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Building Peat: Landscape-scale Habitat Re-creation Within Chat Moss for Wildlife and Climate Benefits

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Summary

Peatland is a biotope of international importance because of its unique flora and fauna and, when in good condition, the potential for globally significant carbon sequestration and storage. Until 300 years ago Chat Moss was the largest of the lowland raised bogs in the Greater Manchester area, covering over 36 square kilometres. During the Industrial Revolution, Chat Moss and virtually every other peatland in the northwest of England were completely degraded through drainage for peat extraction, agriculture, housing and infrastructure, with some entirely destroyed, resulting in numerous local extinctions.

Over the past 40 years there have been determined efforts to restore degraded sites to semi-natural lowland raised bog habitat, increasingly driven by the imperative to protect remaining carbon stocks within peat from oxidisation, thereby reducing greenhouse gas emissions and subsequently resuming carbon sequestration and peat accumulation over the long term. Plans have grown into landscape scale projects, culminating in the formation of a peatlands National Nature Reserve.

Keywords: natural capital, ecosystem restoration, peatland restoration, species reintroduction.

Historical Ecology

The historical ecology of the area was investigated by Osborne *et al*. (2024) and presented at the 2025 Rewilding Futures Conference. This work drew on multiple sources to piece together a picture of the baseline condition of Chat Moss (SJ 70 95) and its flora and fauna, advising current restoration efforts and mitigating the influence of the 'shifting baseline syndrome'. Chat Moss was described by Redding (1842) as of "one of the most dangerous and treacherous bogs in the three kingdoms". The modern-day landscape bears no resemblance to the region's primaeval origin (Figure 1), apart from 5,500-year-old sub-fossil bog oaks left exposed on peat extraction sites (Figure 4C).

Peatlands have traditionally been undervalued, and appreciation for ecosystem services and natural capital has only arisen over recent decades. Manchester's local history is recorded almost exclusively in anthropocentric terms - the mosses were usually dismissed as "wasteland", probably referring to their potential for profitable exploitation being uneconomic. For example, in the 1322 audit of the Barony of Manchester (the earliest historical reference) 'Chatmos' is written off as having "so small a goodness … in so large an extent" (Harland 1861). However, peatlands had value to local people, as common land for foraging, hunting, light grazing and, as described in 1727 by Daniel Defoe, cutting peat for 'fewel'. Defoe (the author of Robinson Crusoe) gave the earliest first-hand description of Chat Moss, an impenetrable wilderness measuring six miles by eight miles; "what nature meant by such a useless production, 'tis hard to imagine; but the land is entirely waste" (Defoe 1724-1727).

The Industrial Revolution was triggered by the innovation of the steam engine in the late 1700s which facilitated coal extraction from the south Lancashire coal field, igniting the local economy with vast quantities of cheap fossil fuel. Coal mining and burning, combined with salt extraction from Cheshire (an important raw ingredient for the early, completely unregulated,

chemicals industry) placed Chat Moss and numerous smaller peatlands along the Mersey Valley at the centre of the Industrial Revolution. Led by George Stephenson, the construction of the Liverpool to Manchester railway during the 1820s (Figure 1) was a huge civil engineering project, which 'floated' the line across the middle of Chat Moss, effectively splitting the peat body and disrupting its hydrological integrity. This triggered a rapid phase of land enclosure, peat cutting and conversion to agriculture (Figure 2), through extensive deep drainage and adding clay and 'night soil' (human waste) to improve the peat. This process yielded some of the most productive arable land in the country but fundamentally changed the chemistry of the peatland leading to the local extinction of virtually all the specialised bog flora and the wildlife reliant on this habitat, from lepidoptera to wetland birds.

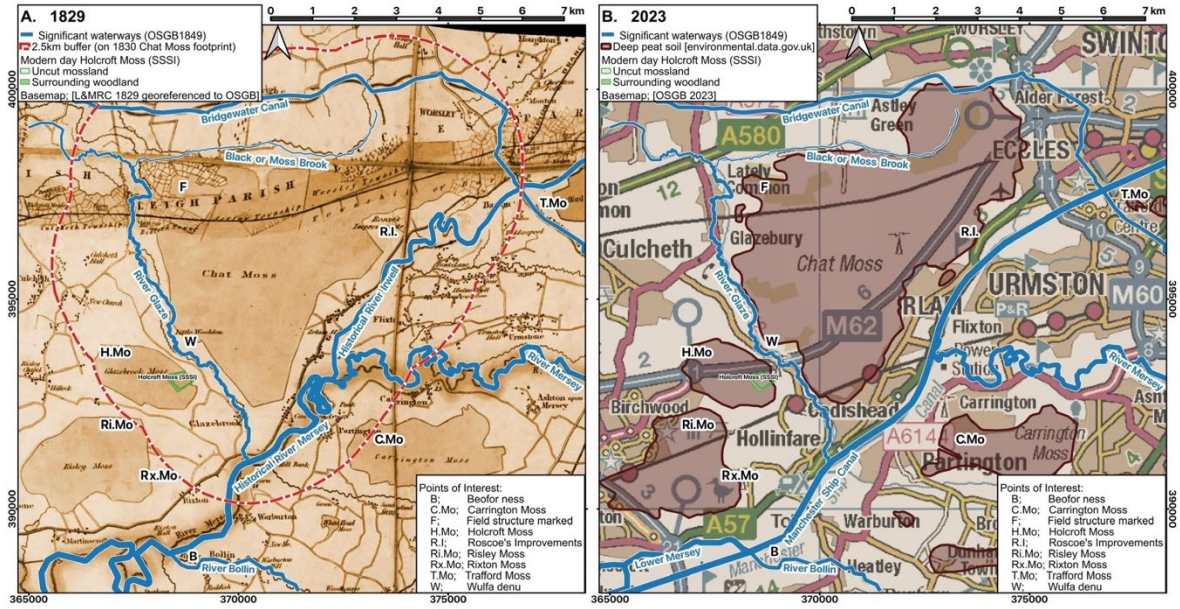

Figure 1. Maps of the Chat Moss area (A) 1829 map showing the Liverpool to Manchester railway, which was under construction. (B) Present-day map of the same area. The Chat Moss footprint is indicated by remaining deep peat soil. Holcroft Moss Nature Reserve (SSSI) is the only remaining area of undisturbed (although still affected by peripheral drainage) peat on the Manchester Mosslands. The Anglo-Saxon era place names Beofor ness (beaver headland) and Wulfa denu (wolves valley) speak to Holocene fauna similar to modern-day Scandinavia or Yellowstone National Park – these keystone species would have shaped the low-lying woody-riparian landscape, fens and peatlands, before both were driven to extinction by the early Middle Ages. Image credit: Osborne *et al*. 2024.

During the mid to late 1800s Merseyside and south Lancashire were one of the UK's largest generators of Sulphur pollution. Apart from coal burning to power industry, metal smelting (Figure 4B) and later electricity generation, unregulated chemical works employing the Leblanc alkali process released unfiltered pollutants (HCl, SO^2, H_2S). This 'acid rain', described by R.A. Smith (a pioneering atmospheric chemist) in 1872, contributed to the habitat degradation and poisoned *Sphagnum* moss on the neighbouring lowland peatlands. The alkali industry created "noxious and injurious" living conditions, bleached local orchards, and eventually resulted in a parliamentary investigation and some of the earliest health and environmental legislation. Air quality has improved significantly in recent decades (Figure 4A). However legacy pollution with industrial metal deposits and nitrogen eutrophication are ongoing issues.

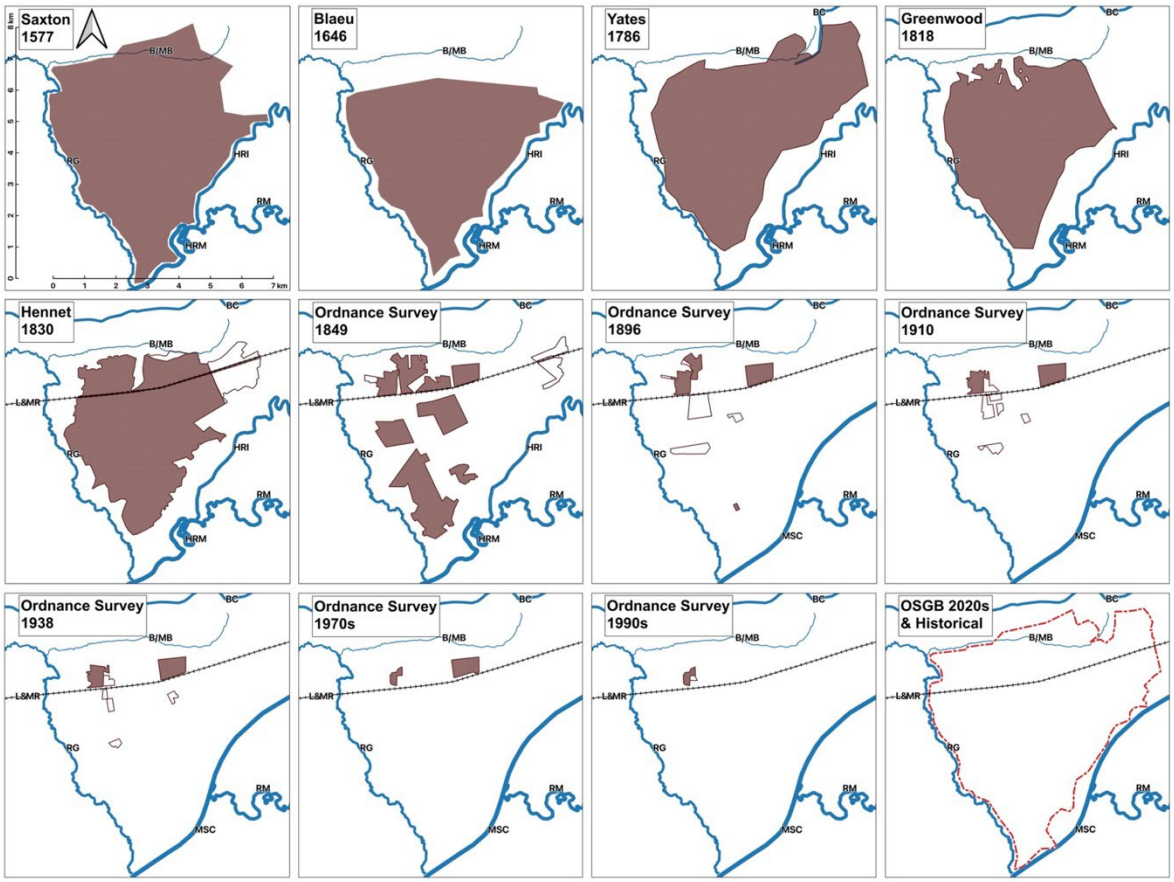

Figure 2. Georeferenced maps of Chat Moss, from the Elizabethan era until the present day. Shallow areas on the edge of the peatland were initially drained, followed by a rapid phase of land enclosure and conversion to agriculture in the decades following the construction of the railway. None of the primordial habitat remained intact by the end of the twentieth century. Image credit: Osborne *et al*. 2024. CC BY 4.0.

Habitat Restoration on Little Woolden Moss

One of the largest individual fragments remaining of Chat Moss is the 107 ha Little Woolden Moss (Figures 3), which was intensively drained and mechanically extracted for peat, leaving an entirely bare, dry, friable surface (Figures 3A and 4C), until acquisition (mostly funded through the National Lottery) by the Lancashire Wildlife Trust in 2012. An existing extraction tenure until the end of 2017 on approximately 45 ha of the site meant that site repair happened in two phases. Initial repair on Phase I (no existing extraction tenure) concentrated immediately on drain-blocking/filling and ground-levelling, which leaves the peat surface better able to retain soil moisture and promote plant establishment (Quinty and Rochefort 2003), and then creating a network of bunds (low peat dams) to more easily manage retention of high ground-water levels in large ‘cells’, particularly as the site was on a slight slope. Drains were either filled with existing peat from the surrounding area, or blocked

with peat dams or plastic piling, depending on the amount of peat remaining and/or the ditch depth. Ground preparation work was mostly completed within six months. Thereafter, efforts moved to the reintroduction of lowland bog plants, which had been completely lost from the site, to cover the bare peat as quickly as possible with the overall aim of creating a *Sphagnum* moss dominated landscape.

Sphagnum mosses (Figure 4D) are the 'bioengineers' of peatland habitat in the northern hemisphere due to their properties of water and nutrient uptake and retention, and chemical exchanges with surrounding waters, which creates a wet, anoxic, highly acidic, low-nutrient environment, with a distinctive assemblage of associated flora and fauna able to tolerate these extreme conditions. *Sphagnum* continues to grow from the tip of the plant, with lower sections gradually being compressed, but a low decomposition rate in this environment ensures that carbon stored in the plant during growth, and in other vascular plants around it, is mostly retained and eventually forms a carbon-rich peat.

Post-extraction, the remaining peat layer on Little Woolden Moss was thin (< 50 cm in places) and compressed through long-term drying, making consistent re-wetting difficult. Introducing plants onto an open, bare, hostile environment, which was alternately inundated and dry, was a challenge (Figure 4C). Natural early colonisers of bare peat are Cottongrasses (*Eriophorum* spp.), both Hare's-tail Cottongrass, which is tussock-forming, and Common Cottongrass, which is rhizomatous and can rapidly form a plant carpet, ideal for environmental protection to reduce the drying effects of wind and sunshine to promote *Sphagnum* establishment. Early revegetation efforts included sustainably translocating spade-sized turves of Cottongrasses from a small neighbouring site by hand, mostly by volunteers. Each of these turves created new plant colonies which eventually joined, although it was at least five years before noticeably contiguous areas developed. *Sphagnum* was initially harvested in small amounts (with permission) from local sources, and either translocated directly in clumps or sometimes in fragments, into the established Cottongrasses, or grown on in controlled conditions before introducing onto the site (Figure 4D). Over time, with further funding, plugs of Cottongrasses and mixed-species *Sphagnum* (purchased from BeadaMoss®) were introduced to accelerate the process, particularly after Phase II of the site was put into restoration measures post-extraction-tenure, and much had been learned from Phase I work. There are now large colonies of *Sphagnum* at a considerable depth regularly dotted across the site, mature stands of Cottongrasses, shallow pools colonised with aquatic *Sphagnum cuspidatum*, and little bare peat remains.

Figure 3. Aerial photographs of the east end of Little Woolden Moss (LWM) and Cadishead Moss (Cad); (A) 2009, peat extraction machinery (a and b) in use on LWM – the site was not brought into restoration until 2012. There are ditches running approximately north to south every 15 m all across LWM, draining into deep (up to 4 m) land drains (c). Cadishead Moss early in the restoration before rewetting; (B) 2025 Cadishead with very little bare peat and *Sphagnum* filling many of the ditches. The east end of LWM has almost confluent Cottongrass cover. Open water (black) (d) with exposed *Sphagnum cuspidatum* lawn (bright green) (e). Over 30 km of bunds (low peat dams) (f) pool water across the reserve, which slopes westward with a drop of approximately 5 m over the length of the site. The bog oak in Figure 4C is marked (g). Image credits: Google Earth.

Subsequently, other bog plants have been reintroduced, where appropriate, or have colonised naturally. Heather (*Calluna vulgaris*) has established well on the drier areas, Cross-leaved Heath (*Erica tetralix*) on intermediate areas, stands of Common Reed (*Phragmites australis*) have appeared, and Soft Rush (*Juncus effusus*) has developed densely (and not particularly desirably) on areas where the peat and underlying sand and clay were turned over during peat extraction for originally-envisaged agricultural use. Other plants have been introduced more latterly, where conditions were appropriate, to improve biodiversity, such as Bog Rosemary (*Andromeda polifolia*), Bog Asphodel (*Narthecium ossifragum*), documented by Hartley (2023), Bog Cranberry (*Vaccinium myrtillus*), Bog Myrtle (*Myrica gale*), Bog Bean (*Menyanthes trifoliata*) and Marsh Cinquefoil (*Potentilla palustris*). There are ongoing management issues related to Birch (*Betula* sp.) colonisation, requiring repeated cutting and stump-treating, but this is likely to reduce as the site becomes permanently wet and covered in bog vegetation.

The improving floral cover and diversity has encouraged a gradual return of a range of fauna associated with this habitat. A 2018 spider survey revealed an abundance of 19 species, 8 of them bog-indicators (Burkmar, 2018). These, along with other insects could account for the prevalence of breeding waders on the site: 35 species of breeding bird have been recorded, including specialised peatland/wetland species such as Curlew, Reed Warbler, Sedge Warbler, Water Rail, and 38 species of birds using the site for feeding and resting on migration, including 10 species of raptors, with Hobbies taking advantage of the 11 species of dragonfly recorded. A 2021 survey of butterflies revealed 14 species, and moths were recorded monthly over 3 years in a developing area of the site, with 62 species of macro-moth and 14 micro-moth species found. Conditions are now suitable for a range of amphibians, and Common Frog, Common Toad, Common Lizard and Palmate Newt have been recorded. The transformation of a ‘bare peat desert’ to a thriving nature reserve was achieved in a decade, and is fully documented by Osborne *et al*. (2021).

Figure 4. (A) Healthy lichen, a biomarker for current air quality. This wet woodland (willow carr) on Astley Moss is a rare habitat, ideal for (Red Listed) Willow Tit (*Poecile montanus*); (B) Evidence of local metal smelting showcased at Irlam Railway Station; (C) 5,500 years old, bog oak rooted in the underlying mineral layer on Little Woolden Moss (Figure 3B); (D) Many colours of *Sphagnum* being cultivated in trays for planting out on the mossland. Image credits: Andrew Osborne.

Astley Moss SSSI

Astley was the first peatland nature reserve on Chat Moss (Box 1, and Figures 5 and 6) dating to the same era as the Humberhead Levels and Fenns & Whixhall restoration areas, and visited by Prince Charles early in the restoration c1990. It was chosen to be the site of the 2020 Large Heath Butterfly (*Coenonympha tullia*) reintroduction programme, currently in its sixth year (Figure 5C).

Box 1. Dave Woodward, Reserve Warden, has been a lead volunteer on the site for over forty years.

"In the early 1980s the Lancashire Wildlife Trust made the rather brave decision to spend a large amount of money to buy Astley Moss, a degraded peat bog, hoping to restore it to an active raised mire. At that time, the site (due to previous drainage and peat extraction, followed by repeated burning) had become a dry grassy woodland area with very little of the original bog vegetation. The intention was to raise the water level in the peat, remove the trees, and encourage the colonisation and growth of Sphagnum Mosses. Initially progress was slow with little money available, and almost all the work done by volunteers, mainly tree removal, ditch filling and moss propagation from the small amounts existing on site. Then things started happening more quickly, adjacent areas of land were acquired to improve the hydrology and natural moss colonisation started. Money became available, such as Lottery and Landfill Tax funding, allowing more extreme engineering works to be carried out, bunding, surface stripping and costly plant introductions. Today most of the site is recovering bog, plant species are thriving although much fine-tuning remains to be done."

Dave Woodward, May 2025

Figure 5. (A) A newly flooded area of Purple Moor-grass (*Molinia caerulea*) tussocks c1990; (B) The same area in 2025, the open water has filled with *Sphagnum* and Cottongrass (*Eriophorum sp*.). White-beak Sedge (*Rhynchospora alba*), Cross-leaved Heath (*Erica tetralix*) and Bog Myrtle (*Myrica gale*) are also established; (C) A newly released Large Heath Butterfly (*Coenonympha tullia ssp. davus*) in 2020. This endangered butterfly was widespread on the Manchester Mosslands, before local extinction about 100 years ago; (D) Dave Woodward filling the '520 m ditch' by hand c1990. Image credits: (A and D) unknown photographer, (B and C) Andrew Osborne.

Peatlands and Climate Change

As previously described, the wet, acidic, anoxic conditions in a healthy bog leads to low plant decomposition and high retention of carbon, which accumulates over time, and has a net cooling effect on the climate. UK peatlands are currently estimated to store 3.2 billion tonnes of carbon (CEH undated), despite centuries of drainage and conversion to alternative uses. Greenhouse gas (GHG) emissions from damaged peatlands were estimated in 2017 to be around 23.1 Mt CO_2e yr^{-1} (Evans *et al*. 2017) which was 5% of the total GHG emissions for the UK (DESNZ 2019). Therefore, the climate change mitigation potential for peatland rewetting and repair is considerable. One example of potential intervention is a study by Manchester Metropolitan University, which has demonstrated a potential 90% reduction in carbon greenhouse gas emission through conversion of grazed pasture in northwest England to a *Sphagnum*-dominated 'carbon farm' within two years (Kennedy *et al.* 2023). Unfortunately, payments to landowners for carbon savings are still in development (Farm Carbon Toolkit 2025). Paludiculture (wetter farming) on peatlands is receiving increasing attention, as it can combine a reduction in carbon losses from peat with an economic return (Evans *et al*, 2021, Wichtmann *et al,* 2016), offering benefits for both the climate and local livelihoods. A range of crops employing wetter-farming methods are currently undergoing research in the Greater Manchester area, including *Typha latifolia* (for insulation materials), celery and blueberry. These are encouraging signs of potential action, but delays now in peatland repair on a landscape scale will make future restoration far more difficult practically and economically, and less effective for climate cooling (Glenk *et al* 2021). Effective, widescale peatland rewetting and restoration are urgently needed to reduce current high carbon losses, and support efforts to fulfil our GHG reduction obligations (Nugent *et al* 2019).

The New National Nature Reserve

Vegetation cover on the established nature reserves Astley, Cadishead, Rindle and Little Woolden Mosses is progressing well. On a recent survey there was very little bare peat, and an average *Sphagnum* cover of 13.0%, although it will be decades before these sites approach a full cover of *Sphagnum* lawns and hummocks. In addition to the plant species already mentioned, these restoration programmes have now progressed to conservation translocations of nationally rare plant species such as Oblong-leaved Sundew (*Drosera intermedia*), Greater Sundew (*Drosera anglica*), White-beak Sedge (*Rhynchospora alba*) and Bottle Sedge (*Carex rostrata*) with the aim of increasing local biodiversity and providing refugia for species at risk of regional extinction.

Building on the core areas of Special Area for Conservation (SAC) of the Manchester Mosslands (Risley, Holcroft, Astley and Bedford Mosses), out into the wider landscape as championed by the Little Woolden Mosses restoration successes, a new 'super' National Nature Reserve (NNR), 'Risley, Holcroft and Chat Moss NNR', has now been formally declared as part of the 'Kings Series' of new National Nature Reserves (Figure 6). On the doorstep to the major urban populations of Greater Manchester and Warrington, this new NNR is supporting nature recovery, providing natural capital benefits and increasing people's access to nature. It covers 530 hectares across 11 sites of the lowland peatlands of Salford, Warrington and Leigh (Wigan borough).

Natural England is collaborating with other approved bodies (Lancashire Wildlife Trust, Warrington Council, Woodland Trust, Forestry England, Cheshire Wildlife Trust and Wigan Council) in this NNR after working together across this landscape for the past two decades as part of a long-term partnership - the Great Manchester Wetlands. This partnership is transforming the landscape between Greater Manchester and Liverpool City Region into a thriving, resilient and inspirational landscape that delivers real benefits to nature, local communities and the local economy.

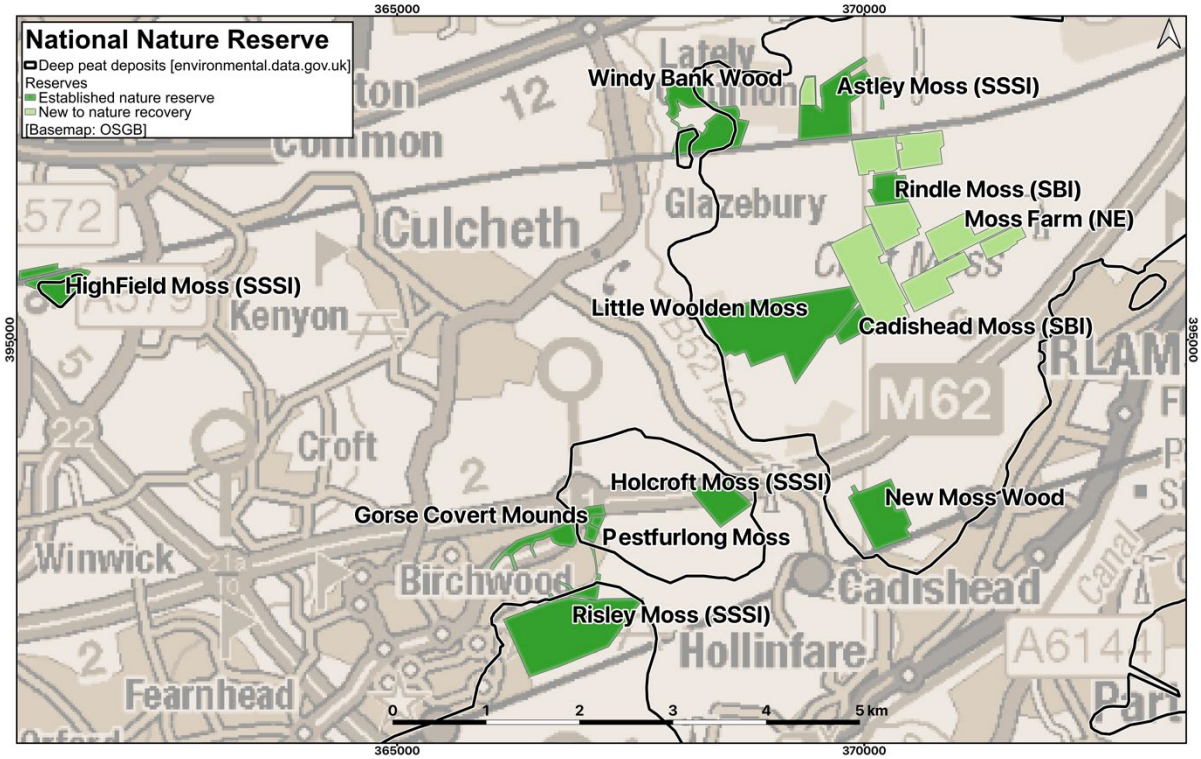

Figure 6. The peatlands National Nature Reserve, including recently acquired Natural England land at Moss Farm (light green in the central area of Chat Moss). These fields are new to restoration, although most of the ditch blocking and bunding work has now been completed. Site of Biological Importance (SBI) is a local designation.

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