



Scotland's
National Nature
Reserves

The Story of Flanders Moss National Nature Reserve



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Scottish Natural Heritage
Dualchas Nàdair na h-Alba

All of nature for all of Scotland
Nàdar air fad airson Alba air fad



The Story of Flanders Moss National Nature Reserve

Foreword

The Earth really does move when you step out onto Flanders Moss National Nature Reserve (NNR). Formed on the Carse of Stirling over 8000 years ago, Flanders Moss is one of the last fragile remnants of the great bogs that once covered much of Scotland. It is now one of the largest lowland raised bogs in Britain and one of the most intact raised bogs in Europe. Flanders' sheer size has been key to its survival over the years.

Flanders Moss displays many of the classical raised bog features. Its distinctive domes shaped by the water within, support a rich, colourful carpet of bog mosses with large areas of the bog still accumulating peat. A whole host of specialist plants and nationally rare invertebrates make their home on this floating habitat. The underlying geology tells a fascinating story of ancient sea level changes and within the peat itself, pollen records changes that have taken place in the surrounding landscape over the years.

Flanders Moss also plays a role in addressing climate change. The carbon in the peat domes is locked up by the rewetting of the surface and the restarting of peat formation by a growing sphagnum carpet locks up more carbon.

Flanders Moss is one of a suite of NNRs in Scotland. Scotland's NNRs are special places for nature, where some of the best examples of Scotland's wildlife are managed. Every NNR is carefully managed both for nature and for people, giving visitors the opportunity to experience our rich natural heritage. Flanders Moss is now more accessible than it ever has been in its history.

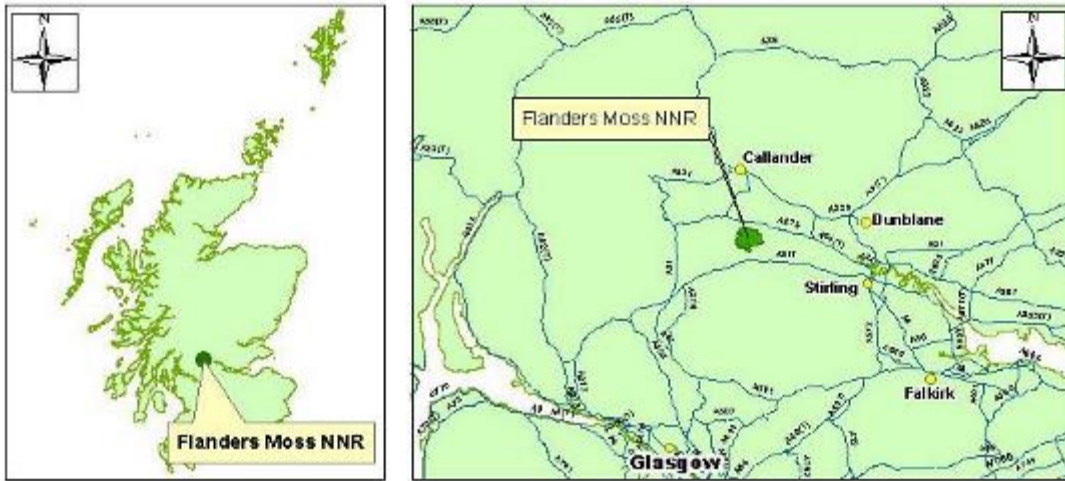
This Reserve Story contains background information about the reserve, describing the wildlife interest, its land use history and management since it became a reserve. The Flanders Moss NNR Management Plan 2016-2026 covers the future management of the reserve.

Contents

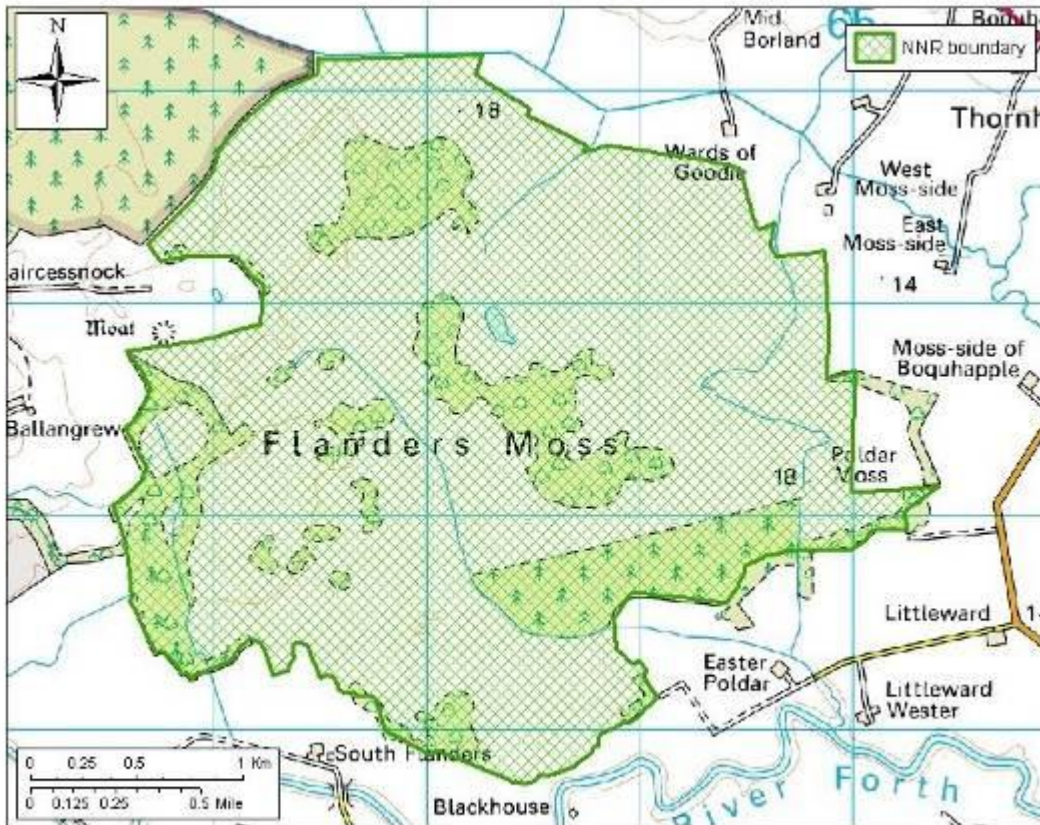
| | |
|---|-----------|
| Foreword | 1 |
| Maps of Flanders Moss NNR | 3 |
| Aerial photograph of Flanders Moss NNR | 4 |
| 1 Introduction to Flanders Moss NNR | 5 |
| 2 The Natural Heritage of Flanders Moss NNR | 8 |
| 3 Management of Flanders Moss before it became a NNR | 16 |
| 4 Management of Flanders Moss NNR | 20 |
| 5 Property Management | 28 |
| 6 Summary | 29 |
| 7 Document properties | 30 |

Maps of Flanders Moss NNR

Location maps



Boundary of Flanders Moss NNR



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Aerial photograph of Flanders Moss NNR



1 Introduction to Flanders Moss NNR

Flanders Moss NNR can be found on the Carse of Stirling, 15 kilometers (km) west of Stirling. At 860 hectares (ha), Flanders Moss is the largest and most intact of a cluster of raised bogs on the Carse, making this whole area one of the most important areas in the UK and Europe for this rare habitat.

Some 8000 years ago, the Carse of Stirling was an estuary surrounded as it is today, by a natural amphitheatre of hills - with the Highlands to the north and west, the Touch and Gargunnoch hills to the south and the Ochills to the east. As the seas retreated, clay deposited on the flat former estuarine land provided a perfect watertight plug, preventing water from draining away. Shallow pools formed in dips on top of the clay, from which many of the Forth Valley bogs started to form. Flanders Moss itself was formed on the estuarine land between the Goodie Water and the River Forth. Many of the Carse bogs have been damaged or entirely removed over the years and Flanders Moss now sits almost completely surrounded by managed farmland. The reserve remains a speck of the once wild and ancient landscape.

Flanders Moss is a lowland raised bog comprising four linked domes of peat. In some areas, the peat is a remarkable 7 metres (m) in depth and has been formed by dead bog mosses being laid down layer after layer in a continual process. At a rate of approximately up to 1 millimetre (mm) per year, it is not surprising that it has taken over 8000 years to form the raised domes of Flanders Moss and perhaps even more remarkable, that large areas of Flanders Moss remain entirely intact.

Raised bogs rely entirely on rainfall to supply them with water. The rain fed domes of Flanders Moss hold the water table close to the surface of the bog and it is this saturation that maintains a thriving wealth of bog mosses. The rainfall on the Carse of Stirling is certainly plentiful enough to support raised bog growth, with a long-term average of 1131 mm per year (between 1961 and 1990). Recent trends show that rainfall is increasing in the area and there is slightly higher rainfall in the west, than in the east of



Bog cotton and pools

the reserve.

Despite the rainfall, past management of Flanders Moss has caused the bog to dry out. The drier conditions are more suitable for tree species and birch and pine have spread across the bog surface. Interestingly, the trees have created conflicting interests on the reserve and while they continue to encourage the drying out process of the bog, in some areas they also support a number of nationally scarce invertebrates.

Flanders Moss has received a considerable amount of academic and specialist interest in the past. Guided events and open days for local people are the focus of our activities to attract visitors to the reserve. With such a fragile habitat and the potential hazards for people accessing this wet and boggy terrain, the opportunities for visitors to really get to know and appreciate Flanders Moss NNR have been limited. New facilities such as the boardwalk and car park now provide opportunities to get close to the bog while the viewing tower gives a fantastic overview of the whole site. We will continue to look at new ways of enticing visitors and providing them with the opportunities to find out more about this rare habitat and what we can do to help preserve it.

Flanders Moss is one of our most recent reserves to be declared. The first 210 ha were declared in 1980. Since then, we have entered into agreements with other landowners and purchased other parts with the new areas being formally declared in 2008. The reserve now covers an area of approximately 821 ha, 95% of Flanders Moss peat body.

Flanders Moss NNR forms part of the Flanders Moss Site of Special Scientific Interest (SSSI) and the Flanders Mosses Special Area of Conservation (SAC). The Flanders Mosses SAC includes four other raised bogs in the Carse of Stirling - Collymoon Moss, Killorn Moss, Offerance Moss and Shirgarton Moss. Part of the Flanders Moss NNR falls within the Western Forth Valley Geological Conservation Review (GCR) site.

Table 1: Designations and qualifying features of Flanders Moss NNR

| Designation | Special Area of Conservation | Site of Special Scientific Interest |
|--------------------------------------|-------------------------------------|--|
| | European | UK |
| Site name | Flanders Mosses | Flanders Moss |
| Habitats | | |
| Active raised bog* | ✓ | ✓ |
| Degraded raised bog* | ✓ | ✓ |
| Species | | |
| Spider (<i>Heliophanus dampfi</i>) | | ✓ |
| Moth assemblage | | ✓ |
| Earth Science | | |
| Quarternary of Scotland | | ✓ |

* Priority habitat for the SAC

2 The Natural Heritage of Flanders Moss NNR

Earth science

The geological interest of Flanders Moss lies in the layers of silty clay and peat found below the surface of the bog. They tell a remarkable story of how changing sea levels in the past have altered the Carse from dry land to estuary and back again.

During the last glaciation, around 22,000 years ago, sea level was lower than today and huge glaciers covered Scotland, pushing the land downwards. As the climate warmed up and the glaciers melted around 15,000 years ago, the sea rose faster than the land and it flooded into the Carse of Stirling. Eventually as the land rebounded, the sea retreated, leaving a layer of beach sands and silty estuarine muds. Plants, then mosses colonised the land surface, forming a layer of peat on the poorly drained ground. Between about 12,900 and 11,500 years ago, the climate chilled again and glaciers built up once more in the Highlands during an event known as the 'Loch Lomond Re-advance'. One of these glaciers extended into the upper Forth Valley forming a prominent end moraine that extends from Menteith to Buchlyvie.

Later, around 9000 years ago, the sea again flooded inland and the Carse of Stirling once more became an extension of the Forth Estuary. The earlier land surface and most of the peat bogs were buried by new mudflats comprising silty clays (sometimes known as carse deposits). However, near West Moss-side farm, the bog grew so fast that it remained above the level of the encroaching sea, forming one of several peat islands in the estuary. It is hard to imagine today, but whales swam in the estuary at this time – their skeletons have been found buried in the carse deposits in several places west of Stirling. When the sea finally retreated 2,000 years later, peat accumulated again, forming a network of bogs that stretched across the Carse of Stirling. Today, scientists can take cores down through the sediments at Flanders Moss and adjacent areas to discover much about the changing climate and sea levels of those past times.

It is not just the record of geological events that Flanders keeps stored below its surface. At a depth of 7 metres, the domes of peat themselves are a time capsule of historical information. Heavy metals, flowering plant pollen, moss spores and unicellular creatures preserved in the peat, all provide us with clues to local environmental changes that have taken place in the area over the life of the bog.

More information on the geological interest can be found in the Quaternary of Scotland Geological Conservation Review for Western Forth Valley.

Habitats

Lowland raised bog

Flanders Moss holds the largest area (550 ha) of near-natural lowland raised bog habitat in the UK, equating to 13.7 % of the British resource and 2.8 % of the total European Union primary raised bog resource. Lowland raised bog habitat is one of the most vulnerable and diminished habitats in the UK with only 5% of intact raised bogs left.

Early in its life, Flanders Moss was just one of a series of raised bogs that formed along the Forth valley. Many have now been completely removed and others planted with conifers. Flanders Moss is also much diminished, only about 60% of its original size but still, by far the largest remaining intact bog.



View over Flanders Moss

For much of the bog surface, the vegetation is dominated by heather, cross-leaved heath and cotton-grass, with an understorey of sphagnum (bog) mosses. The sheer size of Flanders Moss means that it displays more natural bog features than are found on most raised bogs. The classical dome appearance can still be seen. There are large areas of bog that are still accumulating peat and have never been cut over (primary active bog). In places, you can see natural fen (lagg fen) and, natural sections of peat dome edge (rand). A bird's eye view also shows streams that originate from the bog expanse (endotelmic streams). The Northern Pow¹ being one such example.

At Flanders, we still have approximately 20 ha of lagg fen, with fine examples along the High Moss Pow¹, in Ballangrew wood and at the edge of Ballangrew meadow. At Ballangrew, there is a natural transition from acid species-rich grassland to lagg fen to raised bog, with species such as, bog-bean,

¹ 'Pow' – slow flowing stream.

gypsywort and sneezewort found in the lagg fen. Lagg fen is created around the edges of the peat domes where undisturbed seepage from the peat body meets mineral soils. This habitat rarely still exists on raised bogs today, as it has generally been lost to agricultural improvements.

Interestingly, Flanders Moss actually comprises of four separate domes. The domes are all linked by thinner peat forming one interconnected water table, called the 'hydrological body'. In healthy raised bogs like Flanders Moss, the water table is always maintained close to the surface of the bog, so creating the right environment for sphagnum mosses to thrive.

Approximately 250 ha of Flanders Moss can be described as degraded raised bog, which means that at one time the bog has been damaged in some way for example, by planting or ditching. Even though this habitat has been damaged, at Flanders we are lucky that with the right management, these areas are still capable of natural regeneration and longer-term restoration.

Scrub and woodland

In the past trees and scrub had spread over approximately 200ha of Flanders Moss covering parts of the active and degraded raised bog habitats and the lagg fen. Old maps and peat cores from Flanders show that there have been very few trees on the bog for most of its life. Early in the 1800s, a small area of Ballangrew wood on the west edge of Flanders Moss was planted up with conifers. Grazing also ceased during the same time period and this allowed trees to spread onto the drier edges of the bog by 1900. In the last 100 years these trees, mainly birch but also Scots Pine and rhododendron have spread to cover the tops of the domes and much of the edges of the bog.

The birch scrub is of particular value, providing ideal habitat for several rare species of invertebrates found on Flanders Moss. Amongst others, the beautiful moths, argent and sable and Rannoch brindled beauty are both found in the birch scrub on the reserve. The Scots Pine is more of a problem than the birch as if it gets established it creates a 100% canopy cover that stops a lot of the rain from getting to the bog surface.

Flora and Fauna

Mosses and lichens

Sphagnum mosses are the key plants of a raised bog and at Flanders; we have recorded 14 species on the reserve. Amongst these, three species have a limited national distribution (*Sphagnum austinii* (nationally scarce), *S.*

fuscum and *S. molle*) and their presence is an indication of the excellent quality of the bog habitat at Flanders Moss.

It is the sphagnum mosses that create the acidic conditions found on raised bogs. Their water retaining properties maintain waterlogged conditions on the bog, even 7 m above the surrounding ground level. This in turn, helps to preserve dead sphagnum material, which accumulates as peat. These peat forming species are the active component of an active raised bog.

Different sphagnum species have different requirements and subtle variations of conditions across the bog, control the distribution of species and creates the distinctively undulating and often colourful carpet characteristic of the bog surface. A closer look will be rewarded by reds, oranges and various shades of greens and yellows, all forming mosaics of patterns.



Sphagnum mosses

Flanders Moss has an interesting range of lichens. We have recorded 57 species including 19 species of *Cladonia*. *Cladonia* species are lichens generally found on the ground and some species can indicate a past history of burning and drying out of the bog surface. It may be that as the bog becomes wetter with our continued management of the reserve, we may start to lose some of the lichen species which prefer drier conditions.

Vascular plants

Flanders Moss has an exceptionally rich flowering plant community, especially for a raised bog. The relatively harsh conditions of a raised bog, often limit the variety of plants found to mainly heaths, sedges and cotton-grasses, which are all specially adapted to live in water-logged, nutrient poor conditions.



Labrador tea plant

On Flanders we have thriving populations of a whole range of bog specialists such as round-leaved sundew, cranberry and bog asphodel. There are also bog rarities such as, white beak-sedge and the nationally scarce bog rosemary.

Flanders Moss is also famous for being the main location in Scotland for the Labrador tea plant, a relative of the rhododendron. This plant of the high Arctic was thought to be a remnant from the ice age but it is now thought to have been introduced to Flanders in Victorian times. Recent studies have shown it to be spreading on the reserve and work is now starting to try to remove it from the site.

Invertebrates

Flanders Moss is also special for its nationally important populations of rare invertebrates, a number of which have lifecycles that are linked to trees and scrub on the bog. Moths are especially important and 215 species have been recorded so far with one being a rare Red Data Book (RDB) species, eleven are Nationally Scarce and 33 are of local importance. One of the nationally important species is the Rannoch brindled beauty moth. The adult moths emerge early in the year, their caterpillars feeding on heather and bog myrtle. The female of this species is wingless and in Britain they are restricted to the damp moorland habitats of Argyll, Perth-shire and Inverness-shire.

In 2005, we recorded the small RDB moth, *Lampronia fuscatella*. The adults are rarely seen but it can be monitored by the presence of its larvae, which live and feed in small galls on birch twigs.

The reserve also has a thriving population of the argent and sable moth, a UK Biodiversity Action Plan (UKBAP) species. One of the few moths that fly by day, its numbers are rapidly declining in the UK. In southern Britain its larva feeds on young birch, in the north on bog myrtle. Here on Flanders Moss, caterpillars have been found feeding on bog myrtle but may also use birch - only



Argent and sable moth

more research will tell. Flanders Moss is also a stronghold for the large heath butterfly, a proposed priority species for the UKBAP. A survey in 2005, recorded up to 20 individuals in one hour, on the west part of the reserve.

As well as insects, there is a small RDB spider, *Heliophanus dampfi* that is found on the reserve and only six other sites in the UK. This spider was only discovered in the UK in the late 1980s, on a raised bog in Wales. It was found on Flanders Moss and the nearby Ochertyre Moss in 1991 and 3 other bog sites close by in 2011. The Scottish populations seem to prefer living in the bases of cotton grass and purple moor grass tussocks on the moss, where they stalk their prey and pounce using hydrostatically powered legs.

It comes as no surprise that a large wetland such as Flanders Moss is a good site for dragonflies. Ten species have been recorded on the NNR so far including the northern emerald, Flanders being one of the most southerly sites for this rare species.

Birds

Flanders Moss is used by many different species of birds throughout the year. In the summer, 11 UKBAP species of breeding bird use the Moss. Snipe, curlew and stonechat use the open areas of the moss whilst the tree pipit, cuckoo and wood warbler prefer the edge woodland habitats. Ospreys also breed on the reserve and they can often be seen flying over the bog to and from the Lake of Menteith.

Birds can be hard to find on the reserve in winter but at dawn and dusk there is often plenty of activity. Whooper swans, greylag and pink-footed geese all use the small lochan, close to the center of the reserve as a roosting and rest area. The Carse of Stirling as a whole holds nationally important wintering populations of these geese. Hen harrier and short-eared owl also regularly roost on the reserve during winter. With large winter flocks of bullfinch and reed bunting and the occasional great grey shrike, the reserve has plenty to see all year round.

Mammals

On the edge of the Highlands, Flanders Moss is one of few open wild habitats left in the Carse. There are signs that otters regularly pass through the network of ditches on the reserve. Sightings of pine martin have increased in around the fringes of the moss.

Red and roe deer both use the reserve. Red deer tracks crisscross their way across the bog as deer move from thick cover in daytime to feed on

surrounding farmland at night. Numbers have greatly increased in recent years as deer have moved onto the undisturbed moss due to increased forestry activities in nearby woodland. Red deer are likely to have an important impact on the vegetation structure of the reserve through browsing and cause damage on surrounding farmland so management of deer numbers in an important management activity.

Reptiles and amphibians

Adders and common lizards are both found on Flanders Moss. Local people recall Flanders Moss as having a very large population of adders – numbers are certainly thriving around the southern end of the reserve. Common lizards are found all across the reserve and are making good use of the new boardwalk – where on a warm day they bask on the treads. A small population of slow worms is found on one part of the reserve.



Common lizard basking on the boardwalk

As you might expect with a wetland site, the reserve supports a large population of toads and frogs as well as palmate newts. These can be seen spawning in the lochan and in many of the dammed ditches.

The cultural heritage of Flanders Moss

Flanders Moss has played a part in Scottish history through its geographical prominence. Its presence has also dominated the lives of people living around it, especially during the period when so much effort was put into trying to remove the unproductive peat and so win the fertile agricultural land underneath.

Little is left now to show what the land around Flanders Moss must have looked like during this time. In places such as in Ballangrew wood and West Moss-side farm, features such as ditches, peat banks and dams illustrate the techniques and efforts used to drain the bog and remove the peat. These features are of local archaeological significance.

The Story of Flanders Moss National Nature Reserve

Of national importance is the Flanders hill homestead. This enclosure is likely to represent a medieval settlement and is a Scheduled Ancient Monument (SAM). It is situated a few metres outside the Reserve.

3 Management of Flanders Moss before it became a NNR

History of Flanders Moss

| | |
|------------------|---|
| About 13,000 BP | Peat starts to form on the Carse of Stirling during an interglacial period when the glacial ice has melted. |
| 12,900–11,500 BP | Climate gets colder as glaciers form on Scotland and reach the edge of Flanders Moss during the “Loch Lomond Re-advance”. |
| 9,000 BP | As the ice melted again it caused sea levels to rise again flooding the Carse. In a few areas, the peat accumulated faster than the sea rose, creating peat islands in the sea-covered estuary. |
| 7,000 BP | A landslide in Norway causes a huge tsunami that hits the east coast of Scotland, covering the peat with a layer of sand that can be seen in peat cores to this day. |
| 7,000BP | The peak of sea level rises on the Carse. After this period the sea retreated back down the Carse to reach current levels about 2000 years ago. The peatlands started to spread from the island across the Carse again. |
| Recent history | Stirling is a major strategic military location. For any military movements to be made north or south the highland boundary fault to the west and the boglands of the Carse of Stirling, offered an impenetrable barrier. |
| Up to 1750 | There is some small-scale domestic peat cutting and grazing of sheep and cattle on the moss. Seasonal routes across the Carse are used regularly. |
| 1750-1860 | Large scale peat clearing on the Carse is undertaken in an attempt to claim the underlying fertile land. Bogs are drained and stripped of their peat. Common grazing was also removed from Flanders Moss and management for grouse started. |
| 1860 | Peat clearances abandoned as a recession hits agriculture. |
| 1878 | A huge fire burnt across the whole moss (about 2000 acres) in August, taking 3 days to put out. |
| 1945 | First mention of the possibility of a nature reserve and, recognition of the natural history importance of Flanders Moss. |
| 1950 | Flanders Moss is surveyed as part of the Scottish Peat Survey to explore the possibility of using the peat to generate electricity. |
| 1967 | 45 ha of Flanders Moss are bought by Forestry Commission (FC). Ditches are dug in preparation for planting conifers. |

| | |
|-------------|---|
| 1973 | 210 ha of Flanders Moss in the south west corner is notified as a SSSI. FC sells above 45 ha before planting conifers to Scottish Wildlife Trust. This is the first part of Flanders Moss to be acquired for conservation. |
| mid 1970s | 40 ha of Flanders Moss outwith the SSSI is planted with conifers. |
| Early 1980s | 100ha of Flanders Moss is screw levelled and ditched, ready for commercial peat extraction. |

Land Use History

Flanders Moss is unusual in that it is a relatively new landscape that has changed little after it formed. We know that people lived around the Carse of Stirling before Flanders Moss ever existed and generations must have watched the formation of the peat domes on the Carse wetlands after the final Loch Lomond Re-advance.

Up to about 1750, the extent of Flanders Moss would have changed little with only peat being cut around the edges, mainly for domestic fuel. During this time, there were a few scattered farm settlements along the river edges. For local people having a bog on their doorstep was a bonus. The bog was a source of a range of useful materials such as peat for fuel and heather for thatch and also useful grazing for sheep and cattle. Flanders may well have also been burnt regularly to maintain the grazing. All of these actions would have helped to keep the bog free of trees.

The most dramatic and damaging changes to Flanders Moss occurred from 1750. The clay land underneath the Carse bogs became recognised as good agricultural land and the landowners made great efforts to remove the peat wholesale. Some raised bogs on the Carse, like Blair Drummond Moss, virtually disappeared. At Flanders Moss nearly all the eastern half was removed and varying amounts around the edges. Thankfully, peat clearance at Flanders was more difficult than at other sites further east as water, used

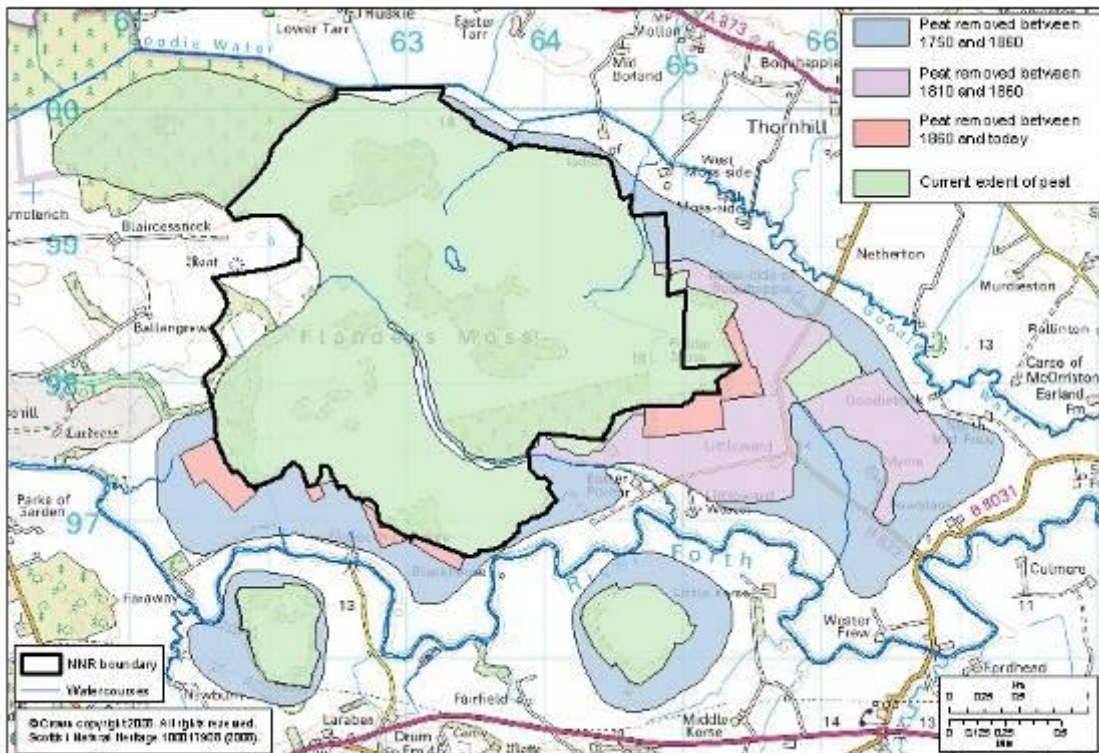


Ditch at Flanders Moss

to flush away the cut peat, was not as readily available and the peat in the main body of the bog was very deep. These factors probably helped prevent much of Flanders being lost.

The clearing of the peat had dwindled on Flanders Moss by about 1860. The recession in agriculture made it more economical to make existing land more productive by improved drainage rather than putting in effort to claim more land. Since 1860 the extent of peat at Flanders Moss has changed little.

Map showing the changes in extent of peat cover at Flanders Moss



New ways of making the moss economically productive were explored. From 1800, stock were excluded and efforts were put into managing the heathery bog surface as a grouse moor. The drier conditions created by the ditching and peat extraction favoured grouse and mountain hare. Burning the heather in rotation to benefit the grouse would also have continued to keep the bog relatively free of trees. It is not known if mountain hare were introduced for sporting reasons as some have suggested, or occurred naturally, but when the grouse moor management gradually lapsed by the mid-1970s, the hare and grouse populations also began to disappear. With the lapse of the rotational burning for grouse moor management, trees started to spread onto the bog.

In 1950, a survey was carried out to explore the feasibility of using peat for generating electricity. Luckily for Flanders Moss, it was decided that there was

not enough peat to make it viable. Even, more recently there has been potential large scale commercial pressure on Flanders Moss. 40 ha of Flanders Moss was planted with conifers and a further 45 ha nearly suffered the same fate before being bought by the Scottish Wildlife Trust (SWT). The market for peat for horticultural use was also developing fast in the 1980s and 100 ha of Flanders Moss was screw levelled and ditched to dry it out ready for commercial peat extraction.

By the late 1980s, nearly 250 years of draining and peat clearance had taken its toll on the hydrology of Flanders Moss. It was greatly reduced in size, it had conifers planted on part, it was criss-crossed with ditches and birch and pine trees were rapidly expanding over the surface, accelerating the drying out process and smothering the bog fauna and flora. As a bog, Flanders Moss was drying out fast and had reached its lowest ebb.

Further details of the land use history around Flanders Moss can be found in the report we commissioned 'A historical background of Flanders Moss' (Harrison, 2003).

4 Management of Flanders Moss NNR

Key events in the history of Flanders Moss since it became a NNR are as follows:

| Year | Event |
|----------------|---|
| 1982 | 210 ha of Flanders Moss on Cardross Estate are declared as a NNR. |
| 1989 | An additional 22.83 ha on northern edge of moss are added to the Reserve. |
| 1992 | The first Flanders Moss Reserve Officer is appointed. Ditch damming starts and the Cardross area of the Reserve is extended by 582 ha. |
| 1994 | The Reserve's European importance is recognised by its inclusion within the Flanders Mosses SAC. |
| 1995 | We purchase Ballangrew meadow and plantation and start large scale scrub clearing on the south dome. |
| 1995 | We purchase the commercial peat extraction planning permissions for £1.8 million pounds and the Cardross area of the Reserve is extended again. SSSI extended to include the whole of the peat body. |
| 1996 | 34 ha of the West Moss-side Farm area of the moss is included into the Reserve. |
| 1996 | First management plan (1996 – 2001) complete for Flanders Moss NNR. |
| 1997-98 | Large scale restoration works started - including the removal of the plantation and major ditch damming work on 30 km of peat workings. |
| 1997 | A sluice is constructed on Moss-side Pow, to recreate lagg fen. |
| 1998 | Peatland conference at Stirling focuses on Flanders Moss and a number of papers are published in the Forth Naturalist and Historian Vol 23. |
| 1999 – present | Rhododendron is cleared from Ballangrew wood and the open areas of the bog. |
| 2005 | The Reserve is extended to include the Littleward Farm area. |
| 2005 – 2007 | Flanders Moss NNR is the focus of a European LEADER + ² funded project, linking it with similar projects in Finland, Ireland and France. |
| 2006 | The first on site visitor provisions are completed on the |

² LEADER+ is a European Community Initiative for assisting rural communities in improving the quality of life and economic prosperity in their local area.

| Year | Event |
|---------|--|
| | Reserve - these include the car park and an all-ability boardwalk. For the first time the public have safe, open access to a part of Flanders Moss. |
| 2006 | West Moss-side Centre is opened with indoor facilities enabling Flanders to hold demonstration and training events. |
| 2007 | Interpretative boards erected on the Flanders Moss path and detailed information about the bog is made available on the web. |
| 2009 | Viewing tower constructed alongside the boardwalk. |
| 2011 | Grazing on former plantation and ex-Scottish Wildlife Trust (SWT) reserve established. |
| 2013 | Lagg fen restoration project started on the West Moss-side farm part of Flanders Moss. |
| 2014-15 | Peatland Action Fund money for restoration works across the site. Mulching, stump flipping, cell bunding, peat damming, scrub clearance all funded and a new hydrological monitoring system. |
| 2014 | Agreement reached for future positive management across the East Moss-side farm part of Flanders Moss. |

Management of the Natural Heritage

When Flanders Moss was first declared a NNR, it was thought that it was enough to conserve only a part of the bog as a nature reserve. As our understanding of peat bogs has grown, we realised that it was necessary to gain an influence over the whole of the peat body as well as the peatland periphery. Likewise, we would need to carry out restoration works across as much of the bog as possible, if we were going to be successful in restoring the bog's hydrology and therefore the bog's vegetation.

Since 1995, we have gradually negotiated new agreements with the different landowners, each time increasing the size of Flanders Moss NNR. To date, we have successfully increased the size of the reserve from 210 ha in 1982, to about 821 ha encompassing approximately 95 % of the whole peat body. We also bought planning permission rights for £1.8 million pounds to prevent permitted commercial peat extraction from the reserve.

Throughout the life of the reserve, our whole focus for management has been to reverse the trends of drying out caused by past ditching, peat removal and the spread of trees. Ultimately, we would like to restore the water table over the whole of the peat body to a stable position as close to the surface as possible. It is only when the water table is consistently close to the bog

surface that sphagnum communities can fully recover and start the process of laying down peat again.

Over the years, we have tried a number of techniques to help restore the water table including ditch damming, lagg fen restoration, tree and scrub management and stock grazing.



Ditch damming

Damming techniques have evolved on Flanders

Sheet piling damming a ditch at Flanders Moss

Moss over the last 20 years. The first damming works we carried out on the south west corner of the reserve used oak and elm boards. These dams took a lot of labour to put in, about 4 man-days for each dam and 20 years later, some are failing. Today, our damming works use sheet piling made from recycled plastic as this is a longer lasting, more flexible and lighter material to use. We also use peat for small ditches with a low flow using blocks dug from the side of the ditch itself. Another way of slowing the flow of water off the site is to use trench damming. This involves building low bunds and closing undersurface cracks around the edge of the peat domes. In 2014 we carried

out 4km of trench damming along either side of the High Moss Pow. A bonus of these techniques is that pools form where the peat is dug out and water collects creating excellent dragonfly habitat.



Regenerating sphagnum

Over the last 15 years, we have dammed approximately 35 km of ditches, using about 1000 dams. We are starting to see the rewards of all this effort. Our monitoring of the water table levels over the last 10 years shows a higher water table over parts of the bog and on the ground, sphagnum carpets are replacing dry bog vegetation. These changes are especially apparent in areas where there is a high density of dammed ditches.

Restoration of lagg fen

During 2013-5, we started to restore lagg fen on the edge of part of the bog at West Moss-side farm. Around much of Flanders Moss, there is a deep peripheral ditch that has replaced the lagg fen that would naturally occur where the water leaks from the peat body. The ditch prevents the leaking water from flooding the neighbouring farmland but also accelerates the drying out of the bog. By using a sluice, a number of dams and bunds to keep the water level high around the edge of the bog, we managed to create some lagg fen habitat.

Tree and scrub management

Historical maps and studies of peat cores show that for most of its life Flanders Moss had few trees on it. It is thought that the tree cover on Flanders Moss has spread due to the drying out of the bog and, the cessation of grazing and burning that would have kept the bog free of trees in the past.

Trees on a raised bog can help to dry out the bog through evapotranspiration (by sucking water out of the bog and evaporation) and interception (preventing rainfall from reaching the moss surface). However it is thought that trees can form a natural component on bogs when the waterlogged conditions keep the trees stunted and scattered. This can be seen on many European bogs and the challenge at Flanders Moss is to try to reach a point where the restored water table is such that it restricts the tree growth.

We have taken a pragmatic approach to managing trees and scrub on the reserve. Our past efforts have focused on keeping open areas of bog open and free of trees, whilst leaving the areas of long established woodland and mature trees. Most trees and scrub once cut down are chopped into pieces on the bog surface and the resulting brash is left to break down and eventually become engulfed into the bog. But some trees are put through a tracked chipper and the resulting chips used to dam ditches and slow water flow of the moss.

During 1997 – 98, we also removed the 40 ha conifer plantation from the south side



Tree removal on Flanders Moss

of the reserve. Our water table monitoring showed that once the trees were removed and the ditches dammed, the water table came right back to the bottom of the furrows. Sphagnum now grows in the furrows between where the lines of trees once grew. The tops of the ridges however have been colonised by heather and birch and remain too dry for sphagnum growth. To deal with this we have used 2 techniques - mulching or stump flipping that level the plantation surface making it easier to get the water table close to the whole surface. So far we have applied these techniques to just under a half of the plantation area with more work scheduled in the next few years.

As well as trees, we have also cleared rhododendron from Ballangrew wood and in places where it has spread onto the bog. Over the past 15 years, we have successfully removed about 8 ha of heavy rhododendron cover and about 40 individual bushes. We will still need to monitor the areas cleared and remove rhododendron seedlings to prevent it from re-establishing.



Habitat restoration at Flanders Moss

Grazing

Having now removed a great proportion of the trees but still with a constant seed source, we recognised that we also needed to find a non-labour intensive way of reducing future tree regeneration onto the moss. In the past, grazing by mainly sheep and some cattle has kept Flanders Moss almost free of trees. Indeed, at Wards of Goodie and West Moss-side where the landowners have maintained grazing, there are few trees.

In 2003, SWT established an experimental grazing plot and introduced traditional breeds of sheep to browse young birch. Initial findings showed that

grazing sheep for two periods of about 4 weeks each summer can help to control further scrub encroachment but more work was needed to find suitable stocking rates that benefited the animals. In 2011 a 60 ha area of the former plantation and ex-SWT reserve was fenced and sheep introduced. The aim is not so much to control existing scrub but to reduce new trees becoming established. The long-term management aim is to increase grazing by sheep across more of the site. This would be at a very low stocking rate and takes the long-term idea of gradually changing the tree landscape of the moss by reducing the numbers of trees regenerating across the moss.

Research

Research on Flanders Moss started well before the bog became a NNR. Being one of the largest and most intact examples of a lowland raised bog it has often been chosen as a reference site for research projects. Projects have included studies on the peat body itself, the species that live on the moss and the effects of restoration management.

Coventry University have studied Flanders Moss and the Carse of Stirling for many years, looking at changing climate during and after the ice ages, and its impact on the landscape - especially the evolution of Flanders Moss itself.

Edinburgh University have studied the peat column at Flanders to investigate the changing levels of atmospheric heavy metals. They were able to show high levels of lead corresponding with peak times of lead smelting including, during the Roman period.

Flanders Moss has also been used to record the recovery of the bog vegetation when a conifer plantation is removed. Forest Research have used the site to look at effective ways of treating scrub with herbicide and the long-term vegetation recovery on the area where the plantation was removed. This work is being used to help plan other conifer removal restoration projects in Scotland. Stirling University have found it useful having a resource like Flanders close by and have used the site for remote sensing research, a long-term woodland monitoring project and various Masters and Honours student projects.

Management for People

In the past there was little tradition among local people to go out on to Flanders Moss - it had a reputation of being a difficult and treacherous place to visit. In the first years of the NNR, we too didn't actively encourage visitors to the reserve because of the difficulties of getting to the edge of the bog, the fragility of the bog surface and the hazards such as hidden, deep water-filled

ditches. Prior to 2006, the number of visitors coming to the reserve was estimated at about 300 - 400 each year – mostly those visiting through organised events.

Guiding specialist groups around the reserve is an important aspect of our work. We hold or host a range of workshops and demonstration and training events. These are tailored for different types of interests, ranging from citizen scientists, through landowners, contractors and conservation managers, to our own staff. We have covered topics such as butterflies, dragonflies, general bog ecology, conservation and management; and also peatland management restoration techniques. With access to an indoor centre at West Moss-side Farm, we anticipate more events such as these in the future. Indeed, arts and crafts workshops held in the centre are already making full use of the bog.

The greatest development has been to enable visitors open access to facilities on the Poldar Moss part of Flanders Moss NNR. There is now a re-landscaped car park, with a cycle rack and from here you can wander along a 900m all ability circular path out onto the bog and up the 7m high viewing tower. Nearly half of the path is a recycled plastic boardwalk, which allows visitors to experience true bog habitat, in a way that keeps them safe from water filled ditches and also, still protects the fragile bog surface.



Viewing tower at Flanders Moss NNR

Local school children, university students and less able groups have made full use of this new path. As well as environmental studies, the bog has inspired art, culture and music topics, so much so, that in 2006, the children of Thornhill Primary School produced a DVD called 'Art on the Moss' and in 2009 the Peat, People and Poetry project inspired bog poems that were performed at a public event at the McLaren High School in Callander. .

The moss is now visited by an estimated 8000 people a year, many are local regulars but others are visiting tourists. In 2010 a visitor perceptions study showed that though the boardwalk is only 900m long the average time people

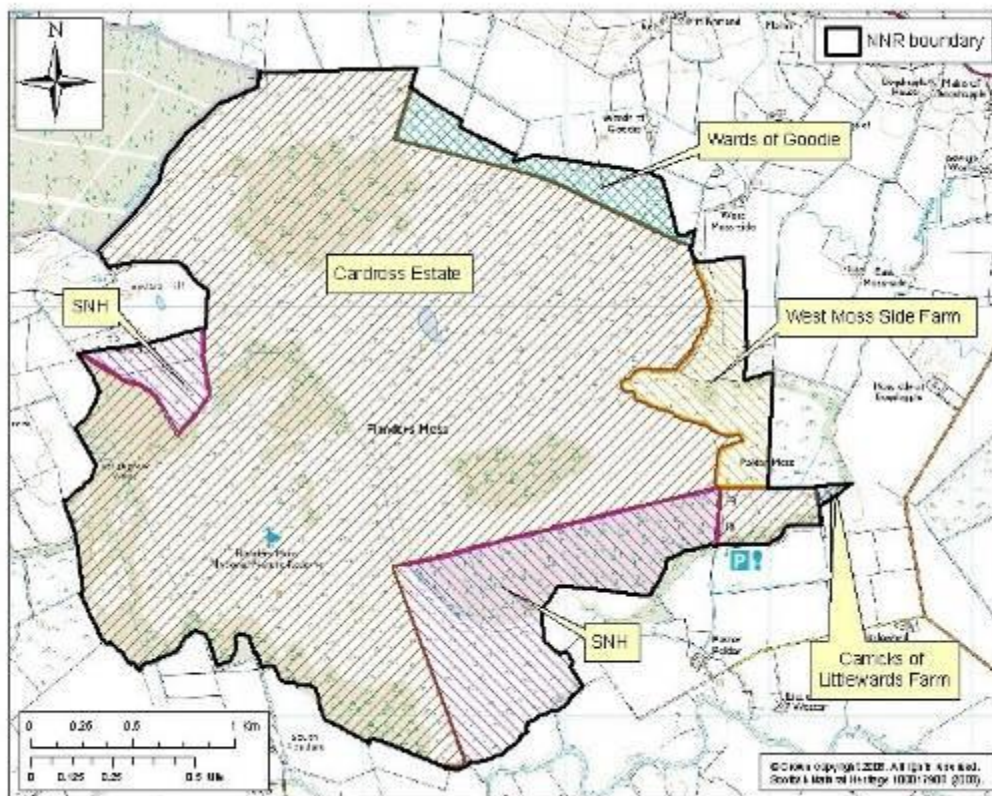
The Story of Flanders Moss National Nature Reserve

spent on site was about 1 hour. The feature of the site that visitors said they enjoyed most was the wide open unspoilt landscape and the sense of peace and quiet that came with it. We will continue to promote the site to visitors so that more can come to enjoy the moss and learn why it is important but we will work to maintain the special experience that visitors get when they spend time on the path.

5 Property Management

Five different parties own Flanders Moss NNR. Scottish Natural Heritage (SNH) only owns 108 ha of the 821 ha reserve having recently acquired 45 ha from SWT. We manage the remaining area of the reserve through Nature Reserve Agreements or leases with the other 4 private landowners. There is no built property on the reserve itself.

Map showing land ownership at Flanders Moss NNR



6 Summary

Flanders Moss NNR is recognised internationally for its natural heritage importance and value as a research and demonstration site. Our management has focused on reversing some of the damage inflicted on the bog in the past. We are now starting to see the success of our efforts and would like to share this with as many people as possible. Our aim is to make sure that Flanders Moss retains its natural character and rich biodiversity, whilst also providing visitors with the opportunity to experience and learn all about how special the reserve is. Flanders Moss also has a contribution to make in addressing climate change. Huge amounts of carbon are locked up in the peat of the moss and by restoring the water levels to the moss this will remain there and not be released to the atmosphere. By restoring the bog vegetation and in particular the sphagnum carpet this stimulates deposition of peat so locking more carbon up in the moss as time goes on.

The future management of Flanders Moss NNR is outlined in the Reserve Management Plan. Management is designed to achieve our primary aim of ensuring that the raised bog and the diversity of other habitats and important species populations are looked after in the long term.

7 Document properties

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Photographs & maps

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Links

For information about Scotland's National Nature Reserves and further information about Flanders Moss NNR please go to: [Scotland's National Nature Reserves website](http://www.nnr-scotland.org.uk) (<http://www.nnr-scotland.org.uk>)

For information on the protected areas associated with Flanders Moss NNR please go to: www.snh.gov.uk/snhi

The Story of Flanders Moss National Nature Reserve

Other useful links:

Scottish Natural Heritage

www.snh.gov.uk

Joint Nature Conservation Committee

www.jncc.gov.uk