Moor House – an outdoor laboratory

70 years of research at Moor House National Nature Reserve

November 2025

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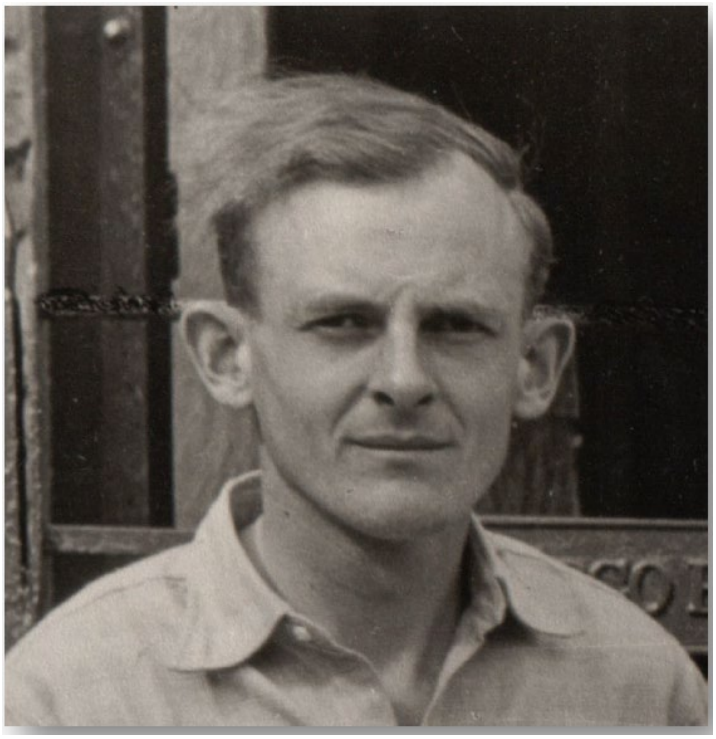
“There is another Britain, to many of us the better half, a land of mountains and moorlands and of sun and cloud, and it is with this upland Britain, that these pages are concerned. It is equal in area to lowland Britain but its population is less than that of a single large town. It lies now, as always beyond the margins of our industrial and urban civilisations, fading into the western mists and washed by northern seas. Its needs forgotten, and its possibilities almost unknown.”
W. H. Pearsall, 1950. Mountains and Moorlands

Dedication

The story of Moor House is also the story of statutory nature conservation in England. Throughout the changes and challenges faced over 70 years, all those involved are bound by the constant that is Moor House. This report is dedicated to all those who have made the journey to Moor House and contributed to the research and running of the National Nature Reserve, and in particular to the first officer-in-charge, Ken Park.



Kenneth Park
1928 -1960

Report details

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Photographs are from the Moor House archive except where specified.

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Executive summary

Moor House was among the first National Nature Reserves designated in England in 1952. Over the past 70 years it has hosted an extraordinary amount of research work, resulting in over 1,000 publications. Research at the reserve spans multiple disciplines and decades, and long-term studies now sit side-by-side with cutting edge work. This report provides for the first time a comprehensive record of publications linked to Moor House, explores key themes and how these have changed over time, and highlights important findings which demonstrate the value of this unique outdoor laboratory.

Figure 1. Moor House Field Station around the time of purchase by Nature Conservancy.

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Introduction

Figure 2. Moor House in winter. Photograph by Ken Park.

Moor House

Location

Moor House National Nature Reserve (NNR) straddles the North Pennine escarpment. The western boundary lies at the upper limit of the enclosed land at 330 m in the Eden Valley, rising to Great Dun Fell (847 m) and Little Dun Fell (842 m) and at its northern edge meets the upper reaches of the River Tees. To the east, the land drops to 498 m, the eastern boundary being the edge of Cow Green Reservoir.

At the time of declaration, Moor House NNR was separate from the adjacent Upper Teesdale NNR and the reserves were administered from the Nature Conservancy's North-west and North-east regions, respectively. In 1999 they were amalgamated to form Moor House – Upper Teesdale NNR. This publication focuses upon Moor House.

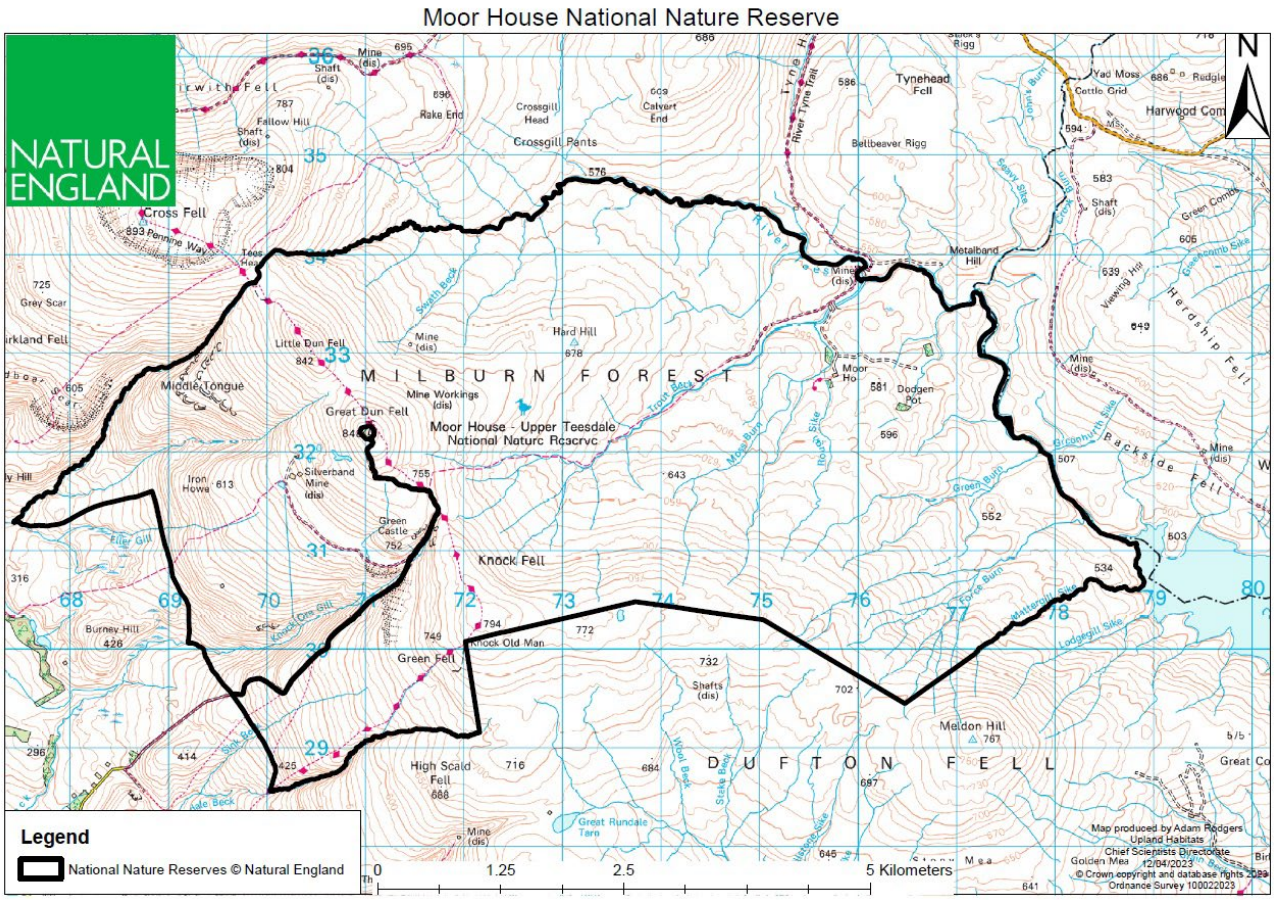


Figure 3. Location and boundary of Moor House NNR. Imagery Ordnance Survey and Natural England. © Crown copyright and database rights 2023. Non-commercial re-use only.

Geology

The underlying geology is largely of the Carboniferous sedimentary series (up to 360 million years before present), overlaid with boulder clay and drift deposits, left by the last glaciation (Johnson and Dunham, 1963). Moor House sits in the middle of the northern Pennine orefield, known chiefly for its silver-bearing lead ore (Kincey and others, 2022). Mining activity is thought to date back as far as AD79 after the Roman subjection of the Brigantes. Mining ebbed and flowed throughout the area as different ores gained or lost value over the centuries. In the 1820s, Britain was the world's leading producer of lead, with a significant proportion being produced in the North Pennines. At Silverband, on the western side of the reserve, barytes was processed between 1939 and 1962.

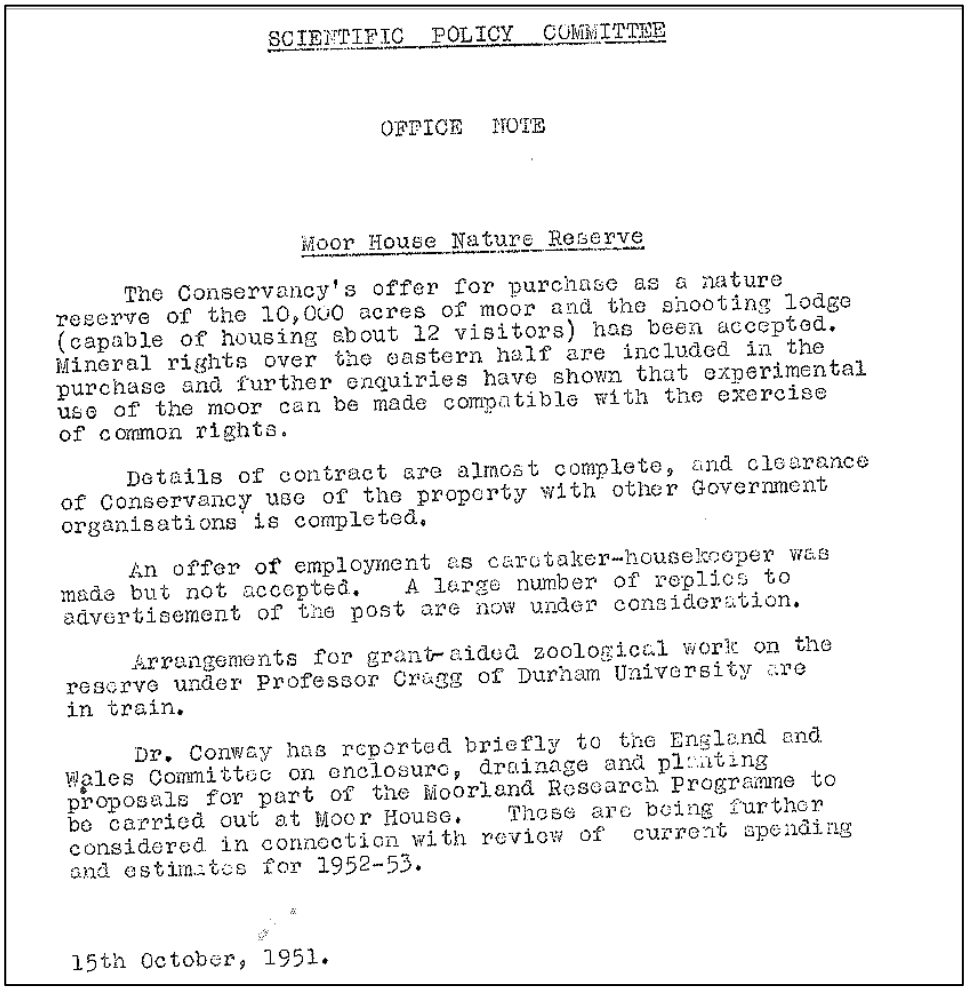
Purchase by the Nature Conservancy

What became the office and accommodation building began life as a mine shop called Nether Hearth. Mine shops were the accommodation used by miners during the week. At the weekend, they would return to their homes and families who lived several miles or more away. In 1842, the Earl of Thanet extended the building into accommodation for shooting parties, with groups going up to the site for two weeks at a time. This new

construction was named Moor House. In addition to the visitor accommodation, there were some attached cottages, used by two gamekeepers.

The break-up of the Appleby Castle Estate in the late 1940s, presented the newly formed Nature Conservancy (NC) with an opportunity to purchase land on which to explore the plants, animals and land management of the uplands. Professor W H Pearsall, who at that time was the Chair of the NC's Scientific Policy Committee, personally recommended the purchase of what became the reserve, as a typical upland estate (Pigott, 1988). The NC's chief executive Sir Max Nicholson visited the area from the Eden Valley side, going up onto Great Dun Fell and looking over the proposed purchase before indicating his support for the proposal.

A price of £5,300 (estimated as equivalent to £160,000-165,000 in 2022) was agreed for 4,406 ha including some mineral rights associated with the Silverband Mine, with the purchase completed in January 1952. On 19th May in the same year, Moor House National Nature Reserve, one of the first in Britain, was declared. Moor House is the largest National Nature Reserve in Cumbria and combined with Upper Teesdale, the largest terrestrial NNR in England.



SCIENTIFIC POLICY COMMITTEE

OFFICE NOTE

Moor House Nature Reserve

The Conservancy's offer for purchase as a nature reserve of the 10,000 acres of moor and the shooting lodge (capable of housing about 12 visitors) has been accepted. Mineral rights over the eastern half are included in the purchase and further enquiries have shown that experimental use of the moor can be made compatible with the exercise of common rights.

Details of contract are almost complete, and clearance of Conservancy use of the property with other Government organisations is completed.

An offer of employment as caretaker-housekeeper was made but not accepted. A large number of replies to advertisement of the post are now under consideration.

Arrangements for grant-aided zoological work on the reserve under Professor Cragg of Durham University are in train.

Dr. Conway has reported briefly to the England and Wales Committee on enclosure, drainage and planting proposals for part of the Moorland Research Programme to be carried out at Moor House. These are being further considered in connection with review of current spending and estimates for 1952-53.

15th October, 1951.

Figure 4. Note documenting the purchase of Moor House by the Nature Conservancy.

The Field Station at Moor House was managed from Merlewood at Grange-over-Sands. An unpublished interview for a proposed book on the history of NC reports that W H Pearsall (who grew up in Ulverston), had been looking for an appropriate building to serve as a regional Research Station and administrative base for the Nature Conservancy (with the region at that point covering the whole of the north of England), stopping at a hotel for refreshments, he learned that the hotel was up for sale, leading to its purchase as the Merlewood Government Research Station.

Establishment as a research centre

The publication in July 1947 of Command Paper 7122 *Conservation of Nature in England and Wales*, set out the requirements for a biological service, and from this came the National Parks and Access to the Countryside Act in 1949 and the creation of the Nature Conservancy – the first science-based government conservation organisation in the world (Sheail, 1998).

Immediately post-World War 2, the study and the understanding of ecosystems was developing, and the founding Act recognised a need for a greater understanding of how nature conservation and land management fitted together. One of the specific roles of NNRs was to act as a focus for research and experimentation, more commonly referred to as “outdoor laboratories”, with the intention of integrating the work of the scientist with the practitioner.

The geology, altitude and climate at Moor House provide ideal conditions for the formation of blanket bog, which took place largely in the Boreal-Atlantic transition 5,000-7,000 years ago. Most of the reserve is covered by blanket bog 2-3 metres deep, but in places the depth reaches 4-5 metres. Inevitably, blanket bog has played a backdrop to most of the studies on the site and there is a paper written by Dr Verona Conway (the first woman in charge of a Government Research Station), for NC’s Scientific Policy Committee, that explains the early thinking:

1. Understanding of processes of erosion and re-colonisation.
2. The re-creation of a genuine and actively growing upland *Sphagnum* bog.
3. The establishment of marginal scrub and small trees on edges of blanket bog.
4. Drainage experiments on bogs.
5. How to obtain the maximum productivity of the land without fire.

Interestingly, Verona Conway also speculated on the types of habitat that the reserve would be able to demonstrate to a stranger visiting the site 40 or 50 years after the establishment of the NNR:

1. Growing blanket bog, undrained, unburnt and ungrazed.
2. Summit limestone communities, ungrazed.
3. Sub-alpine scrub-woodland of Birch, Rowan, Alder, Pine and other trees, growing in suitable localities as a supporting fringe to the blanket bog margin.
4. At least two small lakes with a good bird population

(a) a dammed beck with a fairly rapid inflow and outflow of water at least moderately, lime-rich.
(b) a shallow nearly stagnant expanse of water on one of the flat peaty shoulders.

5. Good quality rough grazing on limestone with soil status and productivity maintained by controlled grazing practice.
6. Second quality rough grazing on drained peat.

Number one on the list has largely been achieved, but views on some of the other suggestions, including the value of creating lakes and the importance of grazing, have changed in the intervening years.

As demonstrated by the bibliography, the work at Moor House has been much wider than originally anticipated. This is likely in part a reflection of the interests of researchers, but also the ebb and flow of the perceived importance of subject areas over time. One thing has been constant, Moor House remains an open-air laboratory for all those who have an interest in what is found there.

Importance and designations

The nature conservation importance of the Moor House is reflected in its designation as an NNR, Site of Special Scientific Interest, Special Protection Area and Special Area of Conservation (citation details of these designations are in Appendix 1). The reserve is home to the headwaters of the Tees and South Tyne and lies within the North Pennines National Landscape. It serves an important purpose for public use as designated Access Land which hosts a stretch of the Pennine Way. There are also several features of historical importance within the reserve, mostly related to the mining history of the area, and some of these are designated as Scheduled Monuments.

Life at Moor House

When in use, Moor House was the highest inhabited house in England at nearly 560 m (1,800 feet), and as a result was a challenging place to live and work. In the early years, the buildings provided accommodation for the officer-in-charge, estate workers, scientists, the resident warden and his family, and visitors to the reserve (in total, there was overnight accommodation for 13 people).

An early configuration of those resident on the reserve is as follows:

- Officer in Charge – Ken Park
- Resident warden – Tom Hodgson (plus his family)
- Resident scientist – usually a botanist. David Welch was a resident scientist during the 1960s working on productivity among other subjects.
- Entomologist
- Field assistant
- Estate worker

- Housekeeper (summer months only)
- Freshwater Biological Association – up to 4 staff members plus 3 sandwich students
- International Biological Programme 1964-74 – 2 staff and a fully furnished laboratory.

Many of those who were present in the early days often highlighted that those based at the reserve formed a community and this sense of community was one of their abiding memories of the reserve. This feeling was no doubt fostered by the fact that the nearest neighbours were several miles down the track, from where it was another 3 miles to the nearest village and shop. The nearest petrol station was in Alston, around 10 miles away.

This was an era that pre-dates data-loggers and automated recording systems, so that data gathering campaigns involved being on-site constantly. In the early years, contracts were let to clear the snow from the track to the field station, although from 1964-1979, this work was carried out by reserve staff. Tricia Burnham, wife of the last resident warden, Paul Burnham, recalled that every winter, they would anticipate being snowed in for around 4-6 weeks and planned their supplies accordingly. The winter of 1978/79, however, was a record when it started snowing the day after Boxing Day and the track was not dug out until Easter on 21st April.

In 1953, the first pony, Betty was purchased to assist with transporting materials around the reserve. The hay meadow was managed to provide winter feed for the working ponies and the small number of sheep owned by resident warden Tom Hodgson.

Figure 5. A working pony at the reserve.

A daily visitor was Alfie Bell, the postman from Garrigill who cycled up the seven-mile track to deliver and collect the mail. He enjoyed a few minutes break and a mug of tea next to the AGA before freewheeling down having brought news of the world outside. There was no phone connection to the outside world until 1960 when a wireless system was installed at the radar station on Great Dun Fell. Moor House had the only radio telephone in England (Kirkby Thore 394) which was used by cranking a handle to allow transmission up

to Great Dun Fell from whence it went down to the Eden valley by land line. Carrying the large batteries up to Great Dun Fell, to power the system, was a routine and especially unpopular job.

Although the NC had purchased the freehold of the site, livestock were grazed on three commons, so little control could be exercised on the number and timing of grazing animals present. This only changed following the 2001 Foot and Mouth outbreak when funding was provided to buy out many of the grazing rights. This has enabled more control of the levels of livestock grazing on the site.

The last warden to live on-site permanently, moved out in 1980/81. The Field Station subsequently closed, and by 1999, the building was taken down on safety grounds, with some of the stone ground up and used to repair the track. This left a bothy and workshop. For a while there was a portacabin, but now all that remains are the bothy and workshop.

Figure 6. Ponies were used to transport materials and young children!

The officers in charge, wardens and senior reserve managers since the designation of the NNR are listed below:

Ken Park, Officer in charge 1952 - 1960
Tom Hodgson, Warden 1952 -1972
Mike Rawes, Officer in charge 1960 -1983
Jim Parkin, Warden 1974 - 1977

Paul Burnham, Warden 1977 - 1986
Terry Wells, Warden 1986 - 1996
Chris McCarty, Senior Reserve Manager 1996 - 2016
Martin Furness, Reserve Staff from 2000, Senior Reserve Manager 2016 – present

Figure 7. Hay making in 1958 – there are three commons within the boundaries of the NNR.

Figure 8. Clearing snow. Photograph by Trevor Crisp.

Bibliography

Methods

The first Moor House bibliography was put together by J.P. Gill, in 1990 and listed the publications related to the site before it became a National Nature Reserve as well as those since (Gill, 1990). This first bibliography sorted the references by title, publication type (e.g. book, paper, degree theses or occasional paper) and how much of the data was based upon work at Moor House.

In around 2006, the original bibliography was typed up as a Microsoft Word document, shortly before the English Nature Northminster House typing pool was closed down. From that period, successive members of the Centre for Ecology and Hydrology (CEH), John Adamson, Rob Rose and Don Monteith have worked with Natural England staff to update the list annually.

The long time period and changing personnel involved make it difficult to detail a full methodology of how references have been compiled. However, generally publications have been supplied to NE upland specialists and NNR staff or found in periodic literature searches using databases such as Scopus. Search terms have included “Moor House” and sub-sites. The best example of the discovery of significant numbers of new references being found, was when “Great Dun Fell” was searched upon rather than “Moor House”. The bibliography covering the period up to the 70th anniversary of declaration in 2022 is available in a spreadsheet alongside this report. New publications continue to be recorded by Natural England as they become available.

As well as scientific studies, the bibliography includes publications from cultural disciplines including art and history. Examples of these are the outputs from work by the artist Laura Harrington or the accounts of the battle to prevent the construction of Cow Green Reservoir.

The early approach of trying to split the publications by type and volume of data generated at Moor House has not been continued, but there has been an attempt at assigning a broad category of subject area based upon the title. It is recognised that many publications could be assigned to multiple categories of subject, so the categories given provide a starting point for those who may be interested in exploring the bibliography further.

Results

The volume of work based at Moor House now stands at over 1,000 publications, an average of 14 each year since 1953 (Table 1). The most commonly studied topics have consistently related to the natural environment and its management, though specific interests have varied over time.

Table 1. Numbers of publications relating to studies based at Moor House categorised by topic.

Category	Pre 1953	1953-1962	1963-1972	1973-1982	1983-1992	1993-2002	2003-2012	2013-2022	Total
Atmospheric chemistry	0	0	1	0	16	20	2	3	42
Carbon cycling	0	0	0	0	0	7	63	24	94
Climate	5	7	6	14	0	11	6	2	51
Climate Change	0	0	0	0	1	22	5	8	36
Conservation mgmt.	2	2	11	7	3	5	7	33	70
Cultural	0	0	3	1	1	5	3	15	28
Datasets	0	0	0	0	0	0	0	4	4
Geology	1	0	5	5	0	0	0	0	11
Grazing	0	3	10	3	1	0	1	6	24
Hydrology	0	2	4	7	1	14	26	24	78
Invertebrates	7	41	71	66	10	20	6	8	229
Longterm monitoring	0	0	0	0	1	7	4	6	18
Meteorology	1	0	0	7	11	27	0	0	46
Plant productivity	0	1	13	20	0	0	0	0	34
Soils	0	6	11	13	7	28	29	5	99
Trees	0	0	4	3	2	0	0	0	9
Vegetation	0	11	26	24	9	35	9	6	120
Vertebrates	0	2	2	15	2	15	9	0	45
Total	16	75	167	185	65	216	170	144	**1038**
Key (number of publications)	0	1-5	6-10	11-20	21-30	31+			

Invertebrates were a focus of many early publications, particularly from the 1950s to 1970s, while in the 1980s and 1990s, atmospheric chemistry became a popular topic. Research on these subjects, along with a steady stream of publications on the vegetation of Moor House, helped to build fundamental knowledge on species and community ecology and environmental processes. Although we talk about the steady output of papers, work often happened in pulses. The 1980s for example, appears to have been a difficult time with changes of staff on the reserve and political decisions elsewhere conspiring to reduce the level of research activity and publications.

In recent decades, soils, hydrology, carbon and climate change have been the subject of many publications, reflecting increasing awareness of our dependence on natural systems. Applied subjects such as conservation management have also come to the fore in recent years, building upon the extensive earlier work on vegetation and grazing. Publications relating to cultural subjects including history and art have been scarce until the most recent decade, demonstrating the potential for new directions in research at the reserve.

Research at the reserve has involved numerous organisations and programmes including the International Biological Programme, Ecological Continuity Trust (Moor House is home to around five percent of the UK's registered long-term experiments), the Environmental Change Network, UK Centre for Ecology and Hydrology and several universities including Durham, Leeds, Liverpool and Newcastle.

The unique long-term projects and experiments on the site include monitoring of vegetation, climate, hydrology, water quality and air pollution as well as the impacts of land management influences including burning, grazing, forestry and tracks. This has led to outputs which help us to understand the impacts of environmental change and management interventions on ecosystem function. These additions to the evidence base have informed knowledge, practice and policy and influenced the way we deliver for the environment.

Spotlight accounts of people and research at Moor House

Hard Hill

Figure 9. Ron Elliott (left) after his move to NC Wales in around 1962.

R.J. “Ron” Elliott M.C., had his university degree studies at Sheffield cut short as a result of the out-break of World War 2. Commissioned into the Durham Light Infantry, he served continuously until being released. The citation for the award of the Military Cross is presented below.

> “Lieutenant ELLIOTT has commanded a platoon of the 16th Battalion The Durham Light Infantry since September 1942, and has taken part in all the actions in which

the Battalion has fought. During the period of 3 December 1943 to 2 May 1945 he has commanded the Pioneer Platoon.
The spirit in which the Pioneers have carried out the dangerous tasks given to them both in and out of action has been largely due the fine example set by Lieutenant ELLIOTT. Lieutenant ELLIOTT and his platoon were responsible for clearing a crossing for tanks over the Foglia. This action was carried out under heavy mortar and machine gun fire. The platoon were twice forced to abandon their work. They finally completed it under the cover of a smoke screen. Lieutenant ELLIOTT's conduct in this action was an inspiration to his platoon.
His devotion to duty and calm and cheerful manner in and out of actions has fostered and maintained a very high spirit of esprit de corps in his Platoon despite many changes due to casualties in his Platoon."

On returning to civilian life, Elliott married, completed a teaching qualification and spent a short time as a teacher. He also returned to university and completed his finals but was suffering from what may now be recognised as the effects of Post-Traumatic Stress Disorder. His tutor at Sheffield, Professor Thomas, had himself served in the trenches of WW1 and was very supportive, including encouraging Elliott to investigate new subject areas. Elliott applied for a post with the Nature Conservancy investigating moorland management including vegetation burning, under the supervision of Professor A. R. Clapham. After 12 months, Professor Clapham suggested that he carried on the research as a PhD student. At this point, Captain Diver, the Chief Executive Officer of the NC had indicated that Elliott would be at Sheffield for three years and that upon completion of the work, he would be likely retained as a staff member of the NC.

Following the completion of his thesis 'The Effects of Burning on Heather Moors of the South Pennines' (Elliott, 1953), Elliott was appointed to the position of Regional Officer for the NC's north of England area (at that time the region covered from Cumbria across to Northumberland and Durham).

Elliott worked with Mike Rawes to set up the Hard Hill grazing and burning experiment plots in 1954. The objective was to establish a series of randomised replicated plots to monitor the effects of grazing and rotational burning treatments on blanket bog vegetation and soil fertility. The layout was devised by John Skellam who was a statistician at the NC's Headquarters, and four blocks (A-D) were established, each comprising six treatment plots measuring approximately 30m x 30m (Figure 8). All blocks were entirely burned to the extent that all vegetation was eliminated (Forrest, 1961). Half of each block was then fenced to exclude grazing, and three rotational burning treatments were replicated in each half. Subsequently, reference plots were identified outside of each main block and surveyed. This was done using aerial imagery from the period and the aim was to establish some controls where there was a degree of certainty that the plots had not been burned for at least 20 years prior to 1954.

Following the establishment of the plots, the vegetation burning featured three treatments: burning every 10 years; burning every 20 years and no burning since 1954. The monitoring of the recovery and development of the vegetation following the initial burning

treatment first took place seven years after the first burns and has been repeated at similar intervals up to the present.

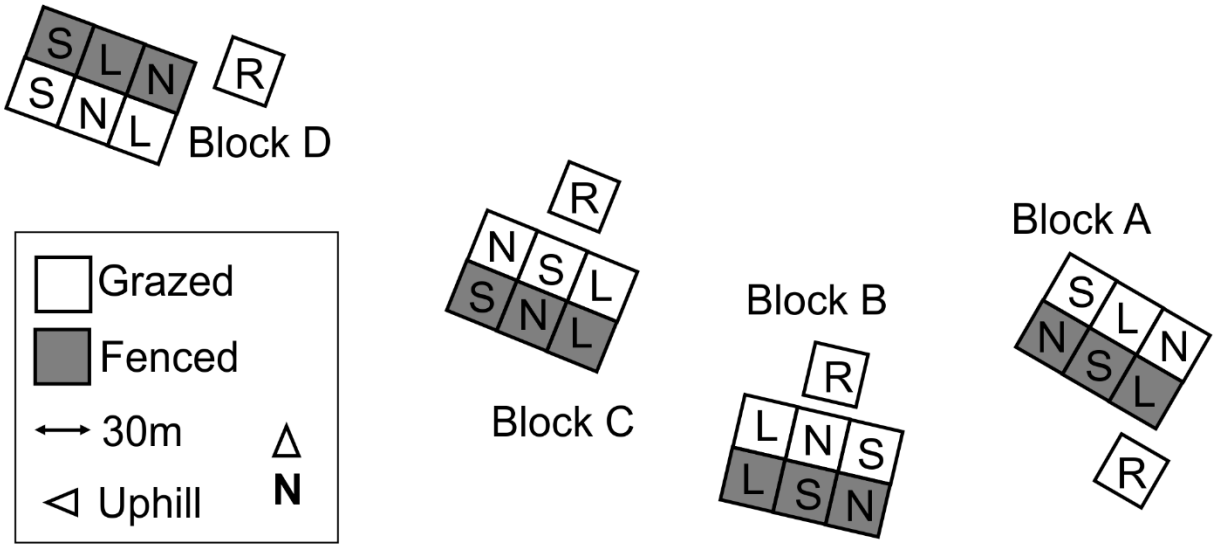


Figure 10. Layout of the Hard Hill experimental blocks and plots (R=reference, N=no-burn since 1954, L=long (20-year) rotation, S=short (10-year) rotation.

Figure 11. Burning the Hard Hill experimental plots. Natural England.

Hard Hill publications

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The International Biological Programme

The International Biological Programme (IBP) was a global project that brought scientists together with the goal of an integrated study of the basic processes of biological productivity. There was a Terrestrial Productivity section that focused upon four major habitat types (biomes) – woodland, grassland, arid land and tundra. Although not strictly falling within the definition of tundra, the exposed habitats found at Moor House were deemed to have features in common with tundra sites elsewhere within the IBP and so close links with the programme were established. Other sites within the UK, e.g. Snowdonia, were included within the overall programme.

At Moor House, the IBP provided funding for the construction of a laboratory and two research staff.

Key IPB Publications

The papers were published in volume: O.W. Heal & D.F. Perkins, eds. 1978. Production – ecology of British moors and montane grasslands, 3-16. Berlin: Springer Verlag.

Listed below are the chapters that relate to Moor House:

- Heal, O.W. & Smith, R.A.H. Introduction and site description.
- Smith, R.A.H. & Forrest, G.I. Field Estimates of Primary Production.
- Grace, J. & Marks, T.C. Physiological aspects of bog production at Moor House.
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- Martin, N.J. & Holding, A.J. Nutrient availability and other factors limiting microbial activity in blanket peat.
- Heal, O.W., Latter, P.M. & Howson, G. A study of the rates of decomposition of organic matter.
- Jones, H.E. & Gore, A.J.P. A simulation of production and decay in blanket bog.
- Clymo, R.S. A model of peat bog growth.

- Rawes, M. & Heal, O.W. The blanket bog as part of the Pennine moorland.

Figure 12. Moor House Field Station with the IBP Laboratory.

Gordon Manley

Figure 13. Gordon Manley in a cutting from The Northern Echo, 10 July 1937. Durham University Library, Archives and Special Collections. CC BY 3.0.

By any measure, Gordon Manley was a remarkable man. He was perhaps best known for his pioneering work on establishing the Central England Temperature series, but prior to that, whilst based at Durham University, he carried out studies of the climate of the North Pennines. He first used a game-keepers cottage at Moor House as a base, but was later able to persuade the Appleby Castle Estate to allow and assist with the construction of a wooden shed, funded by a small Leverhulme Trust award, from which he carried out his studies on climate and weather. The majority of his work in the North Pennines was prior to the purchase of the site by the Nature Conservancy. Nonetheless, the papers relating to the work on Great Dun Fell are included below because in later years, he maintained his interest in the geographic area. File notes from the early establishment of the NNR report that Manley was consulted on several aspects of the proposed work. The reserve visitors book also records that Manley visited the site up until shortly before his death.

Key Gordon Manley publications

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- Manley, G. 1971. The mountain snows of Britain. Weather, 26, 192-200.
- Manley, G. 1973. Climate. In: W.H. PEARSALL & W. PENNINGTON, eds. The Lake District, 106-120. London: Collins.
- Manley, G. 1979. Temperature records on Fountains Fell, with some Pennine comparisons. Field Studies, 5, 85-92.
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Figure 14. Gordon Manley's hut on Great Dun Fell.

Verona Conway

Figure 15. Verona Conway.

Born in Manchester, Dr Conway had attended Withington Girls School then gained a scholarship to read Natural Science and Botany at Newnham, Cambridge, graduating in 1933. She proceeded to study under Dr Harry Godwin at Girton, carrying out her postgraduate studies at Wicken Fen, investigating the autecology of the sedge *Cladium mariscus*. In the autumn of 1941, Dr Conway took up a lectureship post at Sheffield University, in the Department of Botany. It was here that she was first encouraged to investigate the ecology of blanket bogs by Professor W.H. Pearsall and undertook studies of the peatland at nearby Ringinglow. Both Godwin and Pearsall became members of the Scientific Policy Committee of the Nature Conservancy when it was created, and they most likely influenced the direction of Conway's career towards her eventual decision to join the staff of the Nature Conservancy in 1949. Dr Conway was instrumental in setting up the Conservancy's experimental reserve and field station at Moor House in 1952 with the support and encouragement of Professor Pearsall.

Key Verona Conway publications

Conway, V., & Millar, A. 1960. The hydrology of some small peat-covered catchments in the northern Pennines. J. Instn. Wat. Engrs., 14, 415-424.

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Kenneth Park

Figure 16. Kenneth Park.

Kenneth Park was the first “Officer in Charge” at Moor House Field Station, from 1954 to his death by drowning at High Force in 1960, at the age of 32. He laid the foundations of meticulous scientific research on the site which continues to this day. From an early age Ken Park had a strong interest in natural history. He attended school in Newcastle and went from there to serve for three years in the Royal Air Force. He returned to the city to attend university and obtained a first-class degree in botany and a good knowledge of UK arctic-alpine vegetation. His interest in field botany led on to a postgraduate study of the ecology of Upper Teesdale sugar-limestone outcrops. On appointment to Moor House, Ken’s research was focused on the potential productivity of the grasslands on mineral soils. He also established a series of sheep exclosures and used point-quadrat recording to monitor changes associated with different grazing intensities and burning regimes, with a standard of accuracy that makes the work still of value today. Ken was also in general charge of seeing that everything ran smoothly on the reserve, dealing with Nature Conservancy Head Office in London’s Belgrave Square and his line manager at Merlewood Research Station at Grange over Sands. He also guided visiting researchers, mainly from Durham University. When not working Ken walked on the reserve and fished the streams for trout (rather unsuccessfully).

Key Kenneth Park publications

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Conclusion

Moor House has borne witness to a long history of environmental change, varying land-use and scientific advances, and continues to host a wide range of research activity. Change will doubtless continue, with climate change a key concern and focus for future work, and technology and methods in constant development. However, the legacy of Moor House endures, with continued monitoring of decades-old research sites, and recognition that knowledge of the past adds unique value to current studies. Importantly, Moor House continues to inspire scientists, historians, artists and nature lovers alike, with an appreciation for this special place passed on to each new visitor, and something new to learn with each visit.

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Appendix 1. Important nature conservation designations

SSSI Citation

(Note that the SSSI boundary extends beyond the NNR.)

County: Cumbria/Durham **Site Name:** Moorhouse & Cross Fell

District: Eden, Carlisle, Wear Valley

Status: Site of Special Scientific Interest (SSSI) notified under Section 28 of the Wildlife and Countryside Act, 1981. Part of the site is a National Nature Reserve.

Local Planning Authority: Eden District Council, Wear Valley District Council

National Grid Reference: NY 715365

Area: 13,707 (ha) 33,870 (acres)

Ordnance Survey Sheet 1:50,000: 86, 87, 91

1:10,000: NY 62 NE, 63 NE, 63 SE,

NY 63 NW, 64 SE, 64 SW,

NY 72 NE, 72 NW, 73 NE,

NY 73 SE, 73 SW, 73 NW,

NY 74 SE, 74 SW, 82 NW,

NY 83 NW, 83 SW, 84 SW

Date Notified (Under 1949 Act): Upper Teesdale & Appleby Fells: 1951. Cross Fell: 1963. **Date of Last Revision:** Upper Teesdale & Appleby Fells: 1975. Cross Fell: 1975.

Date Notified (Under 1981 Act): 1990 **Date of Last Revision:** 1990

Other Information:

1. At this revision parts of the two formerly separate sites of Cross Fell SSSI and Upper

2. Teesdale and Appleby Fells SSSI, have been extended and amalgamated. The extensions also include Moor House National Nature Reserve (NNR) which covers 3,894 ha and was originally declared in 1952 under Section 19 of the National Parks and Access to the Countryside Act (1949), with subsequent revisions in 1969 and 1976.

3. The Moor House NNR was declared as the first British ‘Biosphere Reserve’ by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in 1975.

4. The Moor House NNR was declared as a ‘Special Protection Area’ in 1982 under the terms of the European Communities Council Directive (1979) on the Conservation of Wild Birds.

5. Parts of the site are listed in ‘A Nature Conservation Review’, edited by D. A. Ratcliffe, 1977, published by Cambridge University Press, as being of national importance.

6. The site lies within the North Pennines Area of Outstanding Natural Beauty (AONB).

Description and Reasons for Notification:

The Moorhouse and Cross Fell area forms an extensive upland block at the northern end of the Pennine system and lies between the villages of Milburn and Garrigill. The site stretches from Rotherhope Fell in the north to Knock Fell in the south and extends eastwards to Burnhope Seat on the Durham border. The area contains the most elevated part of the Pennine mountains rising to 893m (2,930 feet) on Cross Fell with the adjacent twin peaks of Great Dun Fell (847m = 2,779 feet) and Little Dun Fell (842m = 2,763 feet).

These fells rise sharply from the Eden Valley up a scarp slope deeply dissected by river valleys into a tract of blanket bog. The summit ridge forms the divide between western and eastern climatic effects and from it flow streams, westward to the River Eden, eastward to the River Tees, and northwards to the River South Tyne. Underlying the area the geology comprises largely of Carboniferous sandstones, mudstones and limestones which variously affect the overlying vegetation. The importance of the area lies in its rich variety of representative upland habitats with associated animal and plant species. Communities of particular interest are those of blanket bog, sub-montane and montane heathland, montane bryophyte heath, limestone grassland and flushes, and some of the ledge communities. Other habitats of subsidiary interest are areas of acid grassland, acidic flushes, open water, scree and metalliferous spoil sites.

Above about 600m (1,968 feet) and up to 760m (2,493 feet) blanket bog has developed over much of the area and is the most extensive habitat within the site. The most widespread community is that dominated by hare’s-tail cottongrass *Eriophorum vaginatum* with heather. Much of these areas, particularly where there is grouse moor management, such as at the northern and western ends of the site, are in good condition and are much less modified than most of the blanket bog further south in the Pennines. In areas where the water table is higher, bog mosses such as *Sphagnum papillosum*, *S. magellanicum*, *S. capillifolium* and *S. cuspidatum* predominate with other mosses such as *Rhytidiadelphus loreus*, *Hypnum jutlandicum* and *Pleurozium schreberi*, either in lawns or with a mixture of common cottongrass, deer grass, cross-leaved heath and round-leaved sundew. Some areas also have stands of cowberry *Vaccinium vitis-idaea* and cloudberry *Rubus chamaemorus*, the latter being particularly common on Burnhope Seat. As with other areas of the Pennines there are large areas of blanket bog dominated by either pure or

mixed stands of hare's-tail and common cottongrass with heath rush which flourish at the expense of dwarf shrubs due to modification by either overgrazing, over-burning, or drainage of the blanket bog, or a combination of these. Where these effects are severe, peat erosion and 'hagging' has occurred.

Blanket bog gives way to heathland where the peat is generally less than half a metre deep, such as on Melmerby Fell, Stony Rigg, Rotherhope Fell and parts of Cross Fell. Typically, there is a predominance of the dwarf shrubs of bilberry, crowberry *Empetrum nigrum* and heather, and in parts these are rich with lichens such as *Cetraria islandica*, *Cladonia impexa*, *C. arbuscula* and *Hypogymnia pysodes*. At higher altitudes above 550m (1,804 feet) the climate is more severe and this is reflected in the more montane nature of the vegetation with plants such as stiff sedge *Carex bigelowii* and the moss *Racomitrium lanuginosum* becoming increasingly dominant. Cross Fell in fact supports the best and most extensive example of this *Racomitrium* heath in England. The summit cap, on both north and west sides does in fact consistently hold the longest lasting snow-beds occurring south of Scotland.

Much of the heathland forms a variable mosaic with a variety of grassland types. At the highest levels, such as on Cross Fell, sheep's fescue *Festuca ovina* is common and grades into both species-rich and species-poor *Festuca-Agrostis* grassland; both of which occur widely throughout the site. The species-rich facies generally occurs where there are exposures of limestone such as on Melmerby Scar, Cross Fell, the Dun Fells, Knock Fell, Greencastle (Moorhouse), the Bullman Hills, Tyne Head Fell and Bellbeaver Rigg. Here blue moor-grass also becomes predominant with spring sedge and herbs such as wild thyme, limestone bedstraw and fairy flax *Linum catharticum*. Several rare and noteworthy montane and submontane species within these swards include hair sedge *Carex capillaris*, northern bedstraw *Galium boreale*, spring sandwort *Minuarta verna*, mountain everlasting *Antennaria dioica*, mountain pansy *Viola lutea*, autumn and spring gentians *Gentianella amarella* and *G. verna*, alpine cat's-tail *Phleum alpinum* and alpine forget-me-not *Myosotis alpestris*.

The species-poor *Festuca-Agrostis* facies occurs widely along the scarp tops, slopes and valley-sides and typically includes wavy hair-grass and sweet vernal-grass in association with heath bedstraw, tormentil and mosses such as *Polytrichum commune*. Mat-grass occurs sporadically throughout these areas on steeper, leached soils. In other areas, particularly those with slightly deeper soils, dense patches of bracken clothe the hill-sides.

Throughout the site, particularly at the periphery of the blanket bog there are important acid and base-rich flushes. Most of the acid flushes are typically species-poor and occur along stream and river valleys where there are gleyed peaty silts. These areas are dominated by soft rush and the mosses *Polytrichum commune* and *Sphagnum recurvum*. Other flushes, however, have a mixed carpet of bog mosses *Sphagnum* spp. with a variety of sedges such as common sedge *Carex nigra*, white sedge *C. curta* and star sedge *C. echinata*. The locally occurring tall bog sedge *C. magellanica* also occurs in flushed tracts within some areas of blanket bog such as on Tynehead Fell and Burnhope Seat. Base-rich flushes are found in areas where the drainage water is influenced by the underlying limestone, as seen at the head of Knock Ore Gill and below the caps of Cross Fell and

both of the Dun Fells. Many of these communities grade into bryophyte-dominated spring and rill communities. Sedges are common with other local and rare species such as lesser clubmoss *Selaginella selaginoides*, starry saxifrage *Saxifraga stellaris*, marsh saxifrage *S. hirculus*, alpine foxtail *Alopecurus alpinus* and three-flowered rush *Juncus triglumis*. Brown mosses can be very abundant and include *Philinotis fontana*, *Cratoneuron commutatum* and *Scorpidium scorpioides*.

Tall herb ledge vegetation of the ungrazed crags and ledges is another important feature of the site. The ledges on the Whin Sill, such as at Black Doors are generally species-poor unless subject to flushing with base-rich water. Ledges on the limestone, such as at Melmerby High Scar, Great Fell, Crowdundle Beck, Allen's Cleugh, Lady Gill and Little Gill are species-rich and support plants such as green spleenwort *Asplenium viride*, brittle bladder fern *Cystopteris fragilis*, hoary whitlow grass *Draba incana*, hairy stonecrop *Sedum villosum*, roseroot *S. rosea* and the rare alpine cinquefoil *Potentilla crantzii*. Gritstone and limestone boulder screes are well represented on the western escarpment with Cross Fell possessing the largest area of gritstone scree on an English mountain. The boulders provide valuable habitat for lichens and mosses. The gritstone screes support mosses such as *Racomitrium lanuginosum*, *Pohlia nutans*, and *Diplophyllum albicans*, whilst lichens include *Parmelia alpicola*, *P. incurva* and various *Umbilicaria* species.

Open water occurs on the site in the form of several upland streams, which include the headwaters of the River Tees, Knock Ore Fill, Crowdundle Beck, Cross Gill and Blackburn; as well as bog pools and tarns such as at Stony Rigg, Green Fell and Burnhope Seat. Knock Ore Gill represents one of the highest and most precipitous limestone streams in Britain and is a key example of a limestone stream also affected by peat water.

Lead mining has occurred in the past throughout the site, particularly within the Moorhouse NNR area. Many of the spoil heaps are floristically interesting having an abundance of spring sandwort, alpine pennycress *Thlaspi alpestre*, alpine scurvy-grass *Cochlearia alpina* and autumn gentian.

Studies of the invertebrate life of the site have concentrated largely on the Moorhouse NNR, where 27 endangered or vulnerable species and 71 nationally scarce species have been recorded. These include the vulnerable fungus gnat *Macrocera bipunctata* known only from four sites nationally. Many of the beetles are typical of upland moorland habitats, and include the endangered rare beetle *Olophrum assimile*, a species that has been found on only two mountain tops in Britain. The northern dart *Xestia alpicola* is also present at one of its few English stations.

The site is of regional importance for its upland breeding bird community. More than forty species of birds breed on the site including important breeding populations of merlin, peregrine, buzzard, kestrel, raven, short-eared owl, golden plover, dunlin, common sandpiper, lapwing, redshank, curlew and snipe. The latter four wading species nest here at their record elevations in Britain. There are passage records of golden eagle, hen harrier and snow bunting.

Mammals recorded on the reserve include hedgehog, common pygmy and water shrews, water vole, mole, wood mouse, house mouse, brown rat, pipistrelle bat, brown hare, fox,

badger, stoat, weasel, otter, and roe deer. Moor House NNR has been the subject of intensive scientific study in the past and is the best documented area of upland peatland in Britain.

Five localities of particular geological interest have been included within the site:

Knock Fell Caverns:

Knock Fell Caverns lie at the head of Knock Ore Gill. The single cave system in this site is the most perfectly developed and most extensive maze cave system in Britain, formed by ponded water flowing under considerable pressure beneath the water table, in which the pattern of the cave passages has been strongly influenced by enlargement of natural fractures (joints) within the bedrock. Maze caves are typical features of the thin limestone layers of the Great Limestone bedrock, Knock Fell being the finest example. The cave system lies at a higher altitude than any other in Britain and contains well preserved calcite formations and deposits which offer very great potential for the study of the long history of its development.

Sir John's Mine:

Sir John's Mine lies below Tyne Head Fell on the River South Tyne just south of Tyne Head. Although Sir John's Vein is not of interest itself, a level driven on it from the east bank of the Tyne, was used as access to the Great Sulphur Vein as recently as 1941. The Great Sulphur Vein, seen some 400m along this level, comprises a north facing monocline, intensively sheared and faulted, in highly silicified shales at its northern end, below which, 6m of Tynebottom Limestone, dipping north at 40°, is entirely replaced by iron sulphides and quartz (average 9.5% sulphur). The Whin Sill underlying the Tynebottom Limestone is metasomatically altered and mineralised with pyrite in the upper 2m.

Specimens of sulphide ore containing pyrite, marcasite, pyrrhotite and chalcopyrite are localised on the dumps at the Sir John's level entrance and recently specimens of quartz have been found to contain small inclusions of bismuthinite and native bismuth. Some fragments are of brecciated shale in a quartz matrix, sulphide veining in the clasts being of particular interest genetically. All these specimens are clearly from the Great Sulphur Vein, which is believed to represent the root zone of a major fluorite-bearing North Pennine vein system. Some 300 m upstream from Sir John's Mine, where the Great Sulphur Vein crosses the River Tyne, sulphide mineralisation is poorly developed at outcrop and therefore the dumps at Sir John's Mine are, at present, the most accessible source of material from this very interesting mineralisation.

Windy Brow:

Windy Brow Mine lies to the north of Burnhope Seat at the southern end of Windy Brow. The dumps from an old level driven on Windy Brow Vein beneath the Great Limestone, have yielded small but very fine specimens of aurichalcite in two distinct habits. Other secondary minerals are malachite, azurite, and smithsonite, and a small dressing floor at

the dumps yields specimens of galena. The locality is of purely mineralogical interest in yielding the best aurichalcite in Britain.

Cross Fell:

Cross Fell, together with Little Dun Fell, Great Dun Fell and Knock Fell, is important for periglacial geomorphology in northern England. The area includes an excellent assemblage of landforms including gelifluction terraces, ploughing stocks, vegetated hummocks, patterned ground, nivational features and frost weathering features. In some cases the processes are currently active and the area forms part of a national network of sites representing the geographical variation in contemporary periglacial phenomena.

Black Burn:

At the north of the site a small section of the Black Burn, north of Shield Water is important for fluvial geomorphology. It is one of only a few sites in the northern Pennines where upstream input of coarse sediment produced by hushing can be clearly linked to downstream floodplain sedimentation. Below the confluence of Black Burn and Rowgill Burn there is an extensive low terrace with a complex sequence of high-sinuosity palaeochannels preserved on its surface. Comparatively high trace metal concentrations in these sediments suggest that their deposition was contemporaneous with upstream metal mining before the mid-19th century. More recent sedimentation and valley floor incision are also represented. This reach of the Black Burn is also noted for its contemporary bar and bed forms. It is the most extensive, laterally mobile, low-sinuosity boulder-bed stream in the Tyne basin. Midchannel bars, neck and chute cut-offs and boulder berms formed by historic floods are especially well-developed. Black Burn is therefore important for both contemporary and historic river process, landform and sediment inter-relationships.

Moor House – Upper Teesdale Special Area of Conservation Qualifying habitats and species

For further detail and information see https://jncc.gov.uk/our-work/special-areas-of-conservation/

Note that the text below relates to the Moor House part of Moor House – Upper Teesdale SAC and that the SAC boundary extends beyond the NNR boundary.

Annex I habitats that are a primary reason for selection of this site

- **4060 Alpine and Boreal heaths**
  Moor House – Upper Teesdale has the most extensive area of **Alpine and Boreal heaths** south of Scotland and is the best southern outlier. The main sub-type is H19 *Vaccinium myrtillus – Cladonia arbuscula* heath, which occurs on an extensive plateau. Characteristically (as in the Scottish Highlands) there is an abundance of lichens, especially *Cladonia* species, but on this site there is also an unusual abundance of large clumps of the montane lichen *Cetraria islandica*. At the edge of the plateau *Vaccinium – Cladonia* heath gives way below to a wind-clipped form of H12 *Calluna vulgaris – Vaccinium myrtillus* heath. which grades into taller heaths of the same community lower down the slopes. These represent alpine to boreal transitions which, in the more severe climate of the Highlands, would be represented by lichen- or bryophyte-rich prostrate *Calluna* heaths. Similarly, on one level summit at an altitude of 600 m, wind-clipped heather of a short but upright growth form occurs among a profusion of lichens, especially *Cladonia* species. This constitutes an unusual alpine/subalpine form of *Calluna – Vaccinium* heath that is very local in England.

- **6150 Siliceous alpine and boreal grasslands**
  The summit of Cross Fell has the best-developed and most extensive area of **Siliceous alpine and boreal grasslands** in England. The U10 *Carex bigelowii – Racomitrium lanuginosum* moss-heath that covers the summit cap has a high cover of woolly fringe-moss *Racomitrium lanuginosum*.

- **6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)**
  Extensive stands of CG9 *Sesleria albicans – Galium sterneri* grassland occur at this site in northern England. It is an important variant of this community since it contains a rich assemblage of relict arctic-alpine species, such as spring gentian *Gentiana verna* and alpine forget-me-not *Myosotis alpestris*, making Moor House – Upper Teesdale one of the most important arctic-alpine refugia in the UK. The grasslands are for the most part heavily grazed but show transitions to a wide range of other vegetation types, including **7130 Blanket bogs**, acid grassland, **7230 Alkaline fens**, **6520 Mountain hay meadows**, **8240 Limestone pavements**, cliffs and **8120 calcareous and calcshist screes of the montane to alpine levels**.

- **6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels**
  Moor House – Upper Teesdale comprises an area of mixed geology made up of carboniferous sandstones, mudstone and limestones. The combination of acidic

and base-rich soil has given rise to an important range of vegetation types that has also been influenced by climatic conditions on this, the highest part of the Pennines. **Hydrophilous tall herb fringe communities** occur on wet ledges in base-rich rocks, which are inaccessible to grazing livestock. One of the most extensive stands is on a tributary of Little Gill, and examples also occur at Lady Gill, Greencastle, High Cup Nick and Mickle Fell. Typical species that occur in these localities include great wood-rush *Luzula sylvatica*, wood crane's-bill *Geranium sylvaticum*, water avens *Geum rivale*, lady's-mantle *Alchemilla glabra*, wild angelica *Angelica sylvestris* and roseroot *Sedum rosea*.

- **7130 Blanket bogs (* if active bog) * Priority feature**
  This site in the northern Pennines represents **Blanket bogs** in the north of England. The site includes the least damaged and most extensive tracts of typical M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire in England and shows this community type up to its highest altitude in England. This large expanse of peat displays the full range of features typical of the Pennines, with extensive erosion, mainly on higher areas, interspersed with large swathes of bog dominated by heather *Calluna vulgaris* or cottongrasses *Eriophorum* spp. A few areas display small-scale surface patterning, with distinct *Sphagnum* hollows and intervening ridges. Some parts of the site show characteristics of the western-type Scottish **Blanket bogs**, whereas the lichen-rich areas are a feature of bogs in Fennoscandia.

- **7220 Petrifying springs with tufa formation (Cratoneurion) * Priority feature**
  This is one of three sites in northern England that have extensive series of **petrifying springs with tufa formation**. At this site Carboniferous limestones are thinly-bedded amidst shales, sandstones and slates. Tufa springs often occur at the junction between limestone and these other, less permeable, rocks at a range of altitudes. Tufa springs are associated with calcareous glacial drift and can be found in calcareous grasslands, in fen systems of grazed pastures, associated with limestone scar cliffs and screes and amidst acid heathland and grassland. The flora is exceptionally rich and includes rare northern species such as bird's-eye primrose *Primula farinosa* and Scottish asphodel *Tofieldia pusilla*.

- **7230 Alkaline fens**
  This is one of two upland sites in northern England selected for **Alkaline fens**. Spring-fed flush fens of NVC type M10 *Carex dioica – Pinguicula vulgaris* mire are widespread on the moors amidst calcareous grassland, limestone scars, heath and bog, in enclosed pastures amidst a range of acid and calcareous grasslands and in meadows, often as part of complex vegetation mosaics. The site has an exceptionally important rare plant flora associated with flush vegetation, including species such as bird's-eye primrose *Primula farinosa* and Scottish asphodel *Tofieldia pusilla*. On the highest and coldest parts of the site fen grades into Annex I type **7240 Alpine pioneer formations of the *Caricion bicoloris-atrofuscae***, and intermediate examples occur.

- **8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)**
  Moor House – Upper Teesdale is representative of communities on both low and high altitude **siliceous scree** in northern England. Screes are extensive, with diverse plant communities. Cross Fell is a southern outlier of high-altitude gritstone scree, with a flora including rare lichens and some widespread montane vascular

plants. Ferns including parsley fern *Cryptogramma crispa* and holly fern *Polystichum lonchitis* occur on extensive whin-sill screes at lower altitudes.

- **8120 Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)**
  This site is representative of the communities of **calcareous and calcshist screes** in the north of England up to an altitude of 760 m. This site has the most extensive areas of calcareous and calcshist scree in the UK, consisting of Carboniferous limestone. Communities are diverse and there is a mix of northern and southern floristic elements, including holly-fern *Polystichum lonchitis*, rigid buckler-fern *Dryopteris submontana*, limestone fern *Gymnocarpium robertianum*, musk thistle *Carduus nutans* and mossy saxifrage *Saxifraga hypnoides*. Hairy stonecrop *Sedum villosum* occurs where scree is flushed by springs.

- **8210 Calcareous rocky slopes with chasmophytic vegetation**
  This is one of three sites representing **Calcareous rocky slopes with chasmophytic vegetation** in the north of England. Crevice communities occur on extensive limestone scars, especially along the Pennine escarpment and around the summits of hills. Cliff crevice vegetation occurs extensively and to an altitude of 760 m. The most extensive community present is characterised by green spleenwort *Asplenium viride* and brittle bladder-fern *Cystopteris fragilis*. Less common species found in this community include hoary whitlowgrass *Draba incana*, alpine cinquefoil *Potentilla crantzii* and holly-fern *Polystichum lonchitis*. The site is also of interest for its combination of southern and northern flora. Rarer southern species include bird's-foot sedge *Carex ornithopoda* and horseshoe vetch *Hippocrepis comosa*. The whitebeam *Sorbus rupicola*, which is widely distributed but found at only a few sites, is also present.

- **8220 Siliceous rocky slopes with chasmophytic vegetation**
  Moor House – Upper Teesdale, which includes the highest point of the Pennines, has a mixed geology of Carboniferous sandstones, mudstone and limestones, that have influenced the important plant communities that are found there. This cSAC is one of only a very few sites in England supporting **Siliceous rocky slopes with chasmophytic vegetation**. The most extensive occurrences of this community type are where the Whin Sill outcrops at Falcon Clints, Ravenscar, Holwick Scars and High Force. Some examples also occur at Middle Tongue and alongside Cash Burn. Characteristic species present include parsley fern *Cryptogramma crispa*, mountain male-fern *Dryopteris oreades* and northern buckler-fern *D. expansa*. Bearberry *Arctostaphylos uva-ursi* and starry saxifrage *Saxifraga stellaris* also occur in this community.

Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site

- **4030 European dry heaths**
- **8240 Limestone pavements * Priority feature**

Annex II species that are a primary reason for selection of this site

- **1528 Marsh saxifrage** *Saxifraga hirculus*
  This very large site in northern England is the most important site for **marsh saxifrage *Saxifraga hirculus*** in the UK. The site consists of an extensive upland

complex on limestone and gritstone, with acid grassland, blanket mire, limestone outcrops and flushes. Drainage water in many of the flushes is influenced by the underlying geology – Upper Carboniferous mudstones and shales within more extensive limestone. Approximately ten of the flush areas support populations of marsh saxifrage, including areas in the Appleby Fells, Cross Fell and Upper Teesdale, containing a total of over 270,000 plants – >90% of the UK population. In this area distributions are very patchy within flushes so that population estimates are hard to support, but individual populations in these localities can be large, with several localities supporting thriving populations of many thousands of plants. In 1999 the largest population was estimated at 153,100 individuals.

North Pennine Moors Special Protection Area Qualifying Species

For further detail and information see https://jncc.gov.uk/our-work/list-of-spas/

ARTICLE 4.1

QUALIFICATION (79/409/EEC)

During the breeding season the area regularly supports:

- *Circus cyaneus* 2.2% of the GB breeding population Count as at 1993 and 1994
- *Falco columbarius*10.5% of the GB breeding population. Estimated population.
- *Falco peregrinus 1*.3% of the GB breeding population Count as at 1991.
- *Pluvialis apricaria* [North-western Europe - breeding] at least 6.2% of the GB breeding population. Estimated population.

www.gov.uk/natural-england