	353	333	278	84	87	91
YD	Stags Fell Phase 2	411	156	146	143	140	124	224	220	218	213	198	104	105	107
YD	Stags Fell Phase 3	509	207	202	188	179	169	154	150	142	137	130	115	120	124
YD	Stake Moss PeatLIFE	166	155	152	146	131	129	44	43	41	36	35	141	147	164
YD	Summer Lodge	123	112	101	83	79	76	96	87	72	68	65	113	132	138
YD	Tenant Gill	164	157	84	76	61	53	130	80	76	63	53	74	77	87
YD	The Preserves North	61	50	50	47	35	25	16	16	15	12	9	55	58	65
YD	The Preserves South	49	41	41	27	20	10	12	12	8	6	3	37	47	53

YD	Thoralby Common	88	74	70	60	55	55	21	20	17	15	15	144	167	185
YD	West Arkengarthdale Pennine PeatLIFE	66	66	57	53	51	48	66	57	53	51	47	112	119	122
YD	West Arkengarthdale Phase 1	3453	2886	2287	2062	1908	1730	3462	3058	2860	2693	2488	108	114	119
YD	West Stonesdale	1305	1188	1029	949	876	784	728	657	621	588	542	124	131	136
YD	Whitaside	468	446	352	326	306	287	487	373	339	316	296	122	132	140
YD	**All Sites (n = 57)**	**29278**	**21228**	**16858**	**14412**	**12363**	**11600**	**18714**	**15740**	**14310**	**13321**	**12118**	**102**	**110**	**116**
SP	Oxenhope, Midgeley & Warley Moors	1489	1375	864	705	585	500	709	470	388	330	281	84	98	110
SP	**All Sites (n = 1)**	**1489**	**1375**	**864**	**705**	**585**	**500**	**709**	**470**	**388**	**330**	**281**	**84**	**98**	**110**
Yorks	**All Sites (n = 101)**	**50403**	**38903**	**29524**	**23616**	**20525**	**17828**	**30018**	**23499**	**20146**	**18193**	**16248**	**96**	**109**	**117**
FOB	Hareden Fell	64	64	58	58	55	50	68	63	63	59	53	132	132	139
FOB	Holme House	42	42	40	40	37	36	43	40	40	37	35	126	126	134
FOB	Holme House Reveg	27	27	20	15	14	13	24	18	13	12	11	89	116	124
FOB	Langden Head	84	84	83	80	79	73	81	80	77	76	71	173	179	181
FOB	Websters Meadow	176	175	172	170	166	160	176	172	170	166	159	159	161	164
FOB	**All Sites (n = 5)**	**393**	**392**	**374**	**367**	**352**	**333**	**392**	**373**	**363**	**350**	**329**	**150**	**154**	**159**
TOTAL	**All Sites (n = 106)**	**50796**	**39296**	**29898**	**23980**	**20877**	**18160**	**30410**	**23872**	**20509**	**18543**	**16577**	**96**	**109**	**117**

5.1.4. Determining the physical state of peatlands in the YPP area.

YPP's survey specification results in detailed GIS layers that map the physical erosion features present within the surveyed area. Table 3 summarises the quantities of the main erosion features present in the peatland so far surveyed by YPP (as at 31st March 2017 the latest date analysed).

Making the assumption that the reminder of un-surveyed sites will have similar levels of erosion YPP have used the figures in Table 3 to estimate the quantities of these erosion features across the full upland peatland in North Yorkshire (Table 4).

5.1.5. Determining the vegetation characteristics of peatland in the YPP area.

While not a fully comprehensive habitat assessment the YPP survey method provides a lot of useful data on the vegetation characteristics of upland peatlands in the project area. The two most informative datasets are the vegetation community assessment and the indicator species list.

Table 5 summarises the overall percentage of survey points with records for each vegetation community present at the three peat depths (>15cm, >30cm, >40cm) for the peatland so far surveyed by YPP (at 31st March 2017 – the latest date analysed).

These results are initially encouraging in that there are only small amounts of non-bog vegetation communities present. However, much of the bog is in categories with *Calluna vulgaris* at greater than 25% cover even on the deep peat areas.

Table 6 summarises the overall percentage of survey points with each indicator species present at the three peat depths for the peatland so far surveyed by YPP (at 31st March 2017 – the latest date analysed).

These results further emphasise the dominance of Heather across the surveyed bogs and there are some indicators of "drier" communities (Bilberry, *Hypnum* spp., *Polytrichum* spp.) at higher than expected levels while specialist bog species (*Sphagnum* spp., Cross-leaved heath, Crowberry, Cranberry, Bog Rosemary, Bog Asphodel, Sundews) may be lower than would be expected.

Analysis of the raw data (Table 7) shows that *Sphagnum capillifolium* was the most frequently recorded species (at 31st March 2017 – the latest date analysed) – an indicator of a drying bog - closely followed by *S. fallax* which is tolerant of a wide range of conditions. All other species occur at low frequency.

Table 3: Quantities of erosion features recorded in YPP surveys of upland peatland up to 31st March 2017 (the latest date analysed).

Feature	Quantities		
	Administrative Area	Total	Per hectare of peatland
Bare Peat	North York Moors	17ha	40m^2
	Nidderdale	38ha	30m^2
	Yorkshire Dales	169ha	90m^2
	South Pennines	26ha	170m^2
	All areas	250ha	
Length of eroding gullies	North York Moors	50.2km	12m
	Nidderdale	343.8km	25m
	Yorkshire Dales	959.8km	50m
	South Pennines	7.3km	5m
	All areas	1361.1km	
Length of eroding hag sides	North York Moors	4.1km	<1m
	Nidderdale	139.2km	10m
	Yorkshire Dales	971.1km	50m
	South Pennines	0km	0m
	All areas	1,114.4km	
Length of grip	North York Moors	86.2km	21m
	Nidderdale	812.4km	60m
	Yorkshire Dales	2,703.5km	140m
	South Pennines	17.2km	11m
	All areas	3,619.3km	
Length of eroding grip	North York Moors	68.5km	17m
	Nidderdale	498.5km	37m
	Yorkshire Dales	1,773.2km	92m
	South Pennines	7.3km	5m
	All areas	2,347.5km	
Area of micro-erosion	North York Moors	1ha	2.4m^2
	Nidderdale	0ha	0m^2
	Yorkshire Dales	0ha	0m^2
	South Pennines	26ha	170m^2
	All areas	27ha	
Area of dendritic erosion	North York Moors	0ha	0m^2
	Nidderdale	0ha	0m^2
	Yorkshire Dales	20ha	10m^2
	South Pennines	26ha	170m^2
	All areas	46ha	

Table 4: Extrapolated estimated quantities of erosion features across Yorkshire's upland peatlands as of 31st March 2017 (the latest date analysed.

Feature	Administrative Area	Total
Bare Peat	North York Moors	21ha
	Nidderdale	45ha
	Yorkshire Dales	417ha
	South Pennines (in North Yorkshire)	7ha
	All areas	490ha
Length of eroding gullies	North York Moors	62km
	Nidderdale	377km
	Yorkshire Dales	2317km
	South Pennines (in North Yorkshire)	2km
	All areas	2758km
Length of eroding hag sides	North York Moors	5km
	Nidderdale	151km
	Yorkshire Dales	2317km
	South Pennines (in North Yorkshire)	0km
	All areas	2473km
Length of grip	North York Moors	109km
	Nidderdale	905km
	Yorkshire Dales	6487km
	South Pennines (in North Yorkshire)	5km
	All areas	7506km
Length of eroding grip	North York Moors	88km
	Nidderdale	558km
	Yorkshire Dales	4263km
	South Pennines (in North Yorkshire)	2km
	All areas	4911km
Area of micro-erosion	North York Moors	1ha
	Nidderdale	11ha (during restoration 11ha were identified)
	Yorkshire Dales	3ha (during restoration 3ha were identified)
	South Pennines (in North Yorkshire)	7ha
	All areas	22ha
Area of dendritic erosion	North York Moors	0ha
	Nidderdale	0ha
	Yorkshire Dales	58ha (during restoration this was increased to 58ha)
	South Pennines (in North Yorkshire)	7ha
	All areas	65ha

Table 5: Summary of the percentage of survey points with each vegetation community present at the three peat depths for the peatland so far surveyed by YPP up to 31st March 2017 (the latest date analysed).

Vegetation type	Percentage of survey points (%)		
	>15cm peat depth (n = 23,855)	>30cm peat depth (n = 20,498)	>40cm peat depth (n = 18,534)
Blanket Bog Pool (*Sphagnum* dominated)	<1	<1	<1
Blanket Bog (25% Heather cover)	9	11	11
Blanket Bog (50% Heather cover)	23	26	28
Blanket Bog (75% Heather cover)	27	30	32
Blanket Bog (Cottongrass) dominated)	1	1	1
Blanket Bog (Cross-leaved heath dominated) dominated)	<1	<1	<1
Wet heath	4	3	2
Dry heath	17	12	9
Acid grassland dominated by Heath rush	<1	<1	<1
Acid grassland dominated by Mat grass	<1	<1	<1
Acid grassland dominated by Purple moor grass	<1	<1	<1
Acid grassland dominated by Wavy hair grass	<1	<1	<1
Other acid grassland	<1	<1	<1
Acidic flush	3	3	3
Basic flush	1	1	1
Bracken	<1	<1	<1
Other vegetation	2	2	1

Table 6 Summary of the percentage of survey points with each indicator species present at the two peat depths for peatland so far surveyed by YPP up to 31st March 2017 (the latest date analysed).

Indicator species	Percentage of survey points (%)		
	>15cm peat depth (n = 27,743)	>30cm peat depth (n = 23,678)	>40cm peat depth (n = 21,480)
Heather	17	16	16
Common Cotton-grass	9	9	10
Hare's-tail Cotton-grass	11	12	13
Deergrass	<1	<1	<1
Cross-leaved Heath	2	2	2
Crowberry	5	5	5
Bilberry	7	6	6
Cowberry	1	1	1
Cranberry	1	1	1
Cloudberry	1	1	1
Bog Rosemary	<1	<1	<1
Bog Asphodel	<1	<1	<1
Sundews	<1	<1	<1
Purple-moor grass	<1	<1	<1
Heath rush	2	1	1
Soft rush	3	3	3
Wavy-hair grass	1	1	<1
Bent grasses	<1	<1	<1
Fescue grasses	1	<1	<1
Campylopus flexuosus	1	1	1
Hypnum spp.	7	7	7
Pleurozium schreberi	2	2	2
Polytrichum spp.	8	8	8
Sphagnum spp.	5	6	6

Table 7: Summary of the percentage of survey points with Sphagnum species recorded at the two peat depths for the peatland so far surveyed by YPP up to 31st March 2017 (the latest date analysed).

Sphagnum species	Percentage of survey points (%)		
	>15cm peat depth (n = 27,743)	>30cm peat depth (n = 23,678)	>40cm peat depth (n = 21,480)
S. capillifolium	4	5	5
S. compactum	<1	<1	<1
S. cuspidatum	1	1	1
S. denticulatum	<1	<1	<1
S.inundatum	<1	0	0
S. fallax	4	4	4
S. fimbriatum	<1	<1	<1
S. magellanicum	<1	<1	<1
S. palustre	1	1	1
S. papillosum	2	2	2
S. pulchrum	<1	<1	<1
S. squarrosum	<1	<1	<1
S. subnitens	<1	1	1
S.tenellum	<1	0	0

5.1.6. Assessing the amount of burning on peatland in the YPP area.

As it is currently the primary land management tool on blanket bog the YPP survey also records the amount of burning. This is largely managed burning but the method would pick up wildfire burns as well. Table 8 shows that around half of the survey points show evidence of burning.

Table 8: Summary of the percentage of survey points in different burn categories recorded at the two peat depths for the peatland so far surveyed by YPP up to 31st March 2017 (the latest date analysed).

Burn category	Percentage of survey points (%)		
	>15cm peat depth (n=23,745)	>30cm peat depth (n=20,421)	>40cm peat depth (n=18,473)
No burn	44	44	44
Mature old heather	7	6	6
New burn – blackened vegetation	5	5	5
1-5 year old burn – heather regenerating but not closed canopy	11	11	11
5-10 year old burn – closed canopy pioneer heather, up to 15cm high	13	13	13
Heather between 15 and 30cm high	21	21	22

5.2. Raising funds

One of the most significant and time-consuming activities of YPP is raising funds to enable the partnership to function and to deliver restoration works. Funding is divided into two categories:

- Core (revenue) funds – these are the funds needed to cover staff costs, vehicle expenses, publications, equipment, research & monitoring costs, etc.

- Capital funds – these are the funds needed to implement physical works on the ground.

Yorkshire Wildlife Trust has become expert at securing and managing funds from a range of sources and finding ways to overcome bureaucratic and administrative arrangements in order to maximise the impact of these funds in delivering peat restoration.

YPP has also worked well to secure funding from major grant funds including EU-LIFE and DEFRA capital funding.

5.2.1. Core Funding

YPP's **£2,683,546 of core funding** has come from a variety of sources over the years (see Table 9).

Table 9 Sources of funding for Yorkshire Peat Partnership's core costs up to March 31st 2019.

Organisation	Amount £
Yorkshire Wildlife Trust – legacies	84,557
Yorkshire Wildlife Trust – fund-raising	30,971
Yorkshire Wildlife Trust – consultancy	77,753
Yorkshire Wildlife Trust – in kind overheads	135,677
Yorkshire Dales National Park Authority	300,100
North York Moors National Park Authority	93,146
Nidderdale AONB	1,000
North Pennines AONB	10,000
Environment Agency – direct	279,379
Environment Agency – via Pennine PeatLIFE	280,000
Natural England	588,845
DEFRA Peatland Fund – via YWT	33,000
Higher Level Scheme	248,864
Countryside Stewardship	63,567
Yorkshire Water – contracts	337,014
Yorkshire Water – via Pennine PeatLIFE	19,673
Peter de Haan Conservation Trust	100,000
TOTAL	**£2,683,546**
Average per annum	**£268,355**
Loans - Yorkshire Dales National Park Authority	£2,107,341
Loans - The Wildlife Trusts	£1,500,000

5.2.1.1. Yorkshire Wildlife Trust

In the early stages of the project Yorkshire Wildlife Trust secured the £84,557 Joyce Mountain legacy which was used, together with funds from the Yorkshire Dales National Park Authority and the Environment Agency to part-fund the scoping work in 2008 and then funded core costs between 2009 and 2011 and then again in 2014-15. From 2015, as funding sources became increasingly sparse YWT secured a further £115,528 from a range of other sources including donations, small grants and consultancy work. In 2017/18 and 2018/19 the programme was unable to secure full cost recovery so YWT also made an in-kind contributed £135,677 worth of overheads.

5.2.1.2. Yorkshire Dales National Park Authority

Along with Yorkshire Wildlife Trust and the Environment Agency the Yorkshire Dales National Park Authority (YDNPA) was one of the main core funders from the start of the Partnership until 2014-15 with a total contribution of £300,100. YDNPA played a crucial role in funding YPP's delivery through £2.1million of loans which had a huge impact on overcoming administrative problems with the Higher Level Scheme (see section 5.2.3.1).

5.2.1.3. North York Moors National Park Authority

The North York Moors National Park Authority provided £93,146 of funding between 2009/10 and 2012/13 to employ a YPP officer to work on a number of restoration schemes within the National Park.

5.2.1.4. Nidderdale AONB Partnership

Nidderdale AONB provided a £1000 grant in 2015/16 to help with vehicle purchase costs.

5.2.1.5. North Pennines AONB Partnership

North Pennines AONB contributed £7,000 to support the writing of the bid to the EU for the Pennine PeatLIFE project (see section 5.2.1.13) in 2014/15 and also provided £3,000 to support the running costs of the first year of the DEFRA funded Northern Peat Partnership (see section 5.2.1.8) in 2018/19.

5.2.1.6. Environment Agency

As one of the original three funding partners the Environment Agency have contributed funding from a variety of sources to support £279,379 of YPP's core costs. In addition the Environment Agency played a crucial role in securing the Pennine PeatLIFE project (see section 5.2.1.13) as one of the major funding partners and have so far contributed £280,000 to the costs of delivering the project's work in Yorkshire and in the Forest of Bowland.

5.2.1.7. Natural England

Natural England was also one of the original funders of YPP through staff secondment support (£15,521) in 2009/10 and continued with major direct support until through direct support from their Water Framework Directive funds until March 2018 (£573,324) which was mainly focused on supporting the delivery of Higher Level Scheme funded work (see section 5.2.1.9).

5.2.1.8. DEFRA

In autumn 2017 Yorkshire Wildlife Trust, on behalf of 8 organisations, successfully bid to DEFRA's Capital Grant for the Restoration of Peatland in England for £4,445,837 to fund the restoration of 23 sites across northern England as part of the North of England Peat Partnership. £99,000 of this is available to cover management costs over 3 years commencing April 2018.

5.2.1.9. Higher Level Scheme (administered by Natural England through individual land manager agreements).

Until March 2014 YPP were charging agreement holders a fee under the Higher Level Scheme (see section 5.2.3.2) to act as their agents in carrying out surveys, drawing up restoration plans and overseeing capital works. The agreement holders were able to claim these funds back from Natural England. A total of £248,864 of core cost recovery was secured in this way.

5.2.1.10. Countryside Stewardship Scheme (administered by the Rural Payments Agency and Natural England through individual land manager agreements

In 2017/18 transition to the new Countryside Stewardship Scheme was underway. Under this scheme landowners are required to draw up a costed feasibility plan for peatland restoration prior to applying to the scheme. Landowners are required to contract suitably qualified individuals or organisations to draw up these plans for which they are paid a fee. So far, Yorkshire Peat Partnership has won most of these contracts covering £63,567 of core costs.

5.2.1.11. Yorkshire Water contracts.

As part of its need to reduce contamination of drinking water supplies (from Dissolved Organic Carbon) Yorkshire Water has funded a major programme of peatland restoration employing YPP to carry out several restoration contracts and paid a total of £337,014 of contract fees for the management and monitoring costs associated with this work.

In addition Yorkshire Water are one of the major funding partners in the Pennine PeatLIFE project (see section 5.2.1.13) and have, so far, contributed £19,763 to the costs of running this project.

5.2.1.12. Peter de Haan Conservation Trust (PDHCT)

PDHCT is a charitable trust that has supported peatland restoration in the UK for many years and provided a generous grant of £100,000 to help with YPP's running costs during 2017/18 and 2018/19.

5.2.1.13. Pennine PeatLIFE

After two unsuccessful attempts, Yorkshire Wildlife Trust, North Pennines AONB and the Forest of Bowland AONB supported by Environment Agency, Yorkshire Water, United Utilities and Northumbrian Water secured the Pennine PeatLIFE project of €6,502,760 (approx. £6million at the time of the bid) for a programme of peatland restoration across the Yorkshire Pennies, Forest of Bowland and North Pennines. It also showcases the use of UAV techniques, novel restoration methods. The 5 year project commenced in July 2017 and is also trialling the development of a carbon emissions reduction payment mechanism called the Peatland Code.

The funds cover staff and running costs to a total of €1,845,813 in addition to the capital costs of delivering the restoration of 1,353ha of blanket bog habitat

The project is funded by the partners and the EU-LIFE fund as follows:

Organisation	**Funding (€)**
EU LIFE fund	3,849,733
North Pennines AONB (lead partner)	82,339 (mix of in-kind and cash)
Yorkshire Wildlife Trust	52,729 (mix of in-kind and cash)
Lancashire Wildlife Trust	24,909 (in-kind)
Environment Agency	803,250
Northumbrian Water	285,600
United Utilities	452,200
Yorkshire Water	952,000

5.2.2. Capital works funding

YPP has secured a total of **£14,846,154** of restoration funding in Yorkshire since it began in 2008/09 (see Table 10). This has come from the following sources:

Table 10 Sources of Yorkshire Peat Partnership's restoration delivery funding up to March 2019.

Organisation	Amount £
Environment Agency - Water Framework Directive	643,410
Natural England - Water Framework Directive	166,239
Higher Level Scheme (administered by Natural England through individual land manager agreements)	11,155,831
Countryside Stewardship Scheme (administered by Natural England and Rural Payments Agency through individual land manager agreements)	49,492
Yorkshire Water - contracts	2,279,335
Yorkshire Water – via Pennine PeatLIFE	£235,817
DEFRA Peatland Fund - via YWT	258,313
DEFRA Peatland Fund - via Pennine PeatLIFE	57,717
TOTAL	**14,846,154**
Average per annum	**1,484,615**

5.2.2.1. Higher Level Scheme (administered by Natural England through individual land manager agreements).

The most significant source of funds for peatland restoration in the YPP area to date was the Higher Level Scheme. This scheme, administered by Natural England, provided funds to land managers to restore blanket bogs as part of overall agri-environment land management agreements. YPP was employed by the agreement holders to implement the works on their behalf.

5.2.2.2. Yorkshire Water contracts.

As part of its programme to reduce colour (from Dissolved Organic Carbon) Yorkshire Water employed YPP to carry out several restoration contracts in drinking water catchments in Nidderdale and the Yorkshire Dales.

In addition Yorkshire Water are one of the major funding partners in the Pennine PeatLIFE project (see section 5.2.1.13) and have, so far, contributed £235,817 of capital expenditure in the Yorkshire part of the project.

5.2.2.3. Environment Agency WFD

The Environment Agency provided funds for targeted peatland restoration work for a number of sites in the headwaters of watercourses that were failing for water quality in the YPP area.

5.2.2.4. Natural England WFD

Natural England also contributed WFD funds to the management of sites in the headwaters of failing SSSIs.

5.2.2.5. DEFRA

£2,230,419 of the DEFRA funded North of England Peat Partnership (see section 5.2.1.8) has been spent on capital restoration works to date.

5.2.3. Managing HLS restoration funds

5.2.3.1. Implementing restoration works - Receipted invoices and bridging loans

A major stumbling block in the early stages of the project related to the system of paying for works and claiming back from Natural England under the Higher Level Scheme. Under the scheme, 100% grant funded works such as peatland restoration required agreement holders to pay up front and then obtain a "receipted invoice" in order to submit a claim to Natural England. Given the high cost of peatland restoration and the size of invoices (even after YPP broke them down into monthly invoices) most landowners were reluctant to pay out such large amounts and then have to wait for an unspecified period of time while their claim was processed. This meant that, in the early stages of the project little progress could be made except in the North York Moors where the National Park Authority paid the contractors on behalf of the agreement holder and was able to wait until a claim had been processed before being reimbursed by the agreement holder.

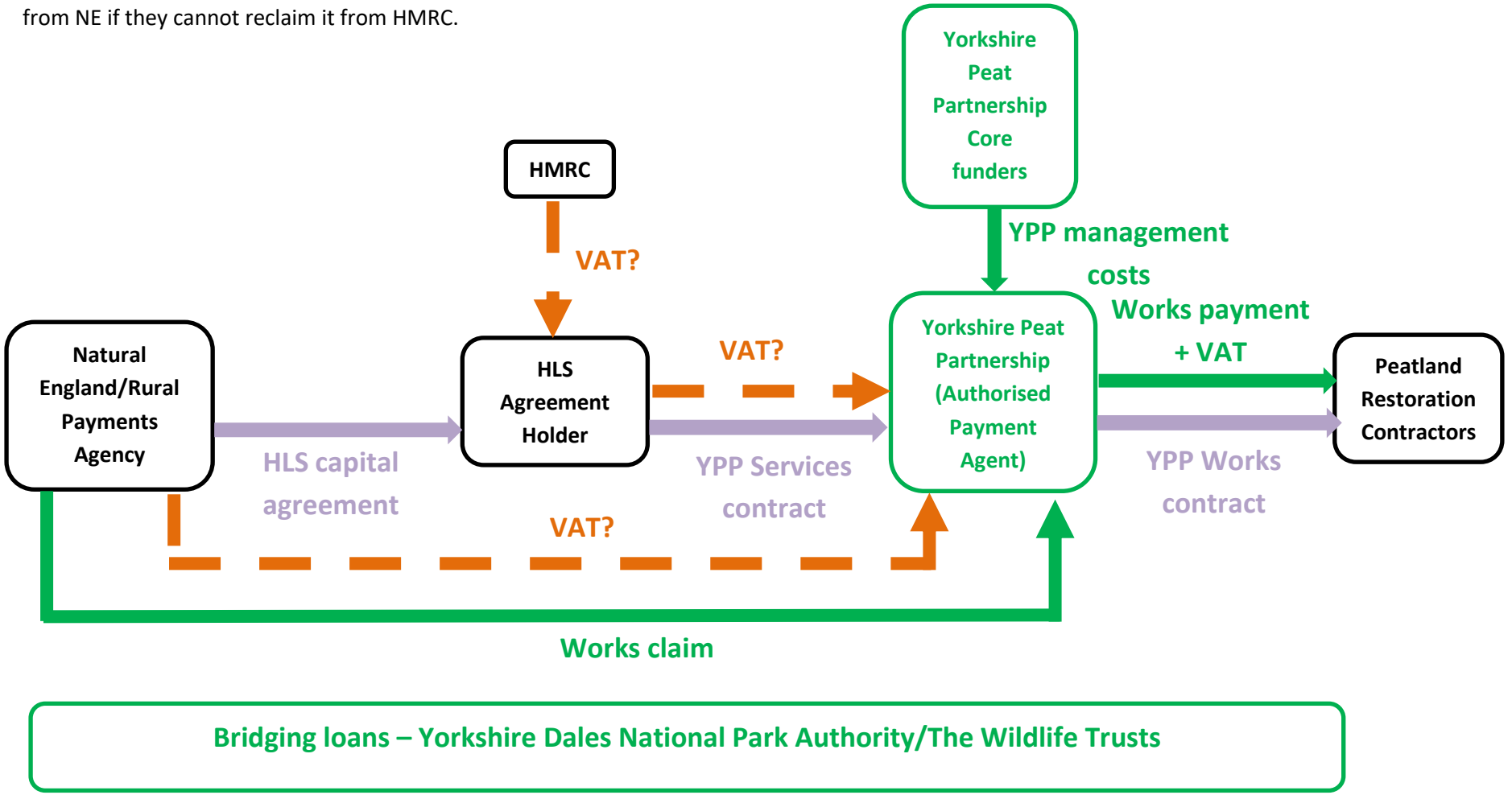
Fortunately, YPP discovered an under-used Natural England process whereby YWT (which has its own Rural Payments Agency (RPA) Vendor number) could act as an "Authorised Payment Agent" to the agreement holder, pay contractors and claim back directly from Natural England without the agreement holder having to finance anything (see Figure 2)

However, a further step was needed before this system could be implemented. As a small charity YWT would have suffered significant cash-flow problems if it paid a number of contractors on a number of different restoration sites and then had to wait for at least 2-4 weeks for claims to be processed. This would have put significant pressure on YWT's finances and a system was needed to bridge the cash flow gap between paying contractors and being reimbursed by Natural England. This was solved with the generous help of The Wildlife Trusts and the Yorkshire Dales National Park Authority who provided interest-free "bridging" loans to cover this gap.

The combination of the Authorised Agent approach and the generous bridging loans enabled the unlocking of substantial amounts of HLS grant funding which has been used to good effect by the Partnership to deliver a massive programme of peatland restoration across the region. Without this administrative fix it is unlikely that YPP would have been so successful.

Unfortunately, as described in section 5.2.4, DEFRA have taken a backwards step under the new Countryside Stewardship Scheme that essentially throws out this fix and turns the clock back to a system that is likely to lock up potential peat restoration funding as most agreement holders won't be able to afford to pay for the restoration work themselves as is now required under the new scheme.

Figure 2: Financial process developed by YPP to implement HLS capital works funded peatland restoration where YPP is Authorised Agent (under a Services contract) to the Agreement Holder enabling them to pay contractors (under a Works Contract) and claim reimbursement directly from Natural England (NE). Before claims can be made NE require contractors to be paid and a receipted invoice received by YPP. This required bridging loans (obtained from the Yorkshire dales National Park Authority and The Wildlife Trusts) to support Yorkshire Wildlife Trust's cash flow while waiting for claims to be processed (usually 2-4 weeks per claim). YPP's management costs under this arrangement were covered by core funders. Agreement holders can only claim VAT costs from NE if they cannot reclaim it from HMRC.



5.2.3.2. YPP's core costs

5.2.3.2.1. HLS Management Plan grant

In the initial stages of the project YPP was also able to charge the agreement holder a fee for surveying, drawing up a restoration plan and overseeing HLS funded works. This was a standard rate rather than a 100% grant so it did not need a "receipted invoice" enabling the agreement holder to claim the cost back from Natural England/RPA prior to paying YWT.

In the early stages of the project the survey was divided into 3 clear stages each with a separate report – Part A (pre-survey), Part B (survey), Part C (post-survey). The fee was calculated on the basis of fixed payments for Part B (Table 11) and then, after Part B was completed a second fee was calculated for completing Part C and overseeing the restoration work on the basis of £200/unit for significant linear features (category 4+ grips, gullies and hags) and £400/unit for bare peat (Table 12). 75% of this was payable on completion of the Part C survey and a draft Restoration Plan. The remaining 25% was payable on appointment of a works contractor.

This system worked for the agreement holder and was reasonably efficient for YPP but it was difficult for YWT to plan its workload and future staffing needs as it did not know in advance how many contracts it would get and therefore how much income from fees it would receive.

From 2011 to the present time Natural England were able to provide funding directly from its Water Framework Directive (WFD) budget enabling the process summarised in Figure 10 which meant that (i) YWT was able to plan ahead for its staffing and resource needs and (ii) no longer needed to charge agreement holders which simplified the management of the project and (iii) has led to greater project delivery as agreement holders have not had to worry about cashflow problems.

5.2.3.2.2. HLS Management fees

Unfortunately, Natural England's core WFD funding is slowly diminishing and they only have £25,000 available in 2017/18 which does not cover YWT's full costs. They have, however, entered into a framework contract with YWT that enables YPP to charge a management fee of 12% of capital costs for the final year of HLS delivery in 2017/18 (see Figure 3).

On the face of it this should provide the replacement funds YPP needs. Unfortunately, however, this payment now comes from the agreement holder and not Natural England. The YWT Board has yet to approve this system as there is increased risk that agreement holders might not be willing to pay leading to financial and cash flow implications for YWT. This represents a bit of a backward step in funding core costs and could lead to the locking up of potential HLS peatland restoration spend. However, it is only for two further years and then different rules apply under the new Countryside Stewardship Scheme.

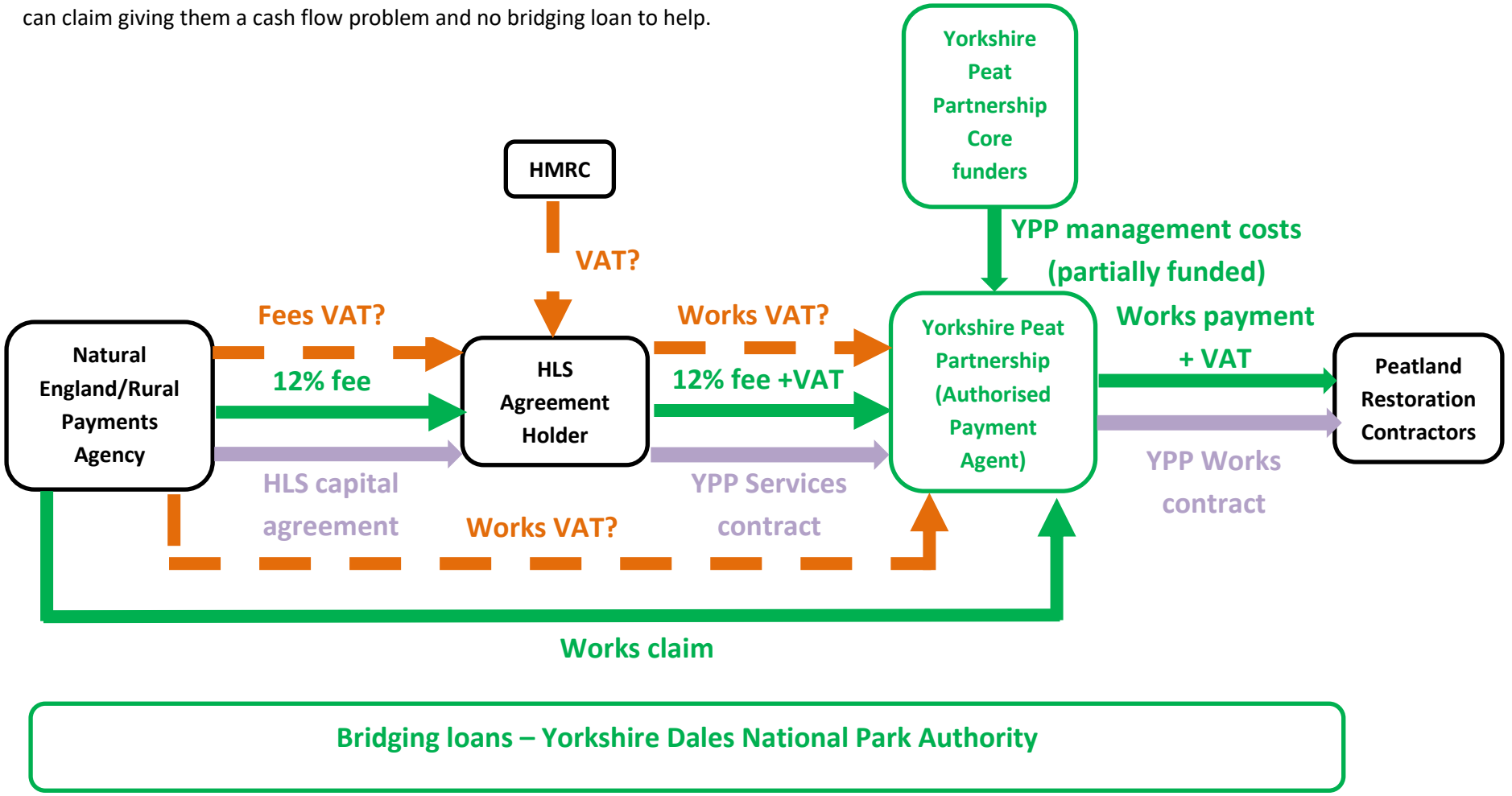
Table 11 Fees for completing Part B survey reports in earlier years of YPP HLS delivery.

Site area (ha)	Fee (£)
6-15	555
16-50	715
51-149	1035
150-200	1110
201-500	1430
501-1000	1750
1001-1500	2070
1501-2000	2390
2001-2500	2710
2501-3000	3080
>3000	3350

Table 12 Fees for completing Part C of the YPP survey and overseeing restoration work based on the length of grips in categories 4 and above, the area of bare peat and the length of gullies.

Item	Fee (£)	Item	Fee (£)	Item	Fee (£)	Item	Fee (£)
Cat 4+ grips	200/km	Gullies	200/km	Hags	200/km	Bare peat	400/ha

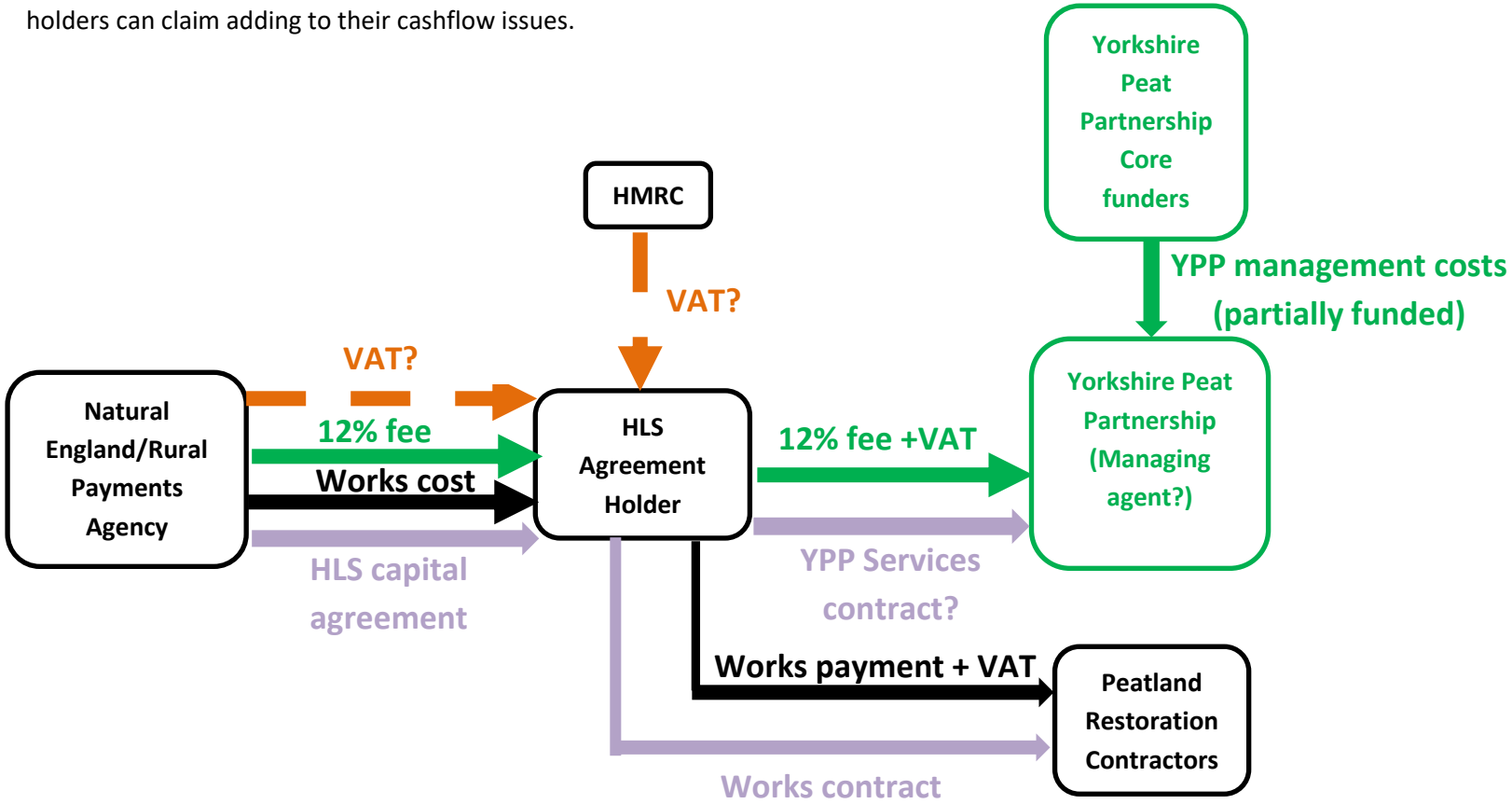
Figure 3: Amended process for YPP to implement HLS capital works funded peatland restoration where YPP is Authorised Agent to the Agreement Holder and pays contractors directly and can claim reimbursement directly from Natural England (NE). Before claims can be made NE require contractors to be paid and a receipted invoice received by YPP which required bridging loans to support Yorkshire Wildife Trust's cash flow while waiting for claims to be processed (usually 2-4 weeks per claim). YPP's management costs are only partially covered by core funders but can charge agreement holders 12% of the capital works to cover costs which they can then claim back from NE. However, this also requires a receipted invoice (from YPP) before agreement holders can claim giving them a cash flow problem and no bridging loan to help.



5.2.4. Managing new Countryside Stewardship agreement funding

From autumn/winter 2017 onwards YPP started delivering restoration works under the new Countryside Stewardship Scheme. However, changes in the administration of the scheme mean that the arrangements used by YPP to unlock the maximum amount of funding from previous agri-environment schemes are no longer available under the new scheme (Figure 4). This represents a significant threat to future funding for peatland restoration in the project area. In the new scheme YPP will still be able to assist landowners with managing the restoration work but they will no longer be able to pay contractors and claim funds directly back from Natural England. All payments to contractors now have to come directly from the agreement holders' bank accounts. Moreover, the agreement holders are required to produce certified statements guaranteeing that they have sufficient existing funds in their bank accounts to cover the costs of the restoration work. Given the size of some restoration schemes it is unlikely that many landowners will be able to meet this requirement and will, therefore, be unable to fully support restoration. This takes YPP right back to the early days of the project.

Figure 4: Likely for YPP to implement Countryside Stewardship capital works funded peatland restoration where, as a result of scheme rule changes YPP is no longer able to pays contractors directly. Under the new rules agreement holders will have to pay contractors, obtain a receipted invoice and then claim from Natural England (usually 2-4 weeks per claim) representing a significant cashflow problem for agreement holders. YPP may still be able to manage the restoration works but their management costs are only partially covered by core funders and would probably need to charge agreement holders 12% of the capital works to cover costs. Agreement holders can claim this back from NE but it also requires a receipted invoice (from YPP) before agreement holders can claim adding to their cashflow issues.



5.3. Pre-restoration work

It is essential for the future smooth running of practical restoration work that YPP establishes a good working relationship with all of the landowners, agents, gamekeepers and farmers who have an interest in the peatland being restored. It is also essential to fully understand what the exact restoration requirements are for the individual peatland site being targeted.

YPP works closely with all relevant stakeholders to gather a substantial amount of information through a comprehensive pre-restoration survey and assessment phase which informs the restoration work at a later stage. Right from its inception, YPP has utilised the latest technology to maximise the efficiency of this survey and assessment phase. YPP's survey protocol has evolved over the course of the project and is now probably one of the most comprehensive pre-restoration assessments carried out by UK peat restoration programmes. The assessment consists 3 interacting stages:

- Communicating and working with landowners and managers.
- Pre-restoration survey and assessment
- Restoration plan

5.3.1. Communicating & working with land-owners and land-managers

The overwhelming majority (>96%) of YPP's work is conducted on private land largely owned and managed for the purposes of grouse shooting and sheep farming (Table 13). Most of the moors YPP has worked on have been within designated sites (SSSI or SAC/SPA) which means that significant financial incentives through agri-environment schemes and other public funds have been targeted at these areas. Combined with a legal requirement and Public Service Agreement target to achieve Favourable Conservation status for SSSIs these funds have proved sufficient incentive to persuade land-owners and land-managers to support peatland restoration on their moors. However, YPP have also worked with landowners over a significant area that has no designation. This demonstrates a positive willingness on the part of landowners to restore the bogs on their land and YPP has generally encountered good support from the land management community.

YPP staff are very knowledgeable and use evidence to direct their restoration works. They have developed a particular skill in translating scientific evidence into practical measures and carefully and patiently explaining this to land-owners and land-managers. YPP's ethos is not to try to force people to do things they don't want to but to explain, demonstrate and trial the different restoration techniques available until land owners and managers are willing for works to take place. Detailed surveys, maps and management plans are discussed at length with landowners. Compromises are made where these don't jeopardise the overall success of the restoration plan and we do not begin work until we are satisfied that the landowner and their staff are fully on board with the restoration proposals.

This can be a time-consuming process and can, at times, involve robust debate and challenge but it is an essential part of the restoration planning process and cannot be circumvented. As a result, of all the restoration schemes we have taken forward, only 3 landowners have refused to support the work.

It is also important to be aware of the other people who have a vested interest in the management of these moors who also need to be comfortable with the works that are proposed – farmers and game-keepers being key to the success of the work - so we also spend significant time explaining our proposals to them as well as the landowners. We have found that in many cases the farmers and game-keepers assist YPP and its contractors with the work itself, helping with access to the sites, carrying in materials and taking an active interest in the work.

Given the level of support we have had from landowners and managers we consider them to be members of the Yorkshire Peat Partnership and they are represented on the YPP Steering Group through the Moorland Association and the National Farmers Union representatives.

Table 13: Landownership of peat areas targeted for restoration by the Yorkshire Peat Partnership up to March 2017.

Landowner	Peat Area (ha)	Proportion
Forestry Commission	105	0.3%
National Trust	959	2.7%
Natural England	54	0.2%
Private	33,963	96.8%
Total	**35,081**	**100%**

5.3.2. Pre-restoration survey and assessment

YPP's pre-restoration survey protocol consists of 5 elements:

5.3.2.1. Pre-survey mapping

Using the best available and most recent digital aerial photography combined with mapped data from a variety of organisations YPP restoration staff will use Geographic Information Systems (GIS – initially MAPINFO but recently switching to QGIS) to digitally map natural watercourses, grips, erosion gullies, eroding hags, dendritic erosion, bare peat and micro-erosion. In addition, to inform the survey and restoration plans, access tracks and footpaths are also recorded. Utilities companies are consulted to determine the locations of any pipes or cables. For each restoration site survey points along transects are also mapped. All of this information is then loaded onto GPS enabled field computers. These are very robust sub-metre accuracy GPS/GIS units that enable direct recording in the field which removes the extensive post-survey data entry needed with more traditional recording methods.

5.3.2.2. Field Survey

Walking the transects pre-loaded onto the field computers YPP restoration staff stop at regular intervals (50-200m depending on the requirements of the client funding the survey) and record peat depth (using threaded drainage rods) heather height, vegetation community, burning categories and indicator species presence (see Figure 13). In addition, erosion features (grips & gullies, hags, bare peat, micro-erosion etc.) that the transect crosses or comes close to are assessed. Any obvious historic environment features are also recorded.

Where unmanned Aerial Vehicle (UAV) flight information is not available a second visit to relevant gullies, grips or bare peat areas is carried out in order to accurately map the locations of sediment traps, slowing the flow baffles and bunds (made of stone, wood, heather bales or coir rolls).

5.3.2.3. Archaeological assessment

As highlighted in section 2 peatlands are an important source of archaeological and paleo-environmental information in their own right. In addition, much of Yorkshire's upland peatlands are in areas with a long history of human habitation, farming and industry. As a result there is a significant historic environment legacy on and around Yorkshire's peatlands. Restoring the integrity of peatlands through re-wetting and re-vegetation helps to preserve the archaeological and paleo-environmental archive present in the peatlands. However, there is also a risk that some archaeological features could be accidentally damaged during the restoration work. To reduce the risk of this happening, YPP have evolved a historic environment assessment method in partnership with the historic environment staff at the Yorkshire Dales National Park Authority, North York Moors National Park Authority and North Yorkshire County Council. This involves 4 steps:

- A draft restoration plan is sent to the relevant organisation for an initial assessment of any important archaeological features and to extract information from the Historic Environment Register;
- If required, a walkover survey by an archaeological consultant is carried out in accordance with a specification developed by the Yorkshire Dales National Park Authority (see Appendix 4);
- YPP staff look out for other historic environment features during their transect surveys;
- The information from the previous 3 steps is used to refine the restoration plan to exclude works or machinery access from the most sensitive sites and/or to provide advice to contractors in areas with archaeological features where peatland restoration work can be carried out with care.

A total of 48 archaeological assessments have been completed up to March 2017. These assessments have been used to guide contractors during restoration works on individual sites but they also contain a wealth of information on the archaeological features present in and around Yorkshire's peatlands. To date YPP has not had the resources to carry out a comprehensive analysis of this information but hopes to do so in the next phase of the programme and will produce a separate report on the historic environment significance of Yorkshire's upland peatlands.

5.3.2.4. Unmanned Aerial Vehicle (UAV) Surveys

Since 2012 YPP has been at the forefront in developing the use of Unmanned Aerial Vehicle (UAV) technology to aid in the restoration and monitoring of degraded blanket bog habitats.

Drones or UAVS give us the capability to capture up to date aerial imagery of our restoration sites at a resolution far in excess of currently available commercial imagery.

Advanced photogrammetry software gives us the capability to stitch the images captured by the UAV into a spatially accurate ortho-photograph suitable for display and analysis within our GIS software. Further, the software is so powerful that from 2D images alone we can create a topographic 3D model of the landscape known as a Digital Surface Model (DSM).

We process this data to around 3.5cm resolution but 1cm resolutions are achievable. In comparison previous datasets we had to work with were 25cm resolution for aerial photographs and 5m resolution for Digital Surface Models.

The resolution of this data has opened up a whole new realm of possibilities for analysis within our GIS and remote sensing software.

This includes but is not limited to:

Surface Analysis: we can detect and model fine scale variations in topography by using focal statistics and roughness algorithms, topographic position indices (TPI) and slope position classifications.

Hydrological analysis: we can determine where water is flowing and congregating using flow path analysis. Work areas can be broken down into hydrologically distinct units by modelling catchment zones within the bog.

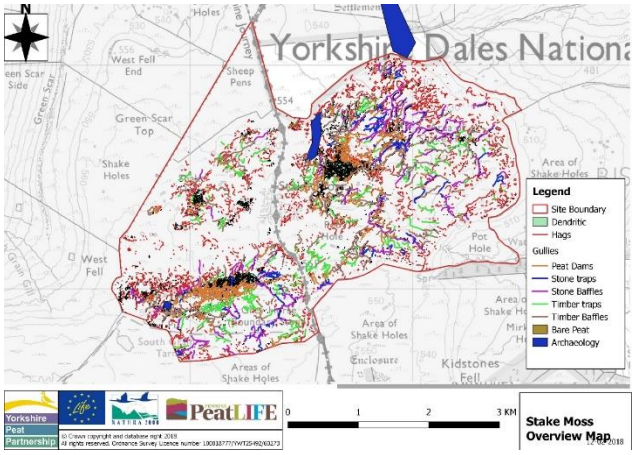
3D visualisation: By importing the data into 3D modelling software we can examine our restoration sites from every angle without having to return back onto site. We're bringing the blanket bog into our office!

Image classification: We use a range of techniques for automated image classification. This gives us the capability to detect broad vegetation communities as well as automatically map areas of bare peat. Hopefully one day we may even be able to detect individual species of *Sphagnum*! We carry this out using traditional unsupervised and supervised classifications as well as newer Object Based Image Analysis (OBIA) techniques.

Cross sectional profiles: The dimensions of eroding gullies can be determined by looking at their cross sectional profiles within GIS software. Further to this we have developed a tool to automatically extract gully depth and width.

A total area of over 10,000ha has been surveyed to date. As far as we are aware this if the biggest dataset of its type in the UK.

5.3.3. Drawing up and agreeing restoration plans



The ultimate end point of all of this survey and assessment work is to produce a Restoration Plan. Yorkshire Peat Partnership has developed a restoration plan template that acts as (i) a summary of the survey information, mainly in the form of maps and (ii) a specification for subsequent capital works, mainly in the form of tables of quantities.

The restoration plan template has evolved during the course of the project and is reviewed annually at the end of capital works season in order to take account of lessons learnt during the restoration season, techniques that worked well and also those that were less successful.

A total of 88 YPP surveyed sites now have Restoration Plans (at different stages of evolution) covering 46,544 of Yorkshire's peat units plus an additional 366ha in the Forest of Bowland.

Not all of these plans have been implemented and some of the earliest plans will now need reviewing and updating in the light of new techniques being available to tackle erosion features that we weren't able to restore the first time round.

YPP Restoration Plans have their limitations in that they cover initial (1-3 year) capital works only. YPP's experience now suggests that some guidance on the management of grazing (livestock and rabbits) and burning should also be included as we are increasingly surveying sites where these issues are limiting blanket bog recovery. YPP is currently working out how best to include this in the Restoration Plan template for new sites going forward. It is also clear that there is usually a need to go back to sites within 10 years (preferably after a period of monitoring) to carry out additional capital works in those areas where the initial restoration hasn't been completely successful. This will also form a component of a new revised template.

Once YPP has produced the Restoration Plan it is essentially a draft until staff have completed another round of consultation with landowners, land managers and other stakeholders to make sure they all agree with the content of the plans. During this process, minor changes and compromises are often made to secure agreement and it is rare that agreement can't be achieved. In a handful of cases agreement has not been reached and works on those sites have yet to be carried out. The reasons for this are usually that the landowner feels that the restoration would be detrimental to their other land management activities or where YPP felt, given its professional experience, that the compromises being made would mean that the restoration measures being proposed would be ineffective.

Once the restoration plans have been agreed by all parties the implementation phase can begin.

5.4. Implementing Restoration

Figure 5 and Table 14 summarise the progress of restoration works carried out by YPP.

There will be other moors across the project area where a small number of landowners and other groups have carried out some works themselves without the involvement of YPP. Some of this will have been done under previous agri-environment schemes. However, YPP has been unable to secure data on these works so these have not been included in this report. YPP have come across some of these previous works during their surveys and have recorded their locations wherever possible.

- **In total YPP has so far begun or completed restoration works (including initial capital works) on 32,343ha of peat units in Yorkshire which is 37% of the estimated total unit area.**

- **No capital works were proposed by YPP on 781ha of peat units in Yorkshire (1% of the total area) although with advances in *Sphagnum* spp. introduction techniques it may be appropriate to re-visit some of these sites in future.**

- **Detailed restoration plans were produced for 11,420ha of Yorkshire's peat units (13% of total area) but have not yet progressed to works largely due to lack of support from landowners or lack of funding or both.**

This represents a remarkable achievement given the period of austerity that began almost immediately after YPP's original restoration target was set and continues to the present time.

The following sections provide more detail on the activities and tasks undertaken by YPP to in order to achieve these targets.

5.4.1. Working with contractors

The majority of the capital restoration works have been carried out by private contractors working under the supervision of YPP staff (or RRT or NT). These contractors are a vital component of the effective delivery of peatland restoration across Yorkshire. The contractors used are specialists in peatland restoration and provide YPP and its partners with innovation and skills that would be very expensive for YPP to employ directly. Table 15 lists the contractors we have worked with to date.

In the majority of cases the Peatland Restoration Plan is used as the basis for a competitive tendering process overseen by YPP staff. The tenders are scored on the basis of a 60:40 price:quality scoring system although, as the majority of contractors we use are already known to be of high quality it is usually price that determines who the successful contractor will be.

Once contractors are appointed YPP staff work with them on behalf of the landowners and funders to oversee the restoration works, ensure the works on the ground meet with the restoration plan or amend them if local conditions dictate. YPP staff also manage the invoicing and claiming procedures and carry out checks to provide evidence of works having been completed.

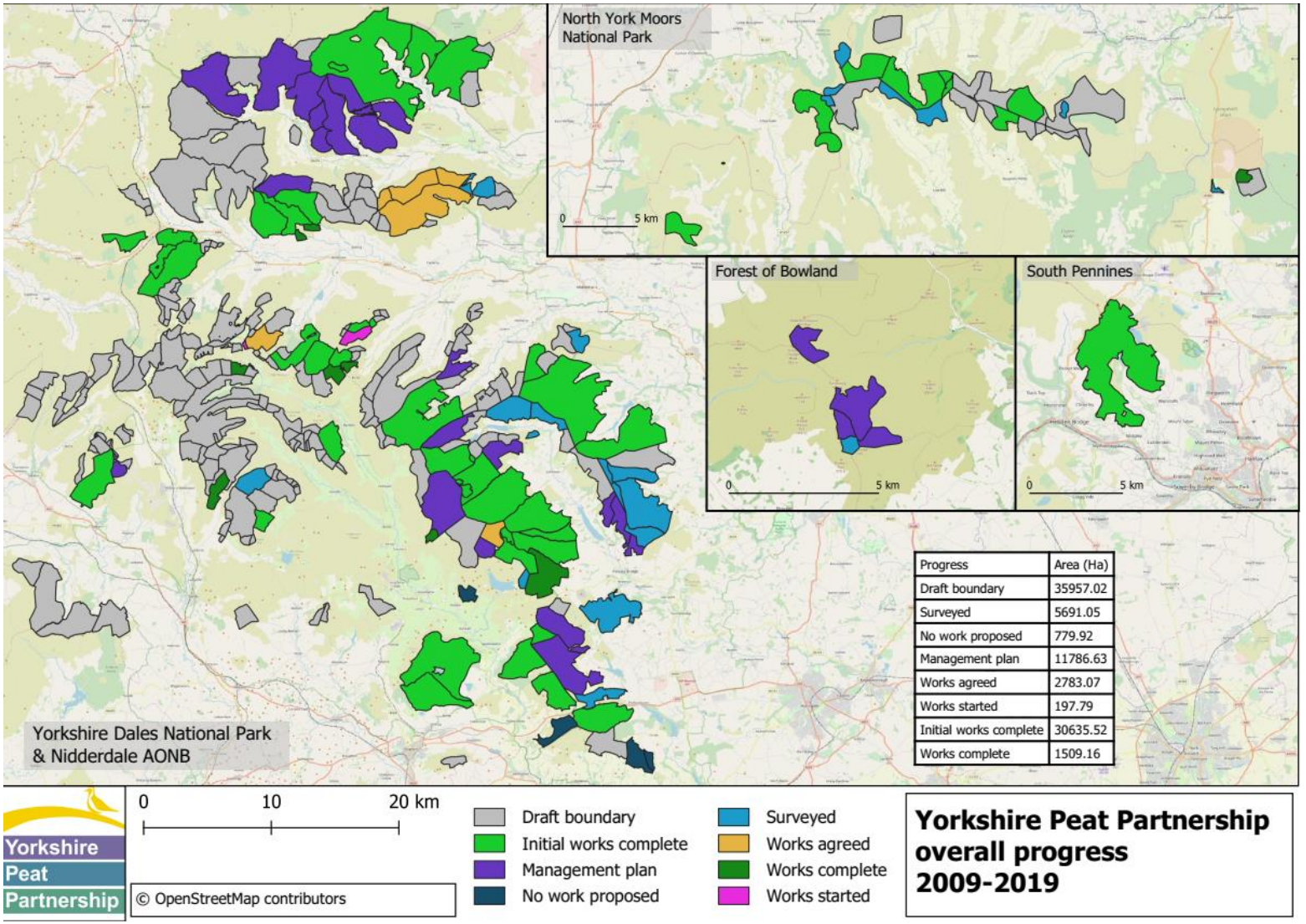
Table 14: Restoration works carried out by YPP 2009-2019 on peat "management units" to date.

Administrative Area	Surveyed only (ha) n = 18	Management plan only (ha) n = 24	Works agreed (ha) n = 6	Works started (ha) n = 2	Initial Works complete (ha) n = 48	Works complete (ha) n = 8	No works proposed (ha) n = 5	Total (ha) n = 111
North York Moors NP	1,026	0	0	0	2,449	72	2	3,548
Nidderdale AONB	3,934	3,067	0	0	9,363	694	352	17,410
Yorkshire Dales NP	704	8,353	2,783	198	17,334	743	427	30,542
South Pennines	0	0	0	0	1,489	0	0	1,489
Total Yorkshire	5,664	11,420	2,783	198	30,635	1,509	781	52,989
Forest of Bowland	27	366	0	0	0	0	0	393
Total	**5,691**	**11,786**	**2,783**	**198**	**30,635**	**1,509**	**781**	**53,382**

Table 15: List of contractors YPP have worked with to date

Contractor
Barker & Bland
Carrick Contractors
Conservfor
Dinsdale Moorland Services
Marsden AES
Terrafirma

Figure 5: YPP Peatland Restoration Progress Map as of March 31st 2019



5.4.2. Practical Restoration Works

Table 16 summarises the restoration work undertaken by YPP up to the end of March 2017 (the latest date analysed). YPP's approach to restoration consists of 3 linked processes:

- Restore hydrological integrity through drain and gully blocking and "slowing the flow" measures.
- Prevent further erosion by re-profiling eroding hags and gully sides and revegetating areas of exposed bare peat.
- Restoring peat function by re-introducing blanket bog species, in particular, *Sphagnum* mosses.

Table 16: Types of erosion features under restoration across YPP sites up to March 2017 (the latest date analysed)

Feature Restored	Administrative Area	Quantity (% of estimated quantity to be restored)
Bare Peat	North York Moors	14ha (67)
	Nidderdale	20ha (44)
	Yorkshire Dales	60ha (14)
	South Pennines (in North Yorkshire)	0ha (0)
	All areas	94ha (19)
Length of eroding hags & gullies	North York Moors	61km (91)
	Nidderdale	365km (69)
	Yorkshire Dales	939km (20)
	South Pennines (in North Yorkshire)	0km (0)
	All areas	1365km (26)
Length of eroding grip	North York Moors	44km (50)

	Nidderdale	442km (79)
	Yorkshire Dales	1358km (32)
	South Pennines (in North Yorkshire)	0km (0)
	All areas	1844km (38)
Area of micro-erosion	North York Moors	0ha (0)
	Nidderdale	11ha (100)
	Yorkshire Dales	3ha (100)
	South Pennines (in North Yorkshire)	0ha (0)
	All areas	14ha (64)
Area of dendritic erosion	North York Moors	0ha (0)
	Nidderdale	0ha (0)
	Yorkshire Dales	58ha(100)
	South Pennines (in North Yorkshire)	0ha (0)
	All areas	58ha (100)

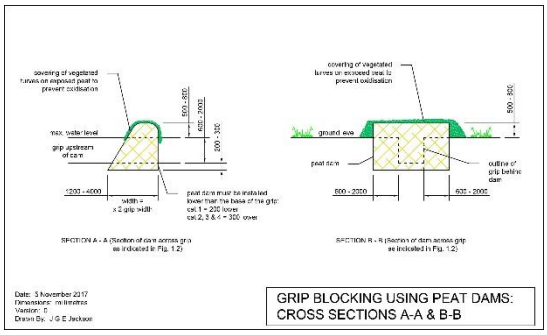
5.4.2.1. Restoring hydrological integrity

One of the most important aspects of blanket bog restoration is to restore the hydrological integrity of peatlands that have been damaged by drainage or through gully erosion caused by other anthropogenic activities.

YPP uses several techniques to block drains and gullies to restore the hydrological integrity of damaged peatlands which are summarised in Table 17.

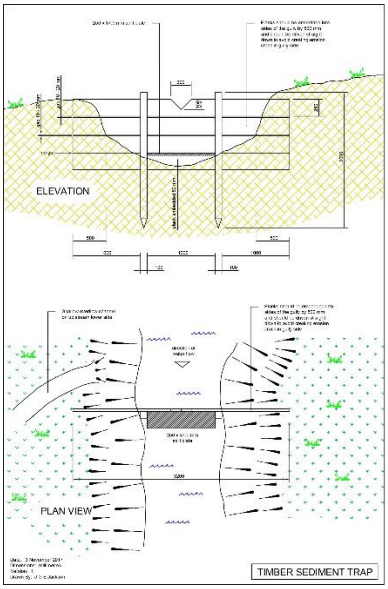
The most effective and cheapest solution where the grips and gullies are still relatively small (up to 3m wide) and there is still a reasonable depth of peat in the base (>30cm deep) and around the grip/gully is to build peat dams installed by specialist contractors using low ground pressure 360° excavators (see Figure 6).

Figure 6: Blocking grips and gullies with peat dams



Where grips and gullies are of similar dimension to those that have been dammed with peat dams but are partially vegetated it is preferable not to disrupt the process of re-vegetation taking place. However, many of these channels still flow and it is possible to speed up their restoration by using timber sediment traps (see Figure 7). These do not work effectively, however, where gullies or grips have eroded down to the base substrate as water flows tend to undercut the timber barrier making the erosion worse.

Figure 7: Blocking gullies with timber sediment traps.



In some areas, where gullies or grips are small and the peat is very shallow YPP have used small heather bales to block the flow (see figure 8. However, there is concern that these will rot before the grip/gully is completely blocked so we are using these less and less where flow is significant.

A more recent development in grip and gully flow management where channels have eroded to the mineral base is the use of stone sediment traps (see figure 9). These are expensive to install requiring helicopters to lift stone onto site but can be very effective. YPP has only been using this technique for 1-2 seasons but, subject to funding, would like to return to some of our earlier sites to increase the amount of gullies blocked.

Figure 8: Blocking gullies with heather bales.

Figure 9: Blocking gullies with stone sediment traps.

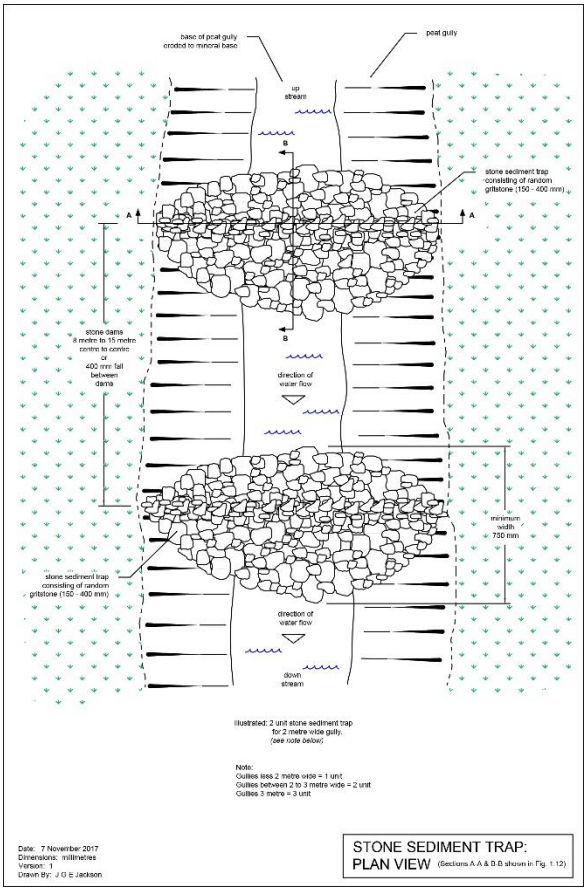


Table 17: Quantities of dams and sediment traps used by YPP in restoration projects up to March 2017 (the latest date analysed).

Treatment	Grips		Gullies	
	km	Estimated number	km	Estimated number
Peat dams	1,579	197,375	81	10,125
Heather bale dams	21	2,625	66	8,529
Stone sediment traps	0.592	74	1	123
Timber sediment traps	7	875	16	1,614
Totals	**1,608**	**200,949**	**164**	**20,391**

5.4.2.2. Preventing further erosion

Where drains and gullies have eroded to such an extent that they cannot be blocked YPP can still work to prevent further erosion by re-profiling and re-vegetating steeply eroding gully/grip edges. The vertical sides of dry peat hags can also be treated in a similar way.

In addition, eroding peatlands also consist of flat areas of completely bare peat or bare peat with sparse vegetation with no moss cover (micro-erosion) or areas that are a catastrophic mosaic of eroding gullies, bare peat and collapsing hags (dendritic erosion).

5.4.2.2.1. Grips, Hags & Gullies

Where exposed edges of a peat block will continually erode away due to the combined effects of freeze-thaw action, cantilever collapse of large blocks followed by desiccating wind erosion during drier periods. Eroding edges of gullies can be caused where a grip has eroded, cracks in the peat have widened or sub-surface channels have collapsed followed by nick-point erosion upstream.

Actively eroding and exposed hags and gullies create an extremely hostile environment for plants to grow and they need to be stabilised before vegetation can then be re-established. YPP uses a range of methods for restoring gullies and hags to a stable, re-vegetated condition to prevent further ongoing erosion. In summary there are 3 main steps to stabilising gully and hag edges:

First, edges are re-profiled to a more stable slope angle by specialist contractors using low ground pressure 360^{o} excavators (see Figure 10).

Figure 10: Gully reprofiling

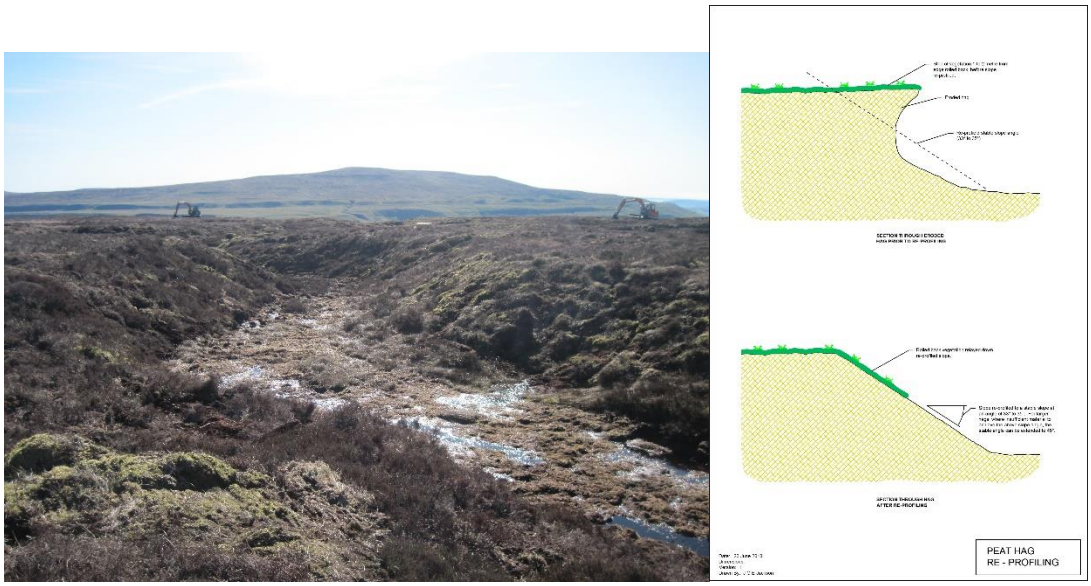


Table 18 summarises the lengths of grips, gullies and hags re-profiled by YPP so far.

Wherever possible existing turves with intact roots are used to cover the newly re-profiled slopes which means they are instantly re-vegetated. However, if there is insufficient vegetation in the area which means that significant amounts of the re-profiled slopes remain bare other treatments are needed (see Table 18).

In these circumstances the next step is to seal the surface of the exposed peat to make it more hospitable for plants to grow. This is done by spreading a bryophyte rich heather brash mulch onto the surface of the peat (see Figure 11). The brash is ideally cut from suitable donor areas nearby or, where insufficient brash is available it can be cut elsewhere and flown onto the site by helicopter. If brash is to be brought in from elsewhere the donor site is subject to a strict bio-security assessment to ensure that pests and diseases are not transferred with the brash.

Figure 11: Brashed, re-profiled slope

To provide further longer-term stability of the bare peat a grass seed mix is applied. The grass roots bind the peat surface into a stable turf that then forms the basis for other moorland species to colonise into or, where these are absent, for brought-in plants to become established. This is done in several steps:

- Application of lime - Eroded peat is very acidic and provides a hostile environment for seeds to germinate. Therefore, granulated lime is applied in late February early March at a rate of 1t/ha ideally 6 weeks, but at least 2 weeks prior to adding grass seed to raise the pH to about 5.
- Application of grass & cotton-grass seed – In the early stages of the project YPP used a grass seed mix comprising non-native and agricultural cultivars that were wholly dependent on repeated applications of lime and fertiliser for their survival until the peat was stabilised at which point they were allowed to die-off. However, due to restricted access on grouse moors this couldn't be applied during optimal conditions so survival rates were poor and YPP tried to rely on the bryophytes within the brash instead which had mixed success rates. On advice from colleagues working in the North Pennines AONB we switched to using a native moorland grass and cotton-grass mix better suited to our conditions (see Table 19 for seed mix) applied in late March at least 2 weeks after the application of lime at a total seed rate of 10kg/ha depending on the site.
- Application of fertiliser - Peat is naturally very nutrient poor and damaged peat even more so. In order to establish the grass sward and provide favourable conditions for initial dwarf-shrub growth it is necessary to provide a short-lived low dose of nutrients using artificial fertiliser ideally applied in July once the grasses are actively growing although YPP often has to apply this in late winter due to nesting bird restrictions. Phosphate fertiliser (P_2O_5) is applied at a rate of 20kg/ha.

Table 18: Lengths of grips, gullies & hags reprofiled and revegetated with brash, seed, lime & fertiliser up to March 2017 (the latest date analysed).

	Grips	Gullies & Hags
Treatment	**km**	**km**
Reprofile	1,638	1,497
Heather brash	2	470
Seed, lime, fertiliser	2	150

Table 19 YPP Moorland grass mix species composition.

Species (Latin)	Species (English)	% of seed mix
Agrostis capillaris	Common bent	**20**
Festuca ovina	Sheep's fescue	**20**
Deschampsia flexuosa	Wavy hair grass	**30**
Eriophorum vaginatum	Hare's-tail cotton-grass	**30**

5.4.2.2.2. Bare peat & micro-erosion

Where flat or gently sloping areas of bare peat occur they are vulnerable to continued erosion to due to a combination of freeze-thaw processes, exposure to the wind and desiccation in dry periods. Water flow and wind erosion across exposed bare peat or micro-erosion can be reduced by dividing it up into smaller 10m x 10m "cells" using bunds made from heather bales or coir logs (see Figure 12).

Once the bunds are installed the bare peat can then be stabilised with brash, grass & cotton-grass seed, lime and fertiliser (see Table 20).

Up to March 2017 (the latest date analysed) YPP had treated 105ha of bare peat and 4ha of micro-erosion.

Table 20: Bunds installed and area of bare peat and micro-erosion revegetated with brash, seed, lime & fertiliser up to March 2017 (the latest date analysed).

a. Bunds

Treatment	Number (n)
Heather bales	3,893

b. Revegetation treatments

Treatment	Area (ha)
Heather brash	105
Grass seed, lime, fertiliser	105

5.4.2.2.3. Dendritic erosion

This is the most extreme form of erosion in the YPP project area and presents the biggest challenges for restoration as the areas are impossible to access by machine and are often difficult even to walk through. YPP's approach to restoring these areas is two-fold:

(i) The use of low bunds made of peat, heather bales or timber to trap peat and reduce water-flow through the dendritic areas.
(ii) Where access is possible, manually applying brash, grass & cotton-grass seed, lime and fertiliser to areas of moderately-sloping gully sides or flatter bare peat.

This approach does not fully restore these areas and ideally repeat treatments at 5 year intervals are needed to gradually fill in the gullies.

Up to March 2017 (the latest date analysed) YPP has commenced restoration in 68ha of dendritic gullying (Table 21).

Figure 12: Bunds to reduce erosion

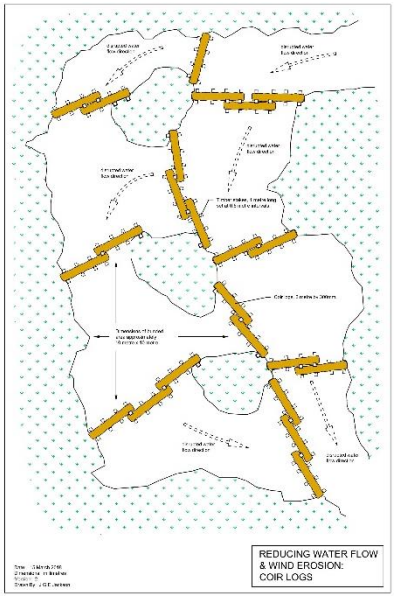


Table 21: Bunds installed and area of dendritic erosion revegetated with brash, seed, lime & fertiliser since 2009.

a. Bunds

Treatment	Number (n)
Heather bales	569

b. Revegetation treatments

Treatment	Area (ha)
Heather brash	19
Grass seed, lime, fertiliser	19

5.4.2.3. Restoring functioning blanket bog

The final stage in YPP's restoration process is to begin to restore the function of the blanket bog habitat. This is achieved by re-introducing typical blanket bog species where they are missing. In particular, the main focus is the re-establishment of *Sphagnum* spp. together with cotton-grasses and dwarf-shrubs. Table 22 summarises what has been achieved to date.

5.4.2.3.1. Dwarf shrub seeds

YPP usually adds a dwarf shrub seed mix to the stabilised bare peat. This is ideally a mix of 50:50 *Calluna vulgaris:Erica tetralix* applied at a rate of 1.5kg per hectare. However, *Erica tetralix* seed is expensive so quantities are often governed by cost. Small amounts of other species (e.g *Vaccinium myrtillus*, *Vaccinium vitis-idaea* or *Empetrum nigrum*) can be added if required although these are generally better applied as plug plants as they require additional seed treatment to ensure decent germination rates. YPP have not generally used other species. The dwarf-shrub seed is usually applied in March at the same time as the grass seed.

5.4.2.3.2. Dwarf shrub and cotton-grass plugs

Young Cotton-grass and dwarf-shrub plants are available from a limited number of suppliers as "plugs". These are used by YPP to increase the long-term stability of the bare peat through targeted planting in areas that are similar to the natural conditions these species are normally grown in. The plugs are usually planted by hand using a standard manual tool.

YPP has so far used Common cotton-grass (*Eriophorum angustifolium*) or planted in blocks in wetter areas at 1 plug per m^2 (See Figure 13) but is also now specifying the use of Crowberry (*Empetrum nigrum*) plugs in drier areas at 1 plug per m^2. Crowberry is also useful in stabilising the top edge of eroding gullies.

Figure 13: Plug planting.

5.4.2.3.3. Sphagnum harvested from donor sites

One of the main objectives in restoring bare peat areas is to re-establish a *Sphagnum* moss layer as this provides the long-term stability the peat needs and re-starts the peat-forming and carbon sequestering processes that restoration is trying to achieve. Where appropriate donor sites are available Sphagnum propagules can be harvested and transported to the restoration site for planting in two forms.

5.4.2.3.4. Capitulum fragments harvested from a suitable donor site

These are cut using specialist low ground pressure machinery from a suitable donor site approved by YPP staff prior to cutting. If there is suitable access the *Sphagnum* can be cut close to the restoration site and can be transported by suitable low ground-pressure vehicles keeping damage to an absolute minimum. For large areas or remote areas with difficult access and to avoid significant ground damage the *Sphagnum* must be delivered to the site by helicopter. Fragments are spread by an adapted low ground pressure machine at a rate of 80-100 capitula per m^2. There is currently no evidence-based information on the best times to spread the capitulum fragments so YPP generally spread at the same time as the brash. At the time of writing only one contractor was providing *Sphagnum* in this format (Figure 14).

Figure 14: Spread *Sphagnum* spp. fragments

5.4.2.3.5. Clumps (small sized handful) of Sphagnum harvested from a suitable donor site

Clumps of *Sphagnum* are harvested (preferably by hand) from a suitable donor site approved by YPP staff prior to harvest (See Figure 15). Clumps are heeled into the bare peat surface in wetter areas at a rate of 1 clump per m^2. Clumps should be planted at the same time as seed is spread in March. A number of contractors provide clumps of *Sphagnum* from regular donor sites.

Figure 15: Planted *Sphagnum* spp. clumps

5.4.2.3.6. Sphagnum grown under horticultural conditions

Where these is a lack of a suitable donor site *Sphagnum* propagules are now available from a single horticultural supplier (Micro-propagation Services(E.M.) Limited) under the BeadaMoss® brand which have been grown using micro-propagation techniques from fragments of locally sourced material. All of the species listed in Table 23 can be provided in these products. These come in several forms for use in a range of moorland restoration conditions:

BeadaMoss beads®

2-5mm gel "beads" that contain juvenile Sphagnum propagules (See Figure 3.14). Micropropagation Services Limited specification for this product is:

(i) Supplied ready-to-use in 15 litre bags (which need to be spread within 2-3 weeks of production) and delivered to site in returnable rigid crates.

(ii) Works best if bare peat has already been re-vegetated (therefore YPP would use this product 1-2 years after re-vegetation). Although, if applied to bare peat a brash/mulch cover is acceptable.

(iii) Application rate for restoration recommended by the supplier is 100-200 litres/ha (7-13 bags/ha).

(iv) Currently applied by hand.

(v) Beads will be hard to find after spreading and the supplier suggests that first growth will be visible after 12-18 months with good results after 2-3 years.

YPP have not used this product extensively and are assessing its success rate on one site before rolling it out on a wider basis.

BeadaGel™

A protective gel matrix with water holding capabilities and nutrients containing large numbers of *Sphagnum* plantlets 1-20mm long with juvenile "innovations" (new capitula).

Micropropagation Services Limited specification for this product is:

(i) Supplied in 2 parts for mixing on day of use (which needs to be spread within 4-5 days of production and within 3-6 hours after mixing). Delivered to site in returnable 20litre tubs and 2litre or 5litre tubs.

(ii) Works best on bare peat where water table can be controlled within 10-15cm of the surface to prevent flooding or drought (eg. lowland bogs). If applied to bare peat a brash/mulch cover is acceptable. (therefore it may not be as effective on bare peat on YPP upland sites as water tables cannot be easily controlled).

(iii) Application rate for restoration of bare peat recommended by the supplier is 0.5 litres/m^2.

(iv) Applied by a backpack "blobber" (see Figure 3.16) or specially designed machine towed by Softrak (therefore, unless this equipment was available for purchase (by YPP or its contractors) YPP would have to use Micropropagation Services Limited to apply this product).

(v) In lowland areas BeadaGel™ is visible after 4-6 weeks with good coverage after 4-6 months.

YPP have not used this product extensively and are assessing its success rate on one site before rolling it out on a wider basis.

Figure 16: *BeadaGel™*

BeadaHumok™

Micro-propagated Sphagnum grown on to produce dense clumps containing many Sphagnum strands several centimetres long (See Figure 3.17). Micro-propagation Services Limited specification for this product is:

(i) Supplied ready-to-use in rolls of 20 in plastic bags of 20 rolls in returnable rigid crates (need to be planted within 7 days of delivery).

(vi) Works best in vegetated or sparsely vegetated areas (therefore YPP would use this product 1-2 years after re-vegetation). Although, if applied to bare peat a brash/mulch cover is acceptable.

(ii) Minimum application rate for restoration of bare peat recommended by the supplier is 0.25-1 plug per m^2.

(iii) Planted by hand, ideally with a dibber but can also be heeled in. Must be bedded into the peat after planting.

(iv) Should establish immediately and show significant growth within a few weeks.

(v) YPP are using this product extensively in both bare peat and where planted into existing sparse vegetation (areas cut for brash in between blocked grips) .

Figure 17: Planted *BeadaHumok™* plugs

Table 22: Re-establishment of blanket bog vegetation on peatlands undergoing restoration up to March 2017 (the latest date analysed)

a. Areas of bare-peat, gullies, hags, dendritic areas and micro-erosion undergoing restoration.

Treatment	
Heather seed (ha)	124
Cottongrass plugs (n)	124,775
Area inoculated with *Sphagnum* (ha)	404
Harvested *Sphagnum* clumps (n)	93,850
Harvested Sphagnum fragments (ha)	332
BeadaMoss beads® (ha)	7
BeadaGel™ (ha)	25

b. Areas of existing vegetation cut for brash that lack existing *Sphagnum* cover.

Treatment	
Area inoculated with *Sphagnum* (ha)	58
BeadaMoss beads® (ha)	20
BeadaHumok™ (n)	50,018

Table 23 Yorkshire Peat Partnership's suggested Sphagnum species mix.

	Species	**%**
Base composition	*S. capillifolium*	30
	S. papillosum	30
	S. palustre	30
	S. subnitens	10
Additional species depending on conditions (adjust base composition % accordingly)	*S. inundatum**	5
	*(S. tenellum**)*	10
	*(S. magellanicum***)*	5

***bare peat only. Adjust the content of other species to accommodate it.*

****not for general use but may be worth adding in specific circumstances where it has been found on nearby moors. Adjust the content of other species to accommodate it.*

6 Monitoring restoration works

In May 2017 Yorkshire Peat Partnership produced a report on the results of restoration works monitoring on 20 restoration sites across the Yorkshire Dales and Nidderdale. The following is extracted from that report (Figure and Table numbering has been changed to match the current report).

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

A series of transects were set up across the areas of each site that had undergone different types of restoration intervention. 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.

6.1 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.

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 24).

Table 24: Results of YPP monitoring of grip restoration work up to May 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**

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.

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. 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 18).

Figure 18: Gouthwaite Moor, 2015: a reprofiled grip (left) and a non-reprofiled grip (right).

Table 25a and 25b show the relative merits of both types of restoration work on grips.

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%.

Table 25a. 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 25b. 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**

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.

Out of the five sites average vegetation cover had gone up on three (Coverhead, Kelber and West Arkengarthdale) but down on Hardcastle and Stags Fell Central (Figure 19). 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 20-23)

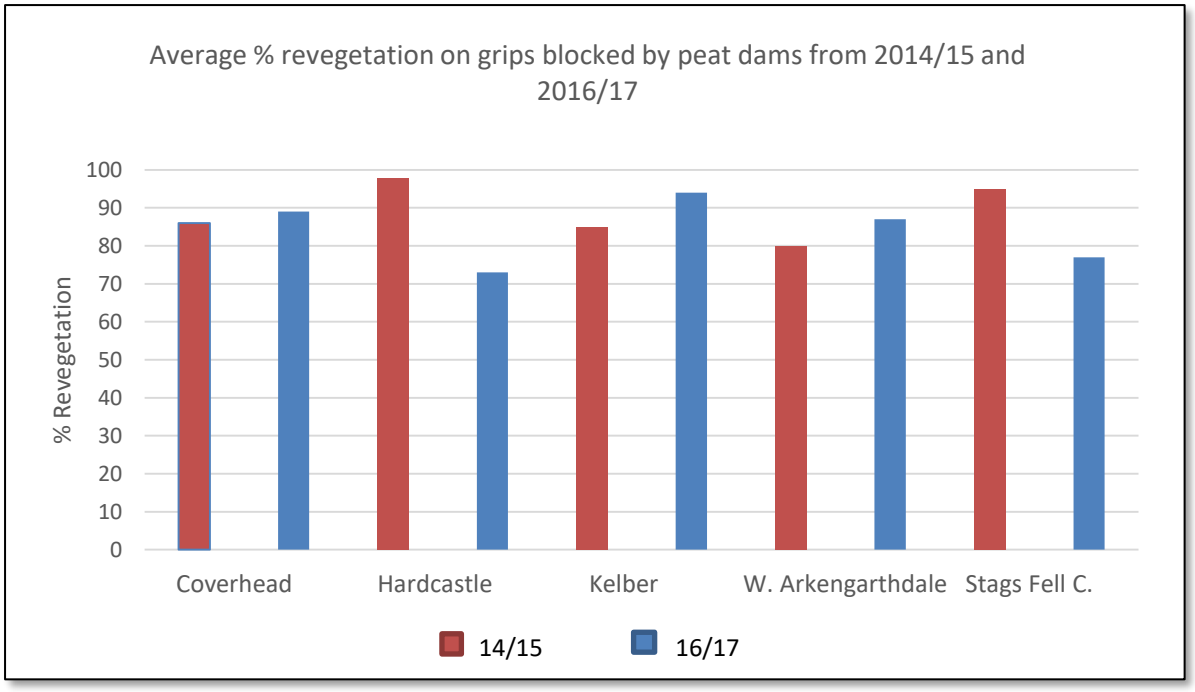


Figure 19: Data comparing vegetation cover on grips blocked by peat dams from sites monitored in 2014/15 and 2016/17.

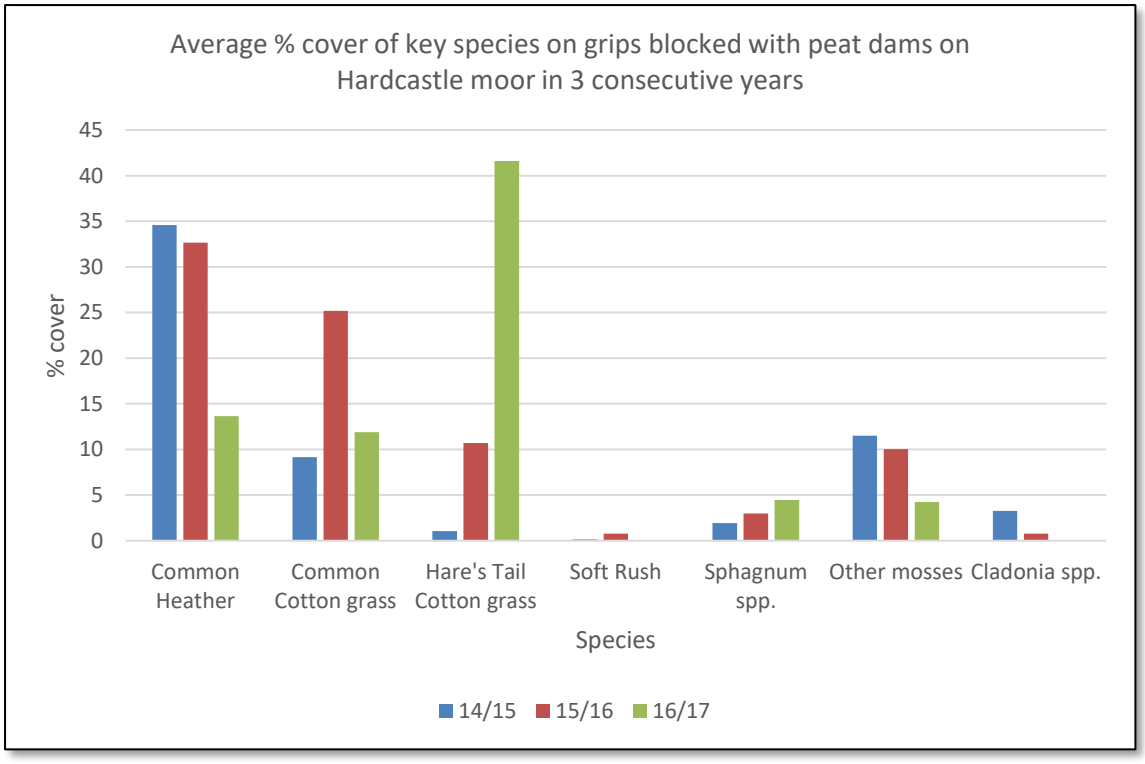


Figure 20: Data comparing percentage of species cover on grips blocked by peat dams on Hardcastle moor monitored in 2014/15, 2015/16 and 2016/17

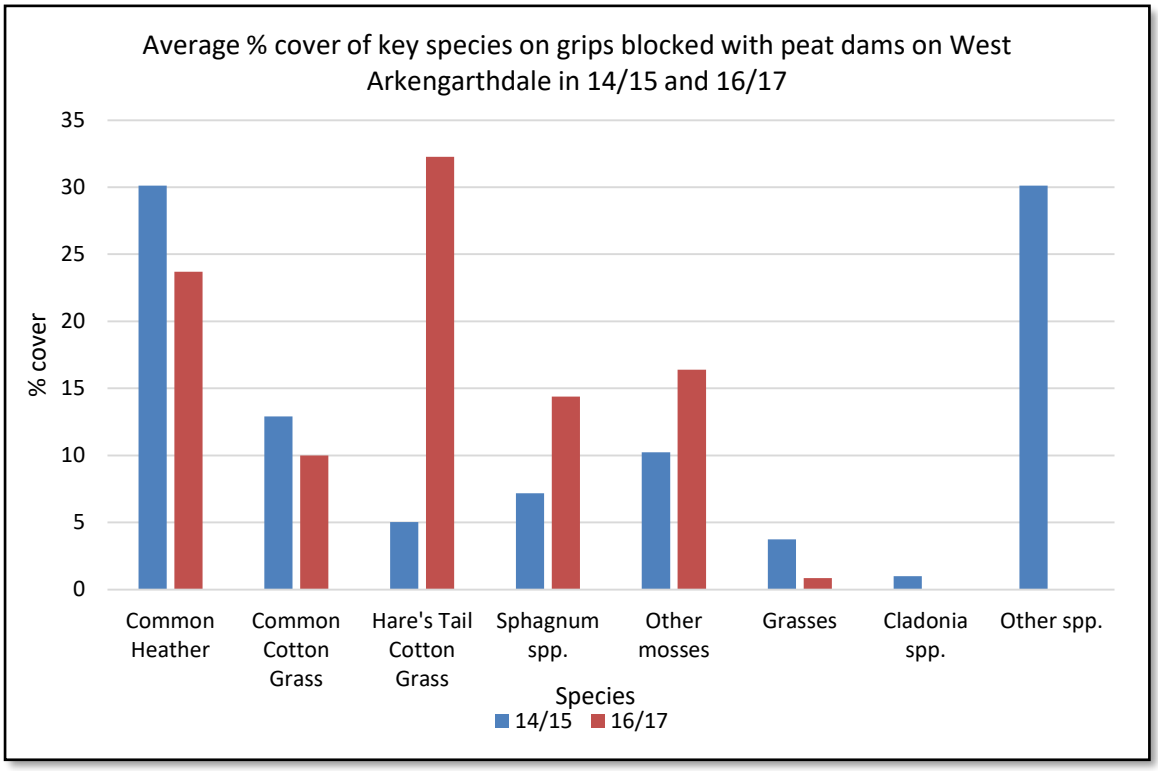


Figure 21: Data comparing percentage of species cover on grips blocked on West Arkengarthdale monitored in 2014/15 and 2016/17.

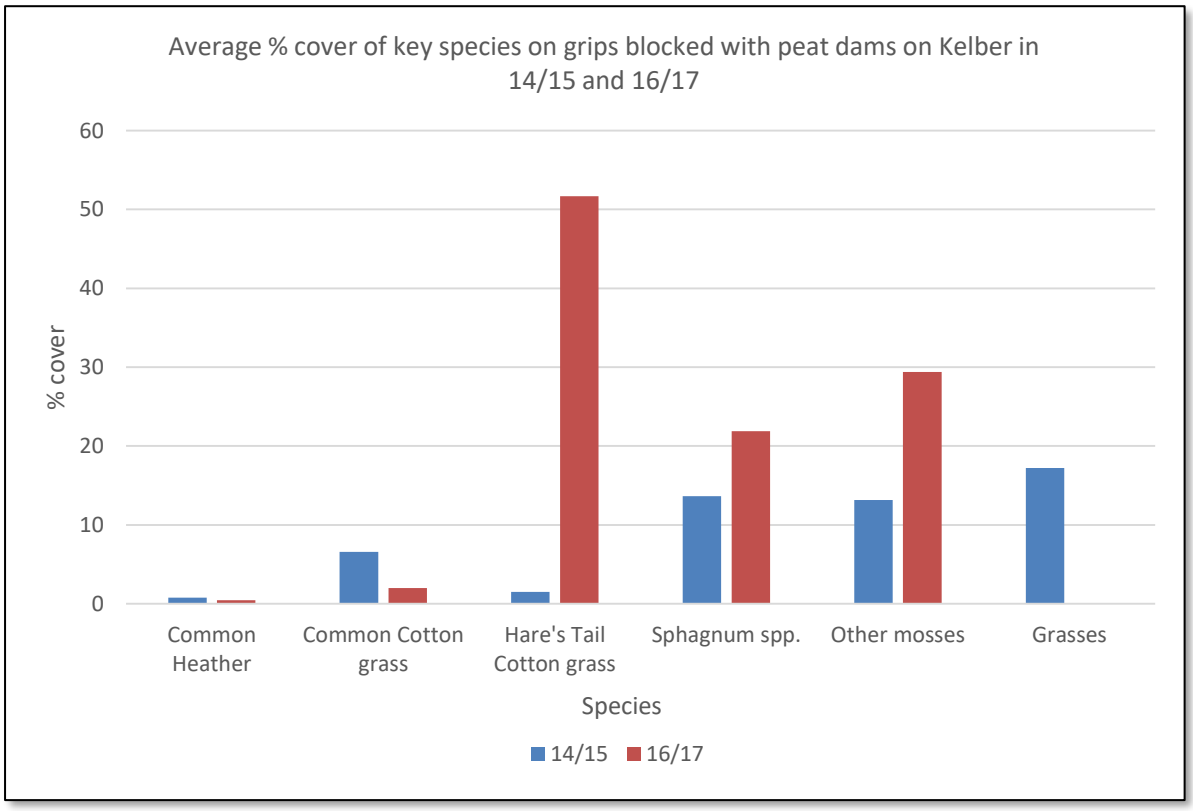


Figure 22: Data comparing percentage of species cover on grips blocked on Kelber moor monitored in 2014/15 and 2016/17.

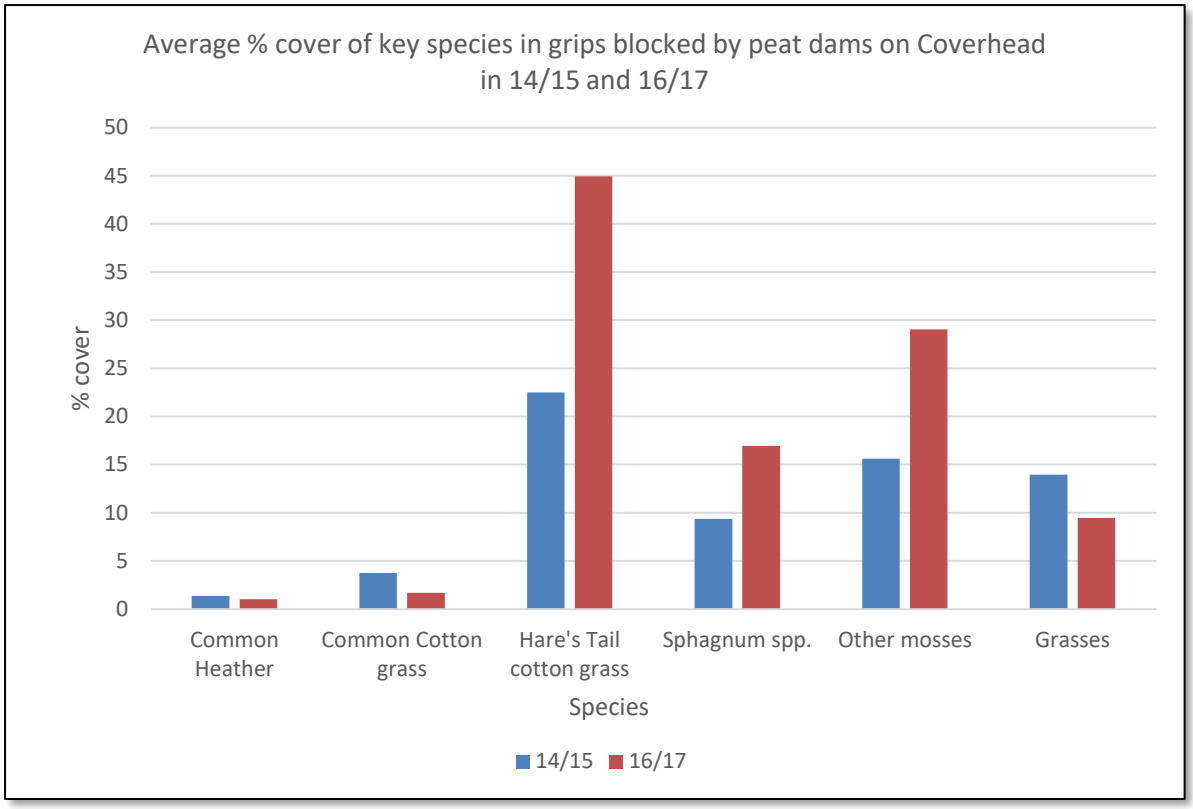


Figure 23: Data comparing percentage of species cover on grips blocked on Coverhead monitored in 2014/15 and 2016/17.

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 20) 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.

6.2 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.

Although the number of sites visited was low for this assessment (*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 26). 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 notably poorly revegetated. This could be due to a number of factors including aspect, exposure, slope angle and quantity of brash and seed used.

Table 26. 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**

6.3 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.

Results from monitoring the success of revegetating areas on bare peat were very mixed (Figures 24 and 25). Within one site the range of revegetation cover varied from 0-100%.

Figure 24: Bare peat on Grimwith Estate (2017) showing an area with no revegetation

Figure 25: 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 27). Again, south-west facing slopes fared particularly badly, with more sheltered areas showing a greater level of success.

Table 27. 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 26).

Figure 26: 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 27a & 27b).

Figure 27a & 27b. Cragdale (2017) showing the use of heather bales to help with revegetation

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.

7 Research

Wherever possible and subject to funding being available YPP has tried to support relevant peat-based research. The vagaries of funding has meant that this has had to be a reactive approach but YPP have managed to support some key research.

At the beginning of the programme YPP supported research through Moors for the Future's Small Research Project Fund and then began to commission its own research projects. All of the research projects are summarized below with more detail available from specific websites or the quoted references.

7.1 Small Research Projects Fund

In 2010 YPP provided £16,645 into the Moors for the Future Small Research Projects Fund and supported the following seven projects. Full reports are available from the Moors for the Future website (http://www.moorsforthefuture.org.uk/moorland-research-fund):

Armitage, R. P. Danson, F. M. & Al-Mustapha, T (2010) *Spatial and temporal changes in fuel moisture content (FMC) in upland vegetation: case study in the Peak District*

Johnston, K. (2010) *Catchment management influences on moorland stream biodiversity*

Menendez, R. & Birkett, A. J. (2010) *Effects of climate and land-use changes on dung beetle communities: predicting the consequences for insect biodiversity and function in British moorlands.*

Quin, S. L. O., Greenwood, S., Littlewood, N. A., Artz, R., Coupar, A. & Woodin, S. (2010) *Moorland restoration: biodiversity and carbon stocks*

Sen, R., Elliott, D., Nwaishi, F., Smith, G. & Caporn, S. (2010) *Impacts of moorland restoration on diversity and distribution of plant growth promoting root symbiotic mycorrhizal fungi and associated soil nitrogen cycling bacterial/archaeal communities in the Southern Pennines*

Shuttleworth, E. L., Evans, M. G. & Rothwell, J. J. (2010) *Impacts of wildfire, erosion and restoration on sediment flux and pollutant mobilisation in the peatlands of the Peak District National Park.*

Tantanasi, J., Evans, J., Agnew, C. (2010) *Adaptive Management for Peatland Carbon in the Dark Peak*

7.2 Peat Cores

In 2011 YPP and the University of Gloucestershire supported a PhD student (Julia McCarroll) to extract peat cores from Mossdale, West Arkengarthdale and Oxenhope Moors to determine historic changes in vegetation and how this might inform conservation today. The results of this work have been written up in Julia's thesis and several published journals as follows:

McCarroll, J. (2014) *Application of Palaecological Techniques to Inform Blanket Mire Conservation in Yorkshire, UK.* PhD thesis University of Gloucestershire, England.

J. Mccarroll, J., Chambers, F.M., Webb, J.C. & Thom, T. J. (2016) Informing innovative peatland conservation in light of palaeoecological evidence for the demise of *Sphagnum imbricatum*: the case of Oxenhope Moor, Yorkshire UK. *Mires & Peat* **18(8)** pp. 1-24.

Mccarroll, J., Chambers, F.M., Webb, J.C. & Thom, T.J. (2016) Using palaeoecology to advise peatland conservation: An example from West Arkengarthdale, Yorkshire, UK. *Journal for Nature Conservation* **30** pp. 90-102.

Mccarroll, J., Chambers, F.M., Webb, J.C. & Thom, T.J. (2017) Application of palaeoecology for peatland conservation at Mossdale Moor, UK. *Quarternary International* **432** pp. 39-47.

7.3 DEFRA burning versus cutting

YPP also provided support to Andreas Heinemeyer and his team at the Stockholm Environment Institute, University of York in a 5 year long research project funded by DEFRA to investigate differences between cutting and burning on blanket bogs on a range of ecosystem services including greenhouse gas emissions and water quality (predominantly dissolved organic carbon). The report of this study is imminent but details of the project can be found at http://peatland-es-uk.york.ac.uk.

8 Conclusions & Next steps

8.1 How did we do?

The following table summarises YPP's original objectives against the outcomes we actually achieved. It is clear that the Yorkshire Peat Partnership has been a hugely successful project getting very close to its original very challenging targets during a period of global austerity.

Original Objectives	Outcome
To restore 50% (35,000ha) of Yorkshire's blanket bog by March 2017, including: Restore 21,262ha of degraded peatland using existing HLS. Secure funding and implement a works programme to restore at least an additional 13,738ha to bring the total restored to 50%.	✓ **32,343ha peat units worked on (37% but the total area of peatland units was revised upwards after this target was set. If we use the original total of 70,000ha this would be 46%). No capital works were proposed 781ha (1% of total area). An additional** X **Could not secure landowner support or funding for works on a further 11,420ha (13% of new estimated total or 16% of the original)**
Complete a programme of desk based surveys of 45 individual peatland sites to provide restoration plans	✓✓ **Surveyed and produced restoration plans for 101 Yorkshire peatland sites plus an additional 6 plans in the Forest of Bowland.**
Establish long-term research & monitoring at a minimum of 2 sites	✓ **Working with the Stockholm Environment Institute supported a 5 year study into the relative merits of burning versus cutting. Established a long-term Sphagnum and ecosystem services study Funded by Yorkshire Water in partnership with University of Manchester.**
Complete a research programme to model the benefits of grip blocking in reducing the flood hydrograph	✓ **Established a project under the University of Leeds led iCASP programme to develop a hydrological modelling package Digibog-Hydro.**
Produce an estimate of the carbon storage and sequestration potential of the Yorkshire region's upland peat.	✓ **Estimated that our peatlands currently store over 38 million tonnes of carbon but we have not yet worked out the sequestration potential.**
Develop and secure funding for a communications and raising awareness programme to promote the importance of Yorkshire peatlands.	✓✓ **Towards the end of the period directly employed a YPP communications officer leading to a considerable uplift in promotion of peatlands through a revamped website and social media presence. Significant coverage on traditional media culminating in Look North and BBC Radio 4 coverage.**
Seek and secure funding to enable the continuation of the Yorkshire Peat Partnership core team beyond March 2013	✓✓ **We kept going and have funds to continue. We also developed innovative approaches to unlock substantial funds and secured funding from a variety of sources enabling peatland restoration projects until March 2022.**
Develop a plan for restoring a significant proportion of the remaining 50% of degraded blanket bog and other peatlands	✓ **This will form the basis of this business plan but will be revised to take account of the new increased estimate of the total area of peatland units in Yorkshire.**

8.2 Next steps

There is much left to do and we now need to draw up the plans for the next phase of our work from 2019 onwards.

This will concentrate on the following key activities:

Consolidate the restoration work already begun by re-visiting those sites with new restoration techniques where the monitoring has highlighted the need for additional restoration work.
Continue to work on new sites with the ultimate goal of restoring all 86,000ha of Yorkshire's upland peatland units where it is needed.
Expand the research and monitoring aspects of our work to try to tackle some of the big questions we have yet to answer (e.g. what is the carbon sequestration potential of Yorkshire's peatlands; what are the impacts of restored peatlands on flood reduction and how far downstream?).
Develop new ways to engage with a wide range of audiences to promote the importance of fully functioning blanket bogs for biodiversity, for carbon storage and sequestration, for flood risk reduction and for high quality drinking water.

9 Acknowledgements

The success of the Yorkshire Peat Partnership is the result of the hard work of by a huge range of partners and could not have happened without them.

Landowners, their agents, gamekeepers, farmers and tenants have helped YPP deliver the restoration work on their land often helping practically but also providing advocacy support and helping to unlock funding.

None of the work could have taken place without our major funders supporting both the capital work but also the hugely important core funds that enable YPP to function. We are hugely grateful to the EU-LIFE fund, DEFRA, Natural England, the Environment Agency, Yorkshire Water, the Yorkshire Dales National Park Authority, the North York Moors National Park Authority, Peter de Haan Conservation Trust & Yorkshire Wildlife Trust. Huge thanks also go to the Yorkshire Dales National Park Authority and The Wildlife Trusts who provided the bridging loaned to enable us to unlock HLS funds.

We would also like to thank our other YPP members (Moorland Association, National Farmers Union, National Trust and Nidderdale AONB Partnership) for supporting and guiding our work.

A special mention goes to Yorkshire Wildlife Trust for hosting the Yorkshire Peat Partnership and providing all the essential back-up services (especially Peter Batchelor and his finance team and Tracey Davison-Franks in HR) we couldn't have done without. The impact and cost of hosting YPP should not be under-estimated.

Last but not least none of this could have happened without the support of hugely dedicated, hard-working staff team (Astrid Hanlon, Pete Christopherson, Tessa Levens, Jackie Smith, Ceri Katz, Mark Brown, Les Hughes, Matt Cross, Kay Waites, Laura Watson, Rosie Snowden, Jenny Sharman, Chris

Miller, Matt Snelling, Chris Osborne, Dom Hinchley, Beth Thomas, Roz Bardon, Lizzie Slingsby, Ollie Mackrill) who have come and gone over the years but remain the heart, soul and spirit of the Yorkshire Peat Partnership.

Appendix 1 YPP staff (YDNPA = Yorkshire Dales National Park Authority; YWT = Yorkshire Wildlife Trust; NE = Natural England)

		08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
Tim Thom (YDNPA to March 2013 then YWT)	14/5/2008-present												
Astrid Hanlon (YWT)	14/5/2008-25/8/15												
Pete Christopherson (YWT)	1/7/2009-31/5/2013												
Tessa Levens (YWT)	2/11/2009-3/7/2015												
Jackie Smith (NE)	1/1/2010-31/3/2013												
Ceri Katz (YWT)	4/1/2010-28/3/2013												
Mark Brown (YWT)	1/11/2011-30/07/2018												
Les Hughes (YWT)	7/1/13-31/5/2015												
Matt Cross (YWT)	5/11/13-30/06/2017												
Kay Waites (YWT)	20/8/2014-31/3/2015												
Jackie Smith (NE)	1/10/16-31/03/2017												
Laura Watson (YWT)	19/10/15-30/4/2016												
Rosie Snowden (YWT)	7/11/2016-present												
Jenny Sharman (YWT to 1/10/2017 then PPL)	7/11/2016-present												
Chris Osborne (YWT)	24/4/2017-present												

Lizzie Slingsby (YWT)	7/8/2017-30/9/2019												
Chris Miller (PPL)	18/9/2017-present												
Matt Snelling (YWT)	26/9/2017-present												
Roz Bardon (YWT)	11/12/2017-30/04/2019												
Dom Hinchley (YWT)	11/12/2017-present												
Beth Thomas (YWT)	11/12/2017-present												
Ollie Mackrill (YWT)	18/12/2017-present												
Lyndon Marquis (YWT)	22/1/2018-present												

Thom, T. J. & Hinchley, D. (2019) ***Yorkshire Peat Partnership*** *- 10 years of restoring Yorkshire's upland peatlands, July 2009 to March 2019.* Full Report. Yorkshire Wildlife Trust, Skipton, November 2019.

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