Forestry Commission Scotland
Coimisean na Coillteearachd Alba

Strategy for Lowland Raised Bog and Intermediate Bog on the National Forest Estate in Scotland 2012-2022

Contents

Front cover: *Blood Moss, Galloway Forest District, 4th August 2010: Five years after plantation was mulched to restore intermediate bog. Surprisingly good condition bog vegetation has colonised much of the area.*

Summary

This report has been prepared to provide a framework for the conservation of Lowland Raised Bog and Intermediate Bog on the national forest estate in Scotland. It details actions which will guide Forest Districts in the management and restoration of these important habitats and informs stakeholders of our intentions.

Lowland raised bog is a rare habitat with an estimated 28,000ha in Scotland (over 800 sites), of which only 2,500ha is in a near natural state. Forestry is the main land use on 192 sites, covering approximately 10,000ha. By proportion of total habitat extent, historic forestry has probably had a larger negative impact on this habitat type than on any other open habitat in Scotland. Although forestry inevitably modifies bog hydrology, the impact is less damaging than other land uses such as agricultural land claim and commercial peat extraction. Published scientific evidence is scant, but observation of afforested sites subsequently restored indicates that worthwhile restoration from forestry can be successful.

Lowland raised bog conservation can deliver multiple benefits including biodiversity conservation, carbon sequestration and storage, flood alleviation and the protection of waterlogged archaeological deposits. Many of the best remaining examples of the habitat are designated as Special Areas of Conservation (SAC) for flora and fauna under EEC Council Directive 92/43 (the Habitats Directive); and/or designated as Sites of Special Scientific Interest (SSSI) by Scottish Natural Heritage (SNH). Lowland Raised Bogs are also a UK BAP Priority Habitat.
Intermediate bogs share characteristics of lowland raised bogs; provide similar benefits and are often more similar to lowland raised bogs in management terms than Blanket Bogs, so are included in this report.

Lowland raised bogs and intermediate bogs on the national forest estate

A detailed spatial analysis of lowland raised bogs and intermediate bogs on the national forest estate (NFE) was conducted in 2009/10 using the SNH inventory[1] and British Geological Survey data. A GIS layer was created that provisionally maps and describes the habitat (including condition attributes) on the NFE. The results show that FES manages 144 probable lowland raised bogs covering about 4,000ha; and 138 possible intermediate bogs covering about 4,500ha. FES probably manages the largest portfolio of lowland raised bogs in Scotland.

1 Lindsay, R.A. & Immirzi, C.P. 1996. An inventory of lowland raised bogs in Great Britain. Scottish Natural Heritage Research, Survey & Monitoring report. No.78

The majority of lowland raised bog and intermediate bog habitat on the NFE is currently afforested and, although about 500ha of lowland raised bog is designated as SAC and/or SSSI on the NFE, a smaller area than this is actually in a near natural condition.

Policy and strategic framework

One of the key outcomes of the Scottish Forestry Strategy, a “high quality, robust and adaptable environment” includes the objective to “help to protect and enhance biodiversity” by aiming to “restore and enhance priority habitats” (2006, 19).

Key Theme 7 (Biodiversity) notes that “the biodiversity value of some open ground habitats, such as raised bogs and internationally important blanket bogs, has been reduced in the past by poorly planned woodland expansion, encroachment or lack of appropriate management” (2006, 47). The Scottish Forestry Strategy is supported by the FCS delivery note ‘Woods for Nature Biodiversity Programme 2008-2011’.

The National Forest Estate Strategic Plan states our intention to help “restore, maintain and enhance Scotland’s biodiversity” (2009, 58); to “survey open and wooded land to identify UK Biodiversity Action Plan priority habitats and use this data to identify potential landscape scale restoration projects”; and to “restore and expand priority open ground habitats at key locations where the benefits of woodland removal outweigh the benefits of retaining woodland cover and publish action plans for key open ground priority habitats” (2009, 63).

The UK Forestry Standard and associated guidance note ‘Forests and biodiversity: UK Forestry Standard Guidelines’ (2011) include several relevant UKFS Good Forestry Practice Requirements in relation to the management and restoration of priority open habitats; evidencing these requirements contributes to our best-practice land and forest management of the national forest estate.

The UK Woodland Assurance Standard requires UKBAP priority habitats to be maintained and where possible enhanced (Section 6.1.1). UKWAS also requires valuable semi-natural habitats which have been colonised, planted or incorporated into plantations, but which have retained their ecological characteristics (or have high potential to be restored) to be identified and restored or treated in a manner that does not lead to further loss of biodiversity or cultural value (Section 6.1.3).

Existing conservation work on the national forest estate

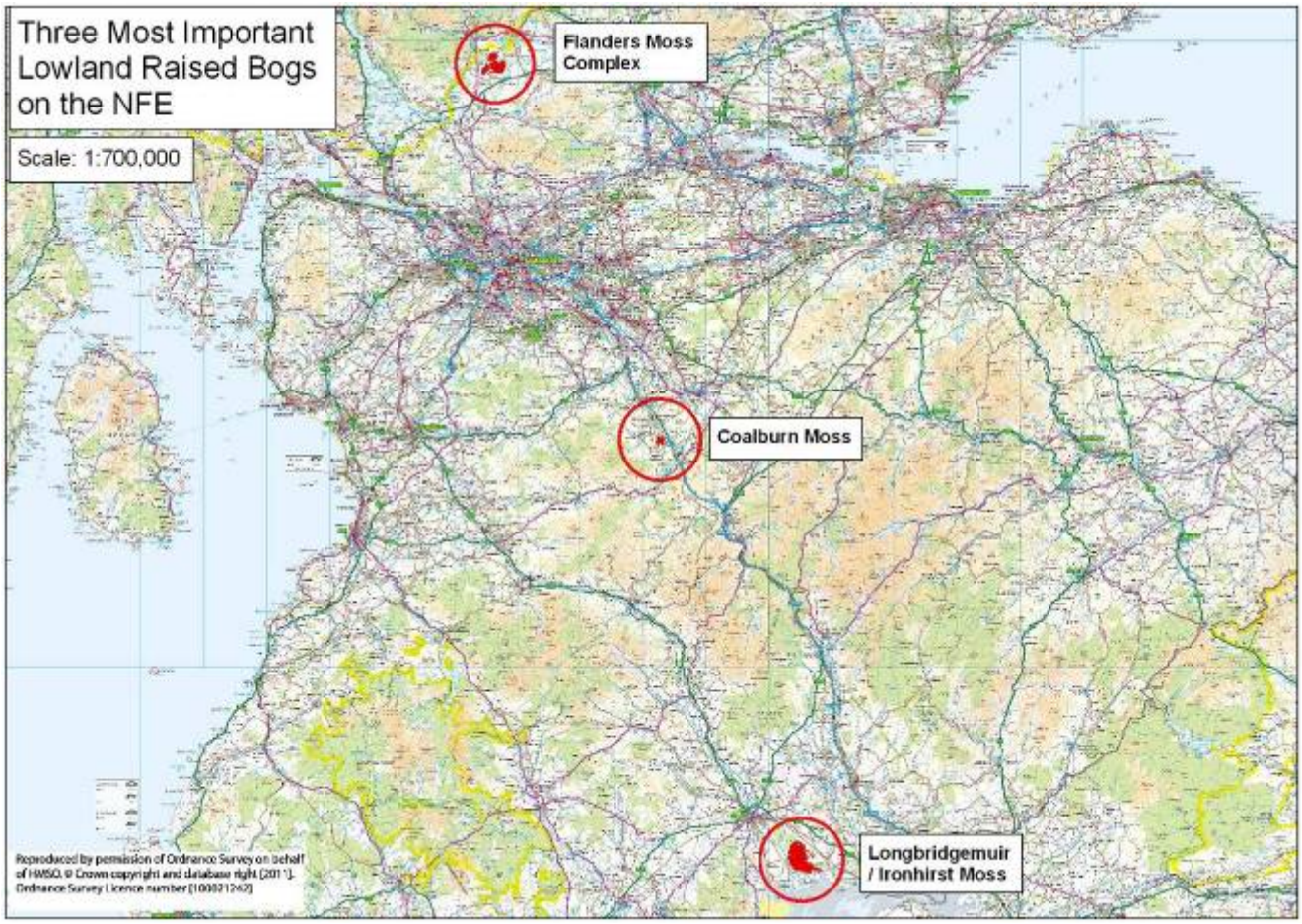
FES is currently one of the leading practitioners of lowland raised bog conservation work in the UK. In Dumfries & Borders Forest District over 350ha of plantation have been felled and over 1,200 peat dams installed at Longbridge Muir (SAC & SSSI) / Ironhirst Moss. Similar work is at an earlier stage at Flanders Moss in Cowal & Trossachs Forest District, where a wood fuel contract has harvested over 100ha of plantation to restore lowland raised bog. Ditches are soon to be blocked with plastic piling at Coalburn Moss (SAC and SSSI) in Scottish Lowlands Forest District. In addition, 70ha of habitat has been restored in Galloway at Moss of Cree and regenerating trees have been removed from sites in both Scottish Lowlands Forest District and Moray & Aberdeenshire Forest District.

Prioritising sites

Considerable field observation has been undertaken over several years to assess the current ecological and hydrological condition of individual lowland raised bog and intermediate bog sites on the NFE. 71 individual sites were assessed and if suitable, prioritised for restoration. A provisional list is provided as the basis for guiding and prioritising future restoration work for these habitats *(Appendix 3)*. Further observation of other potential key sites is recommended with a view to expanding and updating the list. Work with partners and surrounding landowners may also influence priorities. Considering both ecological interest and management opportunities, the three most important lowland raised bogs on the NFE are:

- Longbridge Muir (SAC & SSSI)/Ironhirst Moss (Dumfries & Borders Forest District); This is part of the wider Lochar Mosses partnership project with SNH.
- the Flanders Moss complex (Cowal & Trossachs Forest District); and
- Coalburn Moss (SAC & SSSI; Scottish Lowlands Forest District).

Lowland Raised Bogs



Other important lowland raised bogs on the national forest estate include 23 additional sites so far identified as potentially suitable for bog restoration.

Designated sites on the national forest estate include five lowland raised bogs which are SSSIs (three of which are also SACs) plus two intermediate bogs which are SSSIs (both of which are SACs).

Planned work

Planned conservation work for the period 2012 to 2022 includes:

- Management work to maintain and restore favourable condition status on designated sites.
- A survey programme to inform ditch blocking & scrub control on significant open bog areas.
- Progressing ongoing, high priority lowland raised bog restoration work (1,300ha at Longbridge Muir, the Flanders Moss complex and Coalburn Moss)
    - Removing all remaining mature woodland.
    - Managing regeneration on restoration sites.
    - Installing peat dams on restoration sites.
- Fencing Coalburn Moss for conservation grazing.
- Convening a FES working group to prepare a detailed costed plan for the restoration of the remaining bog restoration resource (currently 1,500ha). It will not be possible to complete this work in the plan period, but some work may begin.
- If suitable opportunities arise working with external stakeholders, partnership organisations and landowners to develop holistic, landscape scale restoration projects, like the one initiated at Lochar Mosses that SNH is leading on.
- Learning from work undertaken and adjusting future programmes and priorities in the light of the knowledge gained.

The report also contains recommendations for incorporating the above work into Forest Design plans and Work Plans and interpretation and community involvement at prominent sites.

Delivering this programme of lowland raised bog and intermediate bog conservation will establish FES as one of the key providers of open habitat conservation in the UK at a time when the scientific and political importance of bogs as carbon stores is increasing in profile.

It should be noted that acquisitions and disposals of land on the national forest estate could result in changes to the work programmes proposed within this strategy.

Habitat importance and management history

The figures below are largely taken from the SNH *Inventory of Lowland Raised Bogs* (Lindsay & Immirzi 1996).

The area of land which historically supported lowland raised bog in Britain is estimated at 66,664ha and the equivalent estimate for intermediate bog is 11,719ha. Much of these historic extents have had their peat removed to supply the horticulture industry or have been modified by other land uses such as agriculture and forestry.

No lowland raised or intermediate bog in Britain has completely natural vegetation although some near-natural vegetation survives on a proportion of sites. The estimated extent of near natural vegetation on lowland raised bogs in Scotland is 2,515ha.

There are 238 predominantly wooded lowland raised bogs in Britain, with 192 of these in Scotland. These sites were planted decades ago, when forestry policies were largely focussed on timber production alone and the biodiversity and carbon storage value of bogs was not fully understood or recognised.

There are an estimated 807 lowland raised bogs in Scotland covering 27,892ha. The largest category of lowland raised bog management in Scotland is agriculture land claim (i.e. peat removal for agriculture). There are 237 sites in this category. There is little realistic hope of restoring such sites where all or most of the dome has been removed. Forestry (both private and public) is the predominant management type on 192 Scottish Lowland Raised bogs, covering approximately 10,000ha. Forestry is less damaging than agricultural land claim, in that the dome is often maintained largely intact. Based on experience and observation it is thought that it is possible to successfully restore at least some of the lowland raised bog resource affected by afforestation.

Due to the large loss of extent and condition of these habitats many of the remaining near natural examples have been designated as Sites of Special Scientific Interest (SSSI's). The EC Habitats Directive lists "Active raised bogs" as a priority habitat along side "degraded raised bogs still capable of natural regeneration"; and has resulted in the designation of examples of each as Special Areas of Conservation (SACs). Lowland Raised Bog is also a UK BAP Priority Habitat.

Raised bogs do occur in the uplands, but these are out with the scope of this report and are best considered alongside Blanket Bog in management terms. Intermediate Bogs straddle the upland / lowland divide and are intermediate in form between lowland

raised bogs and blanket bogs. In fact there is an almost continuous range of topographical variation between lowland raised bogs through intermediate types to blanket bogs and it can be difficult and complex knowing where to draw the line. Intermediate Bogs have been included in this report as in conservation management terms they are best dealt with alongside lowland raised bogs rather than blanket bogs. Similar to lowland raised bogs, intermediate bogs are often more resilient to forestry damage than blanket bogs on account of their generally deeper peat and flatter topography. Therefore, in the case of lowland raised and intermediate bogs there often tends to be a greater opportunity for restoration from plantation. Intermediate bogs also occupy relatively discrete, limited areas like lowland raised bogs, rather than the often larger extents of blanket bogs. There are of course many exceptions to these generalisations, which relate to average macrotope size, topography and peat depth.

Extent and condition of the habitat on the national forest estate

A detailed spatial analysis of the extent and condition of lowland raised bog and intermediate bog on the national forest estate was undertaken in 2009/10. This amalgamated relevant information from various sources including:

- The SNH report: “An inventory of lowland raised bogs in Great Britain” (Lindsay & Immirzi 1996);
- The British Geological Survey (BGS) drift geology GIS theme, which maps areas of deep peat soils;
- Forestry data in the Forester GIS sub-compartment database;
- Recent ortho-rectified colour aerial photography and 1:25,000 maps from the Ordnance Survey; and
- Personal observations of a range of sites by the author and Forest Research.

Lowland peat within the national forest estate was defined using the BGS peat theme and formed the basis for a new GIS dataset. Each of the resulting polygons was remotely assessed and assigned a peatland type (lowland raised bog, intermediate bog, blanket bog or fen), using the above sources. The above sources were also used to describe the condition attributes (*see Appendix 1*) for each polygon including the land use categories (*see Appendix 2*).

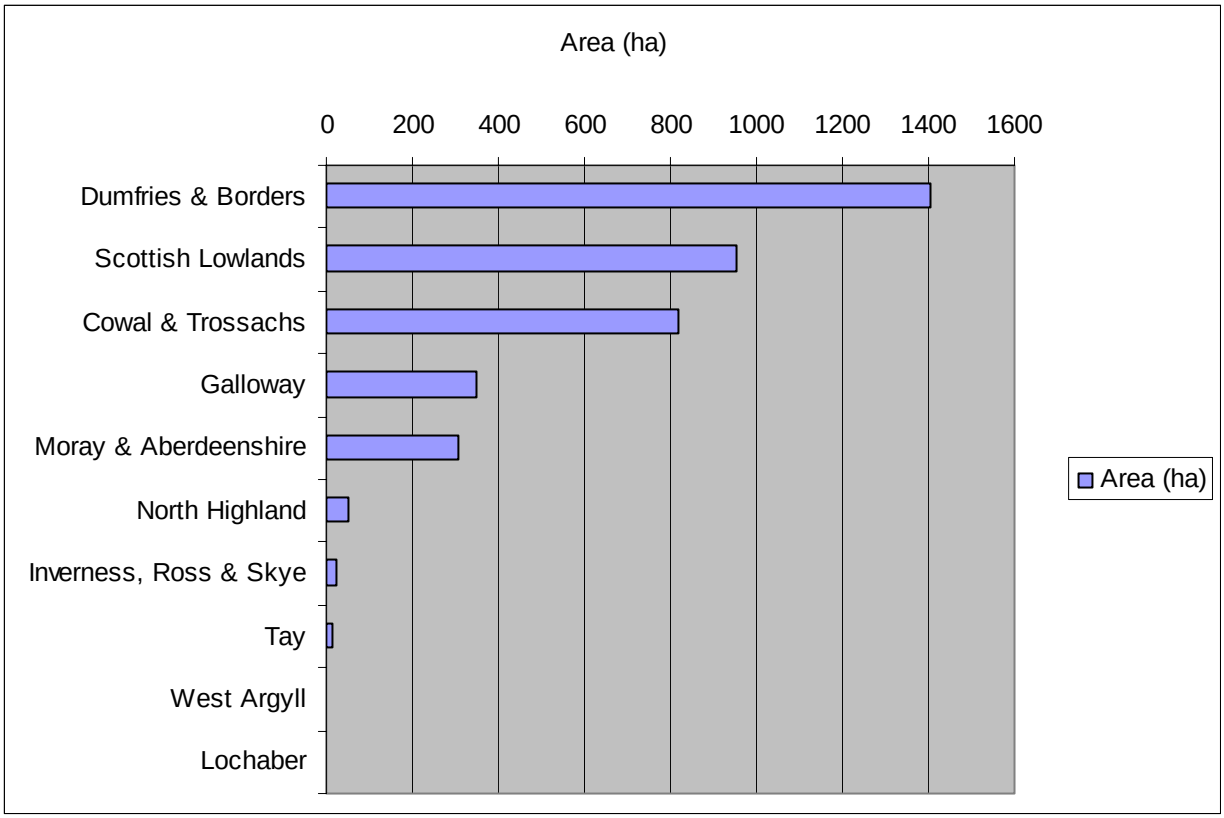
The resulting GIS dataset has greatly improved our knowledge of the lowland peatland resource on the national forest estate and has refined (and added to) the relevant information in the SNH Inventory. However, without field survey, the results are necessarily subjective and provisional. A summary of the results are given below:

Number and type of sites on the national forest estate

FES has a stake in managing at least a part of 302 lowland peatland sites.

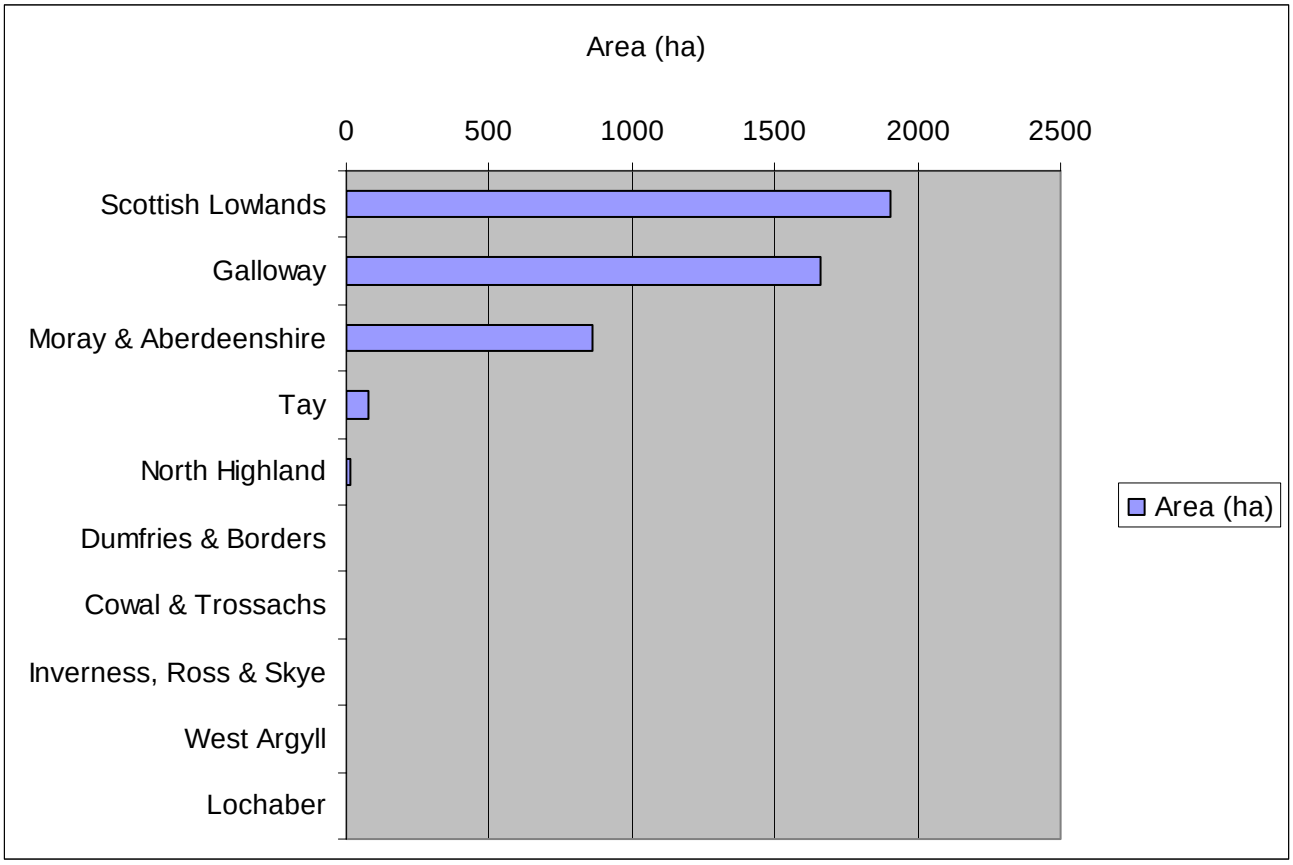
- 144 are thought to be lowland raised bogs, of which FES manages 3,915ha.
- 138 are thought to be intermediate bogs, of which FES manages 4,460ha[1].
- 17 were not categorised into one specific habitat type, but possibly included one of the above habitats, of which FES manages 260ha.
- The remaining sites are thought to be fens.

Area of lowland raised bog by forest district



[1] The intermediate bog area is likely to be the most inaccurate due to the difficulty of remotely separating this habitat from low altitude blanket bog etc.

Area of intermediate bog by forest district



Analysis of open bog and wooded areas

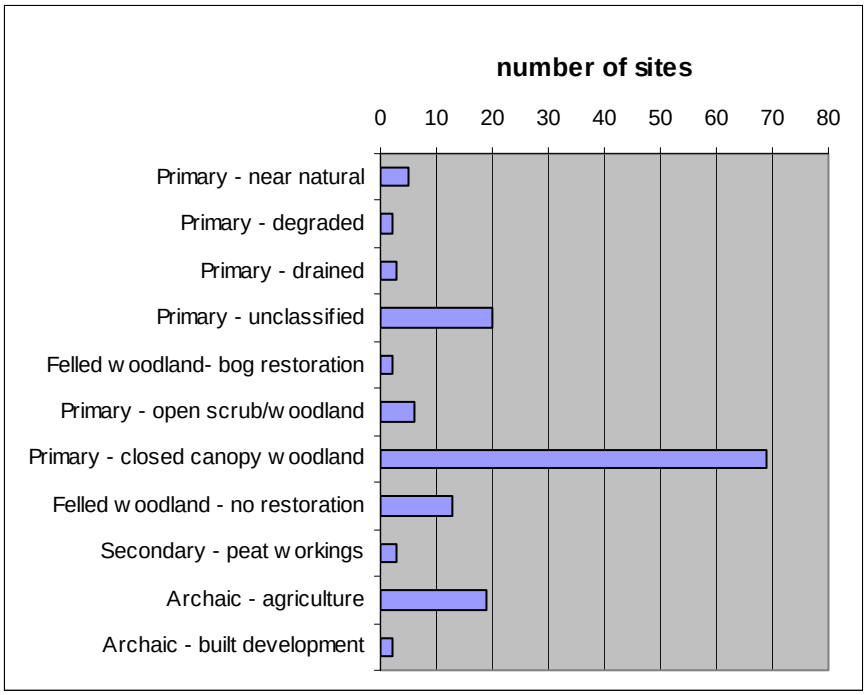
Of the 3,915ha's of lowland raised bog on the national forest estate:

- 1,374ha (35%) is open bog; and
- 2,541ha (65%) is largely wooded.

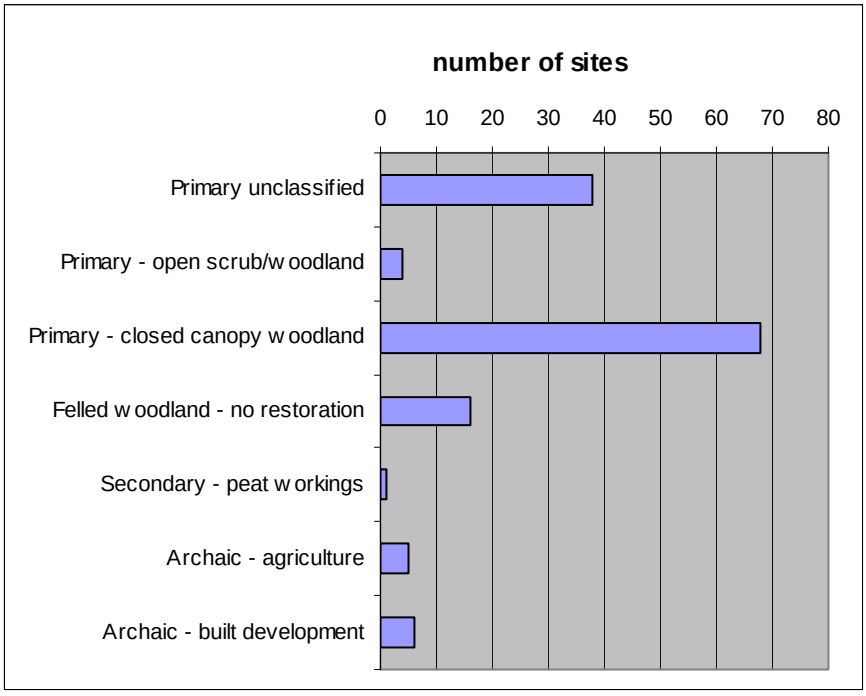
Of the 4,460ha of intermediate bog on the national forest estate:

- 1,105ha (25%) is open bog; and
- 3,355ha (75%) is largely wooded.

Main land use categories for lowland raised bogs on the national forest estate



Main land use categories for intermediate bogs on the national forest estate



SAC and SSSI designation on the national forest estate

Of the 144 sites classed as lowland raised bogs 7 are at least partly designated as SSSI. The total FES managed lowland raised bog designated area is 496ha (i.e. 13% of the lowland raised bog area managed by FES).

Of the 138 sites classed as intermediate bogs 6 are at least partly designated as SSSI. The FES managed intermediate bog designated area is 51ha (i.e. 1% of the intermediate bog area managed by FES).

SSSIs which are also SACs are highlighted in bold in the below table. In all cases the SSSI & SAC boundary are coincident within the national forest estate, except Monadh Mor, where the area of SAC within the NFE is larger by 96ha.

SSSI Lowland Raised Bogs[2]

Longbridge Muir	Dumfries & Borders Forest District	313ha
Coalburn Moss	Scottish Lowlands Forest District	126ha
Lockshaw Mosses	Scottish Lowlands Forest District	30ha
Monadh Mor[3]	Inverness, Ross & Skye Forest District	19ha
Loch Macanrie	Cowal & Trossachs Forest District	15ha

SSSI Intermediate Bogs[2]

Forest of Alyth Mires	Tay Forest District	45ha
Hassockrigg & North Shotts Mosses	Scottish Lowlands Forest District	3ha

[2] Only sites where FES manages >2ha of SSSI/SAC on peatland are listed.
[3] At Monadh Mor only the SAC features, bog woodland and quaking mires are relevant to lowland raised bog.

Policy and strategic framework

One of the key outcomes of the Scottish Forestry Strategy, a "high quality, robust and adaptable environment" includes the objective to "help to protect and enhance biodiversity" by aiming to "restore and enhance priority habitats" (2006, 19).

Key Theme 7 (Biodiversity) notes that "the biodiversity value of some open ground habitats, such as raised bogs and internationally important blanket bogs, has been reduced in the past by poorly planned woodland expansion, encroachment or lack of appropriate management" (2006, 47). Of the actions proposed to reverse biodiversity decline, the following are relevant to lowland raised and intermediate bogs:

- "Achieve favourable conservation status for woodland and associated open habitats in Sites of Special Scientific Interest (SSSIs), Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites [a Priority action];
- Restore and improve the condition of native woodlands and associated open habitats in line with the UK Biodiversity Action Plan's revised Habitat Action Plans and Species Action Plans [a Priority action]; and
- Restore and expand priority open ground habitats at key locations where the benefits of woodland removal outweigh the benefits of retaining woodland cover" (2006, 48).

The FCS delivery note 'Woods for nature: biodiversity programme 2008 – 2011' notes that "for priority open habitats and wood pastures our main effort for non-designated sites will be help to safeguard and enhance significant existing areas in and around woodlands, e.g. through sensitive location, design and restructuring of forests as opportunities arise at time of felling. We may also support larger scale restoration from forest to open habitats in cases where there would be clear and significant net public benefits which outweigh our general presumption against deforestation." The note continues: "we will take suitable opportunities to enhance or restore priority open and wood pasture habitats on the national forest estate as we restructure forests and… will publish proposals for open habitat restoration on the national forest estate" (2008, 9).

'Woods for nature' lists the following relevant actions:

- "Work with SNH to help prevent or reverse damage caused by woodland to non-woodland designated sites"; and particularly
- "Take opportunities to enhance or restore priority open and wood pasture habitats, and publish proposals for the national forest estate" (2008, 25).

The National Forest Estate Strategic Plan states our intention to help "restore, maintain and enhance Scotland's biodiversity" (2009, 58); to "survey open and wooded land to identify UK Biodiversity Action Plan priority habitats and use this data to identify potential landscape scale restoration projects, especially in areas of Scotland which have not yet had projects identified to date"; and to "restore and expand priority open ground habitats at key locations where the benefits of woodland removal outweigh the benefits of retaining woodland cover and publish action plans for key open ground priority habitats" (2009, 63).

The Scottish Government target for designated site condition is to achieve favourable or recovering condition status for 95% of the features on designated sites.

The UK Forestry Standard and associated guidance note 'Forests and biodiversity: UK Forestry Standard Guidelines' (2011) notes that "significant gains for biodiversity can arise from creating new habitats and restoring degraded ones. Restoration of former habitats is most beneficial where the original features survive and the re-establishment and management of a functional ecosystem over the longer term is a practical possibility" (2011, 27). It goes on to note that "some forests have been established on what are now recognised as UKBAP priority open ground habitats, such as bogs and heaths. Although there is a general presumption against deforestation, some of these sites may have potential for restoration where this offers significant benefits for biodiversity" (2011, 28).

Relevant UKFS Good Forestry Practice Requirements include:

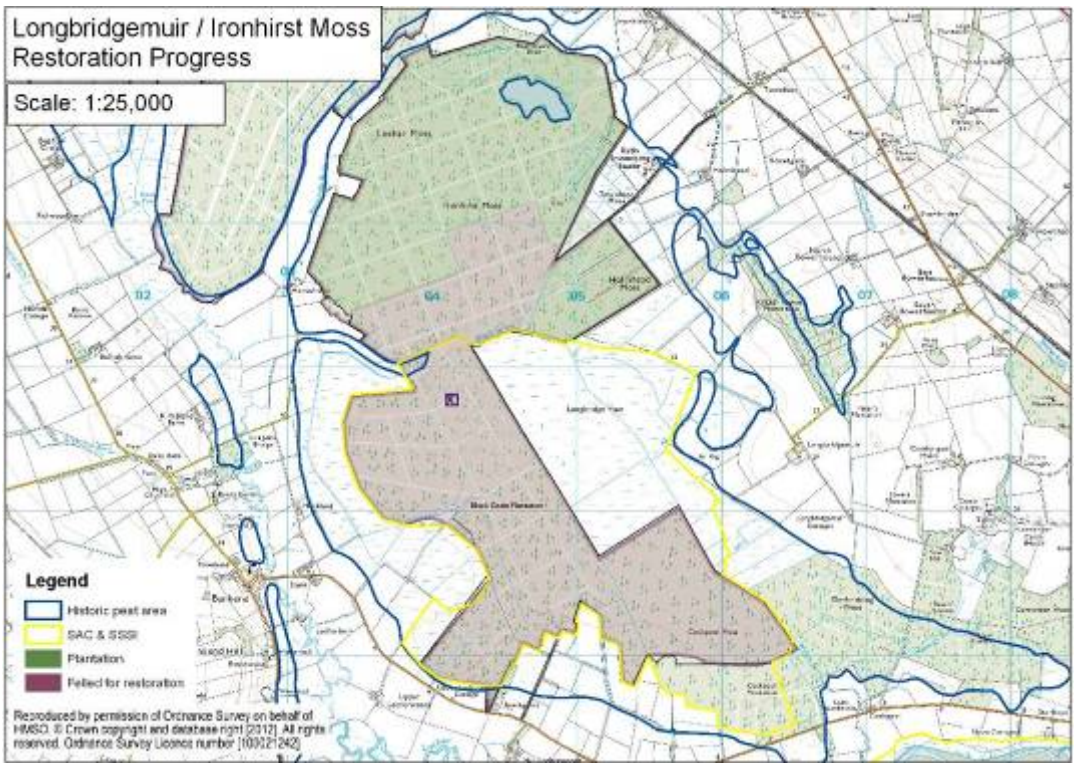
- [4] Particular consideration should be given to conserving, enhancing or restoring priority habitats and species identified in the UK Biodiversity Action Plan, through the delivery of country strategies and local level plans (2011, 13).
- [26] Consider practical opportunities to restore open habitats where their value could be reinstated and sustained (2011, 25).
- [28] Ensure wetland features such as springs, flushes and bogs are protected, and take opportunities to restore degraded features (2011, 25).
- [36] Consider creating or restoring semi-natural habitats: prioritise special and designated sites, extensions to them, and areas beneficial for priority species or habitats (2011, 28).

The UK Woodland Assurance Standard requires UKBAP priority habitats to be maintained and where possible enhanced (Section 6.1.1). UKWAS also requires valuable semi-natural habitats which have been colonised, planted or incorporated into plantations, but which have retained their ecological characteristics (or have high potential to be restored) to be identified and restored or treated in a manner that does not lead to further loss of biodiversity or cultural value (Section 6.1.3).

Existing habitat conservation work on the national forest estate

Much important lowland raised bog and intermediate bog conservation work is already underway, or has been completed on the national forest estate in Scotland and significant progress has been made on the three most important lowland raised bog sites at Longbridge Muir / Ironhirst Moss and Coalburn Moss, both SACs and the Flanders Moss complex.

At 680ha the Longbridge Muir / Ironhirst Moss macrotope (Dumfries & Borders Forest District) is the largest lowland raised bog on the national forest estate. Between 2001 and 2003 major work was undertaken to fell 317ha of plantation and install 1,216 individual peat dams. This was part of an EU Life funded partnership project with Scottish Natural Heritage and the Scottish Wildlife Trust. Following the initial restoration work the challenges of bog restoration have become apparent on this site with tree regeneration and peat cracking both being major issues. Considerable follow-up effort has been undertaken including repeated tree regeneration removal on the restoration area. Some areas have had tree regeneration removed three times. The battle against the tree removal threat is gradually being won and new areas of bog are being restored, with about 50ha of plantation felled on the southern edge of Ironhirst Moss in 2009. Work is continuing here to block ditches and introduce conservation grazing to the site, to control tree regeneration and improve the condition of the bog vegetation.



The Lochar Mosses incorporates the Longbridgemuir & Ironhurst macrotopes and is part of a wider partnership project. SNH is leading on the wider partnership project, to look at landscape scale restoration. This will involve working closely with neighbouring landowners and other organisations.

Ironhirst Moss, Dumfries & Borders Forest District, 3rd October 2010: One year after harvesting plantation to restore lowland raised bog. No ditch blocking has yet taken place, but already water levels are near the peat surface in the dome centre.

At the Flanders Moss complex (Cowal & Trossachs Forest District) similar work is progressing, but is at an earlier stage. A long term wood fuel contract has been established to harvest the plantation on four lowland raised bogs (Flanders Moss West, Gartrenich Moss, Garchell Moss and Arnochoile Wood Moss / Easterhill Moss). Work was initially hampered by the very wet ground conditions, but new lighter machinery has been brought in and work is now progressing. Significant progress has been made on the largest site, Flanders Moss West, with about a third of the plantation, over a hundred hectares, removed from the lowland raised bog in 2010.

The management work at Coalburn Moss in Scottish Lowlands Forest District reflects the different nature of the site in comparison with the above afforested lowland raised bogs. The site is largely free from trees and instead is non-wooded primary bog. Accordingly, conservation work here focuses on removing the relatively small amounts of tree and scrub regeneration and using plastic piling to block the ditches associated with historic agricultural improvements and domestic cutting. Work is ongoing to block ditches with plastic piling following detailed recommendations from SNH.

In addition to the major work being undertaken on the largest and most significant sites conservation work has also progressed on other parts of the lowland raised and intermediate bog resource on the national forest estate. In 2001/2 60ha of plantation was felled at Moss of Cree in Galloway and the ends of plough furrows were dammed with peat to restore lowland raised bog. Since then regeneration has been removed and the site is progressing well towards a reasonably good condition lowland raised bog.

At Blood Moss in Galloway 10ha of plantation immediately adjacent to the SSSI was mulched in 2005 to restore an area of intermediate bog and benefit the condition of the adjacent SSSI and water course. This was undertaken as part of a wider EU Life Atlantic Salmon project with several agency partners. The bog vegetation recovery on this site is particularly impressive.

Work has also been undertaken in Scottish Lowlands Forest District including 10ha of ditch blocking at a lowland raised bog at Drumbow Forest in Forest in 2002; and 1ha of plantation felled on the edge of Cobbinshaw Moss SSSI, an intermediate bog in 2004. In Moray and Aberdeenshire Forest District 13ha of plantation was felled to restore lowland raised bog at Rack Moss in 2005; 5ha of plantation was removed from Moss of Leith Hall to restore intermediate bog in 2006; and 8ha of regeneration was cleared on Gow Moss to maintain open areas of intermediate bog in 2009.

The above portfolio of previous and current work demonstrates that FES is one of the leading organisations involved in lowland raised and intermediate bog conservation in the UK.

Prioritising sites for future work

Considerable research and site survey work has been undertaken by Forest Research, FES staff and contractors over the last several years to assess the current condition and relative value of individual lowland bogs on the national forest estate.

Sites assessed in the field: 71 sites

As part of an exercise to inform this strategy, site reports were prepared for an initial 71 lowland peatlands where information was available to produce a rank order of restoration importance for each of these sites. The initial survey work involved observations of several variables including:

- **Hydrology**: Presence of ditches and whether dry or with standing or flowing water; peat cracking and other drainage features;
- **Vegetation and flora in rides**: Including presence of natural M18 vegetation or degraded M25 vegetation (National Vegetation Classification communities[1]); positive indicator species such as Bog-rosemary *Andromeda polifolia*, Cranberry *Vaccinium oxycoccus* or *Sphagnum magellanicum*; or negative indicator species such as Purple Moor-grass *Molinia caerulea* or *Polytrichum commune* (if abundant);
- **Tree growth:** Noting if the trees were growing well, indicating a dry bog, whose hydrology had been significantly modified; or if the trees were growing poorly due to drainage failure and high water levels; and
- **Bog topography**: Including size, slope and the ratio of rand slope to dome.

For each of the initial 71 sites, the following questions were considered and categories assigned:

- Is the site worth restoring? (Yes / No);
- What is the current ecological value of the site? (Very High / High / Medium / Low);
- What is the potential ecological value if the site is restored / managed? (Very High / High / Medium / Low);
- What is the rate of deterioration if the site is not restored? (Fast / Slow); and
- What is the relative priority for restoration, based on the above?

1 Rodwell, J.S. Ed. British Plant Communities Volume 2: Mires and Heaths. Cambridge University Press 1998.

The size and percentage of the macrotope on the national forest estate was also considered and sites where FES manages only a small proportion were omitted.

Despite some limitations with the methodology, this ranking exercise provided a useful guide as to which sites may be worth restoring from plantation and an approximate order of restoration priority. The sites where restoration is considered worthwhile are listed in approximate order of restoration priority in A*ppendix 3*, where restoration areas are also listed.

Sites assessed remotely: 302 sites

Although many of the most obviously important sites have been included in the above analysis there are many other sites which have not yet been visited and described. A detailed spatial analysis of the extent and condition of lowland raised bog and intermediate bog on the national forest estate was undertaken in 2009/10, resulting in an expanded dataset indicating 302 lowland peatland sites on the national forest estate. The additional unvisited sites have been roughly grouped and prioritised as a desk exercise using the condition attributes described in *Appendix 1,* providing a rough order of condition for bogs where site reports are not yet available.

The ranking was derived by firstly sorting in descending order of condition by “major land use” and then in descending order of condition by “best land use”. The groups of bogs in each land use combination were then sorted in descending order of macrotope size.

Once the above sorting was completed each site was then given a rank order number from 1 to 302; in general terms, the lower the number the better the condition of site and importance for nature conservation. The ranking should be used as a guide only but gives a useful indication of the relative condition and importance of individual lowland raised bogs and intermediate bogs on the national forest estate, if interpreted with the limitations of the analysis in mind.

As part of this analysis the bogs were grouped into the following six categories:

(1) FES Bogs which are largely open.
(2) FES bogs which are largely open canopy woodland.
(3) FES Bogs which are largely closed canopy woodland.
(4) FES Bogs which are largely felled woodland or where restoration has begun.
(5) FES Bogs which have largely had their peat harvested.
(6) FES Bogs which have largely had their peat totally removed.

This categorisation facilitates the consideration of groups of bogs which have similar opportunities for restoration or other conservation management. For example, bogs in **Category 1** represent our finest remaining examples of the habitat and are the most important nature conservation sites (in terms of current ecological value) and should be protected accordingly. Appropriate management of Category 1 sites includes scrub control and ditch blocking to reinstate the water level if required. Ditch blocking is usually undertaken using plastic piling, so as not to damage high quality existing bog vegetation.

Bogs in **Category 4**, where restoration has begun, are generally the second most important nature conservation sites (in terms of current ecological value), but have more potential to improve in value as restoration progresses and the site recovers. Regeneration of trees on these sites tends to be more prolific and two or more rounds of scrub control are often required. Ditch blocking is best with peat dams in these cases as there is usually little vegetation interest to disturb, vegetation will recover in due course. Management of Category 4 sites, where restoration has begun, is aimed at maintaining restored areas free from scrub and moving them towards decent condition active bog vegetation if a reasonably natural water table can be reinstated.
Category 4 sites which are largely felled but restoration is not currently planned will be assessed for restoration potential before restocking.

Bogs in **Categories 2** and **3** are generally the third most important groupings (in terms of current ecological value), but are the groupings with the most potential to improve towards open bogs with decent condition bog vegetation and a functioning hydrology if successfully restored. Due to this potential (and as they represent the largest categories by far), they represent a significant conservation opportunity.

Categories 5 and **6** generally have low conservation value; the peat has been largely removed, and with it the prospects of worthwhile bog restoration. Given the poor prospects of successful restoration there will generally be no conservation work undertaken on sites in these categories. Exceptions may occur where conservation work would be appropriate, where for example primary bog exists, but is not the largest category by area on the site.

Action

[1] Management work to maintain and restore favourable condition status on designated sites

The Scottish Government target for designated site condition is to achieve favourable or recovering condition status for 95% of features on designated sites. Work on designated lowland raised bog and intermediate bog on the national forest estate will usually be given priority over non designated sites and will be agreed with Scottish Natural Heritage.

[2] A survey programme to prescribe management work on bogs with significant areas of open ground.

A survey method will be developed, including aerial photography interpretation provisionally mapping ditches and other relevant features; followed by ground survey to gain an understanding of the hydrological functioning of each site and its management requirements. Following this, a survey programme will be undertaken on open lowland raised bog and intermediate bog on the national forest estate. Twenty eight lowland raised bogs and intermediate bogs with significant areas of open ground (covering 1,020ha) have been highlighted for survey (*see Appendix 4*).

The survey data will allow the prioritisation of sites in this category for management and the production of detailed management plans. All relevant sites will be surveyed and plans will be drawn up for all sites where management is considered appropriate by 2017. Work may begin during the strategy period on some of the most important sites.

[3] Complete current / ongoing high priority lowland raised bog restoration work

Completing the work currently being undertaken at Longbridge Muir (SAC & SSSI) / Ironhirst Moss and the Flanders Moss complex is a high priority. The main objective is to remove all mature woodland from the relevant lowland raised bog domes by 2022. This will complete the restoration of the majority of 1,300ha of lowland raised bog (see *appendix 3, table 1).* Due to the large areas and costs involved, as much of the timber will be harvested as possible to offset the costs - although it is likely that much of the timber will be harvested at a loss.

Tree regeneration on bogs restored from plantation is a significant problem - which needs to be tackled more urgently on recently restored sites than those which are existing open ground. Regeneration removal will be undertaken in all areas which have been felled by 2022, where required and on an ongoing basis. The objective is that no tree regeneration over 2m will be present on felled to restore areas by 2022. This target will also apply to the relatively small areas which have been felled to restore elsewhere in other forest districts.

Restoration sites will also require ditch blocking. Hydrological survey work of all felled to restore areas will be undertaken, with peat dams being installed as appropriate. The latter may depend on wider stakeholder & neighbour discussions and agreement for some sites.

[4] Reinstate conservation grazing at Coalburn Moss

Coalburn Moss (SAC and SSSI; Scottish Lowlands Forest District) is the single largest area of primary open lowland raised bog on the national forest estate. Reinstating the previous grazing regime will be highly beneficial in maintaining and improving the condition of the bog, controlling tree regeneration and encouraging better condition vegetation. The objective is to see fencing and associated infrastructure installed and grazing reinstated at an appropriate stocking level by 2017.

Delivering the above four targets will be a massive contribution to lowland raised bog conservation in the UK. It will almost complete 1,300ha of lowland raised bog restoration on some of the largest and most important sites and secure favourable conservation status on designated sites on the national forest estate.

This would be an important achievement when considered against the approximate 7,200ha of primary un-forested lowland raised bog estimated to be present in Scotland (Lindsay & Immirzi 1996). Using these figures, restoring nearly 1,300ha of bogs described in the above section would increase the area of primary open lowland raised bog in Scotland by up to 18%.

[5] Initiate further lowland raised bog and intermediate bog restoration work on other plantation sites which are ecologically suitable for restoration

The ranking exercise previously described provided a useful guide as to which sites may be worth restoring from plantation and an approximate order of restoration priority. The additional sites where restoration is considered worthwhile are listed in order of restoration priority in A*ppendix 3, table 2*, were restoration areas are also listed. Twenty three sites where it is thought that lowland raised/intermediate bog restoration from plantation forestry may be possible and desirable are included.

The potential restoration area of these bogs (the total area currently covered in trees) is 1,513ha. This is an important conservation opportunity when it is considered against the approximate 7,200ha of primary un-forested lowland raised bog and 1,873ha of primary un-forested intermediate bog estimated to be present in Scotland (Lindsay & Immirzi 1996). Using these figures, restoring the bogs described in this section in addition to the 1,300ha of bogs described in the previous section would increase the area of primary open lowland raised bog and intermediate bog in Scotland by up to 31% - a significant achievement.

Given the resources required to undertake this additional work and the higher priorities outlined above completion of this work will not take place within the current ten year strategy. However, as these sites continue to be exposed to the effects of tree growth and drainage and could deteriorate in condition, planning work (and some physical restoration) will begin within the current ten year strategy where deemed necessary.

An FES working group, comprised of operations and environmental staff will be set up to progress this work. It will be sensible to use the priority order for restoration as a guide only and factors such as cost, availability of equipment, budget and knowledge gained from previous work, etc will also determine the actual order of restoration. The working group will prepare a costed plan for the restoration of these afforested sites by April 2017.

[6] Undertaking further assessments of restoration suitability

A further sixty four sites, which may offer good prospects for restoration, have been identified for survey (*see Appendix 5*). The sites have been selected as they have either sparse tree cover and/or significant open areas, or are larger sites, likely to be more resilient to forestry and drainage. This gives an overall area of 3,372ha selected for future site assessments. Any further sites which are deemed suitable for restoration will

be prioritised, relative to the known sites, and added to the relevant sections of the strategy.

[7] Integrate lowland raised bog and intermediate bog GIS data and the Lowland Bog Strategy in Forest Design Plans and Work Plans

Restoration work and other relevant management in the Lowland Bog Strategy will be incorporated into all relevant Forest Design Plans (ensuring the correct permissions). The lowland raised bog and intermediate bog spatial data created as part of this strategy will be made available to Forest Districts. This will allow relevant opportunities for conservation work to be identified by Forest District staff during Forest Design Plan and Work Plan preparation. There will be a presumption against any restocking on sites which have been identified as suitable candidates for open habitat restoration on the basis of ecological advice.

[8] Explore interpretation, community access and community involvement at prominent sites

Flanders Moss West is one of the most accessible lowland raised bogs on the national forest estate on account of a Sustrans route for walkers and cyclists. Once restoration has progressed the site will be a good candidate for interpretation and/or enhanced visitor facilities. Scottish Lowlands Forest District is well placed for involving local communities in lowland raised bog management and education. There are sites, such as Mossband, Shotts where local community / school involvement could be encouraged. The site is small and at a practical scale for supervised voluntary work such as scrub cutting and ditch blocking - action that both makes a difference and volunteers can feel proud of. The Lochar Mosses project will also in the longer term provide opportunities for wider interpretation.

Appendices

Appendix 1: Attributes for lowland peatland GIS polygons

The below table explains the attributes used to describe lowland raised bog and intermediate bog on the national forest estate (NFE). A GIS layer has been developed mapping all such peatlands and capturing the below attribute data to describe each site (see page 10).
The resulting data has been analysed to describe the habitat resource on the NFE (Pages 11-14) and roughly prioritise and group sites in conservation terms (Pages 21–22).

Attribute	Units/Categories	Description
Reference number	Numeric	A unique number so that each bog can be identified. The numbers are in approximate order of condition. The lower numbers being better condition bog.
Peatland name	Text	Unique name for each site, to aid identification.
Peatland type	Raised/Intermediate /Blanket/Fen	Defines the peatland habitat type using categories based on topography and hydrology.
Peatland Type Source	Text	The source of information for the above category.
Forest Block	Text	The name of the Forest Enterprise Scotland management unit the peatland occurs in.
Forest District	Text	The name of the Forest Enterprise Scotland administrative area the peatland occurs in.
Grid Reference	Ordnance Survey grid reference in format “AB123456”	Site centroid of peatland area.
Macrotope area	Hectares	The total area of the whole peatland system, defined by BGS mapping.
FES peat area	Hectares	The area of the above macrotope on the national forest estate.
FES ownership	Percentage	The percentage of the macrotope area on the national forest estate.
FES open land	Hectares	The area of open bog on the national forest estate.
Major land use	Land use categories (see appendix 2).	The largest land use class for the macrotope as a whole.

Best land use	Land use categories (see appendix 2).	The best condition land use class for the macrotope as a whole.
Land use comment	Text	Describes how the above land use categories were identified.
P1 area (Primary – near natural area)	Hectares	The area of near natural bog on the macrotope as a whole. (I.e. both within and out with the NFE if applicable).
P2 & P3 area (Primary degraded or drained area)	Hectares	The area of primary degraded and drained bog on the macrotope as a whole. (I.e. both within and out with the NFE if applicable).
2nd rotation area	Hectares	The plantation area within the NFE, which has been felled and restocked.
Planning area	Hectares	The area of planning consent for peat extraction in each macrotope. **Note:** the figures may be out of date in some cases.
Macrotope SSSI area	Hectares	The area of SSSI within the whole peatland system on each site.
FES peat SSSI area	Hectares	The area of the site on the national forest estate which is both peatland as defined by BGS and SSSI as designated by SNH.
Main planting year	Date (YYYY)	The year in which the largest proportion of the peatland on the NFE was planted if applicable.
Best planting year	Date (YYYY)	The most recent year in which any part of the peatland on the NFE was planted.
Species	FES GIS abbreviations, i.e. Bi = Birch.	All tree species planted on the NFE within the site are listed in approximate order of abundance.
Comments	Text	Any other important notes.

Appendix 2: Land use categories

The below system was adapted from Lindsay & Immirzi 1996 to describe the condition of individual lowland raised bog and intermediate bog sites on the national forest estate in gross land use terms. This information has been incorporated into a GIS theme (see page 10 and *appendix 1*).
The resulting data has been analysed to describe the habitat resource on the NFE (Pages 11-14) and roughly prioritise and group sites in conservation terms (Pages 21–22).

The following terms are used:

Primary: The peat dome is intact, with little or no peat harvesting.
Secondary: The peat dome has been significantly modified by peat harvesting.
Archaic: The peat dome has been largely removed by harvesting or land claim.
Note: F1 and F2 tend to occur mostly, but not exclusively on primary domes.

The land use categories are listed below in order of declining condition:

Land use category code	Land use category type
P1	Primary – near natural.
P2	Primary – degraded.
P3	Primary – drained.
F1	Felled woodland – bog restoration.
P4	Primary – open canopy scrub or woodland.
P5	Primary – closed canopy woodland.
F2	Felled woodland – no bog restoration planned.
S1	Secondary – regenerating and revegetating.
S2	Secondary – commercial or domestic workings.
A1	Archaic – agriculture.
A2	Archaic – built development.

Appendix 3: Ongoing and potential future lowland raised bog and intermediate bog restoration on the national forest estate.

In the below two tables ongoing restoration sites (part 1) and potential future restoration sites (part 2) are listed in order of suggested restoration, based on ecological value.

Table 1

The below table relates to recommendation (3) "Complete current / ongoing high priority lowland raised bog restoration work".

Site name	Forest District	Site area (ha)
Ironhirst Moss & Longbridgemuir	Dumfries & Borders	681
Garchell Moss	Cowal & Trossachs	122
Flanders Moss West	Cowal & Trossachs	382
Gartrenich Moss	Cowal & Trossachs	193

Table 2

The below table relates to recommendation (5) "Initiate further lowland raised bog and intermediate bog restoration work on other plantation sites which are ecologically suitable for restoration".

Site name	Forest District	Restoration area (ha)	Provisional tree removal Method
Racks Moss	Dumfries & Borders	**385**	Brush cut, mulch & economic harvest.
Nether Bracco Moss	Scottish Lowlands	**57**	Mulch or fell to waste.
Lockshaw Moss	Scottish Lowlands	**37**	NA.
Easter Drumclair Moss	Scottish Lowlands	**5**	Road to harvest and fell to waste.
Cardross Moss	Cowal & Trossachs	**74**	Mulch.
Dun Moss	Scottish	**14**	Fell to waste regeneration.

	Lowlands		
Annabaglish Moss South	Galloway	**222**	NA
Gow Moss	Moray & Aberdeenshire	**253**	Economic harvest & fell to waste regeneration.
Knockmountain Moss	Scottish Lowlands	**4**	Fell to waste regeneration.
Murdostoun	Scottish Lowlands	**99**	Mulch or fell to waste.
Allanton	Scottish Lowlands	**17**	Mulch or fell to waste.
Blairderry Moss West (east of site)	Galloway	**38**	NA
Flow of Dergoals West	Galloway	**35**	NA
Dirnean	Galloway	**16**	NA
Knock of Luce	Galloway	**28**	NA
Carnwath Moss	Scottish Lowlands	**66**	Road to harvest and fell to waste.
Mossband	Scottish Lowlands	**10**	Brush cutting and felling to waste.
Salterhill Moss	Scottish Lowlands	**4**	Economic harvest & brush cutting.
Castle Greg	Scottish Lowlands	**1**	Mulch or fell to waste.
Annabaglish Moss North	Galloway	**36**	NA
Muirhead Moss	Scottish Lowlands	**19**	Mulch or fell to waste.
Camilty Moss	Scottish Lowlands	**51**	Economic harvest.
Woodend Moss	Scottish Lowlands	**42**	Mulch or fell to waste.

Appendix 4: Lowland raised bog and intermediate bog with significant areas of open ground identified for management survey

The below table lists, in decreasing order of survey area, bogs which have been shortlisted for surveys to prescribe management such as ditch blocking etc (See topic (2) on page 23).

A total area of 1,020ha has been highlighted for survey.

Site name	Bog type	Forest District	Reason for survey	Survey area (ha)
Longbridgemuir	Raised	**Dumfries & Borders**	Restoration	**352**
Fannyside Muir	Intermediate	**Scottish Lowlands**	Largely open	**141**
Gow Moss	Intermediate	**Moray & Aberdeenshire**	Significant open area	**91**
Lockshaw Moss	Raised	**Scottish Lowlands**	Significant open area	**76**
Moss of Cree	Raised	**Galloway**	Restoration	**64**
Culponach Moss	Intermediate	**Tay**	Largely open	**51**
Longriggend Moss	Intermediate	**Scottish Lowlands**	Significant open area	**49**
Monadh Mhor	Raised	**Inverness, Ross & Skye**	Largely open	**22**
Mossband	Raised	**Scottish Lowlands**	Largely open	**19**
NS86.4	Raised	**Scottish Lowlands**	Largely open	**17**
Din Moss	Raised	**Scottish Lowlands**	Restoration	**17**
NS86.3 & NS86.b	Raised	**Scottish Lowlands**	Largely open	**16**
Herricks Moss	Intermediate	**Moray & Aberdeenshire**	Significant open area	**15**
Easter Drumclair	Raised	**Scottish Lowlands**	Largely open	**12**
Moss of Cairnty	Intermediate	**Moray & Aberdeenshire**	Significant open area	**12**
Moss of Leith Hall	Intermediate	**Moray & Aberdeenshire**	Largely open	**11**
Fauldhouse Muir	Intermediate	**Scottish Lowlands**	Largely open	**10**

Drumbow Moss East	Raised	**Scottish Lowlands**	Largely open	**10**
Thiefs Burn Moss	Intermediate	**Tay**	Largely open	**9**
Glaikhead	Raised	**Scottish Lowlands**	Largely open	**5**
Flow of Darsang	Intermediate	**Galloway**	Significant open area	**5**
Castle Loch Moss	Intermediate	**Galloway**	Significant open area	**4**
Salterhill Moss	Intermediate	**Scottish Lowlands**	Significant open area	**4**
Drumbow Moss	Raised	**Scottish Lowlands**	Largely open	**3**
Petes Hill Moss	Intermediate	**Scottish Lowlands**	Significant open area	**2**
Craigenfinnie Moss	Raised	**Dumfries & Borders**	Significant open area	**2**
Drumwhirn Moss	Intermediate	**Galloway**	Significant open area	**2**
Longriggend Moss East	Intermediate	**Scottish Lowlands**	Largely open	**1**
Limerigg Moss	Raised	**Scottish Lowlands**	Largely open	**1**

Appendix 5: Lowland raised bog and Intermediate bog with potentially good prospects for restoration shortlisted for assessment

The following sites have been selected for assessment to identify if they are suitable candidates for bog restoration. Sites were picked on the basis of size, i.e. all intermediate bogs over 50ha and lowland raised bogs over 10ha. Bogs with sparse tree cover, which may indicate intact relatively unmodified hydrology, have also been shortlisted for assessment, regardless of size (see topic 6, page 25).

Site name	Bog type	Forest District	Reason for assessment	Assessment area (ha)
Fauldhouse Muir	Intermediate	**Scottish Lowlands**	Size & sparse tree cover	**373**
Knock Moss	Intermediate	**Galloway**	Size	**368**
Moss of Cree	Raised	**Galloway**	Size & sparse tree cover	**347**
Merton Hall Moss	Intermediate	**Galloway**	Size & sparse tree cover	**204**
Flow of Darsang	Intermediate	**Galloway**	Size	**173**
Craiggaveral complex	Intermediate	**Scottish Lowlands**	Size	**162**
Harehill Moss	Intermediate/ Blanket	**Scottish Lowlands**	Size	**155**
Flow of Airriequhillart	Intermediate	**Galloway**	Size	**102**
Mossmulloch	Intermediate	**Scottish Lowlands**	Size & sparse tree cover	**95**
Tormywheel Moss	Intermediate	**Scottish Lowlands**	Size	**84**
Cranloch Moss	Intermediate	**Moray & Aberdeenshire**	Size	**80**
Herricks Moss	Intermediate	**Moray & Aberdeenshire**	Size & sparse tree cover	**77**
Deerhill & Balnamoon Moss	Intermediate	**Moray & Aberdeenshire**	Size	**74**
Hill of Clashmadden Moss West	Intermediate	**Moray & Aberdeenshire**	Size	**69**

Upper Haywood Moss	Intermediate	**Scottish Lowlands**	Size	**55**
Kelly Syke Moss	Intermediate	**Scottish Lowlands**	Size	**53**
Petes Hill Moss	Intermediate	**Scottish Lowlands**	Size & sparse tree cover	**52**
Badachonachar Moss	Raised	**North Highland**	Size	**52**
Drumfeatherin Moss	Intermediate	**Galloway**	Size	**50**
NS96.3	Raised	**Scottish Lowlands**	Size & sparse tree cover	**48**
Easter Deans Moss	Raised	**Dumfries & Borders**	Size	**43**
Moss of Cairnty	Intermediate	**Moray & Aberdeenshire**	Sparse tree cover	**42**
Inshoch Moss	Raised	**Moray & Aberdeenshire**	Size	**38**
Glasnick Moss	Intermediate	**Galloway**	Sparse tree cover	**37**
Castle Loch Moss	Intermediate	**Galloway**	Sparse tree cover	**31**
Craig Moss	Raised	**Dumfries & Borders**	Size	**31**
Brathens Moss	Raised	**Moray & Aberdeesnhire**	Size	**28**
Charlies Houff	Raised	**Moray & Aberdeenshire**	Size	**28**
Moss of Wardhouse	Raised	**Moray & Aberdeenshire**	Size	**26**
Rack Moss	Raised	**Moray & Aberdeenshire**	Size	**22**
Monadh Mhor	Raised	**Inverness, Ross & Skye**	Size & sparse tree cover	**22**
Blackrigg Moss	Raised	**Scottish Lowlands**	Size	**21**
Southwick Burn Moss	Raised	**Dumfries & Borders**	Size	**19**
Woodhouse Moss	Raised	**Dumfries & Borders**	Size	**19**
Wormlaw Moss	Raised/ intermediate	**Scottish Lowlands**	Size	**17**

Northburnhill Moss	Raised	**Moray & Aberdeenshire**	Size & sparse tree cover	**17**
Barhaskine Moss 2	Intermediate	**Galloway**	Sparse tree cover	**16**
Torbain Moss	Raised	**Scottish Lowlands**	Size & sparse tree cover	**16**
Runnaguman Moss	Intermediate	**Tay**	Sparse tree cover	**16**
Rashypans Moss	Raised	**Moray & Aberdeesnhire**	Size	**15**
Youngs Hill Moss	Raised	**Dumfries & Borders**	Size	**15**
Barnsmuir Moss	Raised/fen	**Scottish Lowlands**	Size	**13**
Craigend Moss	Raised	**Dumfries and Borders**	Size & sparse tree cover	**12**
Wardhouse Hill East Moss	Raised	**Moray & Aberdeenshire**	Size & sparse tree cover	**12**
Wardhouse Hill West Moss	Raised	**Moray & Aberdeenshire**	Size & sparse tree cover	**12**
Moss of Leith Hall	Intermediate	**Moray & Aberdeenshire**	Sparse tree cover	**11**
Meadowbank Moss	Raised	**Moray & Aberdeenshire**	Size	**11**
Barclosh Moss Complex	Raised	**Dumfries & Borders**	Size & Sparse tree cover	**10**
Craigenfinnie Moss	Raised	**Dumfries & Borders**	Sparse tree cover	**10**
Cairnton Moss	Raised	**Moray & Aberdeenshire**	Size	**10**
Mountainblaw Farm Moss West	Intermediate	**Scottish Lowlands**	Sparse tree cover	**9**
Drumwhirn Moss	Intermediate	**Galloway**	Sparse tree cover	**9**
Loch Loy Moss	Intermediate	**Galloway**	Sparse tree cover	**9**
Craigmaud Croft Moss	Raised	**Moray & Aberdeenshire**	Sparse tree cover	**8**
Glenend Moss	Intermediate /fen	**Moray & Aberdeenshire**	Sparse tree cover	**8**

Grandhome Moss	Raised	**Moray & Aberdeenshire**	Sparse tree cover	**7**
Moss of Croichnacroy	Raised	**Moray & Aberdeenshire**	Sparse tree cover	**6**
Craigend Moss 1	Intermediate	**Scottish Lowlands**	Sparse tree cover	**5**
Corsekell Moss	Intermediate	**Moray & Aberdeenshire**	Sparse tree cover	**4**
Boghead Moss	Raised	**Moray & Aberdeenshire**	Sparse tree cover	**4**
North Rhodes Moss	Raised	**Scottish Lowlands**	Sparse tree cover	**4**
Whitegates Moss	Raised	**Tay**	Sparse tree cover	**3**
Blackburn Moss	Raised	**Moray & Aberdeenshire**	Sparse tree cover	**2**
Newlees Moss	Raised	**Scottish Lowlands**	Sparse tree cover	**1**