Specialist visit, Moor House-Upper Teesdale NNR and environs, North West Pennines, 18/19 May 2017

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The area of moorland within which Moor House-Upper Teesdale NNR sits (Figure 1) is a watershed area feeding a number of major rivers: the Tees, the Wear, the South Tyne, the Eden and the Lune (further to the south). The NNR itself is largely within the gathering grounds of the Upper Tees, although parts drain westwards to feed the River Eden. The northern boundary of the northern half of the NNR runs along the course of the Upper Tees, above Cow Green Reservoir. The objective of the visit was to discuss freshwater issues and their integration with wider upland management issues.

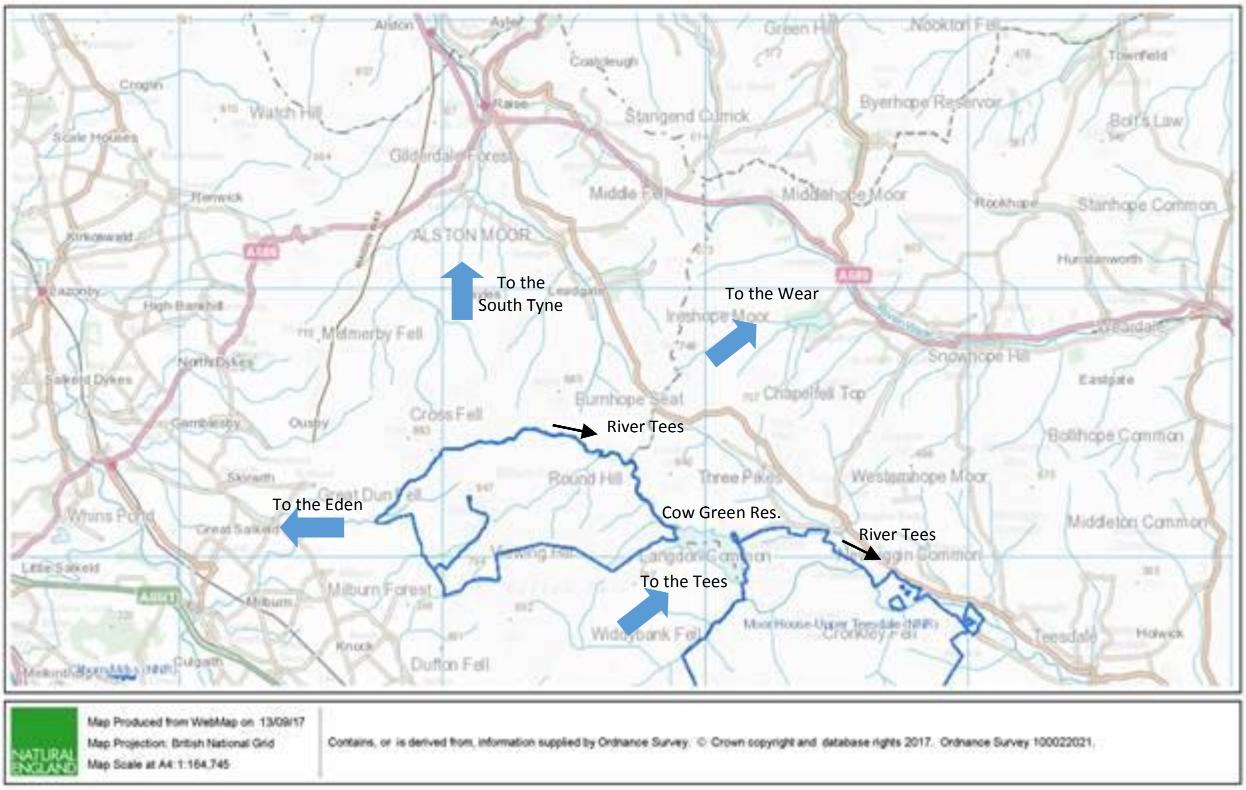

Figure 1. The northern half of Moor House-Upper Teesdale NNR from the northern NNR boundary (looking south eastwards).

On day 1 of the visit (18 May), in the morning we inspected an area just outside of the northern boundary of the NNR but still within the upper Tees catchment. In the afternoon we inspected areas within the boundary of the northern half of the NNR. The following day (19 May) part of the group visited the southern part of the NNR and surrounding area.

1. Day 1 Morning inspection – Tyne Green Syke and environs

We briefly inspected the main River Tees along the boundary of the NNR before walking up Tyne Green Syke to an area of shakeholes on the moorland plateau.

The Tees at this point is physically unconstrained and wanders freely, creating vegetated and unvegetated gravel and cobble shoals (Figure 2). The vegetated shoals lacked botanical diversity but the unvegetated shoals are likely to be important for specialist invertebrates. Trees and scrub are completely absent from the river corridor, as they are in the wider landscape. We had a discussion about whether the absence of trees and scrub is a natural climatic effect or a result of historical land management. Tree growth is clearly possible at this altitude (witness the small conifer plantation at Moor House), although this does not necessarily mean that natural germination and establishment is possible. Land management is a further major influencing factor - prolonged sheep grazing kills off saplings and exhausts the seedbank in moorland areas, and this may well have happened at Moor House. In the immediate vicinity of the channel the hydraulic energy of the river is a further factor, although it would not of itself prevent the establishment of at least scrub as gravel shoals stabilise and vegetate (as with alpine rivers).

Figure 2. The upper Tees running along the northern boundary of Moor House-Upper Teesdale NNR.

We took a kick-sample of benthic macroinvertebrates from the main Tees at this point. A good number of stoneflies were found, including the large predatory *Dinocras cephalotes* and *Perla bipunctata*, the smaller predator *Diura bicaudata*, and scraper/shredder Leuctrids (which all appeared to be *L. inermis*). *Dinocras* and *Perla* are partitioned by their preference for stable and instable coarse substrates respectively, and co-occur where there is a mosaic of such substrates present. Cased caddis-flies found include *Lepidostoma hirtum* (the final instar larva builds an elegant case of plant fragments and silk)) and *Odontocerum albicorne (*a specialist of stony streams and rivers*)*, Caseless caddis-flies include the widespread *Hydropsyche siltalai* and *Rhyacophila dorsalis*, as well as a *Polycentropus* species. Mayflies include *Rithrogena semi-*

colorata and *Ecdyonurus torrentis*, both characteristic of stony, fast-flowing streams and rivers, as well as Baetids. The river limpet *Ancylus fluviatilis* was also abundant. Overall, and as might be expected from the current character of the river, the invertebrates reflect uniformly fast-flowing water habitats, with little representation of species that are adapted to life in pools and backwaters, or in association with riparian trees and scrub, fallen woody material and leaf litter. Although this is quite a typical state for our moorland rivers, it is quite a limited habitat mosaic due largely to the lack of trees and scrub in the river corridor.

Tyne Green Syke provides a completely different type of running water habitat, as well as standing water habitat. The lower section is intermittent, showing no signs of flow at the time of the visit (Figure 3). This leaves pools that are exploited by a range of invertebrates typically associated with standing waters (such as water-crickets observed on the water surface), demonstrating the blurred line between the provision of running and standing water habitats in headwater areas. Further upstream the stream was still flowing at the time of the visit (Figure 4), but it enters a swallow-hole midway along its length to leave the lower reaches without a continuous supply of water. At times of higher flow the swallow-hole will be overwhelmed and the lower sections will flow. DO discovered a vent to the subterranean stream section, through which flowing water could be heard.

Figure 3. Lower end of Tyne Green Syke (not flowing at the time of inspection).

Figure 4. Tyne Green Syke further upstream, above the swallow-hole.

Physical habitat provision in the stream is diverse, created by partial blockages to water flow from boulders of various sizes. This creates variation in current velocities and depth that provides niches for a wide range of species, particularly invertebrates. However, as with the main upper Tees, the lack of riparian trees leaves major gaps in the habitat mosaic, including a lack of leaf litter for shredding invertebrates, lack of woody substrates for specialised species, a lack of debris dams and tree root systems to express the full habitat diversity of the stream, and a limited humid zone for lower plants.

We took a composite sample of the invertebrate fauna along the stream, including the standing pools and the flowing sections. As would be expected, the stonefly assemblage was dominated by smaller species than in the main river, including the predatory *Chloroperla torrentium* and the scraper/shredders *Leuctra inermis* and *Nemoura* (sp.). Caseless caddis-flies were represented by *Plectrocnemia conspersa* – Plectrocnemids are specialists of headwater streams, where they are very active predators. They are abundant in streams that are naturally inaccessible to fish, illustrating the importance of natural barriers to fish movement in headwater catchments (e.g. cascades and waterfalls, swallow-holes). Mayflies were represented by the fastwater specialists *Ecdyonurus torrentis* and *Electrogena lateralis*, and what appeared to be *Habrophlebia fusca. H fusca* is a species of pool and marginal biotopes in rivers and streams, where it feeds on fine particulate organic matter. Scirtid beetle larvae were also present – this family has an aquatic larval stage but the adult beetles live in the wetland margins of watercourses. An adult Dytiscid beetle was also found – again an animal of standing or very slow moving water. Overall the invertebrates found reflect a more diverse habitat mosaic than in the main River Tees, including cascades, pools and wet channel margins. However, the lack of riparian trees still means a river habitat mosaic that is far from complete, which has consequences for the fauna that can be supported.

The hydrology of the stream appears to be natural although there are mine soughs and shafts in the near vicinity that will be affecting at least some of the streams in the area. The hydrology of limestone geologies is naturally complex - the underground section of Tyne Green Syke may not feed into the upper Tees at the surface confluence – it could surface somewhere further down depending on the precise arrangement of limestone and other geological strata.

Near the top of the stream channel the stream bed is heavily incised and associated with peat hags on the ghyll sides (Figure 5). Around this area some grip-blocking activity was evident around the top of the ghyllsides (Figure 6). The hydrological pathway downstream of the peat plug we observed is heavily incised (Figure 7), owing to the need for the grip to connect with the stream bed at stream's incised bed-level. This would appear to be an unnecessary strain on the peat plug that could be rectified by stream restoration (see 'Reflections' below).

Figure 5. Incised channel of upper Tyne Green Syke with peat hagging around the moorland fringe in the background.

Figure 6. Gripping-blocking at the top of the ghyllside of Tyne Green Syke, showing the heavy erosion downstream of the peat plug prior to the connection with the stream.

Grip blocking has created a number of small areas of standing water (see Figure 7). These are widespread across the moor and can be identified on aerial images. Whilst they provide a standing water habitat within the peatland they are temporary because they infill as the hydrological integrity of the system is restored.

Figure 7. Path of former grip, now mostly filled in, and standing water habitat created by grip-blocking.

The fringe of the peat body around the mire-stream transition zone of Tyne Green Syke exhibits extensive hagging (Figure 8). Further into the plateau the hagging becomes more extensive, with some areas stripped down to the mineral soil or bedrock and supporting pools of standing water. Some standing waters observed could be described as occurring in erosion gullies, whilst others in flatter areas appeared more like ‘mud-bottom hollows’ but were associated with areas of erosion with peat hags (Figure 9). AC believes this effect is probably a result of a wildfire at some point in the past.

Figure 8. Peat hagging around the mire-stream transition at the top of Tyne Green Syke.

Figure 9. Extensive peat hagging, and pools in areas of erosion – effects created by historical erosion of the peat body.

We inspected a large number of shakeholes further into the blanket peat. Some of these were dry and some filled with water (Figure 10). Again the effect of mining soughs on the natural hydrology of these shakeholes is unclear. The water-filled examples were largely filled with Sphagna and algae, with no higher plants observed. Water beetles and dragonfly nymphs were observed but the diversity of invertebrates appeared to be low (likely to be naturally so).

Figure 10. Shakeholes on the peat-covered plateau above Tyne Green Syke.

2. Day 1 afternoon inspection – inside the northern half of Moor House-Upper Teesdale NNR

The areas we inspected inside the NNR were more intact blanket bog. Here the vegetation was more hummocky with heather less dominant and a range of Sphagna. There was a lack of grips and a lack of peat hagging. We did not observe any standing waters or streams in this section. The likelihood of standing water being a part of this landscape when the site is naturally functioning was discussed. Whilst acknowledging that this will depend on quantity of rainfall and capacity to hold back the water, it was accepted that there were few hydrologically intact examples in England with which to compare. It was accepted that actions to restore the hydrological integrity of the peatland are likely to change the extent of standing water, but this should not alter the intention to restore hydrological integrity.

Various discrete human modifications past and present were observed (some shown in Figure 11): the work on tracks, the experimental conifer plantation, and the old modifications made to Trout Beck (some of which are associated with water supply to Moor House). It appears these modifications created a number of standing waters according to the map (including a small reservoir feeding Moor House – pers comm Martin Furness). However natural processes appear to be returning Trout Beck to a more natural state (Figure 11), with few associated standing waters.

Figure 11. Modifications observed around Moor House (first two pictures) and evidence of natural processes returning to Trout Beck (last picture).

3. Day 2 visit to the southern half of the NNR, including Tarn Dub

On the morning of 19th May RH and DO walked up from Cronkley Farm to Tarn Dub, from an altitude of 350-420m. The landscape here was noticeably more wooded than the northern half of the NRR and trees were protected from grazing in enclosures in some places, especially around streams (Figure 12).

Figure 12. Presence of trees and scrub in the landscape in the southern part of Moor House-Upper Teesdale NRR.

Tarn Dub waterbody (Figure 13) is a SAC and has been reported as a hard oligo-mesotrophic water with benthic vegetation of *Chara* spp. This is an impermanent water body and was mostly dry when we visited. Large areas from where the water had retreated were covered in *Littorella uniflora* and there were signs of rabbits digging amongst it, illustrating that the area had probably been dry for some time. The species found were indicative of fluctuating water levels (such as *Lythrum portula*, *Apium inundatum, Juncus bulbosus* and *Ranunculus flammula*) rather than hard water, and no charophytes were found. There were a few small white patches of sediment towards the edge of the tarn that might represent marl formation, but these were very small. It is suggested that the overriding environmental influence here is the natural impermanence of the water levels.

Figure 13. Tarn Dub and its setting beneath the edge of Cronkley Scar.

4. Reflections

4.1 Native trees and scrub in the stream/river corridor and wider landscape

The presence or absence of native trees and scrub in river and stream corridors has a major effect on the diversity and completeness of the instream and riparian habitat mosaic (Mainstone *et al*. 2016). They work with natural hydrological and sediment processes to create the characteristic diversity of in-channel and riparian habitat mosaics – tree root systems offer resistance to erosion and help create riffles and pools and lateral channel movement, whilst fallen wood creates partial blockages to flow and enhances the effects of tree roots. Leaf litter provides an important food source for shredding invertebrates (including a range of stonefly species), and submerged wood acts as a substrate for specialist species such as gallery-building caseless caddis flies of the *Lype* genus. Trees and scrub also generate shelter and an extensive humid zone above and around the river/stream channel that can support a range of characteristic mosses and liverworts. The precise ecological role of trees and scrub varies depending on river and stream characteristics, and is different for a very active shingle river like the upper Tees compared to the stable boulder substrates of its sheltered ghyll streams. But whatever the role of trees and scrub the absence of them has a major effect on the diversity and completeness of the instream and riparian habitat mosaic. It is therefore vital that they are present where they are a naturally occurring feature, and are only absent when climatic factors preclude their occurrence.

It seems likely that native trees would be a natural feature along the banks of rivers and ghyllstreams of the area, particularly in sheltered areas, as long as there is a source of saplings and grazing regimes are conducive to their survival. The precise ecological limit of native tree and scrub survival across the area is worthy of detailed consideration if this has not already been addressed. The River Tees lies at around 560 metres where it forms the northern boundary of Moor House-Upper Teesdale NNR, and the surrounding ghylls generally lie in the range 560 – 600 metres. On nearby Ayle Common to the north, a forestry plantation at an altitude of around 450 metres is being cleared and native trees planted, and other forestry plantations in the area (including at Moor House) are at considerably higher altitudes. A trial using planted native saplings and seed from local sources would seem sensible to test the natural limits of native tree/scrub survival, sensibly targeting sheltered ghylls like Tyne Green Syke. It should be remembered that established trees create a microclimate that is more conducive to subsequent tree germination and development, so the process may need to be kick-started to be self-sustaining.

We discussed the effect of native trees in hydrological pathways running off the moorland plateau. Riparian trees along headwater streams help to stabilise the stream bed level, through their root systems and through fallen wood creating debris dams that trap sediment. If streams like Tyne Green Syke can be re-wooded then over time the stream bed-level can naturally restore itself. This would take the pressure of the grip plugs being installed to restore the blanket bog. Whilst modern commercial afforestation even on bog margins will disrupt the hydrological integrity of the peat body, the loss of woodland around the edges of the peat body and on shallow peat on slopes have been implicated as one of the causal agents for peat erosion. Consequently the natural regeneration and sensitive planting of native species, particularly where there are concerns about marginal erosion and slope instability, has been advocated to benefit mire systems (Lindsay, 2010). This is because trees can act like anchors rooting through the peat into the mineral soil beneath, keeping potentially unstable slopes in place.

At some sites such as Swindale a switch to grazing with cattle has had major benefits in terms of restoring scrub and trees to the moorland landscape, restoring the wider natural habitat mosaic as well as encouraging the re-wooding of ghylls (with all of the ecological and biodiversity benefits that brings) (see case study in Natural England 2018). This may be worth trialling in parts of Moor House-Upper Teesdale NNR alongside tree and scrub re-establishment experiments. The effects on species favoured by large-scale open-ness (such as wading birds like curlew) could be monitored as part of this activity.

4.2 Standing waters

The shakeholes we inspected could not easily be fitted into conventional standing water habitat typologies, which presents a challenge for highlighting their conservation importance. There was some peat-staining of the water but it was not very intense. They are presumably largely fed from underlying limestone strata so can be expected to have strong calcareous influence, but the water at the surface will be acidified by sphagna and sphagnum peat, and there is likely to be relatively limited mixing of water layers due to the relatively steep sides and their position in hollows in the landscape.

Overall, the extent of standing water in the area visited was quite high, particularly if intermittent pools in ephemeral moorland streams are taken into account. However, quite a large proportion of this is associated with habitat degradation and modification such as gripping, impounding of streams, and in areas of extensive peat erosion. This is in contrast to the shakeholes and pools in ephemeral streams which are natural features.

The blanket peat has been gripped historically and is only just starting to recover through grip-blocking. Over time this recovery can be expected to alter the extent of standing water. Dependant on the climate envelope and topography, hydrologically restored peat bodies have the potential to support standing waters at least in part due to the microtopography produced by the growth of hummock-forming *Sphagnum* species. The local topography and climate affect the amount of water held on the peat body; in climatically drier locations, pools may not form or be limited to flat areas, but in wetter locations they may also occur on slopes, typically along the slopes contours.

It is still unclear whether natural pools would be widespread at Moor House-Upper Teesdale under natural hydrological conditions, but the most intact area we observed within the NNR currently exists as ridges and furrows, characteristic of drier conditions than those where hummocks and pools predominate. The expression of the microtopography as ridge and furrows or hummocks and pools can be natural (as described above) or a result of past human intervention (such as burning or drainage). Consequently, it is presently unclear whether the ridge and furrows observed are characteristic of the natural state of the site as a whole, or whether it will change with further recovery of the hydrological integrity of the peat body. As the area we visited was on a slope, it can be expected that flatter areas would have a greater likelihood of supporting pools when hydrological integrity is intact. There are suggestions that this geographical location could support pool formation due to a moderate water surplus based on information on rainfall (see Figure 14).

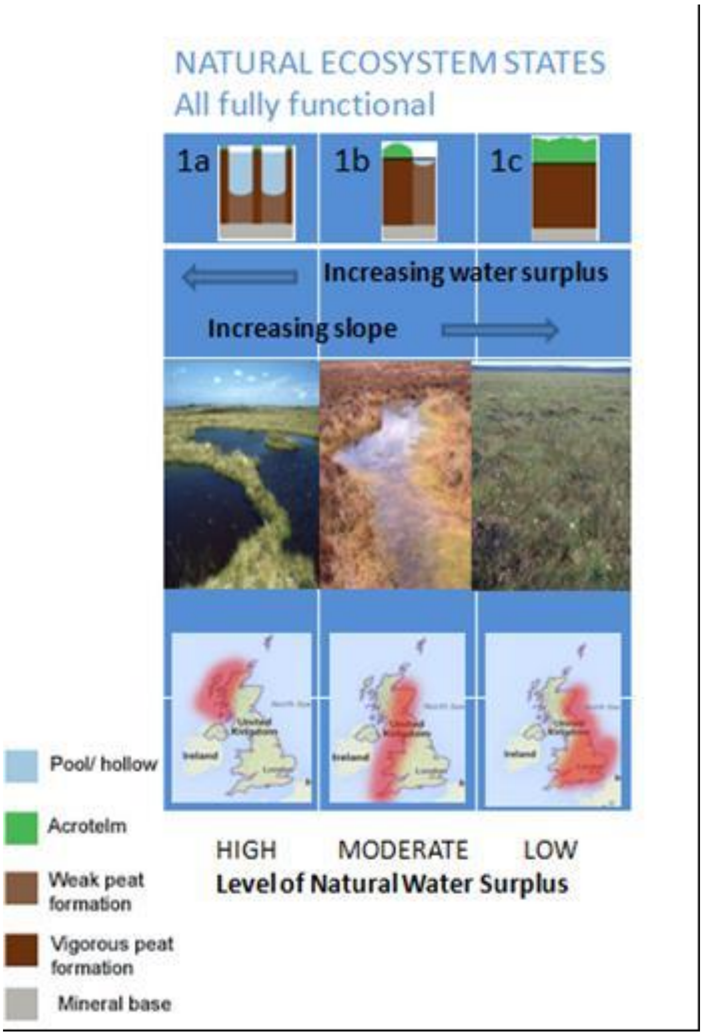

Figure 14. Natural states relating to pool and hummock microtopography dependant on climatic conditions (Lindsay *et al.* 2014).

Grazing will also affect the expression of microtopography. The grazing study plots at Moor House showed that the removal of grazing led to the expansion of low-ridge features at the expense of hollows and mud-bottom hollows. Rawes and Hobbs (1979) attributed this to the sensitive nature of low ridge vegetation, which when trampled by sheep led to its destruction and the expression of pool/hollow features associated with the underlying mineral substrate.

Overall, the importance of standing water habitat in the upland habitat mosaic needs to be emphasised both locally and nationally. Changes in its extent and nature due to restoration of hydrological integrity needs to be embraced.

4.3 Priority habitat issues

The mapping of priority river and lake habitat has received considerable attention over the last few years, with new national maps being created based on natural habitat function (Mainstone *et al*. 2014, 2015, Hall *et al*. 2015) that now need refinement to make them fit-for-purpose for local decision-making. The mapping of pond priority habitat is a separate exercise led by the Freshwater Habitats Trust which we need to generate closer links with (the pond map is not based on natural habitat function). The streams and rivers we inspected around Moor House-Upper Teesdale NNR appear highly natural in many respects, but the lack of trees and scrub present problems with their inclusion on the priority habitat map. This is a wider issue that we need to consider in the uplands as the initiative on priority habitat mapping develops.

4.4 Natural Flood Management (NFM)

The concept of NFM is rapidly moving up the political agenda and there is considerable interest in deploying a range of engineered measures to mimic the flood storage capacity of naturally functioning river/stream and wetland mosaics. Natural England is liaising with Defra, the EA and the Forestry Commission to try and ensure that catchment-based flood-risk management strategies promote natural river and stream ecosystem function as far as possible (Mainstone *et al*. 2016), rather than focusing on engineering solutions (such as 'leaky dams') that reduce natural ecosystem function. A focus on natural ecosystem function provides the water storage benefits of engineered solutions but in a way that restores water and wetland biodiversity at the same time. This debate is highly relevant to the hydrological restoration of moorland, since grip-blocking can be undertaken without reference to restoration of the mire-stream transition and stream/river habitat downstream of the blanket peat. This can leave a vacuum for engineered NFM solutions to fill unless proactive steps are taken to ensure that an approach based on natural ecosystem function is taken.

4.5 Ecologically sustainable game shooting

There are interesting parallels between the issues over red and black grouse management for shooting and those relating to salmonid fish management for angling. In the salmonid angling world there is a very strong movement that promotes self-sustaining river fisheries, which are maintained by the natural productivity of naturally functioning river systems and managed by appropriate controls (often voluntary) on the taking of fish (e.g. catch-and-release, bag limits etc.). In England the Wild Trout Trust is at the forefront of outreach efforts to physical restore river habitat and generate self-sustaining fisheries, with measures that are closely aligned to our biodiversity aspirations for naturally functioning river habitat. There seems to be no similar movement in the game bird world but it would be worth exploring whether such a movement is feasible. This would provide a more strategic framework for promoting the restoration of black grouse habitat, which is closely aligned with the restoration of the moorland fringe for integrated biodiversity objectives (Natural England 2018). It would also support extensification of moorland management for red grouse, providing closer alignment with the restoration of blanket bog and associated upland habitats. The beauty of promoting such a movement is that it is led by stakeholders and allows for an incremental shift in mindsets over time, focusing on places where mindsets are most conducive to change.

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