After-LIFE Conservation Plan

Demonstrating Best Practice in Raised Bog Restoration in Ireland

LIFE09 NAT/IE/000222

1st January 2011 to 31st December 2015

An Roinn Ealaíon, Oidhreachta agus Gaeltachta
Department of Arts, Heritage and the Gaeltacht

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After-LIFE Conservation Plan

For the

LIFE-Nature/Coillte/NPWS co-funded project

"Demonstrating Best Practice in

Raised Bog Restoration in Ireland"

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Prepared by

The Project Team

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PREFACE

This project has restored 685 hectares of raised bog habitat that had been affected by afforestation. The project included seventeen sites in Ireland, and the restoration actions were implemented between 2011 and 2015. The project was co-funded by Coillte, National Parks and Wildlife Service (of the Department of Arts, Heritage and the Gaeltacht) and EU LIFE-Nature. Restoration works are now complete across the sites, but future actions will be required in some cases, to maintain the restored habitats and ensure that they support favourable conservation condition.

This After-LIFE conservation plan represents the final output of the project "Demonstrating Best Practice in Raised Bog Restoration in Ireland" LIFE09 NAT/IE/000222, and was appended to the Final Technical Report on that project as Annex 7.2.5. The purpose of this document is to outline how the project sites will be monitored and managed for conservation into the future. An overview is presented of the historical context within which the sites came to need restoration, with a summary of the main actions implemented during the project, as well as its main achievements and outcomes.

Acknowledgement

A note of thanks and appreciation to Jim Ryan, member of the Project Management Group, who took retirement from the National Parks and Wildlife Service during this project. He has made a lasting contribution to the conservation of Ireland's raised bogs, not least in inspiring us and many others to pursue this quest.

INTRODUCTION

Peatlands have been in the Irish landscape since the last Ice Age, and they form an ancient and prominent part of our natural heritage. Irish peatlands comprise blanket bogs, raised bogs and fens. They are "the country's last great area of wilderness, hovering between land and water, providing unusual habitats for their unique and specialist flora and fauna" (Renou-Wilson *et al*. 2011).

Raised Bogs in Ireland

Raised bogs were once extensive over the Midlands and mid-west of Ireland, covering an estimated 310,000ha or almost 5% of the country (Hammond, 1981), and forming extensive wetlands over much of the central lowlands. Over millennia, these large Midland bogs were intricately linked with Irish history and society. They provided sources of domestic fuel, but were also associated with hard work and poverty. For the most part the bogs were considered wastelands, to be converted to more productive uses.

In the 20th century, with the establishment of Bórd na Móna in the 1940s (from its precursor, The Turf Development Board), peat harvesting escalated to facilitate the commercial production of fuel (both for domestic use and for generating electricity) and horticultural products – an industry which vitally sustained local communities. The result of utilisation of the bogs has led to widespread and sometimes total loss of raised bog habitat.

Raised Bogs and Forestry

The 20th century also saw a move to develop a national afforestation programme, following millennia of forest clearance for agriculture and exploitation of native woodlands. It is estimated that, in the early 1900s, forest cover in Ireland was as low as 1%, indicating almost total deforestation of the countryside. The success of the state forestry programme is evident in the fact that forest cover in Ireland is now 10.5% (Forest Service 2012).

To achieve afforestation of the Irish landscape, successive governments supported a programme of plantation establishment. However, it was also a goal not to compromise the availability of "good farming land", and so afforestation was confined mainly to sites considered marginal or unsuitable for agriculture. Consequently, bogs (both raised and blanket peats) were among the types of land identified as potentially suitable for forestry, and in the Midland region, forest plantations were established on both high (uncut) and cutover raised bogs, mainly during a 20-year period, from the mid-1960s to the mid-1980s. It is estimated that about 74,000ha of plantation forests are located on raised bogs (Black *et al*., 2008), indicating that approximately 24% of the original national area of raised bog has been afforested[1]. Today, forestry is still explored as a potential land use for industrial cutaway bogs (Renou-Wilson *et al*. 2008), but high bog and cutover bog[2] are no longer planted.

The tree species planted on bogs were, by necessity, non-native conifers that could cope with the difficult growing conditions on those exposed, nutrient poor sites, and that could grow relatively quickly to provide timber revenue. The establishment of plantation forests on bogs significantly impacts their ecology. The construction of drains, in preparation for planting, as well as the growth of the trees over time (by evapotranspiration), results in lowering of the watertable and consequent drying out of the peat surface; also, formation of a forest canopy by maturing trees shades out bog vegetation.

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1 Most of these plantations were established on cutover bog; and this figure also includes plantations that were established on "basin peats" that had, before they were planted with trees, been reclaimed for agriculture, and converted from raised bog to grassy fields

2 The terms "high bog", "cutover bog" and others are explained in Appendix 1

Under current national forest policy[3], semi-natural habitats of nature conservation value, including raised bogs, are no longer afforested.

The Conservation Value of Raised Bogs

Surveys carried out by Ireland's National Parks and Wildlife Service (NPWS) enable us to understand the scale of the loss of Ireland's raised bog habitat. Current figures indicate that about 50,000ha of uncut raised bog habitat remain in the country (NPWS 2014) – this represents about 16% of the original natural extent of the habitat. Of this, about 18,000ha is regarded as being of national nature conservation value and is included in a network of protected areas (SACs – Special Areas of Conservation, and Natural Heritage Areas – NHAs) (NPWS 2014).

But, despite the widespread loss of habitat, the remaining peatlands of the Irish Midlands still represent a significant proportion of the active raised bog systems remaining in western Europe. Irish raised bogs "represent some of the finest… examples of their type in the world" (Cross 1990). Furthermore, Ireland's raised bogs constitute an extreme oceanic variant of European raised bog ecosystems, and as such are a unique and irreplaceable biodiversity resource.

There is now growing support in Ireland for conserving the best remaining raised bogs as remnants of what was once extensive natural wilderness.

Raised bog habitats are listed on Annex I of the EU Habitats Directive, with a requirement for Ireland and other EU member states to designate the best remaining sites as Special Areas of Conservation (SACs). The conservation and management of both SACs and NHAs is regulated under international and national legislation. This is a reflection of their conservation importance, and are therefore worthy of every effort to conserve them (Renou-Wilson *et al*. 2011).

Coillte's Approach to Raised Bog Conservation

Most of the forest plantations on raised bogs are currently under the ownership and management of Coillte (The Irish Forestry Board). Since 2000, Coillte has been developing and implementing a nature conservation programme. A key element of this programme is that habitats of particular nature conservation value are mapped and managed with biodiversity as a primary management objective. Coillte's policy is that a minimum of 15% of the estate is mapped and managed in this way – currently, "biodiversity areas" amount to approximately 90,000ha, or 20% of the estate. Management of such a large area poses significant challenges, and Coillte seeks financial support for the proactive management of biodiversity areas. Coillte focusses available resources towards the maintenance and management of the most ecologically valuable habitats.

Since the start of its nature conservation programme, Coillte has actively consulted with NPWS to identify the afforested peatlands on its estate that have the highest ecological value and the potential for restoration. These sites have been given priority attention in Coillte's biodiversity programme, and the consultations with NPWS have informed three of Coillte's four successful LIFE projects, including this one, which were aimed at the restoration of bogs previously affected by afforestation (Table 1).

The primary objective of this project was to continue the process of removing plantation forests from Irish raised bogs of conservation value, and thereby ultimately to contribute towards the restoration of peat-forming conditions on those bogs. All associated objectives of this project were wholly aimed at supporting this main goal.

[3] National forest policy lies within the remit of The Forest Service, of the Department of Agriculture, Food and the Marine https://www.agriculture.gov.ie/forestservice/

Table 1. LIFE projects led by Coillte

START-END DATE	HABITAT	TOTAL AREA OF PROJECT SITES	LIFE PROJECT NUMBER
2002-2007	Blanket Bog	1,967ha	LIFE02 NAT/IRL/008490
2004-2008	Raised Bog	571ha	LIFE04 NAT/IE/000121
2011-2015	Raised Bog	685ha	LIFE09 NAT/IE/000222
	TOTAL (Bogs)	3,223ha	3,285ha 3,223 ha
2006-2010	Priority Woodland Habitats	551ha	LIFE05 NAT/IRL/000182
	GRAND TOTAL	3,774ha	3,836ha3,774 ha

The project has built upon the work carried out under Coillte's previous LIFE-funded project (LIFE04 NAT/IE/000121 "Restoring Raised Bog in Ireland"), which was completed in December 2008. That project demonstrated that tree removal and drain-blocking have encouraging positive effects, even in the short-term, on bog hydrology and vegetation.

This project represents an important collaboration between Coillte (as Co-ordinating Beneficiary) and the National Parks and Wildlife Service (NPWS, as associated beneficiary). The project structure, with Coillte leading the project implementation, reflects Coillte's proven experience in delivering on high-quality habitat restoration projects (Table 1).

As with the previous LIFE sites, all of the sites from this project are incorporated into Coillte's nature conservation programme, and they will continue to be managed with nature conservation as the primary management objective. Two of the project sites (No's 12 and 15, Table 2) were selected as project demonstration sites, and were the focus of a public awareness programme over the course of the project. These sites will continue to be maintained and promoted as demonstration sites.

The Project Sites

In this project, Coillte undertook actions aimed at restoring raised bog habitats on 17 sites, all owned and managed by Coillte, that had been partially or wholly afforested. The 17 project sites covered 685ha within 5 candidate SACs and 12 proposed candidate SACs (formerly NHAs), spread over 7 counties.

Before the project started, approximately two-thirds of the total site area consisted of plantation forest, interspersed with scrub and small amounts of native forest. There were also extensive areas of open bog (both high bog and cutover bog) which, although not planted or drained, have been variously affected by drainage for afforestation or turf-cutting nearby. Table 3 and Figure 1 present an overview of the habitats present on the sites before the project started.

Table 2. Project sites restored in this project, "Demonstrating Best Practice in Raised Bog Restoration in Ireland" LIFE09 NAT/IE/000222

Project Site No.	**Project Site Name**	**County**	**Project Site Area (ha)**	**Coillte Property Name**
1	Curraghlehanagh Bog	Galway	11.03	New Forest
2	Monivea Bog	Galway	9.13	Monivea
3A	Lough Ree - Clooncraff and Cloonlarge Bogs	Roscommon	11.9	Kilteevan
3B	Lough Ree	Roscommon	22.8	Tonagh
3C	Lough Ree	Roscommon	10	Muckanagh
4	Lough Forbes Complex – Ballykenny and Fisherstown Bogs	Longford, Roscommon	16.1	Cloondara
5	Moneybeg and Clareisland Bogs	Meath, Westmeath	14.3	Goreport
6	Derrinlough Bog	Galway	58.9	Ballinphuill, Cloonkeenleananode
7	Keeloges Bog	Galway	4.23	Ballyhard
8	Ballygar Bog	Galway	28.76	Aghrane
9	Aughrim Bog	Galway	44.55	Aghrane
10	Lough Kinale and Derragh Loughs	Longford, Cavan & Westmeath	36.95	Tonymore
11	Mount Jessop Bog	Longford	71.86	Mount Jessop
12	Girley Bog	Meath	32.2	Drewstown
13	Lough Derravaragh	Westmeath	25.63	Derrya
14	Wooddown Bog	Westmeath	50.65	Wooddown
15	Scohaboy Bog	Tipperary	71.8	Sopwell
16	Arragh More Bog	Tipperary	100.68	Derrybreen
17	Cangort Bog	Offaly, Tipperary	13.45	Kilfrancis

Table 3. Summary of habitat types present on the 17 project sites before the project commenced. See Appendix 1 for explanations of the main habitat types.

	Area (ha) present in Project Sites [4]		
	Total Area	Open, Treeless Habitat [5]	Plantation Forest or Scrub
Raised Bog: High bog (uncut raised bog)	370	165	205
Raised Bog: Cutover bog (raised bog previously cut for turf)	285	35	250
Other (non-bog) habitats, some on mineral soil	30	20	10
TOTALS	685	220	465

[4] These figures have been rounded up to the nearest 5ha from detailed figures presented in Project Reports

[5] Some of the areas labelled "Open, Treeless" included small areas of plantation forest and scrub on high bog and cutover bog, which were removed during the project (see next Section)

WORK ACHIEVED IN THE LIFE PROJECT

This project addressed the main ecological threats which affect afforested raised bog habitats through the following actions (Table 5):

- Removing 483ha of plantation forests. Approximately 30% of this was removed manually using chainsaws due to difficult terrain; the rest was felled using harvesting machines, taking care not to damage the underlying peat
- Blocking all drains present in a total area of 443ha across project sites, in order to elevate water levels and hence restore the hydrological balance of the peatland
- Removing naturally regenerating trees and invasive shrubs. During the project, this was conducted over 529ha across the project sites, including repeat removal, or clearance, during 2014 and 2015, where required, on sites that had been cleared earlier in the project
- Maintaining firelines (total 3,520m), to protect vulnerable raised bog sites against fire
- Installing fencing where necessary, to protect against grazing animals/livestock. A total 4,506m of fencelines were installed
- Monitoring the immediate effects of tree-clearance and drain-blocking on bog vegetation: 108 permanent quadrats (or plots) were installed across all 17 project sites, which were recorded annually throughout the project
- Monitoring the immediate effects of tree-clearance and drain-blocking on bog hydrology: 130 Walrags were installed across all 17 project sites. These simple devices record watertable levels within the peat. Readings were recorded monthly throughout the duration of the project
- Consulting with landowners and local community groups to promote awareness of the project and of the value of raised bogs
- Consulting with landowners regarding access and turbary rights. As a result of the consultations conducted during this project, turf-cutting has now ceased on Scohaboy Bog
- Current and future habitats on the project sites were mapped according to the NPWS mapping protocol (see below)
- Constructing amenity facilities at two demonstration sites, including information signage, parking and boardwalk access
- Producing promotional material, including project brochure and results booklet, all of which are accessible on the project website[6]

By the end of the project, the areas that had previously supported plantation forest were converted to open, clearfelled habitat (WS5, Fossitt 2000). While these areas do not look like raised bog habitat yet, the vegetation and hydrology monitoring indicate that removing trees and blocking drains had an immediate effect of raising watertable and enabling *Sphagnum* moss and other bog plants to reappear. Similarly promising results have been demonstrated on other peatland restoration sites across Europe (Anderson *et al*. 2016).

In addition to improving raised bog habitat conditions in previously afforested/drained areas, results have shown that the project actions have had a positive effect on adjacent bog habitats. Bog restoration techniques on afforested peatland systems that were pioneered on Coillte's previous LIFE-funded project, were further developed in this project. For example, a new peat-damming technique was developed and applied on one project site (Aughrim Bog) for blocking large drains. Links with other LIFE-funded projects in Denmark, with a focus on control of natural regeneration and hydrology management, were made and proved to be very beneficial to all parties.

This was the largest single LIFE-funded raised bog restoration project undertaken in Ireland. Coillte has made a significant contribution to conservation of the most valuable raised bog habitat in Europe. The project has served as a hands-on demonstration of the best practice for the restoration of raised bog habitats that were previously afforested. The lessons learned from this project can be applied in future to

[6] Project website can be accessed at http://www.raisedbogrestoration.ie/

other sites where conifer plantations are located on ecologically valuable raised bogs. The implementation of all project actions was successfully concluded by 31st December 2015, and conditions have now been established that will enable these bogs to regenerate and develop further into the future. An important aspect of the project was development of a future "vision" for the project sites.

FUTURE VISION FOR THE PROJECT SITES

Notwithstanding the successful implementation of the project actions, some future actions may be required to maintain the restored habitats and ensure that they continue to support favourable conservation condition[7] of the SAC habitats.

A key consideration in the future management of the restored sites is to ascertain what the future habitat will be – to develop a vision for what the project sites will look like. We have taken a scientific approach to this, and have based our vision for each site on its hydrological and vegetation characteristics.

The ultimate aims of the restoration work carried out during this project are to:

- Maintain areas where raised bog peat-forming conditions are currently present (these areas are defined on Annex I of the EU Habitats Directive as "Active Raised Bog" – see Appendix 1)
- Facilitate the development of raised bog peat-forming conditions in areas where there is the potential for this to happen (these areas are defined on Annex I of the EU Habitats Directive as "Degraded Raised Bog" – see Appendix 1)

NPWS has, over recent years, been mapping "Active Raised Bog" within Ireland's designated raised bog sites, but only recently has research been developed by NPWS which facilitates the identification and mapping of "Degraded Raised Bog" – see text box "Predicting Future Habitats".

All of the project sites were resurveyed and re-mapped according to the new NPWS protocol, and this enabled detailed mapping of the *future habitats* of the restored sites. These maps form the basis of the management actions that will be implemented on the project sites in future.

Predicting Future Habitats

While the project was progressing, NPWS developed a procedure for predicting and mapping portions of raised bog that have the potential to become peat-forming. This procedure has recently been applied across Ireland's designated raised bog network. It has enabled, for the first time, mapping of areas that have the potential for restoration of raised bog habitat conditions.

LIDAR imagery was used to map the slope contours and drainage patterns on each bog. These data were used to model or predict where water gathers, or has the potential to gather, on the peat surface. This, in turn, creates the conditions for "active", peat-forming raised bog habitat to develop.

The areas were then surveyed on the ground, to validate the predictions of the model. This was done by assessing both the presence of water, and the vegetation, in particular a number of plant species which require wet bog habitats. Prime among these "indicator" plants are certain species of *Sphagnum* moss.

Using this procedure, NPWS has mapped those portions of the raised bog SACs which conform to the precise definitions of Annex I raised bog habitats. Areas where peat-forming conditions exist at present are mapped as "Active Raised Bog"; while areas where bog vegetation is present and there is clear potential for water to gather and peat formation to occur in future are mapped as "Degraded Raised Bog" (see habitat descriptions in Appendix 1).

[7] "Favourable Conservation Condition" is a term used in the context of the EU Habitats Directive. For raised bogs, it means maintaining or increasing the area of "Active Raised Bog" habitat (European Union 2007) in the SAC

Figures 1 and 2 show a comparison of the habitat types present in the 17 project sites before the project started (Figure 1) and those that are expected to develop on the project sites in the coming 10-30 years (Figure 2). These diagrams reflect the main outcomes of the project, which are listed here with the main findings of the detailed mapping exercise conducted on the project sites.

Large-scale changes:

- Large areas of conifer plantation on the high bog are removed and will continue to develop into open raised bog habitat. Native birch forest will feature on high bog at two of the project sites (Arraghmore and Wooddown)
- On the cutover bog, there will be a range of habitats present. Extensive areas of dry birch woodland will develop wherever conditions are unlikely to support formation of deep, wet peat. The future birch woodlands were carefully mapped and are confined to portions of the project sites where woodland development will not negatively affect restoration of "Active Raised Bog"
- "Other Habitats" that will continue to develop on the project sites, include: rich fen PF1; dry heath HH1; reedswamp FS1; lake FL4; wet willow woodland WN6; oak-ash-hazel woodland WN2. The codes given for each of these habitats are from Fossitt (2000), where descriptions of the habitats can be found

Annex 1 habitats in the future:

- The area of peat-forming habitats ("Active Raised Bog", "Degraded Raised Bog" and "Bog Woodland") present within the project sites is very small. This reflects the situation observed by NPWS in all of Ireland's raised bog SACs and highlights the fact that healthy, peat-forming "Active Raised Bog" in Ireland is very rare indeed
- Restoration works undertaken within the 17 project sites will support or create 49ha of "Active Raised Bog" either inside the project sites or adjacent to them. This represents 3% of the national area of "Active Raised Bog" and is regarded as a significant national contribution. Some pioneer Active Raised Bog vegetation has been already reported at some sites (e.g. Ballygar, Girley and Wooddown)
- Wet woodland habitats will also develop, and some of these may develop into "Bog Woodland", where conditions are suitable. Bog Woodland has developed or is expected to develop at three sites: Mount Jessop Bog, Arraghmore and Cangort. Small areas of wet woodland on transitional areas between high bog and adjacent mineral soils are expected to develop. This woodland type is a natural component of lagg vegetation, of which very few good examples remain in Ireland.

Table 4. Summary of broad future habitat types that will develop on the 17 project sites in the years ahead

	Area (ha) present in Project Sites		
	Total Area	Open, Treeless Habitat	Woodland/Scrub
Raised Bog: High bog (uncut raised bog)	370	340	30
Raised Bog: Cutover bog (raised bog previously cut for turf)	285	25	260
Other (non-bog) habitats on mineral soil	30	20	10
TOTALS	685	385	300

Figure 1. Habitat types that were present on the 17 project sites before the project commenced. The habitat codes quoted here refer to Fossitt (2000); additional habitat descriptions are provided in Appendix 1

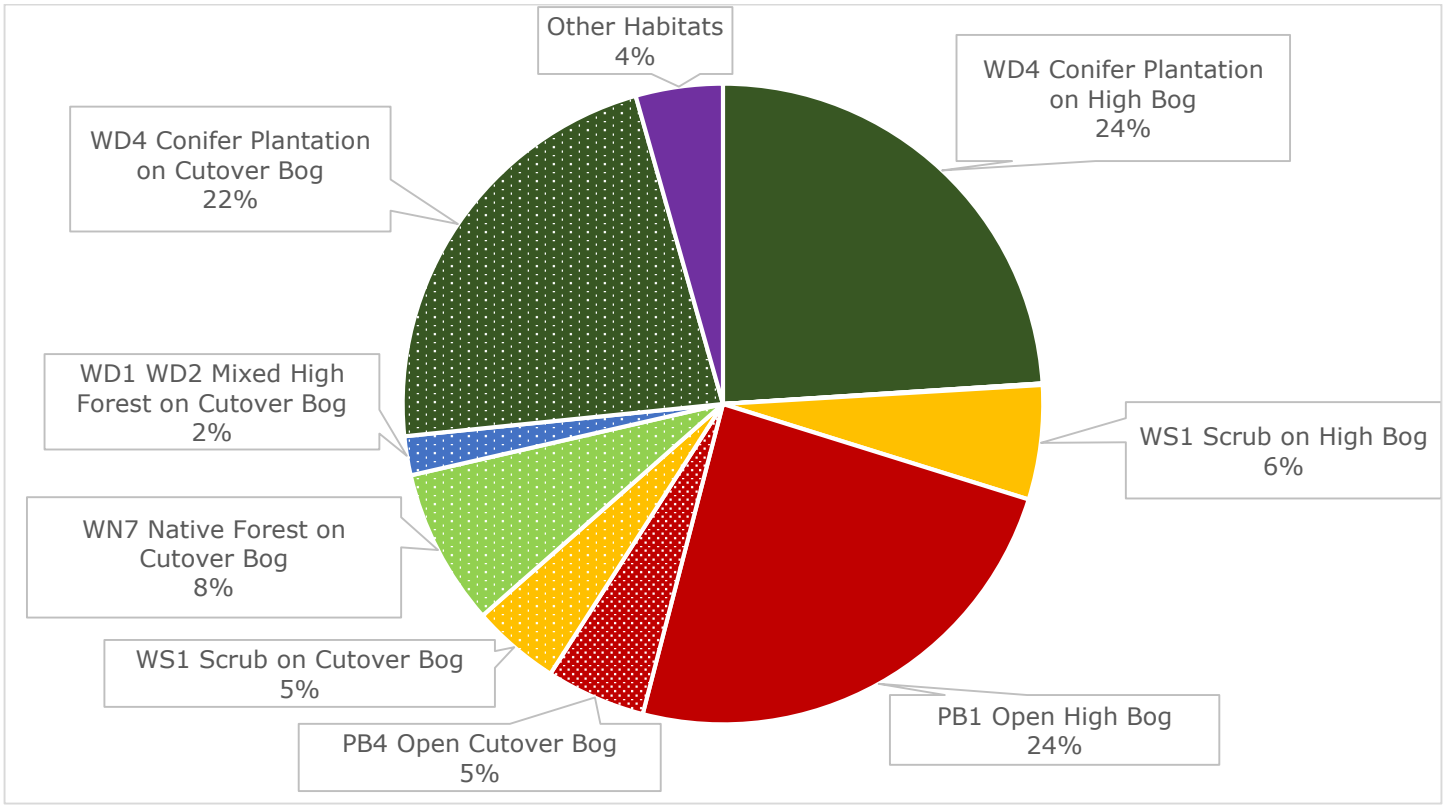
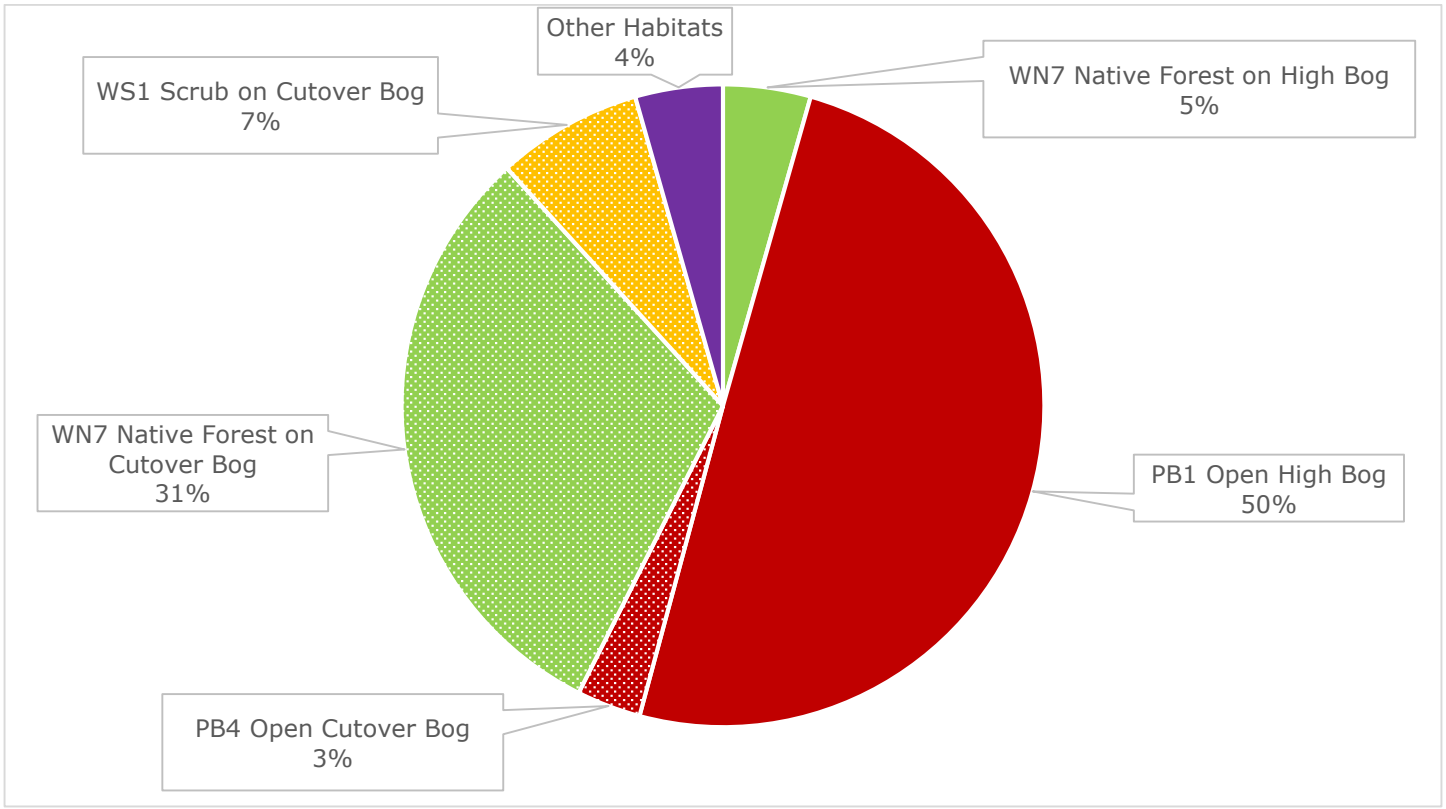


Figure 2. Future Habitats that will develop the 17 project sites in the next 10-30 years.



FUTURE MANAGEMENT PLAN FOR RAISED BOG RESTORATION SITES

Whilst it is clear, even at this early stage in the restoration process, that some sites will take much longer to achieve favourable condition than others, it is essential that all sites are managed in a sensitive way into the future. As all of the sites within the project are dominated by raised bog habitat, the same management prescriptions will, by and large, apply to all.

All of the project sites are incorporated into Coillte's biodiversity programme. Coillte has mapped portions of its estate that have special value for biodiversity. Rare habitats, such as raised bogs, are given priority for monitoring and management actions in a rolling annual programme.

The lessons learned in Coillte's two LIFE projects will prove invaluable in informing future management of plantation forests on protected raised bogs.

A series of actions will be implemented on the LIFE sites, as required, depending on site conditions (Table 6). The actions are described below, and are grouped into:

1. Monitoring
2. Site Maintenance and Management
3. Stakeholder Engagement

1. MONITORING

Coillte Biodiversity Auditing

Every year, Coillte implements a rolling annual programme of biodiversity auditing. Each year, a sample of our best biodiversity areas are visited and audited by Coillte's Environment Officers and/or consultant ecologists.

The purpose of these audits is to assess whether each site is developing towards its future or "target habitat". The audit consists of a walkover survey, to record a broad assessment of habitat condition and to identify any threats which hamper the development of the "target habitat".

The restoration sites from the LIFE project "Demonstrating Best Practice in Raised Bog Restoration in Ireland" will be included in this rolling annual programme of biodiversity auditing.

The recording form used for these audits is shown in Appendix 2. The walkover survey includes a check of dams and fences, as well as major issues such as spread of naturally regenerating conifers/birch.

The auditing reports are discussed with Coillte site managers and informs their annual workplan, which addresses any remedial actions required.

Vegetation Monitoring

Every six years from the end of this project (2015), Coillte will conduct a vegetation survey and habitat mapping exercise on the project sites. The format of these surveys will be to:

a) Revisit and re-record a proportion of the permanent quadrats that were established during the project (the recording form used for recording plots is shown in Appendix 3); and
b) A walkover survey aimed at reviewing and updating the current and future habitat maps for the restored sites, which were prepared during the project in conjunction with NPWS

NPWS conducts a National Raised Bog Monitoring Programme. In this programme, a sample of Ireland's raised bog SACs are surveyed every 6 years. These surveys involve mapping vegetation at community complex/ecotope level, assessing site condition and recording threats. These surveys inform a national report of the conservation status of EU Annex I raised bog habitats – as required in Article 17 of the EU Habitats Directive.

Coillte will liaise with NPWS to co-ordinate both sets of monitoring surveys.

Hydrology Monitoring

Based on the implementation of our previous After-LIFE Raised Bog Conservation Plan, and the experience of NPWS staff, the current evidence is that vegetation monitoring is generally the most useful measure of the long term success of restoration works on the ecology and hydrology of raised bog habitats. Long-term water level monitoring is, therefore, currently considered unnecessary.

Should the vegetation monitoring indicate that recovery of the restored habitats is not proceeding as anticipated, hydrological investigations will be considered to help ascertain the possible causes of such situations.

2. SITE MAINTENANCE AND MANAGEMENT

Control of Regeneration of Invasive Species

In the context of this project, and the restoration of raised bog habitats, lodgepole pine, laurel and rhododendron are considered to be invasive species, which are always to be removed from the restored sites. Each site will be monitored regularly for regeneration of seedlings of pine and other unwanted tree / shrub species – this forms part of Coillte Biodiversity Auditing (see above). Lodgepole pine, laurel and rhododendron will be removed from the high bog and from cutover where necessary. As the high bog portions of restored sites revegetate and become wetter, it is anticipated that regeneration of lodgepole pine will cease after a few years. The presence of rhododendron and/or laurel at Girley, Aughrim, Ballygar, Derrinlough and Lough Ree (Kilteevan) is an on-going problem which is being controlled on a planned basis, but will be a challenging issue into the future.

Control of Birch Regeneration

Downy birch is a native tree species which is regenerating widely over large portions of the project sites. Scots pine, another native species, is also regenerating but on a much smaller scale.

The detailed maps of future habitats for the restored sites identified areas where birch woodland will be the outcome of the restoration works. In these areas, natural regeneration of downy birch and Scots pine will be allowed to proceed *unless* it could adversely impact on the maintenance or restoration of Active Raised Bog. In these areas, the future habitat was mapped as open habitats (see below).

The future habitats also indicate portions of the restored sites where there is the potential for Bog Woodland to develop. In these areas, both downy birch and Scots pine will be allowed to regenerate.

On the other hand, the future maps clearly indicate portions of the site which will be managed for retention as open habitats (open high raised bog and open cutaway raised bog). In these areas, naturally regenerating downy birch and Scots pine will be removed.

Fire Prevention

Coillte staff conduct annual surveys of firelines, and install and upgrade firelines as necessary to protect Coillte properties that are at risk from fire.

If firelines require upgrading, the recommended approach is to strim vegetation without disturbing the underlying peat. This minimises impacts on the raised bog habitat.

Fencing / Trespass

Overgrazing can cause damage to raised bogs. Fencing is a common approach to protecting habitats from grazing animals. However, NPWS recommends that fencing open bogs is not a preferred option and should be carried out only where strictly necessary for conservation management purposes.

During the project, fencing was installed on ten of the project sites. Perimeter fences, where installed, will be checked and repaired if necessary, in order to prevent stock trespass, grazing and illegal access/dumping. Trespassing stock will be removed when necessary.

3. STAKEHOLDER ENGAGEMENT

Public Awareness

Two of the project sites – Girley (Site 12) and Scohaboy (Site 15) – were established during the project as demonstration sites, with information signage, parking and boardwalk access, which will be monitored and maintained. During the project, these sites received very positive support and engagement from local communities.

Both Girley and Scohaboy, along with the demonstration sites from Coillte's previous LIFE projects, attract many visitors each year and are listed on our Coillte Outdoors website as nature conservation areas.

Consultation

Ongoing consultation with the National Parks and Wildlife Service (NPWS) will also form an important part of the future management of each site. This After-LIFE Conservation Plan has been discussed and agreed with NPWS, to ensure that it is compatible with, and supportive of, the national raised bog conservation objectives for SACs and NHAs (NPWS 2014).

Coillte staff will continue to liaise with local communities and local authorities in these areas, to support them in public awareness initiatives.

The After-LIFE Actions that it is envisaged at this stage may be required on each project site are outlined in **Table 6.**

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www.raisedbogrestoration.ie [LIFE09 NAT/IE/000222, LIFE04 NAT/IE/000121]

www.irishbogrestorationproject.ie [LIFE02 NAT/IRL/008490]

www.woodlandrestoration.ie [LIFE05 NAT/IRL/000182]

Table 5 Summary of restoration actions completed on each site

Site No.	Site Name	Conifers on High Bog Only	Conifers on High Bog and Cutover	Conifers on Cutover Only	C1 Manual Fell to Waste	C2 Mech Fell to Waste	C3 Windrow	C4 Drain Blocking	C5 Fencing	C6 Install Dipwells	C7 Remove Nat Regen	C8 Remove Trespass	C9 Fire Prevention
1	Curraghlehanagh Bog	NO	No	Clearfelled Commercial	NO	NO	NO	Peat Plastic	No	YES	YES	NO	NO
2	Monivea Bog	NO	No	Clearfelled Commercial	NO	NO	YES	Peat	YES	YES	YES	NO	NO
3	Lough Ree	NO	Clearfelled	NO	YES	YES	YES	Peat	YES	YES	YES	NO	NO
4	Lough Forbes Complex	NO	Clearfelled	NO	NO	YES	YES	Peat	YES	YES	YES	NO	YES
5	Moneybeg & Clareisland Bog	NO	NO	Clearfelled	NO	NO	NO	Peat	YES	YES	YES	NO	NO
6	Derrinlough Bog	NO	Clearfelled	NO	YES	NO	YES	Peat Plastic	YES	YES	YES	NO	NO
7	Keeloges Bog	NO	Clearfelled Fell to Waste	NO	YES	NO	YES	Peat Plastic	NO	YES	NO	NO	NO
8	Ballygar Bog	NO	Clearfelled Commercial	NO	NO	NO	YES	Peat Plastic	YES	YES	YES	NO	NO
9	Aughrim bog	NO	Clearfelled	NO	NO	NO	YES	Peat Plastic	NO	YES	YES	NO	NO
10	Lough Kinnale & Derragh Lough	NO	Unplanted	NO	YES	NO	NO	Peat	YES	YES	NO	NO	NO
11	Mount Jessop Bog	NO	Clearfelled Fell to Waste	NO	YES	YES	NO	Peat Plastic	YES	YES	YES	NO	YES
12	Girley Bog	NO	Clearfelled Fell to Waste	NO	YES	YES	YES	Peat Plastic	YES	YES	YES	NO	NO

Continued on next page

Table 5, Continued

Site No.	Site Name	Conifers on High Bog Only	Conifers on High Bog and Cutover	Conifers on Cutover Only	C1 Manual Fell to Waste	C2 Mech Fell to Waste	C3 Windrow	C4 Drain Blocking	C5 Fencing	C6 Install Dipwells	C7 Remove Nat Regen	C8 Remove Trespass	C9 Fire Prevention
13	Lough Derravaragh	NO	Clearfelled Commercial	NO	YES	NO	YES	Peat	NO	YES	YES	NO	YES
14	Wooddown Bog	NO	Clearfelled Fell to Waste	NO	NO	YES	YES	Peat	YES	YES	YES	NO	YES
15	Scohaboy Bog	Clearfelled	NO	NO	YES	YES	YES	Peat Plastic	NO	YES	YES	NO	YES
16	Arragh More Bog	NO	Clearfelled Fell to Waste	NO	YES	NO	YES	Peat Plastic	NO	YES	YES	NO	NO
17	Cangort Bog	NO	Clearfelled Fell to Waste	NO	NO	YES	YES	Peat	NO	YES	YES	NO	NO

Table 6 Outline of After-LIFE actions that may be required on each site

SITE NO	SITE NAME	MONITORING		SITE MAINTENANCE AND MANAGEMENT				STAKEHOLDER ENGAGEMENT	
		Coillte Biodiversity Auditing	Vegetation Monitoring	Control of Invasives	Control of Birch	Fire Prevention	Fencing	Public Awareness	Consultation
1	Curraghlehanagh Bog	YES	YES	YES	YES	YES	NO	NO	YES
2	Monivea Bog	YES	YES	YES	NO	YES	YES	NO	YES
3	Lough Ree	YES	YES	YES	YES	YES	YES	NO	YES
4	Lough Forbes Complex	YES	YES	YES	YES	YES	YES	NO	YES
5	Moneybeg & Clareisland Bog	YES	YES	YES	YES	YES	YES	NO	YES
6	Derrinlough Bog	YES	YES	YES	YES	YES	YES	NO	YES
7	Keeloges Bog	YES	YES	YES	YES	YES	NO	NO	YES
8	Ballygar Bog	YES	YES	YES	YES	YES	YES	NO	YES
9	Aughrim Bog	YES	YES	YES	YES	YES	NO	NO	YES
10	Lough Kinnale & Derragh Lough	YES	YES	YES	NO	YES	YES	NO	YES
11	Mount Jessop Bog	YES	YES	YES	YES	YES	YES	NO	YES
12	Girley Bog	YES	YES	YES	YES	YES	YES	YES	YES
13	Lough Derravaragh	YES	YES	YES	YES	YES	NO	NO	YES
14	Wooddown Bog	YES	YES	YES	YES	YES	YES	NO	YES
15	Scohaboy Bog	YES	YES	YES	YES	YES	NO	YES	YES
16	Arragh More Bog	YES	YES	YES	YES	YES	NO	NO	YES
17	Cangort Bog	YES	YES	YES	YES	YES	NO	NO	YES

APPENDIX 1 DESCRIPTION OF THE MAIN HABITATS PRESENT ON THE RESTORED SITES

Habitat Name	Habitat Code (Fossitt 2000)	Description
Raised Bog: High Bog	PB1	Raised bogs are accumulations of deep peat (typically 3-12m) that originated in shallow lake basins or topographic depressions. The name is derived from the elevated surface, or dome, that develops as raised bogs grow upwards by the accumulation of peat. In a fully intact raised bog, the watertable would be higher than the surrounding land. However, such bogs do not exist in Ireland any more. "High bog" refers to the portion of the raised bog that has not been cut for turf. It is also sometimes referred to as the "bog dome". High bog appears as a usually extensive area of typical raised bog habitat, however the nature of the habitat present varies over the high bog (see below). High bog is mostly open (treeless) and comprises typical bog plant species. There is usually an undulating surface of hummocks and flat hollows, also pool systems. Bog mosses (*Sphagnum* spp.) usually dominate the ground vegetation; other typical plants include sedges/grasses (bog cottons *Eriophorum spp.*, deer-sedge *Trichophorum germanicum*), and dwarf shrubs such as ling heather (*Calluna vulgaris*), cross-leaved heather (*Erica tetralix*), bilberry (*Vaccinium myrtillus*). Recent NPWS research demonstrated that only very small portions of the high bog are actively peat-forming (see "Active Raised Bog" and "Degraded Raised Bog", below). This is due to the influence of human activities (e.g. turf-cutting, afforestation, land reclamation, drainage), usually at the margins of the bog, which disrupt the hydrology of the bog, and result in peat on the high bog drying out, with a consequent loss of peat-forming conditions over most of the high bog. <u>Active Raised Bog [Annex I Habitat, Code 7110*]</u> Portions of the high bog where conditions are right for peat to continue to form; watertable is at or within 10cms of the bog surface for most of the year. Vegetation is dominated by actively growing bog mosses (*Sphagnum* species), which are the main peat-forming species. This habitat now occupies a very small proportion (<1%) of the area it once occupied in Ireland. Even in the raised bog SACs specifically designated for active raised bog, this habitat now covers less than 12% of the remaining high bog area, whereas in intact bogs, it would occupy almost 100%. <u>Degraded Raised Bog still capable of natural regeneration [Annex I Habitat, Code 7120]</u> These are areas of raised bogs whose hydrology has been disturbed so that their surfaces have dried out and suffered some species change or loss. Bog species still dominate but peat formation has ceased. The water level is generally ≥10cm below the surface and drops to >30cm below during dry summer weather. To qualify as degraded bog habitat, these areas must still be capable of natural regeneration to active bog within 30 years if their hydrology is repaired. Degraded raised bog habitat has been mapped in Ireland's SACs by NPWS, using a hydrological model which predicts where there is potential to restore active bog on the high bog based on slope and hydrology. Only these areas are now considered by NPWS to qualify as "Degraded Raised Bog" habitat. The current area of degraded bog in Ireland's SACs, identified by the hydrological modelling, is now 1,200ha or 11% of the SAC high bog area. The remainder of the high bog is now referred to as Supporting Raised Bog habitat (see below).

Appendix 1, continued

Habitat Name	Habitat Code (Fossitt 2000)	Description
Raised Bog: High Bog CONTINUED	PB1 CONTINUED	<u>Depressions on peat substrates of the Rhynchosporion [7150]</u> These are open, pioneer-type vegetation communities of flat, wet areas on acid peat. This habitat appears as broad, flat, very wet areas on the high bog, and typical plant species present include white-beaked sedge (*Rhynchospora alba*), sundew (*Drosera anglica*), bog-bean (*Menyanthes trifoliate*), bog-cotton (*Eriophorum angustifolium*) and a carpet of colourful *Sphagnum* mosses. In raised bogs, this habitat is best developed in the "Active Raised Bog", but also occurs in "Degraded Raised Bog" and "Supporting Raised Bog" habitats, and also in wet cutover bog areas. It can re-establish itself relatively rapidly after cutting/drainage/burning if enough acid peat is left and conditions are wet enough, although this re-established habitat is usually in an impoverished form. Because of its wide occurrence, it is only when it occurs in its most developed form in the wettest sections of the active areas that it is considered a priority to conserve it. <u>Supporting Raised Bog Habitat</u> Raised bog habitat (i.e. high bog and cutover) that cannot be considered to be either "Active Raised Bog" or "Degraded Raised Bog". Supporting Raised Bog habitat typically dominates the open surface within which areas of "Active Raised Bog" or "Degraded Raised Bog" occur. The vegetation of these open bog areas is generally characterised by a high cover of by raised bog plant species such as slender bog-cotton (*Eriophorum vaginatum*), ling heather (*Calluna vulgaris*), cross-leaved heather (*Erica tetralix*), bog-asphodel (*Narthecium ossifragum*) and deer-sedge (*Tricophorum germanicum*), however *Sphagnum* cover is always below 50% and may be less than 10% in the drier marginal areas. In such areas it is unlikely that conditions suitable for the development of "Active Raised Bog" will develop, primarily as a result of steep surface slopes which speed up the run-off of surface water. Supporting Raised Bog habitat may also include marginal areas of high bog which have been significantly affected by afforestation and/or peat-cutting and drainage. "Supporting Raised Bog" habitat provides an important support function to adjoining areas of Active and Degraded Raised Bog by slowing water run-off, and so it is important that the water levels in these areas should be kept as high as possible.
Raised Bog: Cutover Bog	PB4	"Cutover bog" refers to the portion of the raised bog that has been cut for turf in the past. The removal of peat and associated drainage has significantly altered the habitat. The peat depth varies and the habitats present may also be varied, ranging from open, wet bog to dry heathery banks, to willow-dominated scrub and mature birch-dominated woodland. Cutover bog is important because, by taking steps to re-wet it wherever possible or to block the flow of water, this may help to slow down water loss from the high bog and thus support the maintenance or development of Active and Degraded Raised Bog habitat on the high bog. In some cases, where very wet conditions are present on cutover bog, Active Raised Bog and other peat-forming lagg zone habitats, such as transition mire and wet woodland can develop. Cutover bog also has tremendous wildlife value and adds to the ecological diversity of the restored sites.

Appendix 1, continued

Habitat Name	Habitat Code (Fossitt 2000)	Description
Birch Forest	WN7	Naturally-growing native forests dominated by downy birch (*Betula* pubescens). Typical species are birch, willow (*Salix* spp.) and Scots pine (*Pinus sylvestris*), with ferns and mosses. Also described as "Birch-purple Moorgrass Woodland" in the *National Survey of Native Woodlands* (Perrin *et al*. 2008) In Ireland, birch-dominated forests develop naturally on peats of various depths. Over large areas of the restored sites, the future habitat will be dry birch forest, which will be allowed to develop naturally over those portions of the site where hydrological modelling indicates that the growth of the trees will not compromise efforts to maintain or enhance "Active Raised Bog". At some locations in the project sites, depending on site conditions, wet birch woodland may develop and in some instances, given the right conditions, a special variant of birch forest, "Bog Woodland", can develop. <u>Bog Woodland [Annex I Habitat, Code 90D0]</u> In Ireland these are broad-leaved forests on a humid to wet peaty soils, with the water level permanently high and even higher than the surrounding water table. These communities are generally dominated by birch *Betula pubescens* or Scots Pine *Pinus sylvestris*, with the ground vegetation dominated by a well-developed moss layer. There is usually a thin shrub layer consisting mostly of willows (*Salix aurita, S. atrocinerea*); typical dwarf shrub species include ling heather, and typical herbs include purple moor-grass (*Molinia caerulea*), soft rush (Juncus effusus) and broad buckler-fern (*Dryopteris dilatata*). It is a very rare habitat because it can only occur in specialised locations where the watertable and water chemistry are conducive to its formation. Its total national extent is currently less than 150ha, but as its area is stable or expanding, it is considered to be in favourable conservation status (Cross and Lynn 2013). It is usually considered to have similar hydrological requirements to the active raised bog, though the watertable tends to fluctuate more and nutrient availability is higher due to ground water influences and/or increased flushing by bog water runoff. It can occur on flushed areas of the high bog or bog margins and on poor fen areas. There is considerable potential for it to develop on wet cutover bog.
Scrub	WS1	Stands of small trees and/or shrubs which, on dry soils, reach a max. canopy height of 5m, and on wet soils 4m. In the project sites, willow-dominated scrub will be a reasonably common future habitat on cutover bog.

APPENDIX 2 COILLTE BIODIVERSITY AUDITING FORM

EMS Document Ref. FORM-039; Version 2; Issue Date 120116

BIODIVERSITY AUDITING FORM

BIODIVERSITY INFO FROM SYSTEM (complete this section as desk exercise)

PROPERTY NAME:	
District/BAU:	Forest Name/No:
Extent of entire biodiversity area if known (ha):	Extent of area being surveyed on this form (ha):
Compt No's (and subs) or MUs visited:	
Environment Officer:	Forest Manager:
Surveyors:	Date(s) of Site Visit:

RAG Rating:
Audit Findings:
CARs / Observations:

Close-out Plan: (BAU to complete – List actions and timeline	
Planned action	Timeline for completion

Appendix 2, continued

EMS Document Ref. FORM-039; Version 2; Issue Date 120116

IS THIS CURRENTLY A BIODIVERSITY AREA? Agreed/Additional/Neither .....

IS THIS OR WAS THIS FORMERLY A PROJECT SITE? LIFE/Millennium/NWS/Other/None .....
(note: read the AFTER-LIFE plan for ex-LIFE sites)

IS THIS A DESIGNATED AREA (HCVF) ? complete box below

HCVF	Y/N	CODE	Specify the Qualifying Interests (link to Qualifying Interests)
SAC			
SPA			
NHA			
pNHA			

BIODIVERSITY INFO FROM THE FIELD (complete next section during site visit)

Current status and condition of biodiversity area including HCVF, LIFE sites, Millennium...etc

Current Habitat:	Target Habitat:

Parameter	YES	NO	N/A	EXTENT <5ha; 5-10ha; >10ha	LOCATION (AREA A, B, C) COMMENTS
LANDUSE					
Damage to boundaries					
Grazing – sheep/cattle					
Grazing – deer					
Browsing – grey squirrel					
Other trespass					
Turf-cutting – hand					
Turf-cutting – machine					
Burning					
Dumping					
Other					

Appendix 2, continued

EMS Document Ref. FORM-039; Version 2; Issue Date 120116

BIODIVERSITY AUDITING FORM

Parameter	YES	NO	N/A	EXTENT <5ha; 5-10ha; >10ha	LOCATION (AREA A, B, C) COMMENTS
CONTROL OF UNWANTED SPECIES/VEGETATION					
Natural regen pine/spruce					
• Regen early stage					
• Regeneration advanced					
• forming dense stands					
Natural regeneration – birch on bog					
• Regen early stage					
• Regeneration advanced					
• forming dense stands					
Natural regeneration – sycamore beech other BL					
• Regen early stage					
• Regeneration advanced					
• forming dense stands					
Spread of invasive shrubs: rhodo/laurel					
• Problem early stage					
• Problem advanced					
• Problem is forming extensive dense stands					
Spread of other invasives: dogweed/knotweed/other					
• Problem early stage					
• Problem advanced					
• Problem is forming extensive dense stands					
ACCESS/INTERPRETATION					
Damage to signage					
Damage to board walks					
Damage to trails / walking paths					
Damage to car park					
Vegetation encroaching on paths					
WATERTABLE/HYDROLOGY (only relevant where Target Habitat = Raised Bog, Blanket Bog, Fen, Marsh/Reedbed, Wet Woodland)					
Dams no longer intact or functioning					

Overall Conclusions on ecological status of the biodiversity area:

Appendix 2, continued

NOTES
Include any other Information or plot data here. Use additional sheets if necessary

APPENDIX 3 QUADRAT FORM FOR RE-SURVEY OF PERMANENT PLOTS ON RESTORED SITES

Site	**Quadrat 1**	**Quadrat 2**	**Quadrat 3**	**Quadrat 4**
Bog Type				
Landuse				
Date				
Grid Ref				
Altitude				
Area	10 x 10m	10 x 10m	10 x 10m	10 x 10m
Location				
Ecotope				
Management				
Firmness				
Drains				
Slope				
Aspect				
Canopy Cover				
Vegetation Cover				
Dwarf Shrub Cover				
Herb Cover				
Bryophyte Cover				
Sphagnum cover				
Open Water				
Brash cover				
Pine Needle cover				
Pine Needle Depth				
Bare Peat				
Species number				

Appendix 3, continued

Species List	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4
Pinus contorta				
Betula pubescens				
Quercus spp.				
Rubus spp				
Juncus spp				
Pteridium aquilinum				
Epilobium spp				
Myrica gale				
Calluna vulgaris				
Erica tetralix				
Narthecium ossifragum				
Carex panicea				
Eriophorium vaginatum				
Trichophorum cespitosum				
Andromeda polifolia				
Drosera rotundifolia				
Cladonia portentosa				
Campylopus atrovirens				
Hypnum cupressiforme				
Hypnum jutlandicum				
Polytricum commune				
Sphagnum recurvum				
Sphagnum capillifolium				
S. subnitens				