IRISH PEATLAND CONSERVATION COUNCIL

In 2019 Ireland declared a climate and biodiversity emergency. The government has acknowledged that our country needs to act with urgency on the causes and impacts of climate change. Peatlands are highly significant in the global efforts to combat climate change. Depending on how we manage our peatland resources they can strongly contribute to the climate crisis or they can support climate mitigation plans and international biodiversity targets. The protection and restoration of peatlands is vital in the transition towards a climate resilient and climate neutral economy. The Irish Peatland Conservation Council have developed this action plan focusing on peatlands. Its overall aim is to provide a roadmap for the protection, sustainable management and restoration of the country's 1.2 million hectares of peatlands. The plan involves rehabilitation and restoration actions to enhance the natural carbon capture and storage ability in peatlands. Realising the potential of our peatlands to be a natural solution to reducing greenhouse gas emissions needs community engagement and a budget of at least €1 billion. It must be completed in the next 20 years.

Irish Peatland Conservation Council
Bog of Allen Nature Centre, Lullymore
Rathangan, Co. Kildare R51V293
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PEATLANDS & CLIMATE CHANGE
ACTION PLAN 2030

Healthy peatlands provide a natural solution to reducing greenhouse gas emissions

Peatlands and Climate Change Action Plan 2030

Published by: Irish Peatland Conservation Council, Bog of Allen Nature Centre, Lullymore, Rathangan, Co. Kildare R51V293.
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Cover Image: Blanket bog complex south of Killary Harbour, Co. Galway. Blanket bogs face a number of pressures - overgrazing, drainage for turf cutting and forestry, burning to improve grazing, recreation and windfarm developments. Together these uses can change the natural function of the blanket bog so that it switches from slowing climate change as a carbon sink, to become a carbon source that releases greenhouse gases to the atmosphere. Photo: © C. O'Connell.

The Irish Peatland Conservation Council was founded in 1982. Our mission is to conserve a representative sample of the bogs and fens of Ireland for people to enjoy now and in the future. We run the national Save the Bogs Campaign and our activities include: education and publicity, promoting environmental awareness, providing information and encouraging the protection and conservation of our national heritage for the common good. We own and manage a network of five peatland reserves in Counties Kildare, Waterford, Meath and Kerry. We own and run the Bog of Allen Nature Centre which is open to visitors and school groups. We provide an extensive information service on our web site at www.ipcc.ie. IPCC has four members of staff and are supported by 100 volunteers. 4,000 individuals subscribe to our campaign. The Irish Peatland Conservation Council is a voluntary, non-governmental organisation, a Company Limited by Guarantee (No. 115156) with charitable status (CHY6829, RCN 20013547).

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2. Executive Summary

frequently asked questions answered

In 2019 Ireland declared a climate and biodiversity emergency. The government has acknowledged that our country needs to act with urgency on the causes and impacts of climate change. Peatlands are highly significant in the global efforts to combat climate change. The protection and restoration of peatlands is vital in the transition towards a climate resilient and climate neutral economy. To assist in the implementation of climate action plans, the Irish Peatland Conservation Council have developed this plan of action focusing on peatlands. Depending on how we manage our peatland resources they can strongly contribute to the climate crisis or they can support climate mitigation plans and international biodiversity targets.

The overall aims of this action plan are to ensure the protection of peatlands currently in good condition and supporting their range of ecosystem functions and to enhance the resilience to climate change of the entire country's peatlands through management, funding, education and collective effort.

This action plan seeks to address a number of relatively simple questions that people ask in any discussion about peatlands and climate change. It is difficult to give precise answers to questions. Using as much information as possible and from our practical experience in peatland protection the Irish Peatland Conservation Council makes the following answers.

How much carbon is stored?

The total soil carbon stock in raised and blanket bogs was calculated for a continuum of sites from industrial cutaway to intact pristine bog in 2000 by Tomlinson[1]. The mean carbon density expressed as tonnes of carbon per hectare (t C ha^{-1}) in raised bogs was 1,314 t C ha^{-1}, in lowland blanket bogs was 1,022 t C ha^{-1} and in upland blanket bogs was 420 t C ha^{-1}.

It follows that 53% of the total stock of carbon in Irish soils is found in raised and blanket bogs which cover <20% of the total land area of the country[1]. The total carbon stock amounted to 1,188,800 tonnes of carbon (t C).

Lodge Bog in Co. Kildare, an uncut raised bog remnant which had an average peat depth of 3.03m was found to have a carbon soil store of 1,329 t C ha^{-1} (Kerr 2011)[2].

A cutover raised bog where peat depth ranged from 2m to 5.5m was found to have an average carbon soil store of 1,422 t C ha^{-1}. These figures were calculated for Girley Bog cutover, Co. Meath (O'Connell et al 2020[3]). Using the average figure from Girley Bog, there many be 452 million t C (tonnes of carbon) stored in the 317,759ha of cutover bog under turbary in Ireland at this time.

How much CO_2 is sequestered in peatland?

In terms of greenhouse gas sequestration the long-term work led by Kiely et al 2018[4] at Glencar in Co. Kerry found that this pristine blanket bog was a carbon sink, sequestering 30 g C m^{-2} yr^{-1} (grammes of carbon per metre squared per year) or 0.3 t C ha^{1} yr^{-1} (grammes of carbon per hectare per year).

How much greenhouse gases are coming off Irish peatlands?

All anthropogenic or human-modified/drained peatlands are net greenhouse gas sources according to research undertaken across a network of different peatland site conditions and uses (Renou-Wilson et al 2018[5] and Wilson et al 2015[6]). The emissions are between 0.81 and 2.86 t C ha^{-1} yr^{-1} for carbon dioxide (CO_2) and between 0 and 0.015 t C ha^{-1} yr^{-1} for methane (CH_4).

The volume of greenhouse gases lost in bog water as dissolved organic carbon have not been included in the figures presented.

How much carbon can be saved by restoring peatland?

Following restoration through rewetting land managers can expect CO_2 emissions to reduce. Following rewetting some sites became a CO_2 sink in the order of 0.4 to 1.04 t C ha^{-1} yr^{-1} such as drained only, domestic cutover bogs, nutrient-poor industrial cutaway and peatlands reclaimed to grassland. In terms of CH_4 all rewetted sites examined continued to be a source ranging from 0.020 to 0.197 t C ha^{-1} yr^{-1} (Renou-Wilson et al 2018[5]).

Restoration not only provides

1 Tomlinson, R.W. (2005) Soil Carbon Stocks and changes in the Republic of Ireland. Journal of Environmental Management 76: 77-93

2 Kerr, E. (2011) The Long Term Carbon Storage Capacity of Lodge Bog, Co. Kildare. B.A. (Mod) Thesis, School of Natural Sciences, University of Dublin Trinity College, Dublin.

3 O'Connell, C. A., Madigan, N. & Farrell, P. (2020) Girley Bog Carbon Project. Irish Peatland Conservation Council, Kildare

4 Kiely, G., Leahy, P., McVeigh, P., Lewis, C., Sottocornola, M., Laine, A & Koehler, A-K. (2018) PeatGHG - Survey of GHG Emission and Sink Potential of Blanket Peatlands. Report No. 228, EPA, Wexford.

5 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). EPA Wexford.

6 Wilson, D., Dixon, S.D., Artz, R.R.E., Smith, T.E.L., Evans, C.D., Owen, H.J.F., Archer, E. and Renou- Wilson, F., (2015) Derivation of greenhouse gas emission factors for peatlands managed for extraction in the Republic of Ireland and the United Kingdom. Biogeosciences 12(18): 5291–5308.

returns in terms of climate mitigation but it also has valuable benefits in terms of biodiversity, water management and landscape quality.

What's involved in restoration?
Peatland restoration involves making agreements with land owners and providing compensation payments for loss of turf cutting or for permission to carry out works on privately owned land. It also involves land acquisition, research to draw up restoration and drainage management plans and training contractors to carry out drain blocking, cell bunding, *Sphagnum* transfer, conifer removal and other works. A very important part of restoration is monitoring including measuring water tables, biodiversity and greenhouse gas emissions.

What are the restoration costs?
The Irish Peatland Conservation Council has calculated a restoration cost all in of between €180m and €202m for the raised bog network of sites which needs to be undertaken by 2036 in line with the Raised Bog SAC Management Plan and the Raised Bog NHA Review. In terms of climate change only (as peatlands do provide many other benefits) this may provide:

* 3,600ha of active peat forming raised bog habitat
* secure the carbon stock of 40.5 million t C in 30,867ha of supporting habitat and
* create a sink for CO_2 of -0.48 t C ha^{-1} yr^{-1} and a source of CH_4 of +0.197 t C ha^{-1} yr^{-1}. (Note values vary from site to site. Also it would be an overall carbon sink but long-term monitoring of greenhouse gases would be required to quantify actual changes following restoration and to take into account dissolved organic carbon in water dynamics).

The price of restoration for all of the peatlands designated of conservation importance in Ireland including blanket bog and fen has been estimated at €1 billion by the National Parks and Wildlife Service (Regan 2020[1]).

Funding for restoration is available through a variety of European initiatives, from the Carbon Tax fund, Climate Action Fund and government subventions. Funding for restoration on privately owned peatland is available from the Peatlands Community Engagement Scheme and from the heritage and biodiversity funding streams of the Heritage Council, the Community Foundation for Ireland and local authorities.

A long-term revenue stream for peatland restoration needs to be found. The most practical course of action is to develop a system of credits based on the value of the "saved" emissions from peatland restoration. The carbon credits are bought by sponsors to offset their carbon footprint. The Peatlands Code is such a system operated by the International Union for Conservation of Nature (IUCN) in the UK[2].

What state are peatlands in?
The Irish Peatland Conservation Council has reviewed the status of Irish peatlands and we find that 299,192ha remains relatively intact within 895 sites of conservation importance. This however is only 25% of the original peatland area in the Republic of Ireland.

The Irish Peatland Conservation Council has reviewed the designation of Irish peatlands for conservation and we find that 331 sites have been designated as Special Areas of Conservation (SAC) and/or Natural Heritage Areas (NHA) covering an area of 153,078ha[3, 4] (13% of the original peatland area in the Republic of Ireland).

The Irish Peatland Conservation Council has calculated the loss of peatland habitat to different uses and have found that 27% of our peatlands are being used for turbary/private turf cutting, 28% are forested, 6% are being used for peat energy, 2% are being milled for horticultural moss peat, 6% have been reclaimed for agriculture and 5% have been overgrazed. This leaves 25% relatively intact but deteriorating in quality due to on-going threats and the slow pace of restoration[4].

What policies need changing to protect peatlands?
A review of peatland policy shows a need for more climate-friendly action in the areas of controlling turf cutting, positioning wind farms, switching to sustainable home energy, stopping the production of horticultural moss peat, placing a carbon tax on turf cut for domestic use, revising the Peatlands Strategy to include blanket bog and fen habitats, publishing the locations of the Raised Bog sites of conservation importance, streamlining peatland management decisions to avoid conflicting decisions and setting conservation targets for blanket bogs and fens.

What actions are needed?
A road map of 12 actions has been formulated to ensure that Irish peatlands realise their full potential in the country's climate action plan. These actions will guide the save the bogs campaign of the Irish Peatland Conservation Council to 2030. local authorities, government departments, community groups, companies will be targeted to take action sooner rather than later on the issues raised.

1 Regan, S. (2020) An introduction to Irish peatlands: extent, pressures, conservation and value. Presentation to Backing Our Bogs Conference University College Dublin 21.7.20
2 https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2019-07/290918%20Peatland%20Code%20poster.pdf
3 Source www.npws.ie
4 Source Irish Peatland Conservation Council Sites Database

3. Foreword

from Team Irish Peatland Conservation Council

This is the seventh Action Plan on Peatlands in Ireland prepared by the Irish Peatland Conservation Council since our formation in 1982[1-6]. The theme of the Action Plan is climate change, in recognition of the vital role that peatlands play in the carbon cycle and their potential through restoration and rehabilitation to mitigate Ireland's greenhouse gas emissions. The need to protect, sustainably manage and restore peatlands has never been more urgent. Public concern about the climate crisis is strong and through the declaration of a climate emergency by the Irish government, political commitment has been given to act now.

The last action plan devised by Irish Peatland Conservation Council was published in 2009[6]. The campaign developed around this action plan focused on peatland biodiversity and it achieved key milestones such as the development of a National Peatland Strategy, the development of new research and understanding on the ecohydrological functioning of raised bogs and the preparation of site conservation and restoration plans for raised bogs.

This Peatlands and Climate Change Action Plan is a single issue plan that is to be used in conjuction with previous action plans. It covers the decade to 2030 which coincides with the United Nations Decade on Restoration. With this plan the Irish Peatland Conservation Council are bringing together all of the relevant research on peatlands and climate change. This includes measuring the extent to which man-modified and relatively intact peatlands are contributing to climate change, how restoration and rehabilitation can reduce greenhouse gas emissions, analysing changes needed in peatland policy and providing a roadmap of actions to ensure peatlands are managed in a carbon-neutral manner.

Methods

The Irish Peatland Conservation Council conducted an extensive literature review to inform this action plan. Information was extracted from the literature to describe the relationship between peatlands and climate change.

Policy documents published by national and local government from Ireland such as the Climate Action Plan, National Peatland Strategy and Sustainable Development Goals Implementation Plan among others were examined. The literature review was also extended to the UK where much work has been done on peatlands within the same biogeographical zone as those in Ireland and in particular the work of the International Union for Conservation of Nature (IUCN) and the actions arising from the Scottish Peatland Strategy.

Scientific papers, Environmental Protection Agency (EPA) reports, university research projects and Irish Peatland Conservation Council's own research were consulted to extract quantitative data on greenhouse gas emissions from natural and man-modified peatland types in Ireland, the volume of carbon stored in different peatland types and the rate of sequestration of greenhouse gases in peatlands.

Scope

Previous peatland Action Plans produced by the Irish Peatland Conservation Council only considered peatland sites of conservation importance. Over 1,000 sites are monitored by the Irish Peatland Conservation Council and we have a database of information about them. As the majority of peatlands in Ireland are man-modified, they all contribute to greenhouse gas emission. A continuum of site condition exists from those with bare peat through forested and grassed peatlands right through to those that may be drained but with vegetation cover and finally to those that are pristine. How all of these sites are managed has a bearing on the management of greenhouse gas emissions and this is given treatment in this action plan.

1 Irish Peatland Conservation Council (1986) The Irish Peatland Conservation Council Action Plan 1986-1988. Irish Peatland Conservation Council, Dublin.
2 Irish Peatland Conservation Council (1989) The Irish Peatland Conservation Council Action Plan 1989-1992. Irish Peatland Conservation Council, Dublin.
3 Irish Peatland Conservation Council (1992) Irish Peatland Conservation Council Policy Statement and Action Plan 1992-1997. Irish Peatland Conservation Council, Dublin.
4 Foss, P. J. & O'Connell, C. A. (1996) Irish Peatland Conservation Plan 2000. Irish Peatland Conservation Council, Dublin.
5 Foss, P. J., O'Connell, C. A. & Crushell, P. H. (2001) Bogs and Fens of Ireland Conservation Plan 2005. Irish Peatland Conservation Council, Dublin.
6 Malone, S. & O'Connell, C. A. (2009) Irish Peatland Conservation Action Plan 2020 - Halting the Loss of Biodiversity. Irish Peatland Conservation Council, Kildare

4. Natural Climate Regulation

through 10,000 years of peatland formation

Actively growing peatlands (i.e. bogs and fens) accumulate organic mass, and thereby sequester carbon as the excess of vegetation production over decay. Carbon is taken in by peatland plants through the process of photosynthesis from carbon dioxide, largely from the atmosphere. However peatlands also release carbon as a direct result of decay processes. Most of the vegetation decay takes place aerobically in the surface horizons (the acrotelm). However, anaerobic decay also continues, albeit at a much slower rate, at depth in cold, anaerobic horizons (the catotelm), releasing methane.

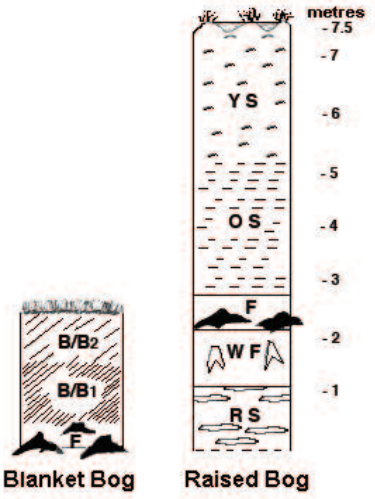


Figure 1: Standardised peat profiles of Blanket and Raised bogs in Ireland (Barry, 1969[1]). Abbreviations used:
Blanket Peat: B/B2: Upper stratum of blanket bog peat, moderately or poorly humified.
B/B1: Lower stratum of blanket bog peat, well humified.
F: Forest peat (usually amorphous), with pine stumps common.

Raised Peat: YS: Younger *Sphagnum* peat. OS: Older *Sphagnum* and *Eriophorum* peat. F: Forest peat, with pine remains most common, except over convexities of the floor in the central plain, where oak and yew occur, with or without pine.
WF: Woody-fen peat.
RS: Reedswamp

Peat is brownish-black in colour and in its natural state is composed of 90% water and 10% solid material. It consists of *Sphagnum* moss along with the roots, leaves, flowers and seeds of heathers, grasses and sedges. Occasionally the trunks and roots of trees such as Scots pine, oak, birch and yew are also present in the peat.

Peat Stratigraphy - Fen and Raised Bog

Barry 1969[1] discussed how Ireland's peatlands began to develop in the post glacial environment of 10,000 years ago as the ice melted and retreated (see Figure 1). At first, much of the landscape consisted of pine, oak and yew forests in areas above flood level and reeds (*Phragmites*) began encroaching into lakes scoured out by the retreating ice sheets. Thus fens began to form. Reedswamp peat was the first peat-type to be formed from the remains of aquatic plants and animals. This overlies silt, clay or marl substrate - the watertight bottom of the lake basin. Reedswamp colonised the lake working from the edge to the centre. Pine forests then developed on the margins to form woody fen habitat.

Figure 2: Measuring the extent of the younger and older *Sphagnum* layers visible in a peat bank left behind by turf cutters on a raised bog at Croghan, Co. Roscommon. The peat accumulates at a rate of 1mm per year and may store[2] up to 1314 t C ha^{-1}. Photo: © C. O'Connell

True acid bog peat began to form on the remains of the pine forests that had fallen as a result of climatic changes corresponding with a shift to wetter conditions and the spread of *Sphagnum* moss. This humified peat layer of old *Sphagnum-Eriophorum* was distinguishable from all other peats as it lacked woody remains of trees. A younger relatively unhumified layer of *Sphagnum* peat formed over the older layer (see Figure 2).

Peat Stratigraphy - Blanket Bog

With the climatic shift to wetter conditions and/or the action of man felling forests to create grazing land along the west coast and uplands of Ireland soils became increasingly waterlogged and developed watertight iron pans in their upper horizons. This was the trigger for blanket peat formation to begin. The forests left behind a peat type consisting of the remains of birch and pine wood. True blanket bog peat then began to form consisting of Cyperaceae, Gramineae and Ericaceae which was humified. Above this, the peat is less humified but has the same composition. *Sphagnum* is not as

1 Barry, T. A. (1969) Origins and Distribution of Peat. Types. Irish Forestry, pp. 40-52.
2 Tomlinson, R.W. (2005) Soil Carbon Stocks and changes in the Republic of Ireland. Journal of Environmental Management 76: 77-93

important in the peat stratigraphy of blanket peats (see Figures 1 and 3).

Case Study: Peat Stratigraphy Mongan Bog

A peat core taken from Mongan Bog SAC in Co. Offaly is reported by Tubridy 1984[1]. Data collected included stratigraphy, loss on ignition and pollen analysis. The results are presented in Figure 4. From 8.5m-11m, layers of calcareous marl overlain by a watertight grey clay layer were found. From 8.5 to 6m the sediments were of fen peat. Ferns dominated the vegetation in Mongan Bog along with other fen flora including Willow (*Salix*), Royal fern (*Osmunda regalis*), Meadow Sweet (*Filipendula ulmaria*) and grasses (Gramineae).

At 6m a *Sphagnum* peat layer was recorded with evidence of heather, sedges and *Sphagnum* mosses on the bog surface. The bog was no longer influenced by ground water and the organic content of the peat was at 95%. High concentrations of heather pollen were recorded in the peat sediments between 5 and 4m. However from 4m upwards records show that the water table was at or close to the surface of the bog and the organic content of the peat reached 99%. Remains of *Sphagnum austinii* - a strongly peat-forming *Sphagnum* were recorded in the stratigraphy in this zone and high concentrations of *Sphagnum* spores and sedge pollen were recorded in the core typical of acid, peat-forming raised bog habitat.

Figure 3: Exposed peat profile at the Claggan Mountain Coastal Trail, Co. Mayo. The image to the right shows the watertight iron pan in the soil below the peat and the image to the left shows the presence of a pine stump in the peat stratigraphy. Lowland or Atlantic blanket bog may store[2] 1022 t C ha^{-1}. Photos: © C. O'Connell

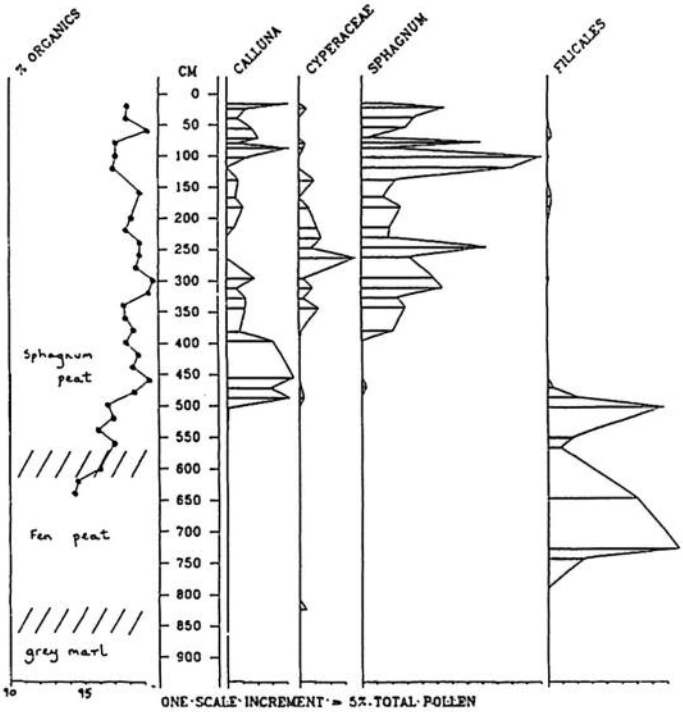


Figure 4: Peat core analysis from Mongan Bog SAC, Co. Offaly after Tubridy 1984[1].

Peat-forming Vegetation

Active refers to a peatland habitat that supports a significant area of peat-forming vegetation and where the right conditions prevail for active peat accumulation to occur. Conditions for active peat formation in raised bogs are well studied in Ireland from many years of Dutch-Irish research. Active peat-forming raised bog typically develops on uncut peatlands with slopes of between 0.2% and 0.6%, depending on effective rainfall which varies between 200 and 900mm per year and which has a range of *Sphagnum* mosses forming a living layer on its surface (Schouten 2002[3], see Table 1). Conditions for the development of active blanket bog are less well researched in Ireland. Active peat

1 Tubridy, M., (1984) 'Creation and management of a Heritage Zone at Clonmacnoise, Co. Offaly. Final Report to E.E.C. project no. 6611/12 by Environmental Sciences Unit, Trinity College Dublin.

2 Tomlinson, R. W. (2005) Soil Carbon Stocks and changes in the Republic of Ireland. Journal of Environmental Management 76: 77-93

3 Schouten, M.G.C. (2002) Conservation and Restoration of Raised Bogs: Geological, Hydrological and Ecological Studies. Department of Environment and Local Government, Dublin, Ireland and Staatabosbeheer, The Netherlands.

forming blanket bog is defined as peatland supporting significant areas of vegetation that are normally peat forming (e.g. *Schoenus nigricans, Molinia caerulea, Eriophorum* species and *Sphagnum* species). Plant communities and microtopography of "active" or peat-forming blanket bog can be very variable[1].

Due to centuries of use and the continued degradation of Irish peatlands <6% of raised bogs are regarded as active and approximately 20-30% of blanket bogs are regarded as active (Regan 2020[2]).

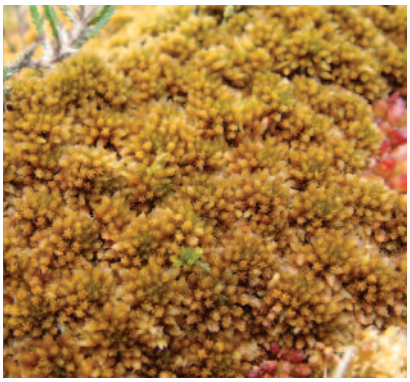


Figure 5: *Sphagnum austinii* (left) and *Sphagnum fuscum* (right) two of the strongly peat-forming mosses in peatlands. Photos: © C. O'Connell

Table 1: Ecology and peat forming capacity of the different species of *Sphagnum* mosses occurring on Irish peatlands (P. Crushell pers comm).

Species	Ecology	Peat-forming Capacity
***Sphagnum austinii* (see Figure 5)**	Hummock-forming	High
Sphagnum capillifolium	Hummock- and carpet-forming	Moderate
Sphagnum cuspidatum	Free-floating in pools and lining hollows	Low
Sphagnum denticulatum	Pool and hollow species	Low
Sphagnum fallax	Occurs in lawns and carpets, shade tolerant, indicative of some nutrient enrichment (soaks and active flushes)	Low
***Sphagnum fuscum* (see Figure 5)**	Forms dense low and wide hummocks	High
Sphagnum magellanicum	Lawn species forming carpets and low hummocks	Moderate
Sphagnum palustre	Forms hummocks and dense carpets, often in shaded conditions, indicative of nutrient enrichment (soaks and active flushes)	Low
Sphagnum papillosum	Lawn, hollow and low hummock species	Moderate
Sphagnum pulchrum	Grows in lawns and hollows, more typical of western bogs	Moderate
Sphagnum squarrosum	Forms carpets and small mounds, indicative of nutrient enrichment (soaks and active flushes)	Low
Sphagnum subnitens	Occurs as individual shoots or small cushions and lawns. Tolerant of minerotrophic conditions	Moderate
Sphagnum tenellum	Occurs as single shoots or weak cushions, typically in disturbed areas of the bog surface	Low

How the Carbon Content of a Raised Bog Peatland is Measured

According to Tomlinson 2005[3] there are four essential pieces of data needed to calculate the volume of carbon stored in a peatland.

1. Area of the peatland in which the carbon content is to be estimated in hectares
2. Total depth of peat in the peatland
3. The types of peat present in the peatland e.g. (*Sphagnum* peat, woody fen peat, reed peat) and the thickness of each layer identified
4. The bulk density (the oven dry weight of a known volume of peat) of the different peat layers in the peatland. Bulk density values for different peat types have been quoted in Tomlinson 2005 from the work of Hammond 1989[4] as follows:

Poorly Humified *Sphagnum* peat: 0.062
Humified *Sphagnum* peat: 0.082
Woody Peat: 0.125
Fen/Reed Peat: 0.116

Once these values are known, conversion factors are used to determine organic carbon in a peat sample. These assume that different types of peat contain different portions of organic carbon as follows:

Poorly Humified *Sphagnum* & Humified *Sphagnum* peat are 51% or 1.96 organic carbon
Woody Peat is 49% or 2.04 organic carbon
Fen/Reed Peat is 36% or 2.78 organic carbon

Thus the carbon stock in the peatland measured in tonnes carbon per hectare (t C ha^{-1}) is:

Bulk Density x %C x Thickness of the Peat Layer x Area of the Peatland

To convert carbon to carbon dioxide multiply by 44/12 (the proportion by weight of carbon in a CO_2 molecule) and this gives a figure for the volume of CO_2 in tonnes CO_2 per hectare that could be lost from the peatland if its natural balance was altered through drainage and peat removal.

1 NPWS (2019) The Status of EU Protected Habitats and Species in Ireland, Volumes 1-3. Department of Culture Heritage and the Gaeltacht, Dublin.
2 Regan, S. (2020) An introduction to Irish peatlands: extent, pressures, conservation and value. Presentation to Backing Our Bogs Conference University College Dublin 21.7.20
3 Tomlinson, R.W. (2005) Soil Carbon Stocks and changes in the Republic of Ireland. Journal of Environmental Management 76: 77-93
4 Hammond, R. F. (1989) The characteristics of Irish Midland peatlands which can influence future land use programmes. In: Mollan, C. (Ed.) The Utilisation of Irish Midland Peatlands. Royal Dublin Society, Dublin, pp 49-62.

5. Carbon Storage in Peatlands

the largest natural terrestrial carbon store in Ireland

Peatlands exist because the microbes associated with decay do not decompose the organic matter produced from plant growth. As a result peatland vegetation sequesters carbon each year. A persistently high water table is necessary for this function. As this process has been going on for many thousands of years peatlands are a significant carbon store. Peatlands store more carbon than any other terrestrial ecosystem but once drained, that carbon store is released and that is very damaging to the environment.

Since the beginning of their formation, Irish peatlands have been a persistent net sink of atmospheric carbon dioxide (CO_2), a persistent source of atmospheric methane (CH_4) and a persistent source of carbon (C) in the form of dissolved organic carbon (DOC) in surface/subsurface runoff to rivers. At the same time peatlands have accumulated significant soil carbon stores. This means that the sink of CO_2 has exceeded the sum of the source (emission/loss) of CH_4 and DOC, thereby resulting in the sequestration of carbon in peatlands over the millennia, as pristine peatlands are considered to be a small annual sink for carbon (Kiely et al 2018[1]).

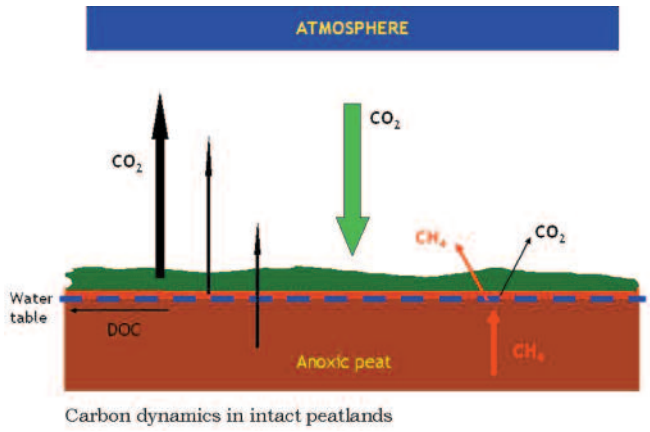
Peatland carbon is increasingly recognised as a persistent and dynamic component of the terrestrial biosphere and the global climate system (Chambers et al 2011[2]). Its importance is due to:

1. the large proportion of global soil carbon that occurs below ground in peatland ecosystems
2. the climate and land-cover sensitivity of emissions of CH_4 and exchange of CO_2 from the global peatlands including those of the northern hemisphere and the tropical peatlands and
3. the link to aquatic systems and the oceans via dissolved carbon.

Carbon Dynamics in Peatlands

In a natural peatland system, the movement of greenhouse gases (e.g. methane and carbon dioxide) between the peatland and air and water is complex. Although peatlands accumulate carbon over the long term, they both fix and emit carbon dioxide and release considerable amounts of methane, a by-product of anaerobic decomposition.

Drainage of a peatland upsets the accumulation process and leads to a vast increase in the amount of CO_2 released to the atmosphere from the peatland, a by-product of aerobic decomposition. While water loaded with dissolved organic carbon (DOC) naturally leaves



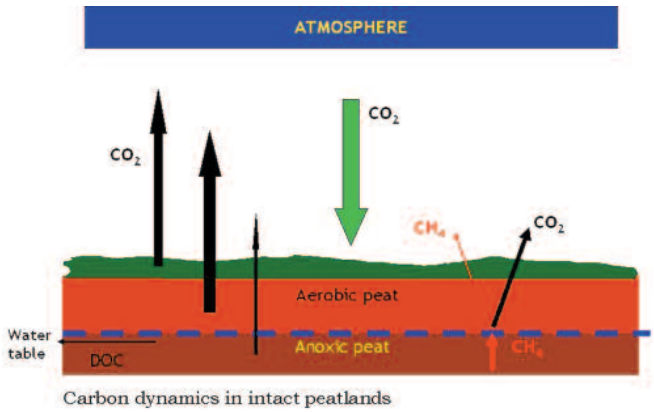


Figure 6: Carbon dynamics in an intact peatland with a high water table (above) and with a low water table (below). Photos: © D. Wilson 2008[3]

1 Kiely, G., Leahy, P., McVeigh, P., Lewis, C., Sottocornola, M., Laine, A. & Koehler, A-K. (2018) PeatGHG – Survey of GHG Emission and Sink Potential of Blanket Peatlands. EPA Research Report No. 228, Environmental Protection Agency, Dublin.

2 Chambers, F. M., Beilman, D. W. & Yu, Z. (2011) Methods for determining peat humification and for quantifying peat bulk density, organic matter and carbon content for palaeostudies of climate and peatland carbon dynamics. Mires and Peat 7: 1-10.

3 Wilson, D. (2008) Death by a thousand cuts: small-scale peat extraction and the Irish peatland carbon store: In: Farrell, C. & Feehan, J. (eds.), Proceedings of the 13th International Peat Congress, After Wise Use - The Future of Peatlands, Tullamore, Ireland.

pristine peatlands, drainage increases the amount of DOC losses. The diagrams prepared by Wilson (2008[1]) illustrate these concepts (see Figure 6).

Carbon Storage

There are many figures quoted across the scientific literature concerning the volume of carbon stored in Irish peatlands. The figure is a dynamic one as peatlands continue to be exploited and removed from the landscape. The loss of soil carbon stock in our peatlands is driven by their exploitation for fuel for private use, for electricity generation (until December 2020 for Shannonbridge and Lanesboro Power Stations and 2023 for Clonbollogue/Edenderry Power as planning permission is in place until then and the station burns both peat and biomass to produce electricity) and for horticultural peat. Further losses are continuing due to the impact of drainage on sites designated for conservation that have not yet been restored.

In 2000 the Republic of Ireland peatlands were estimated to store 1065 million tonnes of carbon (Mt C) in just 17% of the land area of the country (Tomlinson 2005[1]). This corresponds to 53% of all soil carbon stored in the island of Ireland. Note this figure does not include fen peats (see Table 2). However Tomlinson (2005[1]) also found that between 1990 and 2000 the soil carbon stock in raised and blanket bogs decreased by 24 million tonnes of carbon (M t C) due to industrial peat extraction.

The National Peatlands Strategy of 2015[3], states that peatlands store 1,566 M t C, corresponding to 64% of the total soil organic carbon stock in Ireland. No breakdown of this figure across the different peatland types is presented in the strategy.

Kiely et al 2009[4] provide comparative figures for soil

Table 2: Carbon Stocks in Irish Peatlands

Tomlinson 2005[2] estimated the carbon stocks in Irish peatlands including raised bogs, lowland blanket bogs and mountain blanket bogs but not for fens. This includes the full continuum of peatland condition within the three peatland types in the Republic of Ireland (ROI). He found the following for data collected from 2000:

Peatland Type	Mean C density (t ha^{-1})	Area ha ROI	Carbon Stock (t C)	% Total Carbon Stock in ROI
Raised Bog (Basin Peat)	1,313.51	375,600	493,354,368	24.41
Atlantic/Lowland Blanket Bog	1,022.10	382,000	390,441,184	19.32
Mountain Blanket Bog	420.20	431,200	181,190,948	8.96
Total		**1,188,800**		**52.69**

Table 3: Carbon levels in Irish mineral-rich and peat-rich soils and catchment stream waters from Kiely et al 2009[4].

Parameter	Mineral Soil		Peat Soil
Soil Organic Carbon	<5%		>45%
Bulk Density	0.8-1.3 g cm^{-3}		0.17-0.25 g cm^{-3}
	Arable Catchment		**Peat Catchment**
Streamwater Dissolved Organic Carbon (DOC) Range	1,121 kg m^2 yr^{-1}	to	15,622 kg m^2 yr^{-1}

Bog Water and Carbon

The yellowish-brown colour of bog water is a familiar sight in the bogs. Water discharged from bogs contains Dissolved Organic Matter (DOM) leached from the peat soil. DOM is composed of natural acids and proteins produced by the specialist peat forming plants unique to bog ecosystems. It is the organic forms of carbon, nitrogen and phosphates contained in DOM that are responsible for the colour of bog water. Drainage transforms a bog from a carbon sink to a carbon source.

Carbon is lost from the peat by two pathways: - as direct atmospheric exchange through soil respiration and as DOM in water discharged from the drainage ditches cut into the bog. Once discharged into receiving water the organic compounds making up DOM are broken down by decomposers and carbon dioxide is one of the compounds released from the decomposition process. The carbon dioxide released in this way is considered a fugitive emission in relation to climate change (Cody 2020[5]). Particulate organic carbon is also present suspended in the water discharged from bog drains and can settle in stream beds and estuaries. Again this material is decomposed releasing carbon but it is a process that may take up to 30 years (Goulsbra et al 2014[6]). Further work on bog water is being carried out by a number of research projects. The Living Bog Raised Bog Restoration Project is examining water discharge and water quality from 12 raised bogs in the Irish midlands before and after drain blocking to help quantify carbon dioxide release and the potential savings from restoration. The UCD SWAMP project aims to investigate the pressures on Irish waters from drained peatlands and develop mitigation measures.

1 Wilson, D. (2008) Death by a thousand cuts: small-scale peat extraction and the Irish peatland carbon store: In: Farrell, C. & Feehan, J. (eds.), Proceedings of the 13th International Peat Congress, After Wise Use - The Future of Peatlands, Tullamore, Ireland.

2 Tomlinson, R.W. (2005) Soil Carbon Stocks and changes in the Republic of Ireland. Journal of Environmental Management 76: 77-93

3 National Parks and Wildlife Service (2015) National Peatlands Strategy, Department of Arts, Heritage and the Gaeltacht, Dublin.

4 Kiely, G., McGoff, N. M., Eaton, J. M., Yu, X., Leahy, P & Carton, O. (2009) SoilC - Measuring and Modelling of Soil Carbon Stocks and Stock Changes in Irish Soils. EPA Report No. 35, EPA, Wexford.

5 Cody, J. (2020) What is in the Bog Water? Catchments Newsletter 13: 31-33.

6 Goulsbra, C., Evans, M., Allott, T., Rowson, J. & Evans, C. (2014) The effect of particulate organic carbon deposition (POC) on the gaseous carbon budget of a floodplain in an actively eroding peatland. EGU General Assembly Conference Abstracts.

Figure 7: Peat core measuring 3m removed from Girley Bog, Co. Meath for stratigraphy and bulk density determination in 2020. The changing colours and textures of the peat within the core represent different types of peat laid down in the history of the development of this site. Photo: © N. Madigan

organic carbon, bulk density and streamwater dissolved organic carbon (DOC) for mineral soils and peat (see Table 3) in river catchments. These figures inform our understanding of soil organic carbon in Ireland.

The Irish Peatland Conservation Council have been directly involved in two studies on our reserves at Girley Bog and Lodge Bog that sought to quantify the carbon stored in the peat deposits of these sites. Lodge Bog in Co. Kildare, an uncut raised bog remnant which had an average peat depth of 3.03m was found to have a carbon soil store of 1,329 t C ha^{-1}. This figure was calculated using site-specific bulk density figures analysed for a 6m peat core taken from the site by Kerr (2011)[1]. As Lodge Bog covers an area of 35ha, the carbon store for the entire bog may be calculated as 46,515 t C.

At Girley Bog in Meath (see Figure 7), the cutover bog was found to have a carbon store ranging from 910-2,084 t C ha^{-1} based on peat depths ranging from 2.06-5.55m recorded in the area (O'Connell et al 2020[2]). The mean carbon soil store for the Girley Bog cutover was 1,422 t C ha^{-1}. As the cutover bog area in this 100ha site is 27.5ha this implies that the mean carbon soil store for the entire cutover bog is 39,105 t C.

1 Kerr, E. (2011) The Long Term Carbon Storage Capacity of Lodge Bog, Co. Kildare. B.A. (Mod) Thesis, School of Natural Sciences, University of Dublin Trinity College, Dublin.
2 O'Connell, C. A., Madigan, N. & Farrell, P. (2020) Girley Bog Carbon Project. Irish Peatland Conservation Council, Kildare

6. Carbon Sequestration in Peatlands

a fragile and dynamic function at risk from climate change

Research on the greenhouse gas dynamics of peatlands to determine carbon balance has been undertaken by a number of workers on both pristine and man-modified sites.

Pristine Sites

In the Glencar SAC blanket bog habitat in Kerry, the Hydromet Research Group in University College Cork set up the an eddy covariance flux tower for the purpose of measuring the fluxes of CO_2, CH_4 and DOC in this pristine peatland (see Figure 8). While they monitored the site from 2002-2011 only for six years in that period did they have quantitative data on the three elements of the carbon balance budget in this site (see Table 4). Although they found that for two of the six years measured the site overall was a source of carbon due to the response of the components to weather conditions, for the other four years the site was a sink. The overall balance showed that the site was a sink with a total carbon sink balance of the order of –30 g C m^{-2} yr^{-1} or 0.3 t C ha^{-1} yr^{-1} (Kiely et al 2018[1]) when the data collected for the six years was analysed.

Table 4: Glencar, Co. Kerry Carbon Budget (data recorded from 2003-2008). Source: Kiely et al 2018[1]

The Glencar pristine blanket peatland:
is a sink for CO_2 of the order of –50 g C-CO_2 m^{-2} yr^{-1};
is a source of DOC of the order of +14 g C-DOC m^{-2} yr^{-1};
is a source of CH_4 of the order of +4 g C-CH4 m^{-2} yr^{-1};
has a total carbon sink balance of the order of –30 g C m^{-2} yr^{-1}.

Note that a negative flux means uptake or sequestration.

Understanding Carbon Sequestration in Bogs

Kiely et al 2018[1] found that during the growing season from May to September the bog was a carbon sink, while from October to April it was a carbon source. There was one exception, during a very dry period in May 2010 the bog was a source of CO_2. This particular year of monitoring confirmed that ground surface wetness i.e. the water table level has a significant influence on the behaviour of CO_2.

Drained "Intact" Sites

This category of peatlands includes all sites that may have marginal and/or internal drains but which have never had their entire peat-forming vegetation removed. The majority of Irish peatlands fall into this category as a result of over 400 years of

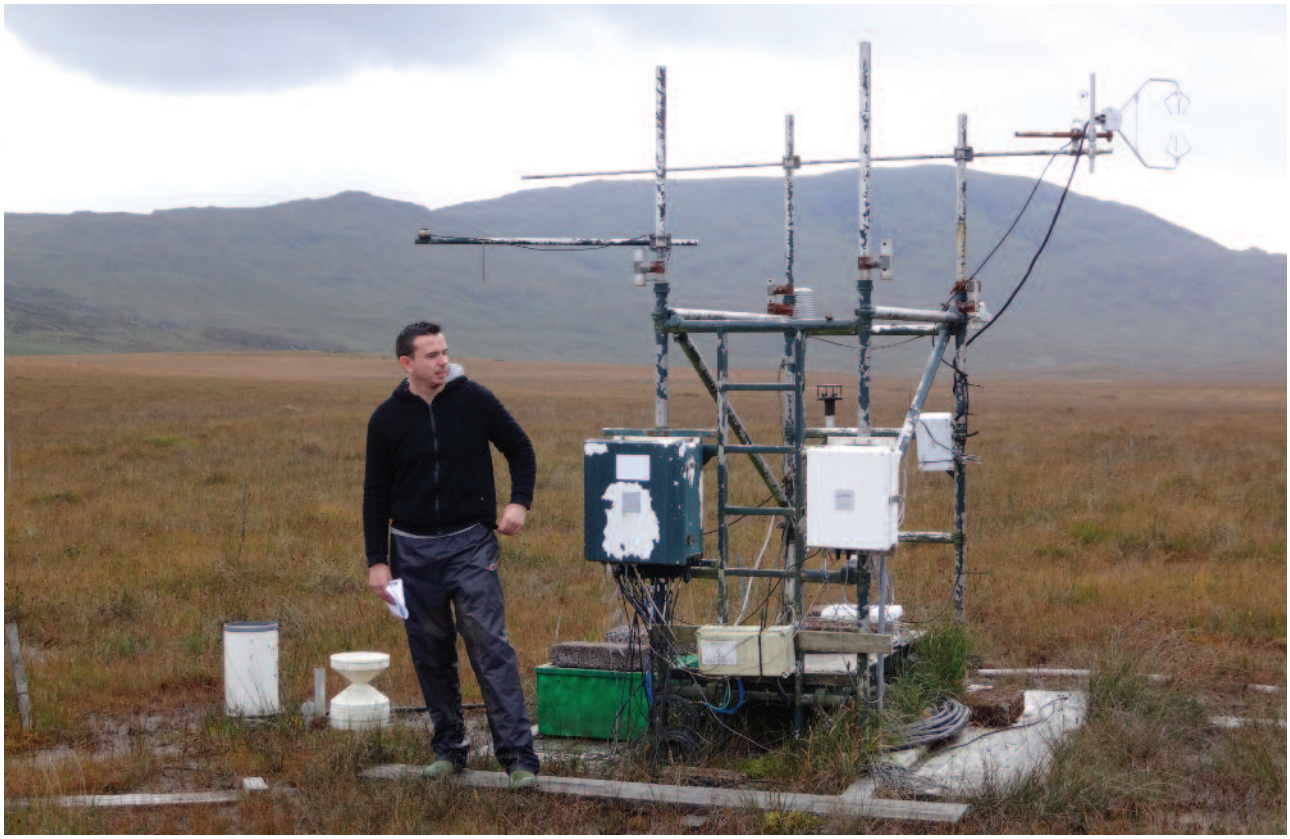


Figure 8: Greenhouse gas monitoring equipment on Glencar Bog SAC, Co. Kerry. This site was found to be sequestering carbon and had a total carbon sink balance of the order of –30 g C m^{-2} yr^{-1}. Photo: © C. O'Connell

1 Kiely, G., Leahy, P., McVeigh, P., Lewis, C., Sottocornola, M., Laine, A & Koehler, A-K. (2018) PeatGHG - Survey of GHG Emission and Sink Potential of Blanket Peatlands. Report No. 228, EPA, Wexford.

Figure 9: Bog cotton (*Eriophorum angustifolium*) is a member of the sedge family of plants. This species has air channels within its stem and root structure, an adaptation to living in waterlogged conditions. Usually these channel oxygen from the aerial parts of the plant to its roots in the waterlogged peat. But these air channels also facilitate the movement of methane gas from the anaerobic peat zone to the atmosphere. The diagram inset shows a cross section through the stem of bog cotton and the presence of aerenchyma tissue. Photo: © C. O'Connell

exploitation for turf fuel and other activities involving drainage.

Renou-Wilson et al 2018[1] measured greenhouse gas emissions from a network of different drained "intact" sites (the NEROS network) which included four raised bog sites and 1 blanket bog site. They found that these sites were a source of CO_2 at +1.35 t C ha^{-1} yr^{-1} and a source of CH_4 in the range of +0 to +0.015 t C ha^{-1} yr^{-1}.

Effects of Climate Change

The dynamics and the interannual variation in the three components of the carbon balance (budget) of pristine peatlands is considered to be fragile and potentially at risk from a changing climate. The carbon balance of man-modified peatlands is already disrupted and this increases the risk to such sites from climate change and enhances their role in accelerating climate change.

A wetter climate is likely to release greater amounts of both CH_4 and DOC than are emitted currently. A wetter climate, by raising the water table level, is likely to reduce the CO_2 exchange between the atmosphere and the peat surface. The exploitation of peatlands for agriculture, peat extraction and afforestation, all involve drainage which in turn lowers the level of the water table significantly. A lower water table not only alters the pattern of CO_2 and CH_4 exchange between the atmosphere and the peatland surface but also the hydrology and the magnitude of the DOC flux component of the carbon budget.

CH_4 fluxes are also strongly influenced by the vegetation composition of the peatland, in particular aerenchymatic plant species, such as sedges including bog cotton (see Figure 9). These plants have air channels within their structure to allow for the exchange of gases between the parts of the plant growing above the bog surface and the roots which can penetrate up to 60cm deep into the peat. With this unique cellular structure, these plant species facilitate the movement of CH_4 from the anoxic peat directly to the atmosphere, by-passing the oxic peat zone where CH_4 is oxidised to CO_2.

Climate Changes Predicted for Ireland by the End of the 21st Century

Ireland has seen an increase in the mean annual air temperature of 0.4°C during the period 1980-2008, a shortening of the frost season and increases in the length of the growing season and the spread of species suited to warmer temperatures. The most recent climate change projections for Ireland indicate that by 2050, average annual temperatures will rise by between 1°C and 1.6°C, with the greatest change in daily minimum temperatures projected for future winters: the number of frost days will be reduced by 50%, and the length of the growing season will increase by over 35 days per year. There are also projected to be significant decreases in precipitation in spring and summer (with an increase in the number of extended dry periods, defined as at least five consecutive days with daily precipitation <1mm) but more frequent heavy precipitation events in winter and autumn (Nolan 2015[2]).

1 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). EPA Wexford.

2 Nolan, P. (2015) Ensemble of Regional Climate Model Projections for Ireland. Environmental Protection Agency, Wexford.

7. Peatland-rich Nation

protects its carbon store to help combat global warming

Peatlands originally covered 1.17 million hectares of the Republic of Ireland according to Hammond 1979[1] (see Tables 5 and 11 and Figure 12). In the global league table of peatland cover the Republic of Ireland is in position 3 with 17.2% of our land area covered in peat[2]. A lack of awareness of the benefits of peatlands means that they have been severely overexploited and damaged as a result of actions including drainage, agricultural conversion, forestry, burning and mining for fuel and horticultural peat, among others. Figure 10 shows the current status of our peatland resources based on their uses to date while Figure 11 gives a breakdown of the ownership of Irish peatlands.

Bord na Móna Bogs

Bord na Móna was formerly the largest industrial semi-state peat company operating in Ireland. Their land holding of peatland is significant at 88,000ha. This divides into 8,000ha in Mayo and 80,000ha in the Midlands of Ireland. The Bord na Móna Biodiversity Plan 2016 to 2021[3] reported on the results of an assessment of the status of the land bank of the company undertaken from 2012 to 2015. The use of the Bord na Móna land bank at this time is described in Table 6 as published in 2016[3]. In 2018, the company began to move away from peat production as part of a "brown to green" strategy. In 2020, they secured funding from government to carry out rehabilitation of 33,000ha of peatland formerly in active production (see Table 6).

Table 6: Land Use of Bord na Móna owned peatlands. The total area is 88,000ha. Source: IPCC Sites Database and Bord na Móna Biodiversity Plan 2016-2021[3].

Land Status	Cover	Area (ha)	Description
Active Production	55%	48,400	Milled Peat, sod peat, sod moss, horticultural peat production bogs
Cutaway Bog	30%	26,400	Naturally regenerating lands out of production and lands in afteruses such as plantations, sand & aggregates, landfill & composting facilities
Bog Remnants and Marginal	12%	10,560	Degraded raised bog with supporting habitats as well as some active raised bog, birch woodland and cutover bog
Drained Raised Bogs	3%	2,640	Sites never fully developed for peat production and which have a high conservation value nationally. These sites are part of the Bord na Móna Raised Bog Restoration programme and are expected to be designated as SAC or NHA
Total		**88,000**	

Table 5: Peatland Resources in the Republic of Ireland 1979[1] and the intact area in 2020 of conservation value (from the IPCC database)

Peatland Type	Area (ha) 1979[1]	Area (ha) 2020
Total	**1,175,617**	**299,192**
Fen	92,508	23,049
Raised Bog	308,742	46,196
Blanket Bog	774,367	233,403

Coillte Peatland Resources

Coillte is the largest single owner of peatland in the Republic of Ireland as shown in Table 7 (NPWS[4]). 20% of the resource is under its management which involves an area of 232,509ha. Information on the Irish Peatland Conservation Council sites database indicates that Coillte fully or partially own 97 sites of conservation importance in Ireland. The company is committed to managing 20% of its estate for biodiversity although to date they have only restored 1.38% of peatland habitat[5].

National Parks and Wildlife Service (NPWS)

The NPWS own a selection of peatlands which they manage for nature conservation. According to the Peatlands Strategy 2015[4] they own 41,339ha of peatland. Information on the Irish Peatland Conservation Council sites database indicates that NPWS fully or partially own 77 sites of conservation importance in Ireland.

Table 7: Peatland Resources in the ownership of Coillte. Source: IPCC Sites Database and the National Peatlands Strategy 2015[4].

Peatland Type	Area (ha)
Total	**232,509**
Raised Bog	31,725
Blanket Bog	188,334
Industrial Cutaway Bog	12,450

Private Ownership

The remaining area is in private ownership by individuals, non governmental organisations and other commercial interests. This includes areas being cut for domestic turf, industrial horticultural peat production sites by companies other than Bord na Móna, farmed peatland and relatively intact sites under conservation designation.

Near Natural Peatlands

The designation of peatlands under Irish and/or European legislation is a crucial step in their

1 Hammond, R. F. (1979) The Peatlands of Ireland. Soil Survey Bulletin No. 35, Teagasc, Dublin.

2 Taylor, J. A. (1983) The peatlands of Great Britain and Ireland. In Gore, A. J. P. Ed. Ecosystems of the World Volume 4B, Mires: Swamp, Bog, Fen & Moor. Elsevier Scientific Publishing Company, Oxford.

3 Bord na Móna Biodiversity Action Plan 2016-2021, Bord na Móna, Newbridge, Co. Kildare

4 National Parks and Wildlife Service (2015) National Peatlands Strategy, Department of Arts, Heritage and the Gaeltacht, Dublin.

5 www.coillte.ie/our-forests/public-goods/biodiversity

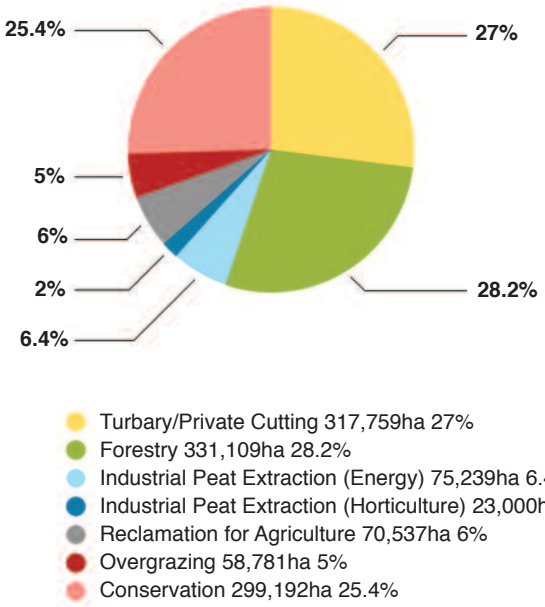


Figure 10: Peatland Utilisation in the Republic of Ireland 2020[3, 4, 5, 6, 7]. The total peatland area is 1,175,617ha.

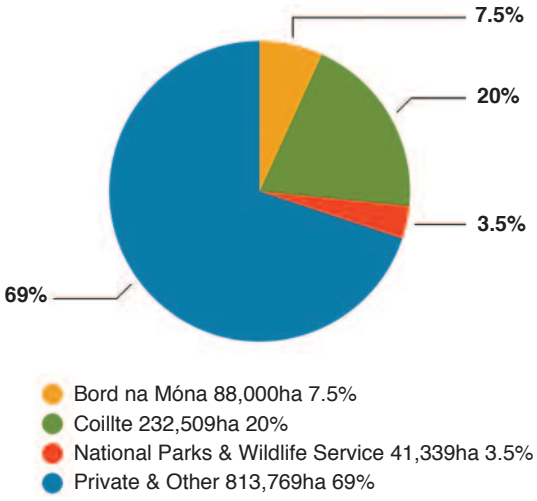


Figure 11: Ownership of peatlands in the Republic of Ireland[2]. The total peatland area is 1,175,617ha.

Table 8: Peatland habitats designated in the Republic of Ireland 2020. Source: IPCC Sites Database and www.npws.ie 27.7.20. Please note that some sites are a complex of one or more habitats or one or more designations and there is overlap between categories and designations as a result.

Habitat Code	Habitat/Peatland Type	# SAC	# NHA	# Sites	Area (ha)
Total		**192**	**148**	**331**	**153,078**
7230	Alkaline Fen	38			
7210*	Calcareous Fen	17			
7220*	Petryfying Springs with Tufa	20			
7140	Transition Mire	20			
7120	Degraded Raised Bog	62			
7110*	Active Raised Bog	54			
7150	Rhynchosporion	63			
91D0*	Bog Woodland	13			
7130(*)	Active Blanket Bog	50			
4010	Wet Heath	45			
4060	Alpine Heath	35			
Total Number	Fen Complex SAC	87			
Total Number	Raised Bog SAC	63			
Total Number	Blanket Bog SAC	64			
Total Number	Fen Complex NHA		16		
Total Number	Raised Bog NHA		75		
Total Number	Blanket Bog NHA		73		
Total Number	Fen Complex NHA & SAC			99	8,200
Total Number	Raised Bog NHA & SAC			129	30,867
Total Number	Blanket Bog NHA & SAC			137	200,574

Table 9: Peatland SPAs for threatened birds in the Republic of Ireland 2020 . Source: IPCC Sites Database and www.npws.ie 30.9.20

Bird Species	# SPA
Total # SPAs Designated	**41**
Bewick Swan	1
Chough	13
Curlew	1
Golden Plover	10
Greenland White-fronted Goose	16
Hen Harrier	2
Lapwing	7
Merlin	5
Peregrine Falcon	11
Whooper Swan	13
Wetland & Waterbirds	15
Fen Habitat SPA	*23*
Raised Bog Habitat SPA	*11*
Blanket Bog Habitat SPA	*18*
# of peatland habitats with SPA designation	***52***

protection. At present we have 192 SACs and 148 NHAs (Table 8) are designated. The designation of peatlands is incomplete and this is creating difficulties among the authorities charged with protecting sites from unwanted developments. The Irish Peatland Conservation Council maintain a database of peatlands of conservation importance in Ireland which contains over 1,000 sites (see. Figure 13).

Habitat Condition

The principal milestone in monitoring peatland habitat condition is the mandatory six year cyclical reporting carried out by NPWS under Article 17 of the Habitats Directive. In 2019 NPWS[1] described the Conservation Status of our peatland habitats as largely "Bad and Deteriorating". In terms of climate change the bad status of our peatlands is of serious

1 NPWS (2019) The Status of EU Protected Habitats and Species in Ireland, Volumes 1-3. Department of Culture Heritage and the Gaeltacht, Dublin.
2 National Parks and Wildlife Service (2015) National Peatlands Strategy, Department of Arts, Heritage and the Gaeltacht, Dublin.
3 Malone, S. & O'Connell, C. A. (2009) Irish Peatland Conservation Action Plan 2020. Irish Peatland Conservation Council, Kildare.
4 Forest Statistics Ireland 2019. Department of Agriculture, Food and the Marine, Wexford.
5 McNally, G., Keane, M. & Renou-Wilson, F. (2008) Forestry on Peatlands. In: International Peat Congress 2008 After Wise Use Mid-Congress Tours. Ed. C. A. Farrell. Bord na Móna, Newbridge.
6 Reilly, J. & Riordan, P. (2008) Peat in Energy. In: International Peat Congress 2008 After Wise Use Mid-Congress Tours. Ed. C. A. Farrell. Bord na Móna, Newbridge.
7 A Review of the Use of Peat in the Horticultural Industry: Key Issues Consultation Paper January 2020

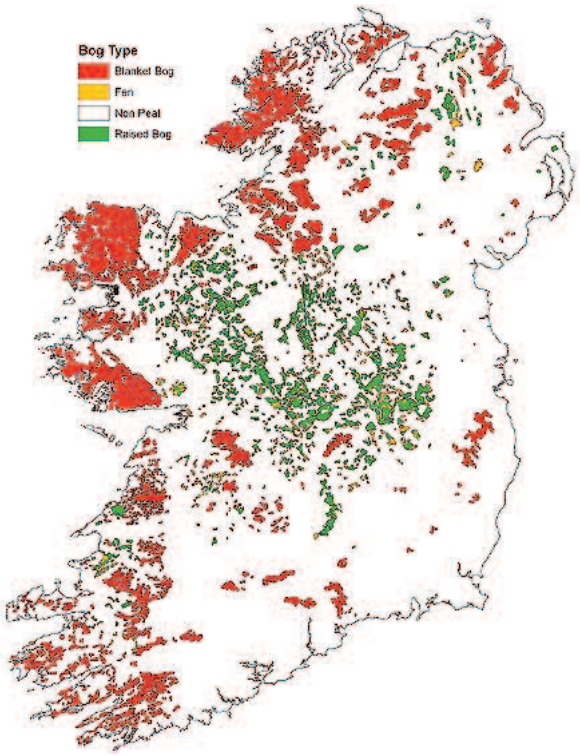


Figure 12: The peatlands of Ireland from Hammond 1981[3]

Figure 13: Peatlands of conservation importance in Ireland held within the Irish Peatland Conservation Council database 2020. Photo: © T. Whyte.

concern as the sites may be lacking the resilience needed to adjust to climatic events and predicted changes in temperature and rainfall. As a result sites urgently require management and restoration to repair their hydrology which benefits both biodiversity and mitigates climate change.

Bird Species Status

The status of Irish birds is assessed using the Birds of Conservation Concern guidelines (Colhoun & Cummins 2013[1]). The assessment from 2014-2019 found that many peatland birds are on the amber or red lists as a result of habitat loss. These include Merlin, Meadow Pipit, Red Grouse, Curlew, Snipe, Golden Plover, Skylark, Kestrel, Hen Harrier, Marsh Harrier, Peregrine and Lapwing. Reporting to the European Union on the status of birds protected within Special Protection Areas (SPAs) is undertaken every six years according to Article 12 of the Birds Directive. Table 9 shows the number of SPAs designated for each threatened peatland bird.

Raised Bog Natural Heritage Areas Habitat Review

In 2014 a review of the Natural Heritage Area (NHA) raised bogs network in Ireland was carried out by the National Parks and Wildlife Service[2]. Over 270 raised bog sites were examined including 53 SAC raised bogs, the existing 75 NHA raised bogs, and over 100 other non-designated sites. As a result of the review a reconfigured NHA network of 61 sites is proposed but has yet to be formally recognised in Irish law (see Table 10). Advantages of this change include: the areas of both Active Raised Bog and Degraded Raised Bog Still Capable of Natural Regeneration will be greater in the new network than in the current network. The figures are presented in . Management complexity in the new network will be much lower due the lower number of sites and the number of active turf cutters. Despite the acknowledgement of the role of bogs in climate regulation, the analysis gave no weight to the carbon stores present within the sites reviewed. Up to 100 good peatland sites (including 25 NHAs that are to be de-designated) are consigned to drainage, turf cutting and greenhouse gas release. Furthermore in the six years since the reconfiguration, landowners and managers have not been informed making the protection and restoration of the sites impossible.

Table 10: Proposed reconfiguration of the Natural Heritage Area Network of raised bogs (NPWS 2014[2])

	Current	New
Number of Sites	75	61
Active Raised Bog Area (ha)	284	290
Degraded Raised Bog Area (capable of Restoration) (ha)	410	475
Total Active and Degraded Bog Area (ha)	694	765
Estimated Number of Active Turf Cutters	3,091	518
Number of Sites (part of 7 sites removed/retained)	75	61
Turf Cutting Cease Date	Continues	2017
Number of Sites to be Designated		25
Number of sites to be de-designated (7 partial)	46	

1 Colhoun, K. & Cummins, S. (2013) Birds of Conservation Concern in Ireland 2014 - 2019. Irish Birds 9: 523-544

1 Review of Raised Bog Natural Heritage Area Network, 2014, National Parks and Wildlife Service, Dublin

3 Hammond, R. F., (1981) The Peatlands of Ireland 60. An Foras Talúntais, Dublin

8. Peatland Resources

highly significant in Ireland's efforts to combat climate change

Table 11: The original area of peatland habitat per county and the current area remaining with intact carbon stores and biodiversity. Source: IPCC sites database and Hammond 1979[1]. * The Blackstairs Mountains Blanket bog which occurs in Wexford and Carlow was not included in Hammond's figures.

	Original Area (ha) Source: Hammond 1979[1]				Intact Area (ha) Source: IPCC database of peatland sites								
County	Fen Area (ha)	Raised Bog Area (ha)	Blanket Bog Area (ha)	Total Area (ha)	Fen Area (ha)	# Sites	Raised Bog Area (ha)	# Sites	Blanket Bog Area (ha)	# Sites	Total Area (ha)	Total # Sites	% Original Area
Clare	7883	6,766	46,831	61,489	687	22	1,326	6	4,540	13	6,552	41	11
Cavan	81	7,689	3,185	10,995	304	10	444	6	5,603	3	6,351	19	58
Carlow	0	197	850	1,047	75	4	29	2	2,658*	1	2,762	7	264*
Cork	0	0	74,198	74,198	952	16	0	0	8,872	18	9,823	34	13
Donegal	0	0	149,125	149,125	639	15	0	0	41,291	43	41,930	58	28
Dublin	0	0	469	469	93	3	0	0	0	0	96	3	20
Galway	10,012	50,314	99,413	159,739	2,650	32	11,419	56	33,089	16	47,158	104	30
Kildare	5,844	18,473	0	24,317	339	13	2,642	16	0	0	2,981	29	12
Kilkenny	316	1,016	405	1,737	563	13	208	2	35	1	806	16	46
Kerry	4,654	10,999	81,211	96,864	299	10	474	7	14,384	21	15,157	38	16
Longford	1,232	20,527	0	21,759	698	11	3,919	20	0	0	4,617	31	21
Louth	81	1,012	0	1,093	164	10	300	1	300	1	764	12	70
Leitrim	16,030	5,876	35,513	57,419	399	14	254	3	12,542	10	13,194	27	23
Laois	5,140	10,478	5,241	20,859	606	6	1,003	9	1,115	1	2,724	16	13
Limerick	352	1,853	18,827	21,032	722	21	72	3	919	5	1,714	29	8
Meath	3,901	6,388	0	10,289	254	12	540	7	0	0	794	19	8
Monaghan		1,437	1,416	2,853	288	36	259	5	592	1	1,138	42	40
Mayo	469	28,906	182,569	211,944	2,585	36	574	3	66,554	34	69,713	73	33
Offaly	13,901	47,712	2,533	64,146	959	18	5,981	30	1,115	1	8,055	49	13
Roscommon	4,828	39,764	1,190	45,782	1,734	23	7,698	37	1,397	4	10,829	64	24
Sligo	1,279	6,662	29,562	37,503	573	30	664	2	14,103	10	15,340	42	41
Tipperary	4,298	15,000	14,691	33,989	1,306	15	3,339	17	3,875	9	8,520	41	25
Westmeath	11,026	26,702	0	37,728	1,295	21	4,945	24	0	0	6,240	45	17
Wicklow	0	971	15,633	16,604	558	12	105	2	14,773	8	15,436	22	93
Wexford	566	0	162	728	418	8	0	0	2,658*	1	3,076	9	423
Waterford	615	0	11,343	11,958	433	21	0	0	2,989	4	3,422	25	29
Total	**92,508**	**308,742**	**774,367**	**1,175,617**	**19,592**	**432**	**46,196**	**258**	**233,403**	**205**	**299,192**	**895**	**25**

1 Hammond, R. F. (1979) The Peatlands of Ireland. Soil Survey Bulletin No. 35, Teagasc, Dublin.

9. Managing and Protecting Carbon

through peatland restoration

The role of managing Ireland's peatlands is really important for carbon accounting at national level. Because of the climate crisis land managers need to work together from all sectors not only to restore carbon sequestration function in peatlands but more crucially to protect the carbon stocks in those peatlands and prevent their continued degradation and loss from accelerating climate change. It must be borne in mind that the majority of Irish peatlands have been converted to other uses such as agricultural land, forested land, industrial peat land and cutover peatland from domestic turf cutting and are emitting greenhouse gases which are contributing to climate change. Alongside such peatlands are the sites designated for conservation which also have been degraded by on-going drainage, turf extraction and other uses (see Table 12).

In their current state, all Irish peatlands are also vulnerable to the changes presently occurring and predicted to occur to our climate. Without restoration climate change itself will accelerate further loss of sites, loss of carbon stores and loss of carbon sequestration function. Decisions must be made about what needs to be done to manage the carbon stocks remaining in our "drained only intact" and man-modified peatlands.

When peat is wet the carbon stocks are safe and carbon sequestration may be occurring. When peat is drying, the carbon stock is being lost as well as the capacity of the peatland to sequester carbon.

The multiple advantages of peatland rewetting (in restoration and rehabilitation) projects have been assessed by Renou-Wilson et al 2018[1] and they have ranked the peatlands in rewetting priority order based on maximizing biodiversity provision, climate mitigation and taking into account the area of land area available in each land use category (see Table 13). Drained only/domestic cutover and grassland sites are ranked in first and second position in terms of restoration priority based on maximizing synergies between biodiversity and greenhouse gas emission reduction.

In Ireland the Irish Peatland Conservation Council have been monitoring on-going peatland restoration on over 65 sites and on-going peatland rehabilitation on 40 former industrial extraction sites. These projects have provided valuable practical experience on the feasibility and techniques of peatland restoration and rehabilitation (Mackin et al 2017[2] and Bord na Móna 2016[3]).

Peatland restoration/rehabilitation and rewetting projects have proven to be cost-effective compared to other available

Table 12: The greenhouse gas emission levels from various peatland uses in the Republic of Ireland before and after rewetting from Turraun Bog (Wilson et al 2015[4]) and the NEROS network of sites (Renou-Wilson et al 2018[1]). N_2O was not detected in either the drained or rewetted sites studied (see Figures 14 and 15).

Peatland Type LUC land use category	Site Example	Drained CO_2 Emissions t C ha^{-1} yr^{-1} (+ source - sink)	Drained CH_4 Emissions t C ha^{-1} yr^{-1} (+ source - sink)	Rewetted CO_2 Emissions t C ha^{-1} yr^{-1} (+ source & - sink)	Rewetted CH_4 Emissions t C ha^{-1} yr^{-1} (+ source & - sink)
Nutrient-rich Industrial Cutaway	Blackwater Turraun	+1.51 +2.86	+0-0.015 range for all Land Use Categories (LUC's)	+0.32	+0.173
Drained Only & Domestic Cutover	Cuckoo Hill, Moyarwood, Sharavogue, Killyconny, Croaghonagh	+1.37		-0.49	+0.197
Nutrient-poor Industrial Cutaway	Bellacorrick	+0.91		-1.04	+0.092
Grassland	Glenvar	+0.81		-0.40	+0.044
Forestry	Cloonshanville, Scohaboy (Sopwell), Carrickbar, Poolagoona	not measured		+1.02-5.6	+0.020-0.026

1 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). EPA Wexford.

2 Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017) Best practice in raised bog restoration in Ireland. Irish Wildlife Manuals, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

3 Bord na Mona Biodiversity Action Plan 2016-2021, Bord na Móna, Newbridge, Co. Kildare

4 Wilson, D., Dixon, S.D., Artz, R.R.E., Smith, T.E.L., Evans, C.D., Owen, H.J.F., Archer, E. and Renou- Wilson, F., (2015) Derivation of greenhouse gas emission factors for peatlands managed for extraction in the Republic of Ireland and the United Kingdom. Biogeosciences 12 (18): 5291–5308.

Table 13: Rewetting priority order of different peatland types in the Republic of Ireland. This is extracted from the Environmental Protection Agency NEROS Report 2018[1]. The ranking order is based on maximizing biodiversity provision, climate mitigation and taking into account the area of land available in each category.

Peatland Type LUC land use category/ Rewetting Priority	Biodiversity Provision	CO_2 Emissions	Land Area Coverage in Ireland (ha)	Paludiculture Options	CH_4 Emissions	Potential Costs of Rewetting High	Difficulty maintaining high water level in some sites	Priming Effects from Brash Decomposition	Potential N_2O Emissions
1. Rewetting drained-only & domestic cutover	High	High CO_2 emissions avoided	High (c. 260,000-600,000ha)		Moderately High	Yes	Yes		
2. Rewetting grassland areas	Modest	High CO_2 emissions avoided	Medium (c. 300,000-374,690)	Yes	Moderate	Yes	Yes		
3. Rewetting industrial cutaway	Low (but potentially new ecosystem diversity)	High CO_2 emissions avoided	Medium (c. 67,715-100,000)	Yes	Moderate		Yes		
4. Rewetting afforested areas	Modest	High CO_2 emissions	Medium (c. 321,927)		Moderate		Yes	Yes	Yes

carbon reducing technologies. They also have the added bonus of re-establishing the multiple benefits arising from peat-forming ecosystems including biodiversity, water regulation and recreation. For example Wilson et al 2012[2] examined the greenhouse gas emissions from different revegetated communities colonising the rewetted cutaway bog at Bellacorrick in Co. Mayo The work assessed the potential economic value of restoration in terms of avoided losses and gains of C (€/tonne CO_2-eq ha^{-1}) through the use of a number of timeline scenarios. These followed the peatland from the cessation of peat extraction (Tzero), through rewetting (T1) and on to the present day (Tpresent). The results showed that in the period T1 to Tpresent, an estimated 75 tonnes CO_2-eq ha^{-1} was mitigated by the restoration actions at Bellacorrick – resulting in an estimated value of €1506 ha^{-1} in avoided losses. In addition, net C sequestration at the peatland during the 12-month period of this study (Tpresent) was worth an estimated €118 ha^{-1} yr^{-1}. The rewetting of industrial cutaway and cutover bogs corresponded to an average cost-effectiveness value of just under €4 per tonne of carbon dioxide equivalent (CO_2-e), a value that would support climate mitigation efforts involving rewetting of peatlands. While these results are exciting they come with warnings from the researchers. The cutaway bog studied occurs in the blanket bog region which is very different in terms of rainfall and peat substrate and may not be representative of potential savings that rewetting of the industrial cutaway raised bogs of the midlands of Ireland might provide. Also the results are based on 1 year of measurement of greenhouse gases and do not take into account inter-annual variations nor the rapidly changing plant succession that occurs during rewilding of rewetted cutaway bogs. Nevertheless studies such as this are vitally important to stimulate rewetting action and to form a basis for carbon accounting and trading of carbon credits.

Emissions from damaged peatlands and carbon savings from peatland restoration are eligible for national accounting under the UN Framework Convention on Climate Change. There is therefore an opportunity for Ireland to look at including peatland restoration and re-wetting in our national climate action plans (IUCN 2017[3]).

Figure 14: "Dark" chamber on Moyarwood Bog, Co. Galway used for measuring methane (CH_4) and nitrous oxide (N_2O) fluxes. Photo: © D. Wilson

Figure 15: "Clear" chamber on Clara Bog, Co. Offaly used to measure net exchange of CO_2 between an ecosystem and the atmosphere (NEE). Photo: © D. Wilson

1 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). EPA Wexford.

2 Wilson, D., Renou-Wilson, F., Farrell, C., Bullock, C. & Muller, C. (2012) Carbon Restore – The Potential of Restored Irish Peatlands for Carbon Uptake and Storage. Climate Change Research Programme (CCRP) 2007-2013 Report Series No. 15, EPA, Wexford.

3 IUCN (2017) Peatlands and Climate Change. IUCN Issues Brief. www.iucn.org.

10. Peatland Restoration in Practice

an expensive, time-consuming collaborative effort

A continuum of peatland condition occurs, ranging from relatively intact and degraded sites with a full or partial peat-forming function and carbon store through to bare peat and grassland with no peat-forming function and with an eroding carbon store. The position of a particular peatland along that continuum determines its potential for recovery, through natural processes or management intervention so that it returns to good condition. Where management is required, the cost-effectiveness of that intervention needs to be considered.

In very simple terms, the more degraded a site, the longer it will take to restore, the more it will cost and the lower the likelihood of success. In some cases, that cost may not appear to represent good value in the short term, but on the basis of greenhouse gas emissions savings alone it is likely that in most cases it will be cost-effective in the medium to longer term. This does, however, highlight the merits of intervening at an early stage and ensuring that peatlands already in good condition are managed sustainably. The development of site management plans in line with national habitat and species conservation objectives and climate mitigation strategies is crucial to inform actions on sites.

Some types of damage/ degradation are relatively easily reversed. If a site is over-grazed, reduce the level of grazing. If invasive species are present, remove them. If a site is under-grazed, increase the grazing. If a site is trampled by visitors, provide and maintain boardwalks. If a site has been planted with conifers, remove the trees, block the drains and control regeneration. If a site is drained, block the drains. If the site was formerly an industrial production area, reprofile the remaining peat and block drains to achieve maximum rewetting which stabilises the surface peat and protects the carbon stocks remaining in the peat.

In reality restoration of Irish peatlands is not an easy task because damage has caused years of deterioration on sites. This includes subsidence, puncturing of the natural hydrological seal within the peatland basin or removal of the peat substrate through turf cutting and industrial harvesting.

Restoration Targets

The National Parks and Wildlife Service[1] have set a target to protect 3,600ha of active raised bog and its supporting habitat of 30,867ha. To this end they have proposed a restoration programme in three phases of 6 years ending in 2036 for all of the raised bogs in Ireland designated in SACs or NHAs which amounts to 129 sites (see Table 8).

In relation to blanket bogs and fens, no conservation target has been set to date. Due to the severe losses of pristine examples of these peatland types, IPCC would expect that Government will set a conservation target to protect all of the active peat-forming habitat that remains and the supporting habitat in the sites in which the active peatland area occurs. Based on IPCC's tracking of peatlands of conservation importance in our sites database, for blanket bogs this would be in the range of 233,500ha (see Table 11) and for fens the figure at present would be 19,592ha (see Table 11). The estimate for fens is likely to be low as this habitat has not been formally surveyed by NPWS researchers to date.

Restoration Achieved and In Progress

Prior to the development of the National Raised Bog Special Areas of Conservation Management Plan 2017-2022 restoration works were carried out on over 65 sites in Ireland[2]. Significant projects were undertaken by Coillte to remove conifers from peatlands of conservation importance between 2002 and 2015 through 3 projects funded from the EU LIFE programme, Coillte and NPWS. The work involved restoration works on 1,207ha of raised bog across 29 sites and 2,000ha of blanket bog across 17 sites[3]. In 2009 Bord na Móna launched its Raised Bog Conservation Programme targeting sites that were drained but never advanced into peat production. To date restoration has been carried out on 39 sites and 3,964ha of raised bog[4]. Some sites are of sufficiently high quality to be designated as SACs (Clonboley Complex (including Ballydangan Bog) Roscommon and Killeglan Bog Cluster Roscommon) or NHAs (including Glenlough Bog Longford/Westmeath, Clonwhelan Bog Longford/Westmeath, Knockahaw Bog Tipperary/Kilkenny and Ballysorrell Bog Tipperary).

NGO's play a key role in restoring peatlands in their ownership

1 National Raised Bog Special Areas of Conservation Management Plan 2017-2022, National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin

2 Malone, S. & O'Connell, C. A. (2009) Ireland's Peatland Conservation Action Plan 2020. Irish Peatland Conservation Council, Kildare

3 Coillte Life Projects Reference Numbers: LIFE02 NAT/IRL/008490; LIFE04 NAT/IE/000121 & LIFE09 NAT/IE/000222

4 Bord na Móna Biodiversity Plan 2016-2021, Bord na Móna, Newbridge, Co. Kildare

including BirdWatch Ireland, Irish Wildlife Trust and the Irish Peatland Conservation Council.

The National Parks and Wildlife Service have also been active in this area and have carried out a variety of restoration works on raised bogs in liaison with Dutch peatland conservationists. In the period from 2004-5 to 2011-13 they undertook restoration works on 12 raised bog sites with an active peat forming target of 39.3ha (NPWS[1]). These works were funded through EU Cohesion and EU LIFE funding with matched funding from the NPWS. They also undertook significant work on the restoration of blanket bogs through the control of grazing using the Commonage Framework Plans from 2002 onwards[2].

Other privately-funded groups engage in restoration. A positive step in the protection and management of peatlands was the establishment of Community Wetlands Forum in 2013. This group with a membership of 21 communities (www.community-wetlandsforum.ie accessed 19.10.2020)[3] works to help communities appreciate their local peatland and seeks to ensure that community engagement is valued in the management of peatlands by all those working on restoration.

Restoration projects in progress include the Interreg VA project CANN Collaborative Action for the Natura Network (2017-2021). This project will develop Conservation Action Plans for SACs on the border with Northern Ireland and conduct direct conservation actions on a portion of these. A second project is also working cross-border – the CABB project Co-operation Across Borders for Biodiversity (2017-2021). Conservation actions from these projects will include drain blocking, fencing, adopting suitable grazing regimes and writing conservation action plans. CARE-Peat (2019-2022) is another Interreg project which aims to develop techniques to monitor and restore the carbon storage capacity of peatlands. This project will involve two demonstration sites in Ireland - Cloncrow Bog NHA, Co. Westmeath and Cavemount Cutaway Bog in Co. Offaly.

The SAC raised bog restoration programme described in the National SAC Management Plan has been underway since 2016. The Living Bog Raised Bog Restoration Programme (LIFE14 NAT/IE/000032) is a high profile restoration project which aims to restore 12 raised bog sites over a 5-6 year period delivering 752.7ha of active peat-forming raised bog habitat at a cost of €5.4 million (NPWS[1]). To accelerate the raised bog restoration programme another 9 raised bogs are to be restored in 2020 using €5 million funding collected from the Carbon tax. In relation to blanket bogs the LIFE-IP PAF Wild Atlantic Nature project 2020-2028 will protect and restore 24 blanket bogs at a cost of €12 million. It will involve the removal of encroaching trees and shrubs, blocking drains and improvement of fire management measures.

Eco-hydrological Models of Peat-forming raised bog habitat

Much research work has been commissioned by the National Parks and Wildlife Service to develop an understanding of the eco-hydrological functioning of raised bogs so that they can predict based on physical measurements of site topography such as slope, rainfall and hydrological attenuation/drainage patterns available from LiDAR data for each raised bog site where the supporting conditions for peat forming vegetation occur on a raised bog site (Mackin et al 2017)[4]. Active peat-forming

Figure 16: Ardagullion Bog, Co. Longford SAC 2341 showing the complexity of restoration. A conifer plantation on 25ha of this site was removed as part of a Coillte LIFE-funded project in 2008 (LIFE04 NAT/IE/000121) and the extensive drain network on the bog surface has been blocked in 2019 with up to 800 peat dams as part of the LIFE-funded Living Bog project (LIFE14 NAT/IE/000032). In addition a barrier dam has been constructed in the cutover bog containing two wiers. These actions will protect the existing active bog of 14ha in the site and extend it by 9ha. Photo: © NPWS[1].

1 National Raised Bog Special Areas of Conservation Management Plan 2017-2022, National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin

2 Malone, S. & O'Connell, C. A. (2009) Ireland's Peatland Conservation Action Plan 2020. Irish Peatland Conservation Council, Kildare

3 Flood, K. (2017) Community Wetlands Forum Strategic Plan 2017-2020

4 Mackin, F., Flynn, R., Barr, A. & Fernandez-Valverde, F. (2017) Use of geographical information system-based hydrological modelling for development of a raised bog conservation and restoration programme. Ecological Engineering 106: 242–252.

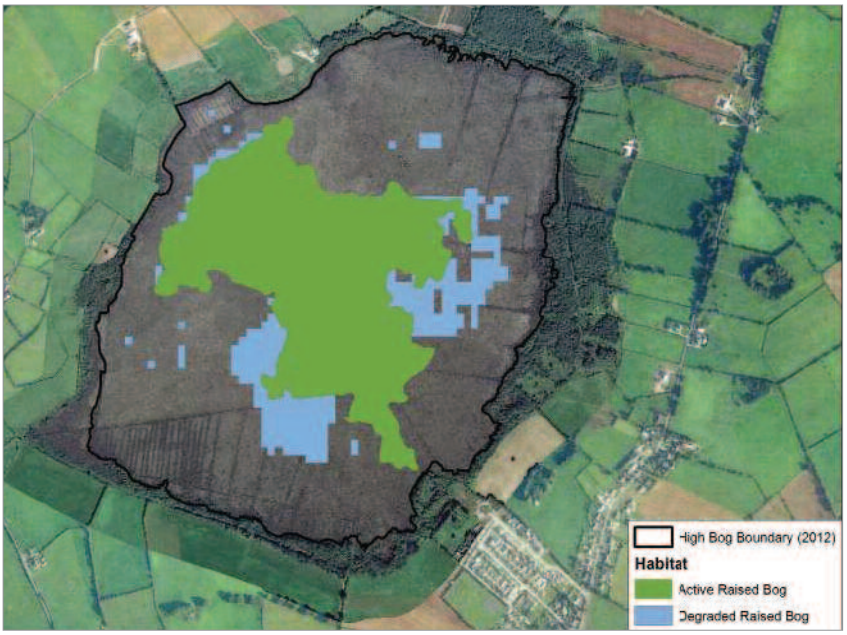
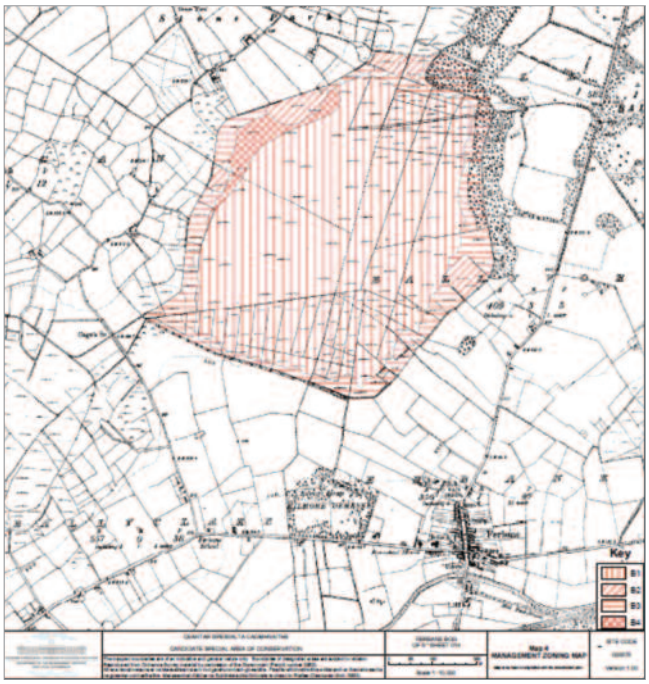


Figure 17: Turf-cutting ceased on Ferbane in 2011 and private turf cutters have been compensated through the turf compensation scheme. The map above shows the area of active peat forming habitat on the site in green. The degraded raised bog area that can be restored to peat formation with management works principally blocking almost 16,000 metres of drains on the high bog on the southern and eastern margins of the site is shown in blue. Photo: © NPWS[1]. The map below shows the management zones on the Ferbane Bog labelled B1 to B4. Different management strategies have been devised for each zone with the highest priority being given to B1 and B4 on the high bog Photo: © NPWS[2].



raised bog typically develops on uncut peatlands with slopes of between 0.2% and 0.6%, depending on effective rainfall which varies between 200 and 900mm per year. It may also occur in more localised focused-flow flushes on slopes exceeding 1%. On the ground peat forming conditions can be verified by the presence of specific vegetation ecotopes. The information gained has been used to develop hydrological management plans and site specific restoration plans for each raised bog. These plans contain a series of maps of necessary restoration action measures. Tasks are zoned prioritizing those actions that are cost effective and achieve the greatest impact first. Priority is given to the creation of conditions in suitable locations where active peat formation can be achieved. This includes high uncut bog locations as well as cutover bog locations. The restoration plans resulting are complex and depend on the co-operation of all stakeholders and landowners in a particular site and in the landscape surrounding a site that may be affected by the hydrological changes within the peatland. As a result drainage management plans have been prepared for each raised bog and the landscape within which it sits. A key element in this regard is the need for the National Parks and Wildlife Service to communicate with local communities in a conversation about restoration and to provide incentives to ensure good will and co-operation with the necessary restoration process.

Restoration in practice is very complex as shown in Figures 16 and 17 of Ardagullion Bog in Longford and Ferbane Bog in Offaly, two sites included in the Living Bog EU LIFE Raised Bog Restoration Project 2016-2020 (LIFE14 NAT/IE/000032). Achieving a site-specific conservation objective may take 10 or more years after restoration works are finally completed. Besides restoration works within the designated site, drainage management, beyond the raised bog boundary, is integrated into the restoration plan for each bog. Drainage management plans are developed for each site in consultation with local communities and these help to allay fears of farmland being subject to flooding as a result of site restoration.

1 National Raised Bog Special Areas of Conservation Management Plan 2017-2022, National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin

2 National Parks and Wildlife Service Conservation Plan for 2005-2010 Ferbane Bog cSAC Site Code 575 Co. Offaly

Peatland Rehabilitation

Peatland rehabilitation generally refers to rewetting and other actions concentrated in peatland sites that cannot be returned to their former state. It applies to cutaway bogs, peatlands managed for grassland and peat soils under forest plantations.

With the closure of milled peat production across the Bord na Móna industrial cutaway bogs, much attention has been focused on the future of such sites and on their rehabilitation. Creating hydrological regimes that support the development of peatland habitats such as fens and wet woodlands is essential on cutaway bogs but equally, management actions that reduce greenhouse gas leakage from these sites and protect the remaining carbon stores are vital. Drain blocking, control of water outflow and profiling are important actions in such rehabilitation. These must be followed by on-going monitoring to ensure their effectiveness.

Because of the climate crisis, land managers need to work collectively from all sectors not only to restore carbon sequestration function in peatlands if they can but more crucially to protect the carbon stocks in those peatlands and prevent their decomposition from accelerating climate change.

Rehabilitation Targets

In light of the serious impact of greenhouse gas emissions from peat soils, rehabilitation, rewetting and restoration programmes need to be designed for all peat soils. In this regard rehabilitation of industrial cutaway bogs has begun through the work of Bord na Móna. Under the IPC License, this company must stabilise the peat in sites commercially exhausted which automatically

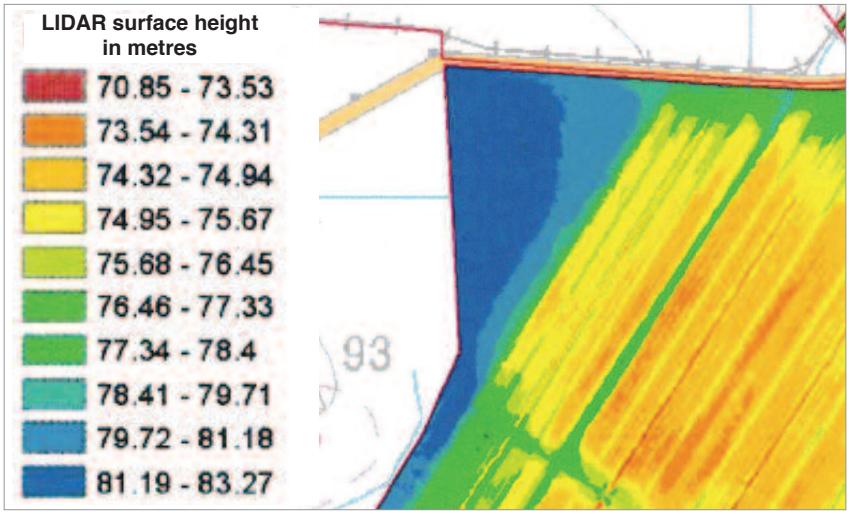


Figure 18: The first stage of site assessment involves a consideration of surface levels across the industrial cutaway site. This site is Lodge Wetlands North near Lullymore in Co. Kildare. It's rehabilitation began in 2016. Photo: © Bord na Móna

Figure 19: Typical starting point site condition for rehabilitation at Cavemount, Co. Offaly in 2019. Photo: © C. O'Connell

sets a rehabilitation target of 88,000ha of peatland. The Government approved funding of €108m to Bord na Móna from the Climate Action Fund for the rehabilitation of 33,000ha of industrial cutaway bogs that were formally peat energy sites from 2021-2025[1]. Objectives must be set for this Enhanced Peatland Rehabilitation Scheme (EPRS) before large scale rehabilitation and repurposing of cutaway bogs is undertaken.

Besides stimulating the creation of jobs, a national management plan for the cutaway bogs is needed that is climate proof. Drained cutaway bogs are significant CO_2 emission hot spots. These must be targeted for rewetting as a climate mitigation strategy. Renou-Wilson & Wilson 2018[2] have shown that rewetting industrial cutaway peatlands corresponds to an average cost-effectiveness value of just under €4 per tonne of CO_2-e avoided which clearly supports such mitigation methods. As rewetted cutaway bogs are highly sensitive to annual weather conditions, monitoring (to include greenhouse gas dynamics, vegetation composition and water table levels) is essential to ensure that the rewetting rehabilitation measures employed are sustainable and climate proof.

1 Cabinet approves €108 million funding for ground-breaking Bord na Móna rehabilitation plan. Department of the Environment, Climate and Communications 24 November 2020

2 Renou-Wilson, F. & Wilson, D. (2018) Vulnerability Assessment of Peatlands: Exploration of Impacts and Adaptation Options in Relation to Climate Change and Extreme Events (VAPOR). Report No. 250, EPA Wexford.

Figure 20: Hydrological images for Lodge Wetlands South, Co. Kildare from 2015 (left) before rehabilitation began and in 2020 (right) showing rewetting of the residual peat through the creation of berms and blocking the outflow from the site. In managing for climate change it is necessary to rewet a greater proportion of such sites through reprofiling of the peat surface remaining in the post-industrial site. Photos: © Bord na Móna

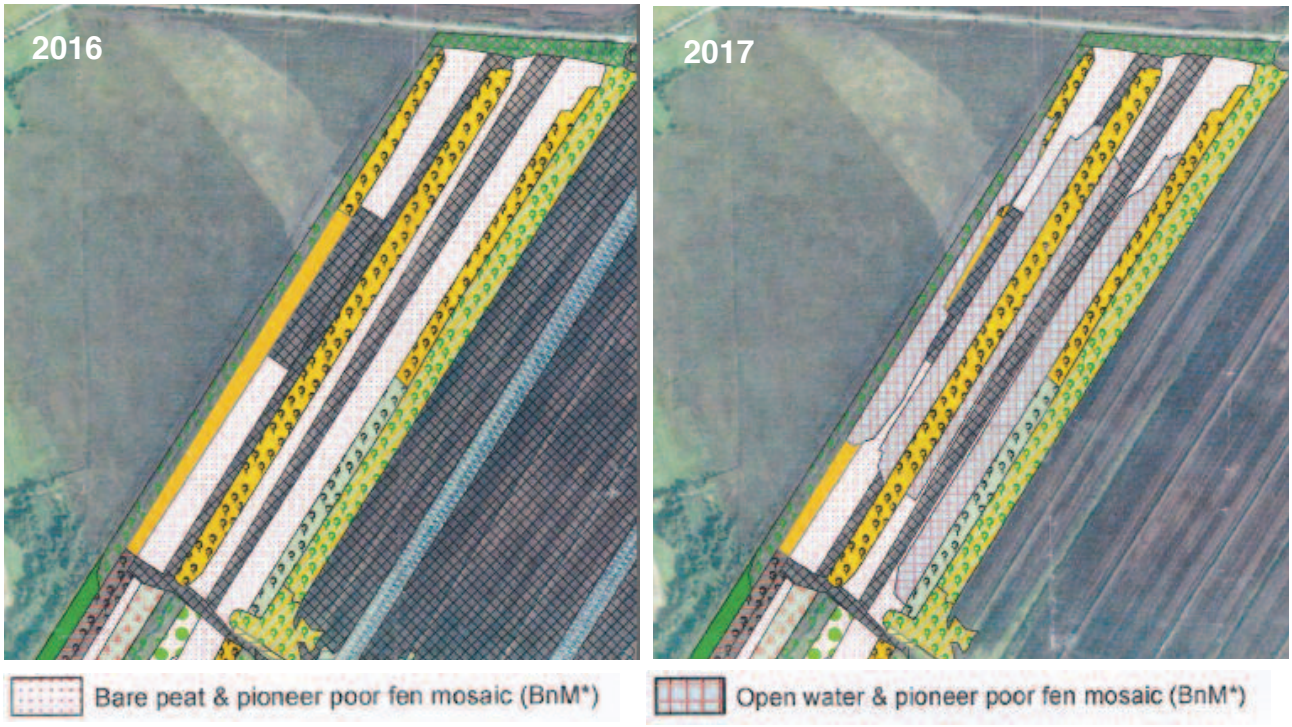


Figure 21: Vegetation maps for Lodge Bog Wetlands North, Co. Kildare from 2016 (left) when rehabilitation began and in 2017 (right). The spread of wetland habitat described as open water and pioneer poor fen mosaic can be seen across the low lying areas of the site. Photos: © Bord na Móna

A decision pathway for successful rewetting and climate proofing of cutaway bogs may have the following steps[1]:

1. Site assessment (see Figures 18 and 19)

2. Site preparation works for maximum rewetting bringing the water table close to the surface including reprofiling and levelling the peat surface, cambering the edges of peat fields, compartmentalising sections by constructing berms and managing outflow

3. Monitoring of effectiveness including water table (see Figure 20), vegetation change (see Figure 21) and greenhouse gases

4. Intervention works to correct undesired successional and hydrological outcomes.

A decision tool is urgently needed to consider the future of peatlands under forestry and privately owned sites under agriculture and turbary. There are very strong arguments for rewetting in terms of its effectiveness in reducing CO_2 emissions as shown in Tables 12 and 13 from the Environmental Protection Agency[2].

1 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). Report No. 236, EPA Wexford.

2 Renou-Wilson, F., Wilson, D., Rigney, C., Byrne, K., Farrell, C. & Müller., C. (2018) Research 236: Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS). Report No. 236, EPA Wexford.

11. Peatland Restoration Methods

nature-based solutions to reduce net emissions of greenhouse gases

The techniques used for restoring peat-forming conditions on bogs are summarised in Table 14. Prior to drain blocking it is necessary to remove invasive birch and pine trees from around the drains to provide access for wide track machines that are used for building peat dams. In the Living Bog LIFE Raised Bogs Restoration Project (LIFE14 NAT/IE/000032) teams of three workers with chain saws removed trees obscuring drains. The chain saw team were followed by a 3 tonne excavator with a thumb grab attachment to remove the cut trees away from the restoration zone.

Machines used to block drains using peat dams are specially adapted for the wet bog environment (see Figure 22). A seven tonne machine was used with wide tracks to 13 feet and with a load bearing of <2 pounds per square inch (psi). When blocking drains using peat, the peat used must stick together. The sides of the drain where the dam is to be constructed are cleaned. This means the peat keys in firmly and prevents the dam from failing. The dam is built in layers using peat with a paste-like consistency taken from a borrow pit on the bog surface. The bucket on the digger is used to apply pressure to the peat dam and crush the peat down into the drain. The surface scraw from the borrow pit is placed over the top of the peat dam. The position of dams is determined using GPS which allows a contractor to upload a map of the dam positions to his vehicle.

Current best practice in raised bog restoration recommends that dams are constructed at every 10cm fall in elevation to bring the water table within 10cm of the surface. A minimum of three dams per 100m is recommended and where peat dams are used a maximum of ten dams per 100m is best practice to ensure the bog surface is not significantly disrupted by an excessive number of borrow pits. Peat dams are the most common material used for drain blocking in raised bogs; however, alternative methods include the use of plastic sheet piling which is inserted into the drain and driven down to an appropriate depth. In some cases, a combination of peat

Figure 22: Specially adapted machine developed by Bord na Móna to construct peat dams on bogs of conservation importance. Photo: © Bord na Móna

Case Study: Effectiveness of Drain Blocking

On Lodge Bog in Co. Kildare, the Irish Peatland Conservation Council blocked 4km of drains with 198 dams constructed from plastic drain piling (see Figure 23)[2]. Within days the water level on either side of the dams rises. Vegetation changes take longer and this requires monitoring. In 2010 and 2016 IPCC monitored the effectiveness of the dams in terms of *Sphagnum* moss recolonisation by recording % cover in a quadrat placed on either side of a dam. The results showed an increase in the number of dams with between 75 and 100% cover of *Sphagnum* moss from 25% in 2010 to 51% in 2016. They also showed a decrease in the number of dams with 0% *Sphagnum* cover from 65% in 2010 to 23% in 2016. The increase in *Sphagnum* cover over the 6 year period proves that drain blocking works and that it facilitates the spread of *Sphagnum* moss and the reduction in the loss of carbon from the site as a result.

Figure 23: Drain with high water table after blocking with plastic sheet piling on Lodge Bog, Co. Kildare in 2010. Photo: © M. Kenny

1 Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017) Best practice in raised bog restoration in Ireland. Irish Wildlife Manuals, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

2 McCluskey, A. & Geraghty, G. (2016) *Sphagnum* moss returns after drain blocking on Lodge Bog. Peatland News 62: 16, Irish Peatland Conservation Council

Table 14: Peatland restoration measures practiced in Ireland (Source Mackin et al 2017[1] and Jack McGauley The Living Bog pers comm 31.7.2020 and 19.10.2020). Cell bunding and other bunding methods being trialled at present and are not included. Significant costs are incurred in compensating land owners for loss of turf cutting or for undertaking necessary management works on their land, for the development of restoration and drainage management plans, land purchase and essential on-going monitoring of the effectiveness of restoration.
*** High Density Polyethylene.**

Restoration Technique	Method	Estimated Cost € (includes materials & labour)	Dimensions	Materials
Peat Dams	Wide track machine 12 feet wide with load bearing pressure <2psi or no more than 1.6 lb inch^{-2}	€30 per dam installed	1m deep, 50cm above bog surface and 50cm wider than drain width of 1-2m	Machine and peat
Plastic Dams (See Figure 23)	By Hand	€90 per dam installed	1m deep, <1m wide	Corrugated sheets of 5mm HDPE* interlocking piling 25cm wide
Partial infilling of drain	By Hand	€15 per linear metre using local peat infill	Variable length, 1m deep, 1m wide	Humified Peat
Site preparation for drain blocking - tree clearance	Chainsaw crew of 3 and thumb and grab machine to remove cut trees	€1,200 per day	Clear material away from drains and access routes	Machine
Removal of conifer plantation	Clear felling using specialist harvester machine or chain saw	Harvester: €1200-€1500 per ha. Chainsaw €900-€1200 per ha.	Hectare cleared of conifers	Machinery
Barrier Dam (See Figure 24)	Machine	€25-€30 per linear metre	Trench 1.5m deep and 0.5m wide, filled with peat. Finished height 1m above bog surface and covered with living bog vegetation or scraw	Humified peat and machine
Weir	Constructed from 8x4' steel sheet, 6mm thick, seams welded. Finished structure coated in galvanised	€3,500	Specific to barrier dam	8x4' steel sheet, 6mm thick
***Sphagnum* transfer inoculation (See Figure 25)**	Hand	€1,325 per ha	Hectare of bare peat inoculated	Live *Sphagnum* moss from donor site, straw

Figure 24: Barrier dam constructed on Ardagullion Bog in 2019 as part of the Living Bog Restoration Project to provide peat-forming conditions in the cutover bog. Photo: © J. McGawley

dams with plastic sheet piling can be effective where significant flow is experienced, as the plastic can prevent erosion of the peat in the dam while the peat forms a more effective seal in the drain than plastic alone.

Barrier dams are suited to flat areas of cutover bog where there is sufficient water supply run off from the high bog. They are less than 1m in height and constructed from low permeability peat to prevent water flowing under the dam. Weirs or outlets are necessary to ensure that water levels do not rise too high behind the barrier dam. Weirs are a bespoke construction to match site requirements. Barrier dams have been constructed at Killyconny Bog, Co. Cavan and Ardagullion Bog in Co. Longford (see Figure 24).

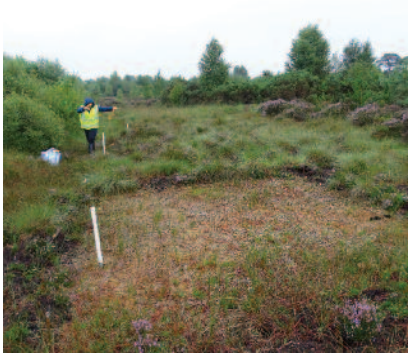


Figure 25: *Sphagnum* inoculation trial in 2020 three years after inoculation on Girley Bog, Co. Meath by the Irish Peatland Conservation Council in 2018. Photo: © C. O'Connell.

1 Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017) Best practice in raised bog restoration in Ireland. Irish Wildlife Manuals, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

12. Pricing and Funding Restoration

an investment in natural capital

Site restoration and management works on Irish peatlands are being funded through a range of schemes including the carbon tax, climate action fund, the EU Life Programme, InterregVA, the Department of Agriculture's Green, Low Carbon, Agri-Environment Scheme (GLAS) and the European Innovation Partnership (EIP) funded through the EIP-Agri budget of the Department of Agriculture. Restoration requires a long-term financial commitment from government, which may only be realistically sustained through developing a mechanism for business support in return for specific benefits such as carbon credits (see Figure 26).

Cost of Restoration

The raised bog SAC Management Plan[1] estimates over €22m for ecohydrological restoration measures for the first of three cycles of restoration from 2017-2022 for raised bogs. €96m for compensation payments to turf cutters (€23,000 to 4168 turf cutters) formerly working sites is needed. These values exclude associated public sector costs of the Department of Culture, Heritage and the Gaeltacht and other government departments, the cost of research contracts to develop restoration plans and costs already incurred by other restoration works carried out prior to 2017 including €4.65 million spent by Coillte on the removal of conifer plantations from 29 raised bogs (at a mean cost of €160,391 per site).

Specifically the Living Bog Raised Bog Restoration Programme (LIFE14 NAT/IE/000032) cost was €5.4 million for partial restoration on 12 raised bog sites over a 5-6 year period. In 2020 the Irish government approved €5 million for raised bog restoration on state owned land in 9 raised bogs. These two projects involving a total of 21 sites suggest an average cost of €495,238 per raised bog for ecohydrological restoration plus an additional €1.08m per site to compensate turf cutters (based on an average number of 47 turf cutters per site). Using these figures IPCC estimate a budget of between €180m and €202m to restore the raised bog network of between 114 and 128 sites. This would yield 3,600ha of active peat forming raised bog and secure the carbon stock of 40.5 million t C in 30,867ha of supporting habitat which would be a sink for CO_2 of -0.48 t C ha^{-1} yr^{-1} and a source of CH_4 of +0.197 t C ha^{-1} yr^{-1} (i.e. an overall carbon sink).

In view of the costs involved it is not surprising that a €1 billion budget cost has been proposed to complete restoration of all of Ireland's peatlands and protect the carbon stored in various habitats (Regan 2020[2]). At the level of €5 million provided by government in 2020, IPCC estimate that it will take a minimum of 200 years to restore Ireland's peatlands. This is not sustainable as the sites will become extinct over this period. Therefore the restoration budget needs to be multiplied 10 fold to €50 million per year to achieve protection and greenhouse gas reduction from peatlands within a realistic time frame of the next 20 years, i.e. by 2040.

Peatlands Community Engagement Scheme

The Department of Culture, Heritage and the Gaeltacht set up a fund to provide small grants to community groups for peatland research, restoration and education projects. The annual budget/award level for the scheme in the first four years of operation was as follows:

2018 - €137,000
2019 - €131,000
2020 - €100,000
2021 - €200,000

Projects were funded to a maximum of 75% of costs capped at €25,000. At these levels a community group applying for funds cannot for example achieve drain blocking across a peatland site. This situation is unfair in light of the level of funding being spent by government on state-owned peatland.

Cessation of Turf Cutting Compensation Scheme

A payment of €1,500 per annum (index linked) for 15 years together with a once-off incentive payment of €500 is given to turf cutters in raised bog SACs and NHAs deemed to meet certain criteria. To the qualifying individual this is worth at least €23,000. By the 30th November 2020, 4168 turf cutters applied to the scheme and €36.7 million has been paid out. This scheme will cost government at least €96 million upon completion.

Protected Raised Bog Restoration Incentive Scheme

Within the Living Bog Raised Bog Restoration Project a new scheme was put in place to provide local landowners with a payment for facilitating restoration. The Incentive Scheme made a minimum payment of €1,000 per landowner or €1,450 per hectare

1 National Raised Bog Special Areas of Conservation Management Plan 2017-2022, National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Dublin

2 Regan, S. (2020) An introduction to Irish peatlands: extent, pressures, conservation and value. Presentation to Backing Our Bogs Conference University College Dublin 21.7.20

(Jack McGauley pers comm 19.10.20).

Funding Restoration Long-term
Finance must be made available for restoration on peatland owned by other stakeholders besides the State. Complete site restoration is needed, not partial restoration on state-owned land in bog sites.

A new funding source for peatland restoration is the value of the "saved emissions" or carbon credits that are made through drain blocking and other measures in peatlands. Peatland researchers have calculated how much carbon can be saved through restoration. This data allows for the development of carbon credits and in the UK the Peatland Code (see Figure 26) is such a system operated by the IUCN. Sites enter the restoration programme for at least 30 years and the carbon credits are bought by sponsors to offset their carbon footprint. This process provides a long-term revenue stream for peatland restoration, topping up Government funds.

IUCN National Committee United Kingdom

Peatland Programme

PEATLAND CODE

The Peatland Code is a voluntary standard for UK peatland projects wishing to market the climate benefit of restoration.

An example of natural capital financing

The Peatland Code provides assurance and clarity for business and other investors in peatland restoration projects through independent validation and verification. The Code works on the basis that during restoration, carbon savings are made through rapid emissions reductions.

The Peatland Code story so far...

- **2013 - Pilot restoration projects** established in:
  - South West England
  - Lake District
  - Wales
  - Alongside work with a series of projects under Scottish Government's Peatland Action programme;
- **2015 - Peatland Code v1.0 launched** following Defra funded and commissioned report to develop peatland carbon metrics and financial modelling to enable quantification and valuation of the carbon impacts of peatland. A concept standard only.
- **2017 - Peatland Code v1.1 launched and certification body appointed.**

What is natural capital?

"Stocks of assets in an ecosystem, which interacts to yield a flow of goods or services."

Natural Capital Coalition

Natural capital is often overlooked: if too much is taken from a financial system we end up bankrupt or owing a debt. The natural world is the same. If we continue to take without replenishing stocks or allowing nature to recover we could end up with ecosystem collapse.

Supporting ecosystems through sustainable management, conservation and restoration can yield economic benefits by driving revenue and providing cost-savings. This creates scope and justification for business investment through natural capital.

The initial version of the Peatland Code has proved invaluable at introducing the concept of 'Payment for Ecosystem Services' and stimulated discussion within numerous stakeholder groups.

The Peatland Code process

Actively eroding / drained peatland → Project plan validated against Peatland Code → Funding agreed / restoration begins → Ongoing managment, monitoring & verification → Project concludes - minimum 30 years

Validated Project - Dryhope

Where: Cappercleuch, nr Selkirk, Scotland, UK.
Who: Philiphaugh Trust
Developer: Forest Carbon Ltd. in partnership with Tweed Forum
Funding: Peatland Action, Scottish Rural Development Programme & Carbon Finance.
Carbon Finance provider: NEX Group – financial trader
"Most of our emissions arise from the running of our offices and employee travel commitments. We mitigate our total carbon emissions through investment in carbon reducing projects."
Project Size: 77.05ha
Restoration Activity: Drain blocking and hagg/gully re-profiling
Project commenced: December 2017
Project Duration: 45 years
Claimable Emissions Reduction: 6484 tCO2e

Why and how to get involved

Action now to invest in peatlands will avoid far greater future costs to businesses and wider society from climate change and environmental harm resulting from damaged peatlands.

We are keen to hear from any businesses who are interested in making a real impact on climate change, environmental and social health by funding peatland restoration through the Peatland Code.

A wide range of peatland projects across the UK are available for funding with tried and tested methods available to deliver restoration.

We are keen to hear from any peatland restoration projects who are intrested in being funded through the Peatland Code.

Resources, information and support are also available for projects wishing to promote this mechanism to business contacts.

www.iucn-uk-peatlandprogramme.org/peatland-code

Figure 26: Advertising poster for the IUCN Peatland Code which provides a funding stream for peatland restoration measures in return for the carbon credits they can provide to business and community. Source: https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2019-07/290918%20Peatland%20Code%20poster.pdf (Downloaded on 13.10.2020).

13. Climate Change Policy & Peatlands

providing evidence to improve practice

Sound public policy for peatland protection is critical to the success of long-term climate change mitigation. In this chapter the Irish Peatland Conservation Council examine current practice in relation to the management of peatlands to see whether they are net climate savers or climate killers.

National Peatland Strategy

The main peatland policy document in Ireland is the Peatland Strategy which was published in 2015[1]. This Strategy guides the government's approach to peatland management and conservation in the future, taking into account current and potential uses of this key resource.

The Strategy was developed by the Peatlands Council, a stakeholder group established by government on the 7th April 2011. The Council was established to respond to commitments set out in the Programme for Government and to assist Ireland in responding in a strategic way to the requirements of the EU Habitat's Directive. This Directive requires Ireland to protect and conserve important peatland habitats. The Council is independently chaired and is made up of representatives from the Irish Peatland Conservation Council, Coillte, Irish Farmers Association, Irish Environmental Network, Irish Rural Link, Bord na Móna and National Parks and Wildlife Service.

The document contains a series of principles and actions in relation to peatlands. It has been accepted and recognized by all government departments. However this document is currently under review. The revised strategy must strengthen policy and action in relation to blanket bogs and fens and regulate and manage the country's peat resources. We must see realistic timelines set for the various actions to be achieved for example by 2025, by 2035 and by 2050. Information on who is responsible for the implementation of the actions needs to be included for transparency.

Since publication of the Peatland Strategy many additional policy documents have been issued by government which have a bearing on Climate Change (see Table 15) and in general they acknowledge the important role that peatlands play in climate but do little else.

Table 15: Policy documents impacting on Irish Peatlands in relation to Climate Change

* The National Raised Bog Special Areas of Conservation Management Plan 2017-2022
* The Climate Action Plan 2019
* National Biodiversity Action Plan 2017-2021
* The Wildlife (Amendment) Bill 2016
* Land use, land-use change and forestry (LULUCF) regulation for 2021-2030
* Draft Wind Energy Development Guidelines
* Sustainable Development Goals National Implementation Plan.
* Status of EU Habitats and Species Report 2019
* Peat in the Horticultural Industry Review (on-going 2019-2020)

Turf and Carbon Tax

The most recently published Climate Bill commits to bringing Ireland to net zero carbon emissions by 2050 (see Table 16). In response to the Bill, the Government announced an increase of €7.50 on the carbon

Table 16: Ireland's Climate Change Policy Timeline

Date	Event/Publication	Commitment
2002	Ireland ratifies Kyoto Treaty on climate change	To stabilise GHG emissions from 2008 to 2012 to 13% above the 1990 levels
2007	National Climate Change Strategy 2007-2012	Sets out a range of measures to meet Ireland's European climate change commitments
2015	Climate Action and Low Carbon Development Act	Placed national climate policy in legislation
2016	Ireland ratify the Paris Agreement	Limit global temperature increase to well below 2^0 C, while pursuing efforts to limit the increase to 1.5^0 C
2017	National Mitigation Plan	Contains over 100 existing mitigation measures and those under consideration - described as a 'first step' towards 2050
2018	Planning for a Climate Resilient Ireland	Ireland's first statutory National Adaptation Framework
2019	Climate Action Plan To Tackle Climate Breakdown	The plan commits to evaluate in detail the changes required to adopt a net zero target by 2050 and acknowledges the challenges ahead to achieve this target
2020	Climate Action and Low Carbon Development (Amendment) Bill 2020	Establishes, in law, a climate resilient and climate neutral economy by 2050 and introduces a system of successive 5-year, economy-wide carbon budgets starting in 2021

1 National Parks and Wildlife Service (2015) National Peatlands Strategy, Department of Arts, Heritage and the Gaeltacht, Dublin.

tax on fuel bringing it to €33.50 per tonne to include auto and solid fuels. This is welcome as carbon tax revenue is being utilised to restore peatlands and therefore reduce greenhouse gas emissions. However this policy has a serious loop hole. The tax does not apply to private turf production for domestic use as this fuel is not being purchased and at the point of cutting from the bog it is not suitable for burning. It must be dried first. For

Figure 27: Energy-related CO_2 emissions in Ireland 2005-2018[1] demonstrate that peat products have the highest emissions of all fuel types used. Photo: © SEAI[1]

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphtha	73.3	264.0
Petroleum Coke	92.9	334.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.9	204.7
Electricity		
(2018)	104.2	375.2

these reasons turf cut for domestic use escapes the carbon tax. IPCC are concerned that increasing the tax on other fuels that may be used by households for heating which directly affects household budgets will be a driver for an intensification of private turf cutting. Despite greenhouse gas emissions being the highest from turf of all fossil fuels (see Figure 27[1]), there is no carbon tax to be paid on its production. Should we see an increase in the volume of turf being burned annually there will be an automatic increase in greenhouse gas emissions. The Government must resolve such issues if its Climate Bill is to be effective and not simply a practical climate killing policy.

Protecting Sites from Harmful Development

Amendments are necessary to the Wildlife Act 1976 (and Amendment 2000) to allow for the reconfiguration of the raised bog natural heritage area network. Until these amendments are signed into law, it is Government policy not to release the full details of the network of peatlands nor to contact the owners of the sites proposed for inclusion in the new network. Meanwhile it is impossible for Planning Authorities and other regulators to properly control damaging development. Another climate killing policy.

Stopping Turf Cutting on Designated Raised Sites

National Parks and Wildlife Service have revealed that turf cutting is continuing on 287 plots across 16 raised bog SACs in 2020. The information came to light following a Freedom of Information enquiry made by the Irish Wildlife Trust and published 12th November 2020 at www.iwt.ie. Clearly enhanced community engagement is needed involving listening to turf cutters plans and developing creative incentive packages to put an end to turf cutting on SACs. Monitoring the demise of the sites through the defiant action of turf cutters is a climate killing policy and is unacceptable.

Conflicting Peatland Management Decisions

Irish Peatland Conservation Council are continually coming across conflict in the manner in which decisions are made on how peatlands are to be managed. For example Kildare County Council refused planning permission for the development of a solar energy project on Timahoe bog, stating that they were concerned about the disturbance to deep peat deposits that the development would incur and the impact on climate change of peat oxidization. Similarly they (and subsequently An Bord Pleanála) refused planning permission to allow for turf cutting on an area of peatland adjacent to Ballynafagh Bog SAC on the grounds of climate change and the impact that the peat cutting and the subsequent longer term burning of the turf cut would have on climate change. These are good examples of climate saving policy in action. On the other hand, Kildare County Council are allowing the cutting of turf and moss peat on Snipe Bog near Monasterevin, in the county which clearly is releasing carbon and impacting the environment (see Figure 28). Either climate change and its prevention is an issue or it is not and there is a need for clear policy that is rigorously and consistently implemented.

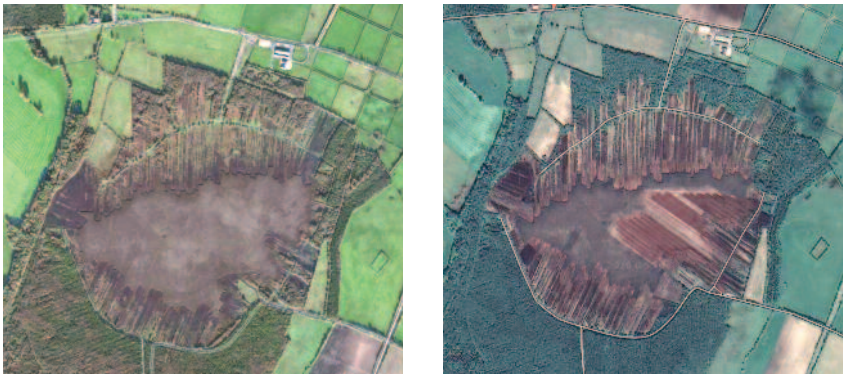


Figure 28: Snipe Bog in Co. Kildare. Turf cutting from the perimeters and a new moss peat extraction development reported to IPCC in 2020 is systematically removing all of the high bog area. This activity is permitted but is at odds with protecting carbon stocks contained in peatlands and with the Kildare Climate Adaptation Strategy. Photo: image on the left is © Bing Maps 2020. Photo: on the right © Google Maps 2020.

1 Energy-related CO_2 emissions in Ireland 2005-2018. SEAI 2020 Report.

Summary of the legal position in respect of peat extraction in Ireland[1]

(i). There is an obligation to obtain planning permission in respect of any peat extraction project which requires assessment under either the Environmental Impact Assessment (EIA) Directive or the Habitats Directive. An EIA is mandatory, under domestic law, where the peat extraction would involve a "new or extended" area of 30 hectares or more. (See Planning and Development Regulations 2001, Schedule 5, Part 2, paragraph 2(a)). In the case of sub-threshold development, a screening determination would have to be made by reference to the detailed criteria set out at Schedule 7 of the Planning and Development Regulations 2001. A screening determination for the purposes of article 6(3) of the Habitats Directive would also have to be undertaken.

(ii). Peat extraction which is being carried out without the benefit of planning permission, where required, is vulnerable to enforcement proceedings.

Any person is entitled to apply for orders pursuant to section 160 of the Planning and Development Act (PDA) 2000. There is no time-limit on an application seeking an order which requires the cessation of peat extraction. A planning authority is empowered to serve an enforcement notice and/or to apply for orders pursuant to section 160 of the PDA 2000. Where a complaint is made and (i) a planning authority establishes, following an investigation, that unauthorised development (other than development that is of a trivial or minor nature) is being carried out, and (ii) the person who has carried out or is carrying out the development has not proceeded to remedy the position, then the authority is obliged to issue an enforcement notice and/or to make an application pursuant to section 160 unless there are compelling reasons for not doing so. (See section 153(7) of the PDA 2000 (as inserted by the Environment (Miscellaneous Provisions) Act 2011)).

(iii). Section 5 of the PDA 2000 provides a simple procedure whereby the question of whether a particular development (including peat extraction) requires planning permission can be determined, initially, by the planning authority and, thereafter, on review by An Bord Pleanála. By way of example, the proceedings in Bulrush Horticultural Ltd. v. An Bord Pleanála arose out of a section 5 declaration made by An Bord Pleanála in respect of peat extraction. A section 5 declaration, which has not been challenged by way of judicial review, can be relied upon to ground enforcement proceedings. (See Killross Properties Ltd v. Electricity Supply Board [2016] IECA 207; [2016] 1 I.R. 541).

(iv). In the event that a developer carrying out peat extraction wishes to regularise the planning status of the activity—for example, in response to the threat of enforcement proceedings—then the substitute consent procedure under Part XA of the PDA 2000 has to be invoked. Relevantly, there is no automatic entitlement to apply for substitute consent; rather, a developer has to apply first to An Bord Pleanála for leave to make an application for substitute consent. The Board may only grant leave to apply if it is satisfied that "exceptional circumstances" exist such that the Board considers it appropriate to permit the opportunity for regularisation of the development by permitting an application for substitute consent.

(v). In parallel to the planning legislation, certain large-scale peat extraction involving an area in excess of 50 hectares is subject to licensing by the EPA under Part IV of the Environmental Protection Agency Act 1992.

Source: Judgment of Mr. Justice Garrett Simons delivered on 20 September 2019 in case 2019 No. 222 J.R. between FRIENDS OF THE IRISH ENVIRONMENT LIMITED (Applicant), MINISTER FOR COMMUNICATIONS, CLIMATE ACTION AND ENVIRONMENT MINISTER FOR HOUSING, PLANNING AND LOCAL GOVERNMENT IRELAND AND THE ATTORNEY GENERAL (Respondents)

Controlling Peatland Drainage for Extraction

Small scale turf extraction and moss peat production occur across numerous sites in Ireland. Such activity drives climate change. In practice land managers from local authorities and wildlife rangers right through to individual landowners have a lack of understanding of the legal position pertaining to the control of peatland development in Ireland. A recent Judgement by Mr Justice Garrett Simons[1] provides clarification on this complex area of planning law. That there has never been an Environmental Impact Assessment undertaken for an industrial peat development project in Ireland despite over 80,000ha of land being in peat production is another example of the lack of planning control in this area.

Land Purchase for Conservation

Existing policy of the National Parks and Wildlife Service is to only purchase peatland sites that are damaged (M. Eakin EPA 26.2.2019). Such a policy makes no sense given the importance of peatlands in mitigating climate change. No value is being put on the long-term carbon stores

Figure 29: Sheheree Bog, Co. Kerry, a pristine site up for sale in 2019 and passed over by the National Parks and Wildlife Service as it was not damaged. Photo: © C. O'Connell

1 Judgment of Mr. Justice Garrett Simons delivered on 20 September 2019 in case 2019 No. 222 J.R. between FRIENDS OF THE IRISH ENVIRONMENT LIMITED (Applicant), MINISTER FOR COMMUNICATIONS, CLIMATE ACTION AND ENVIRONMENT MINISTER FOR HOUSING, PLANNING AND LOCAL GOVERNMENT IRELAND AND THE ATTORNEY GENERAL (Respondents)

Figure 30: Former industrial cutaway bog that is being managed for biodiversity and for the production of wind energy. Such sites need to be audited to determine whether the rehabilitation has made them climate proof. Photo: © C. O'Connell

contained within pristine peatlands, or their ability to sequester carbon as they function naturally (see Figure 29).

On the other hand does this policy imply that a far greater value is being placed on carbon emissions saved when damaged peatlands are restored? Such a policy can only be deemed satisfactory if a realistic funding stream is being provided by government for peatland restoration works on damaged peatlands of conservation importance. IPCC do not find this to be true. For example funding of €5 million was made from Carbon Tax revenue to undertake raised bog restoration in 2020. The National Parks and Wildlife Service themselves have indicated that a budget in the region of €1 billion will be required for peatland restoration[1]. Given the scale of the damage to Irish peatlands and the pace of restoration on such a low budget the Irish Peatland Conservation Council have calculated that it would take 200 years to repair the existing damage to our network of peatlands of conservation importance. This would take us to the year 2220. Clearly the role of peatlands in accelerating climate change and helping to mitigate the effects of climate change is not being taken seriously.

Industrial Peatland Rehabilitation

With regard to industrial peatlands the government approved funding of €108m to Bord na Móna from the Climate Action Fund for the rehabilitation of 33,000ha of industrial cutaway bogs that were formally peat energy sites. The programme will take place from 2021-2025[2]. Bord na Móna are providing €18m towards this project which will provide employment (310 jobs), enhance biodiversity, protect carbon stores (109m tonnes) and sequester 3.2m tonnes of greenhouse gases. The devil will be in the detail of this project which is to be monitored by the National Parks and Wildlife Service. Consideration of the carbon resilience of each rehabilitated site must get priority if such sites are to be prevented from accelerating climate change. There is a lack of published information on the costs and methods being used to rehabilitate cutaway bogs so that they become climate resilient. In the interest of transparency, the public must understand the carbon savings being made through the enhanced rehabilitation proposed. The industry, being commercially driven favours rewetting in combination with other economic uses such as windfarm as seen at Mount Lucas (see Figure 30). The company recently announced that they are to raise €1.6 billion for a renewable energy programme which will supply one third of all Irish homes with renewable energy by 2030[3]. Bord na Móna Powergen have 14 renewable projects in play in 2020[4] as part of their renewable energy plan (see Figure 31).

Horticultural Peat Industry

There has been much media coverage of the closure of the peat-fired power stations across Ireland recently in favour of generating energy from

1 Regan, S. (2020) An introduction to Irish peatlands: extent, pressures, conservation and value. Presentation to Backing Our Bogs Conference University College Dublin 21.7.20

2 Cabinet approves €108 million funding for ground-breaking Bord na Móna, rehabilitation plan. Department of the Environment, Climate and Communications 24 November 2020

3 https://www.bordnamona.ie/company/news/articles/bord-na-mona-to-raise-e1-6-billion-for-climate-action-projects/

4 Proposed Ballydermot Wind Farm Brochure 2020. Bord na Móna, Newbridge, Co. Kildare

Figure 31: Overview of Bord na Móna Powergen projects as of 5th October 2020. Photo: © Bord na Móna[2]

Figure 32: Moss peat comes from drained carbon-rich bogs such as this site near Tyrrellspass, Co. Westmeath. 23,000ha of Irish peatlands are being mined for horticultural peat according to a review of the horticultural peat industry published in 2020[1]. Photo: © C. O'Connell

low-carbon sources. This decision, though welcome, is completely undermined by the continued production of moss peat at numerous sites across the country, the majority of which operate outside of planning and licensing systems (see Figure 32). Over 3/4 of a million tonnes of horticultural peat was being exported from Ireland worldwide in 2018 from an area of 23,000ha of peatland[1]. Bord na Móna, Bulrush, Clover, Erin Peat, Harte Peat, Klasmann-Deilmann Ireland and Westland are the major producers but there are 30 additional small producers[1].

The production of this product is regarded as an agricultural and not a mining activity. There is no carbon tax on it and in Irish garden centres bags containing moss peat are not properly labelled with their peat content or with a warning that its use destroys habitat and contributes to climate change. This is another example of a climate-killing policy that will prevent Ireland reaching its greenhouse gas reduction targets and which is destroying natural habitat. As most of the horticultural peat sites are still operating on an acidic peat substrate there is great potential for such sites to be restored using a combination of drain blocking, bunding and *Sphagnum* transfer.

For many years NGOs and leading professional gardeners including Monty Don have been advocating the use of peat-free composts as a campaign action to protect peatlands and all of the ecosystem services that they provide.

This work has stimulated the development of alternative peat free products. Bord na Móna has developed a Resource Recovery business which produces 31 peat free products from organic waste.

1 A Review of the Use of Peat in the Horticultural Industry: Key Issues Consultation Paper January 2020
2 Proposed Ballydermot Wind Farm Brochure 2020. Bord na Móna, Newbridge, Co. Kildare

It is ironic and disturbing that in 2020 Bord na Móna has been given over €100 million to rehabilitate peatlands formerly used for energy peat and at the same time the company is continuing to aggressively exploit other peatlands in its land bank to produce horticultural peat. The 2018 Annual Accounts of Bord na Móna[1] make the following statement in relation to its horticultural business "*Our professional business - which is driven by our reputation for high quality Irish peat - is expected to continue its development with an expanding footprint in International markets*". The Irish Government must bring horticultural peat production to an end immediately if its investment in cutaway bog rehabilitation is to be nothing more than a great swindle and waste of money.

Making the Switch

We need to make it easy for households to make the switch from burning turf to renewable energy. The map in Figure 33 shows the large number of homes burning peat in Ireland in 2016. Household peat burning caused 840,000 tonnes of CO_2 emissions in 2018. Government must reduce the pressure on peatlands and climate from turf cutting and burning (Figure 34). The SEAI Better Energy Communities Programme is a national retrofit initiative aimed at upgrading buildings to high energy efficiency and renewable energy usage. The Midlands area which has a high dependency on turf for home heating is a target for this scheme. Although the scheme is available since 2018 and grants of up to 30% are available - which can be coupled with turf cutting compensation payments - uptake has been poor as the necessary renovations are disruptive to rural households. In addition solar power panels could be rolled out to provide electricity for homes, reducing the need for supply from the national grid and helping to eliminate the burning of fossil fuels including turf to heat homes and provide hot water. Surplus energy generated in homes from the use of solar panels can also feed back into the grid, but this requires access.

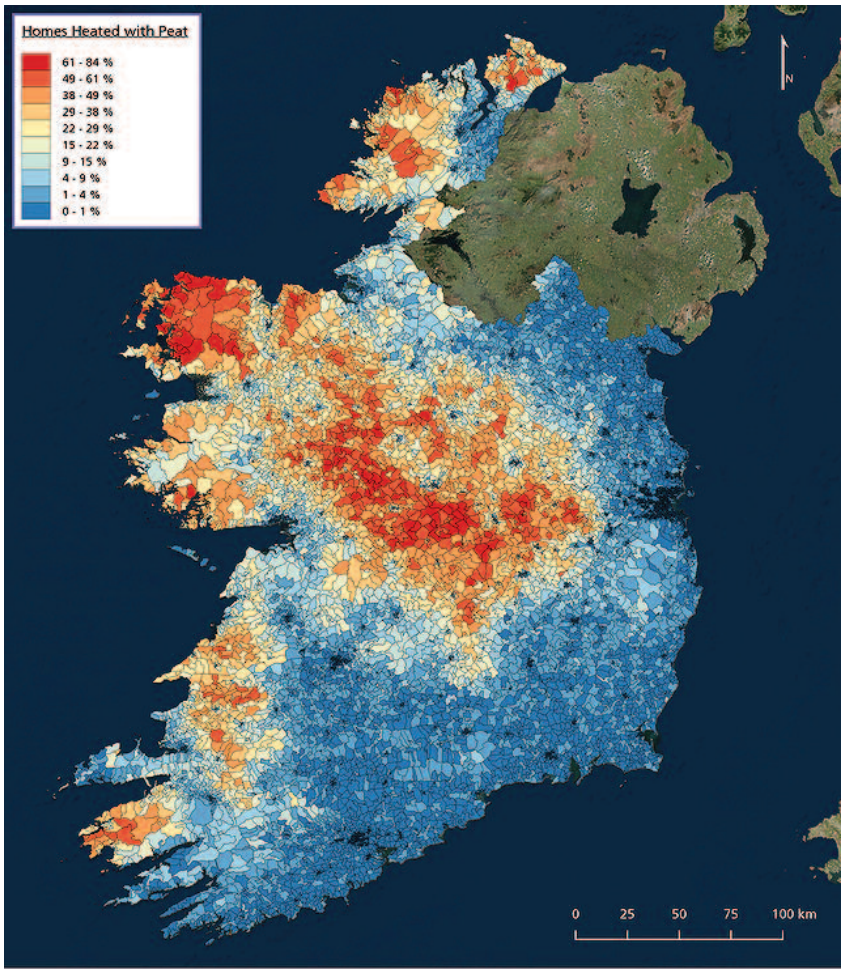


Figure 33: Map of homes heated using peat in Ireland, from Census 2016. Photo: © https://www.reddit.com/r/ireland/comments/75zpav/map_of_homes_heated_using_peat_from_census_2016/

Figure 34: Destruction of peatland habitat and its natural carbon store for turf cutting for domestic use. A sustainable alternative must be found to remove this pressure. Photo: © C. O'Connell

1 https://www.bordnamona.ie/wp-content/uploads/2018/07/BNM-Annual-Report-2018.pdf

Funding for Private Restoration and Rehabilitation

The Irish Peatland Conservation Council does not see any funding streams at present being provided for private citizens who may wish to carry out rehabilitation and restoration works on cutover bogs that they own, in the interests of protecting their carbon store at the very least. Such work needs to be encouraged with well thought out programmes of investment and should be part of agricultural land management.

The recently launched Just Transition Fund by government has the potential to get local communities involved in conservation of the bogs in their community. The bogs might not be seen as fuel/summer grazing land only but as a vital carbon sink that can also provide employment in tourism, restoration and climate action.

Wind Farms and Bog Bursts

In 2020 alone media highlighted two bog slides or bursts relating to site preparations for wind farms in Shass Mountain/Drumkeeran, Co. Leitrim (see Figure 35) and in Meen Bog, Co. Donegal. For many years the Irish Peatland Conservation Council have raised concerns over planning applications to construct windfarms on upland blanket bog sites on the grounds of habitat loss through fragmentation and due to the climate crisis. In our submission to the Wind Energy Guidelines we found that the draft Wind Energy Guidelines 2020[1] placed too much emphasis on the developers and not enough on the protection of peatland habitats. No monitoring is being undertaken on windfarms developed on blanket bog habitat. If a peatland needs to be drained for a windfarm then the development is in the wrong place (Figure 36). If a windfarm is proposed on a designated site it is also in the wrong place. 90% of North Western Europe's wetlands have been drained and this has had an alarming outcome visible in the current climate catastrophe with flooding, increased rainfall, species extinctions and extreme weather all of which can cause bog slides and significant spikes in greenhouse gas emissions not to mention loss of additional habitats, farmland and livelihoods[1].

Figure 36: Wind farms built on carbon-rich peatlands lose their advantage in the fight against climate change. Photo: © C. O'Connell

Figure 35: Bog slide at Drumkeeran from Shass Mountain, Co. Leitrim. The bog burst due to works associated with a wind farm construction in 2020. Photo: © T. Moseley

1 Irish Peatland Conservation Council Submission on the Draft Wind Energy Guidelines 2020 (see http://www.ipcc.ie/wp/wp-content/uploads/2017/08/dWEG-2020_IPCC.pdf)

14. Peatland Roadmap

building blocks to fight climate change

The overall aims of this action plan are to protect, sustainably manage and restore Ireland's 1.2 million hectares of peatlands.

The building blocks on the road to success involve management, funding, education and collective effort. These will drive the Irish Peatland Conservation Council's campaign on climate change over the next ten years.

The actions IPCC will take for peatlands and climate change are summarised in Table 17. A variety of groups, both government and non-governmental have responsibilities in relation to the protection and sustainable management of Irish peatlands. Action from these groups is required sooner, rather than later.

The actions presented in Table 17 derive from the Irish Peatland Conservation Council's analysis of our database of over 1,000 sites of conservation importance. This shows an on-going and shocking degradation of site condition due to human activities. The most impactful continues to be turf cutting for domestic use. Campaign steps to change this are outlined in Action 10 of Table 17.

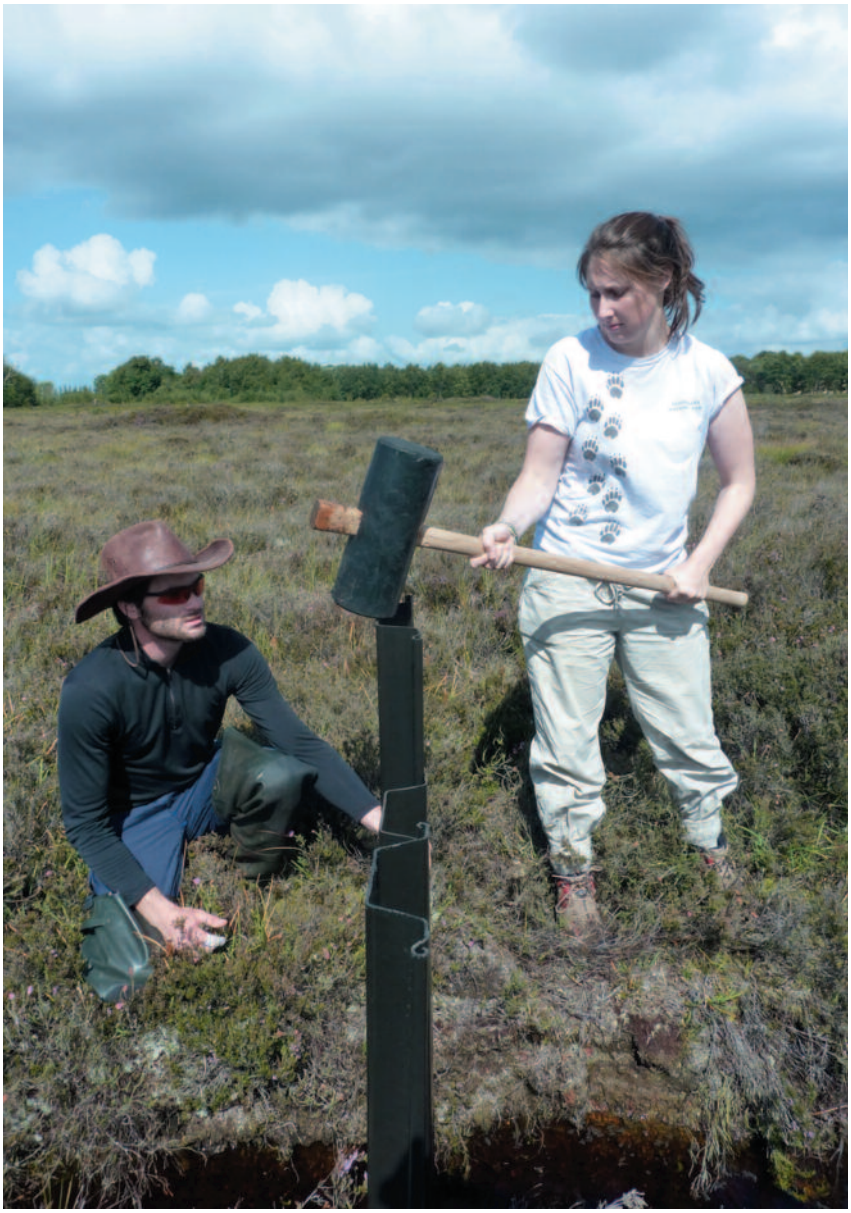


Figure 37: Local action on species conservation, habitat creation and restoration, coupled with community engagement and education has the power to provide climate change solutions. Photo: © Irish Peatland Conservation Council

While the recent announcements by Bord na Móna indicate a withdrawal from peat extraction by this company, there still remains over 50 horticultural peat companies operating within Ireland who are having a significant impact on our remaining raised bogs, the most threatened peatland type in western Europe (see Action 8 in Table 17).

It is vital that all government policies, planning, forestry and wind energy do not allow any further degradation of our peatland carbon stock. While the Irish Government may congratulate itself on its plans for a climate resilient and carbon-neutral economy, this must be turned into action on the ground targeted at peatlands in recognition of their benefit in the fight against climate change. The Irish Peatland Conservation Council will be campaigning for the development of an immediate 20-year peatland restoration and rehabilitation action plan with a budget of €1 billion as one powerful solution to climate change (see Action 1, Table 17). Community buy-in will be crucial to success and IPCC will be ensuring that there are ample opportunities for communities to be informed and to participate in the peatlands and climate change action plan (see Action 6, Table 17 and Figure 37).

Table 17: Campaign actions for peatlands and climate change to be pursued by the Irish Peatland Conservation Council.

#	Campaign Actions for peatlands and climate change	Priority	Timescale On-going Short 0-3 yrs Medium 3-5 yrs Long 6-10 yrs	Bodies Responsible
1	Develop a 20-year, €1 billion peatland restoration and rehabilitation action plan to help combat climate change and set up an overseeing group to direct and co-ordinate the programme	High	On-going	National Parks and Wildlife Service, Bord na Móna, Non-Governmental Organisations, Local Authorities, Government Departments of Environment, Climate, Agriculture and Heritage, Peatlands Council
2	Set an annual target and funding stream for peatland restoration and rehabilitation quantifying the greenhouse gas emissions saved and the biodiversity enhanced	High	Short	National Parks and Wildlife Service, Government Departments of Environment, Climate, Agriculture and Heritage, Teagasc
3	A network of demonstration sites on best practice restoration and rehabilitation must be established and documented	High	Medium	Non-Governmental Organisations, Local Authorities, Community Wetlands Forum, Private Individuals, National Parks and Wildlife Service
4	Develop a decision tool to assist land managers in identifying the sites that will give the best short-term restoration or rehabilitation results	Medium	Short	National Parks and Wildlife Service, Bord na Móna
5	A carbon credit system which will allow private corporations and individuals to fund peatland restoration must be developed so as to increase and maintain the level of funding streaming through to peatland restoration	High	Medium	National Parks and Wildlife Service, Government Departments of Environment, Climate, Finance, Public Expenditure and Reform
6	A new story line in education regarding peatlands and climate change must be developed and implemented across all curricula, back to back with a strong public awareness campaign	High	Short	National Parks and Wildlife Service, Non-Governmental Organisations, Local Authorities, Community Wetlands Forum, Heritage Council, Government Departments of Education, Environment, Climate
7	A nationwide land-use and habitat mapping system needs to be made publically available to inform policy development, planning decisions and management actions in relation to climate change	Medium	On-going	National Parks and Wildlife Service, Bord na Móna, Local Authorities, Government Departments of Environment, Climate, Agriculture, Rural Affairs and Heritage, Ordnance Survey Ireland, Environmental Protection Agency, European Environment Agency, Teagasc, Universities
8	Industrial harvesting of peatlands for horticultural moss peat must be stopped and alternative products that are sustainably produced developed. Rehabilitation plans for cutaway areas must be developed and implemented	High	Short	Peatlands Council, Government Departments of Environment, Climate, Agriculture, Rural Affairs and Heritage,
9	Planning laws need to be extended to provide protection for peat carbon stocks remaining in man-modified peatlands	High	Short	Government Departments of Environment, Climate, Justice, Local Authorities
10	Burning turf in private homes must be phased out as a community led initiative, through the provision of grant aided, accessible, sustainable energy sources dovetailed with carbon credits for rewetting from turf-producing bogs	High	Short	Government Departments of Environment, Climate, Finance, Rural and Community Development, Sustainable Energy Association of Ireland, Local Energy Communities, Local Authorities
11	A field survey of fens, setting conservation targets and developing management plans for blanket bogs and fens and the completion of the designation of Special Areas of Conservation and Natural Heritage Areas for peatland habitats must be undertaken	High	Long	National Parks and Wildlife Service, Government Departments of Environment, Climate, Agriculture and Heritage
12	Long-term greenhouse gas monitoring projects on peatlands (to include dissolved organic carbon) need to be established for all peatland in a continuum from intact sites through to sites with a thin coating of peat to allow for reporting of the success of restoration and rehabilitation in terms of greenhouse gas reduction	Medium	On-going	National Parks and Wildlife Service, Environmental Protection Agency, Universities

15 Healthy Peatlands

keep the benefits flowing

Peatlands provide many benefits. These benefits are regarded as natural capital. Natural capital is the world's stocks of physical and biological resources, including air, water, minerals, soils, fossil fuels and all living things. These stocks work together to deliver ecosystem goods and services that in turn provide benefits to society. These benefits include harvestable products like food, materials and fuel, clean water for people to drink and for industry to use, purified air to breathe, the natural decomposition of wastes, the conservation and recycling of essential nutrients like nitrogen and phosphorus, medicine, pest control, pollination, flood and drought regulation and beautiful places to visit. These services matter to people because they give us things we need. But because they are 'free', we don't value them in the same way we value things we have to pay for. The values of peatlands are listed below. This list is adapted for Irish peatlands but was originally published in the Scottish Peatland Strategy (2015[1]).

Nature: uniquely adapted groups of birds, plants, fungi, invertebrates and micro-organisms, some not found together anywhere else in the world occur in peatlands. For example half of all endangered birds and 25% of rare plants occur in peatlands. One quarter of all of our mammals depend on peatlands for some phase of their life cycle. Ireland contains over 50% of all raised bog habitat remaining in Europe. Internationally the blanket bogs of Ireland and the UK form the largest single contribution (10-15%) of this habitat in the world.

Figure 38: Healthy functioning peatlands such as the Roundstone Bog in Co. Galway naturally capture and store carbon. Photo: © C. O'Connell

Half of Irish designated lands contain peatland.

Water supply: peatlands play an important role in the provision of drinking water both in areas where catchments are largely covered by peatlands and in drier areas where peatlands provide constant availability of water. Many of our salmon rivers depend on peaty catchments.

Flood management: intact peat bogs contain about 90% water and help to maintain steady flow rates on rivers and reduce downstream flood risks compared to damaged peatlands.

Historic environment: almost 4000 archaeological sites have been recorded within peatlands and the National Museum have over 3000 artifacts catalogued in their collection from peatlands.

International image: peatlands provide the backdrop for Ireland's wild countryside valued by the film and tourism industries and a key part of the brand for much of our food, drink and textiles.

Fuel: while commercial exploitation and turf cutting are not sustainable in the long-term, turf stacks and clamps are a familiar, if declining, sight in parts of the west, and the scent of peat smoke is distinctively appealing to residents and visitors.

Carbon storage & sequestration: peatlands store 1,566 million tonnes of carbon, 64% of the total soil organic carbon stock in Ireland[2], Figure 38. Undisturbed peat accumulates carbon form the air at a rate of up to 0.7 tonnes per hectare per year[3].

Livestock grazing: many peatland areas support grazing livestock, mostly sheep, but locally cattle. On some sites these can be used to control scrub and tree regeneration.

Education: peatlands are widely used as outdoor classrooms providing topics ranging from history/archaeology to restoration, climate change and conservation.

Harvestable products: collecting bog myrtle for midge repellent, tapping birch water and collecting berries for domestic preserves or gin additives are valuable.

Cultural enrichment: peatlands provide a sense of place for many and are an inspiration for Irish art, song, poetry and literature. Their colours are also captured in some tweeds and knitwear.

Health & Recreation: walking for its own sake, to reach distant mountains or a stream brings the benefits of physical exercise, refreshes the senses and encourages calm reflection in otherwise busy and crowded lives.

1 Scotland's National Peatland Plan (2015), Scottish Natural Heritage, Scotland.
2 National Parks and Wildlife Service (2015) National Peatlands Strategy, Department of Arts, Heritage and the Gaeltacht, Dublin.
3 Pearce, F. (1994) Peat Bogs Hold Bulk of Britain's Carbon. New Scientist: 6 Article