RESTORATION OF PEATLANDS IN IRELAND

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1 INTRODUCTION

Peatlands are widespread in Ireland, forming a considerable portion of the land surface area. There are a range of types present, but generally four broad categories are recognised: Atlantic raised bog, mountain blanket bog, Atlantic (lowland) blanket bog, and fens. The classification is based mainly on floristics and has been well documented by Irish vegetation scientists (Moore 1968; Doyle 1982; 1984, 1990a, 1990b; Doyle & O'Críodáin 2003; Farrell 2001; MacGowan 2000; O'Connell 1981; White & Doyle 1982).

Another peatland category that can be added to these established landscape units is *degraded* peatland habitats. Relatively intact ('*near-pristine*') bogs[1] often exhibit some level of degradation such as effects of marginal drainage while there are also examples of bare and eroding peatland habitats that exhibit severe levels of degradation. As a consequence there is broad scope for restoration projects to restore either at the plant community level and/or the ecosystem level.

This paper focuses on raised and blanket bogs: an overview of the extent of peatlands in Ireland is provided with a summary of the threats (past and present); this is followed by an overview of the restoration programmes that have been initiated to deal with different types and levels of degradation.

2 EXTENT OF PEATLANDS AND CURRENT CONSERVATION STATUS

The original cover of peatlands in the Republic of Ireland was 17.2% or 1,177,670ha: this figure was compiled from many different sources and included thirteen categories of peatland types and land-use (Hammond 1979). More recent mapping methods and the development of the Derived Irish Peatland Map (D.I.P.M.) indicate that the current land cover is 13.8% (Connolly *et al.* 2007); and 14.96% (1,030,000ha) if the peatland areas owned by Bord na Móna are included (*personal communication with J. Connolly 2007*).

While this is a considerable area of the national land cover, the figure is a reflection of the extent of *peat soils* (those with at least 30cm of peat present), and is not indicative of the extent of *near-pristine* peatland sites, particularly bogs of nature conservation interest such as *active* raised bog and *active* blanket bog priority habitats. The reality is that only a small proportion of this area comprises *near-pristine* bog sites; and that even those that are designated for nature conservation continue to be degraded by one or more on-going threats such as turf-cutting, commercial afforestation and/or overgrazing.

In Ireland, the National Parks and Wildlife Service (NPWS) is responsible for the selection, designation and management of protected areas for habitats and species of flora and fauna under the E.U. Habitats and Birds Directives and the Irish Wildlife Act (Amendments 2000). Of the original 1,177,670ha of peatland in the Republic of Ireland, an estimated 18,424ha of raised bog; 184,000ha of blanket bog; and 20,000ha of fen are currently included within Special Areas of Conservation (SACs) and statutory Natural Heritage Areas (NHAs) (Douglas 2006).

This total of approximately 220,000ha of peatland conserved is less than 20% of the original area and represents the best remaining examples of raised and blanket bogs in Ireland and in some instances in Europe. However, all raised bog SACs have ongoing turf-cutting at bog edges and/or some sites are partially planted with coniferous forestry. Monitoring of habitat

[1] It should be noted that in Ireland all bogs exhibit some level of degradation and therefore, in this paper the best remaining examples are referred to as *near-pristine* sites.

condition has been initiated by the NPWS for the raised bogs. Results to date indicate that there has been a significant decline in the area of *active* raised bog in Ireland in the last ten years (Douglas 2006).

3 THREATS TO IRISH PEATLANDS

The main causes of degradation of bogs in Ireland are peat extraction, afforestation and overgrazing. Since the value of peatlands for nature conservation has been highlighted under the E.U. Habitats Directive, a number of regulatory measures have been introduced by the Irish Government to control and limit further degradation. The range of threats and some of the prescribed controls are outlined below.

3.1 Peat extraction

3.1.1 Turf-cutting:

Turbary or the right of private individuals to cut turf for domestic use has been on-going for centuries in rural areas of Ireland. Since the 15th century traditional turbary has been responsible for the loss of 544,000ha of raised and blanket bogs or 46% of the original peatland area in the Republic of Ireland (www.ipcc.ie).

In the past, traditional hand cutting of turf took generations to produce a significant impact, but mechanisation of the process has allowed for more peat to be harvested over a wider area of bog and also on a semi-commercial basis. Nonetheless, only 15% or so of the privately produced sod peat is traded (Fitzgerald 2006). While turf-cutting is generally concentrated at bog edges, the drainage and edge effects can be manifested as subsidence within relatively intact parts of the bog, as evidenced at Clara Bog, Co. Offaly (Schouten 2002).

Turf-cutting is on-going at a number of bogs that have been designated for nature conservation. There is a clear conflict of interest in these situations and a Government funded scheme has been established, aimed at phasing out all turf-cutting at the edges of designated sites by 2008.

3.1.2 Industrial peat extraction:

Bord na Móna owns 80,000ha of peatland, and harvests 4 million tonnes of milled peat per annum. The land resource comprises active peat production bogs for energy and horticultural peat with fringing areas of bog remnants and scrub, riparian zones, access and workshop areas, and transport routes. The bogs are largely centred in the midlands and comprise lowland raised bogs, with one Atlantic blanket bog site in the west of Ireland. All bogs (150 units) have been developed for peat production to some degree.

The main market for milled peat is the energy sector, both for burning in three new power stations constructed in the last 6 years and for domestic consumption (briquettes). Bord na Móna is also a large market player in the production of horticultural peat with a number of other small horticultural competitors also operating since the late 1950s (Clarke 2006). In 2003 it was estimated that Bord na Móna and some 30 smaller Irish moss peat producers sold 2.6 million cubic metres of horticultural-grade peat with an estimated total turnover of €48 million (Hourican 2003).

Based on estimates of volumes harvested by private peat producers it may be inferred that a probable total of 100,000ha is being utilised for peat harvesting in Ireland, i.e. 7.5% of the original total peatland area. Of this, 6.4% is attributable to energy peat; the remainder to horticulture (Fitzgerald 2006).

Industrial peat extraction results in complete loss of the pre-existing peatland ecosystem character. Once the commercial peat has been removed, the production fields have variable peat depth (0.5m to >2m); remaining peat is compressed and there are large scale fluctuations in the water-table. The potential to restore these areas to lowland raised bogs is minimal; however there will be some scope for restoration of ombrotrophic peat-forming plant

communities where peat remains above the influence of alkaline waters. There is evidence of re-establishment of *Sphagnum* and other typical bog species on former horticultural peat production areas in Ireland (personal observations). However, most horticulture bogs are further utilised for energy peat, which generally brings the surface of the cutaway bog to a level of influence from alkaline waters and establishment of fen communities.

Any peat producer operating on 50ha or more must apply to the Environmental Protection Agency (EPA) for an IPPC (Integrated Pollution Prevention Control) licence. Since 1999, Bord na Móna conducts its peat extraction activities under the terms of nine such licences, issued and regulated by the EPA. Condition 10 of IPPC Licensing requires that Bord na Móna must submit a plan for the post-industrial rehabilitation of each peatland unit, describing the proposed after-use. A broad-based rehabilitation plan was submitted to the EPA in 2002 (Farrell 2002) for the full range of conditions encountered within Bord na Móna peatland areas: specific plans for areas near the end of their production life will be submitted on a continual basis.

Bord na Móna is the only peat producer in Ireland that operates under IPPC Licensing.

3.2 Afforestation of peatlands

In the 1940s only 1.5% of the land area of Ireland was forested (less than 1% native woodland); this led to a major afforestation drive by the Forest Service (the authority responsible for the administration of forestry grant schemes in the Republic of Ireland). Consequently, approximately 9% of Ireland is currently under commercial forestry mostly planted with exotic species, such as Lodgepole Pine *Pinus contorta* and Sitka Spruce *Picea sitchensis* (www.ipcc.ie).

The annual planting target of 30,000ha per annum resulted in extensive planting of peatlands, which at the time were largely considered as wastelands and marginal lands for agriculture. Up to 6,400ha of formerly intact raised bogs and 211,000ha of formerly intact blanket bogs have been planted (Ryan & Cross 1984; Farrell & Boyle 1990).

The effect of afforestation on these peatlands is complex: the most obvious effect is the dramatic change from a treeless landscape to a densely wooded forest, with significant changes in hydrology and water quality draining the afforested areas. Peatland catchments are particularly sensitive to changes in water chemistry and there is currently concern in relation to mobilisation of nutrients from peat soils following clear-felling in peatland catchments and effects on salmonid waters and subsequent effects on Annex II species such as Freshwater Pearl Mussel *Margaritifera margaritifera*.

The Forest Service has since produced guidelines which specifically exclude grants for afforestation of peatlands that are designated as SACs and NHAs. *Coillte* (the state forest company and the largest forestry company in Ireland managing 444,000ha of forested lands, mostly conifer plantation) has also undertaken extensive bog restoration projects with the aim of restoring blanket and raised bog areas that were originally planted for commercial forestry (*see later*). They have also adopted a policy not to afforest further peatland areas, predominantly for economic reasons.

3.3 Overgrazing

Extensive areas of blanket bog have been severely degraded due to increased numbers of grazing sheep, particularly in the west of Ireland. The introduction of the E.U. Headage Payment scheme in the 1980s led to a dramatic increase in sheep numbers with a near three-fold increase nationally (over 10 million sheep, with one quarter of this number in counties Galway and Mayo). The scheme was designed to assist farmers in ‘disadvantaged’ peatland areas but led to devastation of the hills as stocking pressures resulted in catastrophic deterioration in vegetation (Bleasdale 1998).

A loss in plant cover leads to exposure of bare peat surfaces and subsequent erosion of peat to the underlying mineral soil in some places. This in turn led to acidification of lakes and

siltation of the spawning beds of salmonids in these regions. In the period 1987-1997 it is estimated that overgrazing damage had left 7% of Ireland's total blanket bog area severely damaged with a further 7% under the same threat (Foss 1998).

Changes in E.U. policy and payment schemes have resulted in a significant reduction of sheep numbers on the blanket bogs and vegetation will recover, although at variable rates depending on the initial peatland habitat type and level of degradation once the grazing pressure is removed (Farrell 2004, 2007). The NPWS is currently working with Teagasc (the Irish Agriculture and Food Development Authority) and individual sheep farmers to devise appropriate grazing management regimes.

4 PEATLAND RESTORATION: RESPONDING TO DIFFERENT STARTING POINTS

It is clear from the previous discussions that there are a range of management practices that pose threats to the integrity and nature conservation value of peatland habitats in Ireland. In response a range of restoration projects have been initiated to deal with the different starting points of degradation.

While the restoration approaches can vary in method, the underlying thought process for any peatland restoration project must follow the following thread: what is the restoration objective, can it be restored and/or how can it be restored. This requires an assessment of the present condition of the peatland, an outline of aims and objectives and a management plan to achieve these aims. A brief overview is provided here of the background to the different restoration projects while more detailed information can be attained directly from those involved in both the original restoration work and subsequent monitoring and evaluation (see References and Table 1).

4.1 The Irish Raised Bog Restoration Project

Initial bog restoration projects in Ireland were led by a joint working group of Irish and Dutch scientists in a bid to prevent further degradation and loss of the internationally significant Irish raised bog habitats. The Irish and Dutch partnership resulted in the establishment of a comprehensive overview of the problems with respect to management and restoration of the Irish raised bogs. The main challenges identified were to overcome impacts of drainage at different levels including: superficial drainage by ditches cut in the surface of the bog; drainage of the marginal zones as a result of peat extraction; marginal drainage by deep ditches; and arterial drainage schemes (Schouten 2002).

Based on establishing the threats and identifying the knowledge gaps, a detailed research programme was devised and two sites were studied in detail: Raheenmore Bog and Clara Bog (both located in Co. Offaly). The baseline ecological and hydrological studies were exhaustive and provided the basis for development and implementation of restoration procedures. Work at Raheenmore comprised the building of three peat dams to offset the effects of drainage caused by small-scale peat cutting at the bog edge: one of the dams remains intact. The work in Clara involved blocking surface drains originally installed by Bord na Móna in the 1980s across Clara East: the drain blocking has promoted the recovery of extensive growth of *Sphagnum* species and return of favourable water levels for peat formation. On-going research at Clara includes investigating the potential to restore the Lough Roe soak system and minerotrophic vegetation (Crushell *et al*. 2006).

The insights gained during the Dutch-Irish collaboration were used in the *Irish Raised Bog Restoration Programme* (1994-2000) to identify raised bogs for designation as SACs and in the planning of rehabilitation measures on sites in the two countries (Schouten 2002). A key feature was the development of guidelines for blocking drains (Mc Donagh 1997): the drain-blocking intensity is dependent on the surface topography of the bog, and dams are installed at each point representing a 10cm change in level either by excavator and/or by hand. There are a number of examples of on-going restoration works on raised bog SACs and NHAs (see Table 1).

4.2 Coillte projects

Coillte has undertaken extensive bog restoration projects on land originally planted for commercial forestry in the 1980s. The main aim is restoration of blanket and raised bog in the SAC lands in its ownership (funded by the E.U. *Life-Nature* programme). The key feature is removal of poor growing pines and blocking drains, usually by means of plastic sheathing inserted along bog drains. The plastic dams are formed by lengths of interlocking, corrugated plastic which are cut to size on site and hammered into the drains. On relatively flat sites dams were placed every 15 metres along drains and closer intervals on slopes.

The blanket bog restoration projects were initiated in 2002 and cover 20 sites of a total of 1212.3ha within or adjoining candidate SACs within the *Coillte* estate on both Atlantic and mountain blanket bog. The sites consist of un-planted or partially/wholly afforested blanket bog/heath habitat. Most of the project sites are located in north Mayo, within sensitive salmonid catchments, where protection of watercourses is also an important consideration. The actual restoration work includes: fencing of 718.6ha of open blanket bog to prevent grazing; drain-blocking in order to restore the high water-table; the felling/removal of some 494ha of conifer plantation in order to increase the blanket bog area; and the felling of naturally regenerated conifers from open bogs (www.irishbogrestorationproject.ie).

A restoration project was also initiated in 2004 on afforested raised bog sites in *Coillte* ownership. This project aims to restore 571.2ha of raised bog on 14 sites to a favourable conservation status. The restoration work is similar to that carried out on the blanket bog sites in that most of the drains were blocked by plastic dams; however some were blocked using machine placed peat dams (www.raisedbogrestoration.ie).

4.3 Bord na Móna peatland rehabilitation

Bord na Móna has initiated a number of research projects looking at potential commercial and non-commercial after-use options for cutaway bog areas. These are demonstrated on a large-scale at the Boora Parklands in County Offaly (Egan, 1998, 2006; O'Connor & Reynolds 2000; Rowlands & Feehan 2000a, 2000b; Trodd & Murray 2000). Currently the option of regeneration of semi-natural habitats is considered the most likely after-use for up to 50% of the cutaway bogs. Natural colonisation of the cutaways results in a mosaic of semi-natural habitats including (a) *wetland habitats*: poor fen, rich fen, reed beds, open water, and (b) *dryland habitats*: acid grassland, heathland and birch woodland. These areas are rich in biodiversity and will contribute to the national biodiversity resource and wildlife conservation strategy (Egan 2006; Farrell 2006).

To date, the scope for restoration of peat-forming ecosystems on Bord na Móna bogs has been limited. The former industrial site located in the west of Ireland at Bellacorick however provides a case study of restoration of peat-forming communities on a large-scale (Farrell 2001, 2006; Farrell & Doyle 1998, 2003). The original Atlantic blanket bog ecosystem had been altered irreversibly by industrial peat production and it was considered impossible to restore the area to the former Atlantic blanket bog habitat. However, spontaneous regeneration of peat-forming vegetation had occurred in core areas where the water-table remained at the peat surface. These observations led to the development of a detailed rehabilitation plan that incorporated the following criteria: stabilisation of peat through acceleration of re-vegetation; and mitigation of silt run-off and restoration of peat-forming conditions where possible. These objectives were achieved through extensive drain-blocking; ridging on gravel hills and slopes; the creation of replacement settlement areas throughout the area with greater attention to those areas identified suitable for *Sphagnum* establishment.

However, most of Bord na Móna lands are currently managed for milled peat production for three power stations and this will continue until 2020, and possibly 2035 depending on national energy policy. It is likely that there will be potential for restoration of bog vegetation (restoration at plant community level) on industrial sites in the future.

4.4 Irish Peatland Conservation Council Lodge Bog restoration project

Other bodies involved in peatland restoration include the Irish Peatland Conservation Council (IPCC). The IPCC was established in the 1980s, essentially as a lobby group for the protection and conservation of boglands in Ireland but also with an educational remit.

In 2005 an area of bog known as Lodge Bog (35ha), formerly part of the extensive Bog of Allen complex and bordered by industrial production bog was transferred to the IPCC by Bord na Móna. The IPCC carried out a comprehensive ecological and topographic study; and following the guidelines developed through the *Irish Raised Bog Restoration project*, completed a drain blocking programme in a bid to prevent further drying out of Lodge Bog. Up to 155 dams consisting of plastic piling were inserted across Lodge Bog at every 10cm change in surface level (O'Connell 2006).

The project is relatively small-scale but is a significant educational platform whereby the IPCC can introduce concepts of bog restoration to both children and adults visiting the Bog of Allen Nature Centre, which operates as the headquarters for the IPCC in Ireland.

4.5 Other restoration projects

There are a number of other restoration projects ongoing in Ireland and Northern Ireland and these are outlined in Table 1.

5 PEATLAND MANAGEMENT POLICY AND FUTURE RESTORATION

Peatlands in Ireland have been subject to a range of management pressures and threats to their integrity and there is a need for an integrated approach to develop a national peatland management policy. This will be led by policy changes at Government and E.U. level. There will however be scope to prevent further degradation and reverse the damage processes through restoration projects.

The restoration carried out to date largely relates to areas designated for nature conservation, SACs and NHAs. There is an obligation under the E.U. Habitats Directive to prevent further degradation of Natura sites and where possible restore those bogs that are part of the Natura 2000 network: therefore these areas take priority in restoration. The restoration work carried out by the NPWS on SACs and NHAs is showing positive results in restoring appropriate hydrological conditions and peat-forming plant communities. They are successful at the plant community level although slow to recover at the ecosystem level. Cessation of turf-cutting at the edges of bogs designated for conservation is fundamental to prevention of further degradation.

The *Coillte* projects are relatively new and tree removal and blocking drains are the key restoration measures. The results to date vary between sites. In general, recovery of bog vegetation is slow but in some instances there is good regeneration of *Sphagnum* species in former drains, and no regeneration of conifers.

Bord na Móna has worked on a number of restoration projects with the NPWS, but the scope for restoration within Bord na Móna sites has been limited to date. There is a requirement to fill the knowledge gap in determining the potential rate of recovery of bogs utilised for horticultural peat that may never be transferred for energy peat. Bord na Móna will fulfil this requirement under IPC Licensing.

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Table 1. Summary of restoration and/or rehabilitation projects initiated in Ireland to date.

	Name	County	Owner	Bog type	Objective	Action	Contact
	NGOs						
1	Fenor Bog	Waterford	IPCC	Fen	Rewetting and restoration of secondary fen	Ditch blocking; tree removal by hand	bogs@ipcc.ie
					Reduction of nutrient input		
2	Lodge Bog	Kildare	IPCC	Raised bog	Rewetting of drained bog surface	Ditch blocking; tree removal by hand	bogs@ipcc.ie
3	Blackditch Wood	Wicklow	BirdWatch	Fen	Restore natural habitats	Re-profiling drains; tree removal by hand	www.birdwatchireland.ie
	Private						
4	Ardkill	Kildare	Private	Raised bog	Rewetting of drained bog surface	Ditch blocking; tree removal by hand	
5	Kilcolman	Cork	Private	Fen	Control of water levels	Sluice installation	
	NPWS						
6	Ballykenny	Longford	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
7	Bellanagare	Roscommon	NPWS	Raised bog	Restore surface flushes	Ditch blocking	www.npws.ie
8	Carrigower	Wicklow	NPWS	Transition mire	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
9	Carrowbehy	Roscommon	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
10	Clara	Offaly	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking; peat dams	www.npws.ie
11	Clara	Offaly	NPWS	Raised bog	Restoration of Shanley's Lough soak system	Digging out peat; creation of open water	
12	Clonfinane	Tipperary	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
13	Fisherstown	Longford	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
14	Gariskill	Westmeath	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
15	Girley	Meath	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
16	Kippure	Wicklow	NPWS	Blanket bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
17	Lisnageeragh	Galway	NPWS	Raised bog	Restore soak and natural drainage features	Ditch blocking	www.npws.ie
18	Mongan	Offaly	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
19	Moyclare	Offaly	NPWS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.npws.ie
20	Raheenmore	Offaly	NPWS	Raised bog	Rewetting of bog edges	Construction of surface peat dams	www.npws.ie
21	Sharavogue	Offaly	NPWS	Raised bog	Restoration of lagg	Ditch blocking	www.npws.ie
	Bord na Móna						
22	Corlea	Longford	BNM	Raised bog	Preservation of wooden trackway	Bunding of bog remnant, lagoon creation	www.bnm.ie
23	Blackwater	Offaly	BNM	Industrial Cutaway	Creation of wetlands and dryland habitats	Ditch blocking	www.bnm.ie
24	Clongawney	Offaly	BNM	Industrial Cutaway	Creation of wetlands and dryland habitats	Ditch blocking	www.bnm.ie
25	Drinagh	Offaly	BNM	Industrial Cutaway	Creation of wetlands and dryland habitats	Ditch blocking	www.bnm.ie

26	Lullymore	Kildare	BNM	Industrial Cutaway	Creation of rich fen and poor fen	Blocking main outfalls	www.bnm.ie
27	Turraun	Offaly	BNM	Industrial Cutaway	Creation of wetlands and dryland habitats	Ditch blocking; bunding	www.bnm.ie
28	O'Boyle's Bog	Mayo	BNM	Atlantic BB cutaway	Rewetting of drained bog surface	Intensive drain blocking	www.bnm.ie
29	Oweninny Bogs	Mayo	BNM	Atlantic BB cutaway	Rewetting of drained bog surface	Intensive drain blocking, pool creation	www.bnm.ie
30	Ballycon	Offaly	BNM	Industrial Cutaway	Creation of wetlands and dryland habitats	Intensive drain blocking, pool creation	www.bnm.ie
	Coillte						
31-50	Blanket Bog	20 sites	Coillte	Blanket Bog	Rewetting of drained bog surface	Ditch blocking; tree removal	www.coillte.ie
51-64	Raised Bog	14 sites	Coillte	Raised Bog	Rewetting of drained bog surface	Ditch blocking; tree removal	www.coillte.ie
	Northern Ireland projects						
65	Ballynahone	Derry	EHS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.ehsni.gov.uk
66	Black Bog	Tyrone	EHS	Raised bog	Rewetting of drained bog surface	Ditch blocking	www.ehsni.gov.uk
67	Brackagh	Armagh	EHS	Raised bog	Reduction of water loss and nutrient input	Water diversion, bunding	www.ehsni.gov.uk
68	Lough Naman	Fermanagh	EHS	Raised bog	Restoration of drained bog surface	Ditch blocking	www.ehsni.gov.uk
69	Peatlands Park	Armagh	EHS	Raised bog	Restoration of drained bog surface	Ditch blocking, surface levelling	www.ehsni.gov.uk