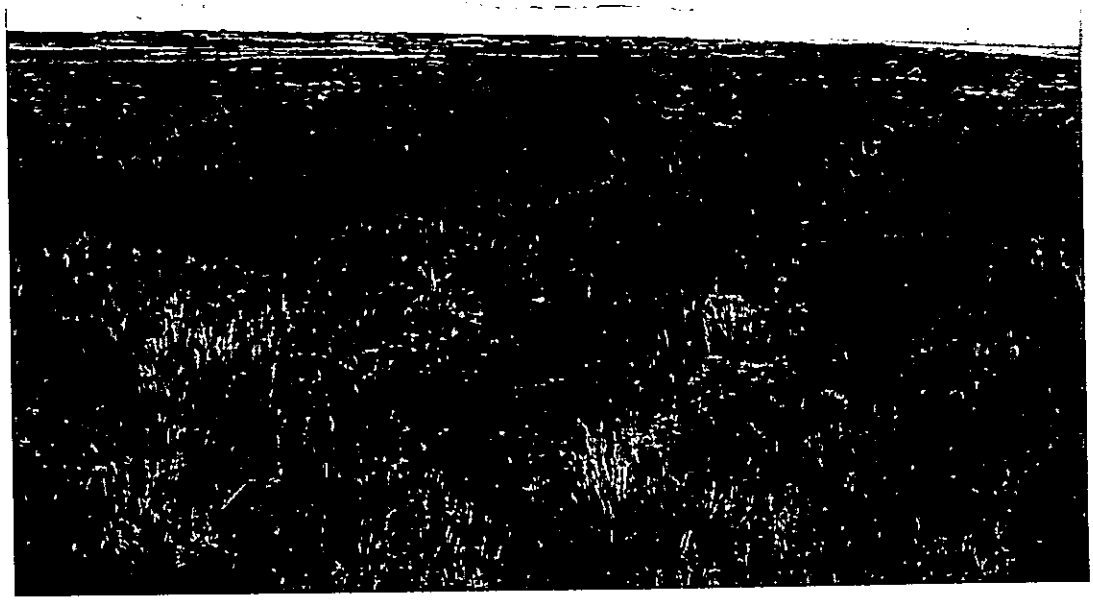
THE DISTRIBUTION, ECOLOGY AND CONSERVATION OF BLANKET BOG IN THE REPUBLIC OF IRELAND



A report to Dúchas the Heritage Service.

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SUMMARY

Between 1987 and 1991 seven surveys of blanket bog in different regions of the Republic of Ireland were undertaken by the Wildlife Service. The main purpose of these surveys was to assess the extent, composition and condition of blanket bog sites, with a view to identifying the best areas for conservation. These surveys were mainly concentrated in the more extensive lowland and highland blanket bogs of counties Mayo, Galway, Donegal and Kerry, however a selection of mountain blanket bog sites were also visited. This report presents an overview of the information contained in these blanket bog reports.
The main findings of this survey are as follows:

- In total, just over 101,000 hectares of blanket bog were surveyed between 1987 and 1991. The majority of this blanket bog area (63%) was of the lowland type, with highland and mountain blanket bog accounting for 23% and 14% of the area surveyed respectively.

- These blanket bog surveys have demonstrated the great range of vegetation types and habitat conditions to be found within the blanket bog habitat. In addition, the surveys have revealed many previously unknown sites for rare plant species.

- Counties Mayo, Galway and Donegal contain the largest areas of low-lying Atlantic blanket bog surveyed while Donegal, Mayo and Sligo contain the largest areas of Highland blanket bog surveyed. High-altitude mountain blanket bog has a much more scattered distribution, with counties Wicklow, Cavan, Sligo, Leitrim and Cork containing the largest areas surveyed.

- At the time of survey, the ecological and structural integrity of many sites was being seriously disrupted by damaging activities such as overstocking of sheep, burning, peat-extraction and drainage. Damage brought about by these factors continues to be a problem within many sites.

Whilst a substantial proportion of the estimated lowland blanket bog area was surveyed, there still remains much survey work to be undertaken in highland and mountain blanket bog areas. An analysis of areas surveyed in comparison with the estimated area of intact blanket bog within each county has revealed that counties Donegal, Kerry, Leitrim, Cork, Clare and Limerick are most deserving of further blanket bog surveys.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

Within the European Union, blanket bog is considered to be an important, but scarce wildlife habitat. As a result of this scarcity 'active' examples of the habitat have been listed for conservation under Annex 1 of the E.U. Habitats Directive. Because of the presence of a significant proportion of the world's existing blanket bog resource the habitat has received a good deal of survey and research in the Republic of Ireland, particularly within the last twenty years. By the 1980's, a small number of extensive blanket bog areas had already been listed by An Foras Forbartha as Areas of Scientific Interest, e.g. Roundstone Bog, however much of the resource was still unsurveyed at that stage (Ryan and Cross, 1984). In view of this obvious gap in information, four full seasons of ecological survey work was carried out on blanket bogs in the Republic of Ireland, in the period from 1987 to 1991. The results of these surveys are documented in seven unpublished regional reports to the National Parks and Wildlife Service (Douglas and Grogan 1987, Foss and McGee 1987, Douglas *et al.* 1989a, Douglas *et al.* 1989b, Douglas *et al.* 1989c, Douglas *et al.*, 1990, Goodwillie and Mooney 1991). The primary aim of these surveys was to assess the composition and conservation interest of previously undocumented and undesignated blanket bog sites in order to identify those worthy of designation as Areas of Scientific Interest. Subsequently these surveys have provided much of the background information for the survey and designation of Natural Heritage Areas and Special Areas of Conservation which have replaced Areas of Scientific Interest.

Although the surveys conducted between 1987 and 1991 have contributed much to our understanding of the composition and quality of blanket bogs in Ireland, a national synthesis of these regional surveys had not yet been undertaken. With this in mind, a review study of these surveys was commissioned by the Dúchas The Heritage Service in 1999. The primary aims of this review study are as follows:

(1) To characterise and describe the composition and range of blanket bog vegetation in Ireland, drawing on information contained in the regional blanket bog survey reports and in other sources in the available scientific literature.

(2) To assess the mode and effects of damaging operations, such as afforestation, overstocking by sheep and peat extraction, currently taking place within blanket bog areas.

(3) To analyse the areas of blanket bog surveyed and, arising from this, to determine if there are any types of blanket bog and/or areas of the country that have been undersurveyed.

(4) To outline areas deserving of further survey.

(5) To compile a database of blanket bog survey data in order to facilitate rapid retrieval of ecological information and to enable comparative analysis of the data.

Because blanket bog typically occurs as a mosaic with other habitats such as wet heath, dry heath and oligotrophic lake, the composition and quality of these associated habitats is also be considered in this review.

Nomenclature in this report follows Webb *et al.* (1996) for flowering plants, Smith (1978) for mosses, Smith (1990) for liverworts and Dahl (1968) for lichens.

CHAPTER 2. AN INTRODUCTION TO THE ECOLOGY OF BLANKET BOGS

2.1 What is blanket bog?

Although there are a number of differing schools of thought as to what exactly constitutes blanket bog, the habitat can be simply defined as an accumulation of peat soil, which forms an extensive blanket over the landscape. One of the most important aspects differentiating blanket bog from closely related peatland habitats such as wet heath is peat depth and, as a general rule, blanket bog is usually understood to be >1m in depth (Lindsay, 1995). In undisturbed conditions, blanket peat is maintained in a +/- permanently waterlogged condition, owing to high precipitation and low evapotranspiration rates. It is the combination of waterlogging, low pH and low evapotranspiration which leads to the establishment and growth of blanket bog. In contrast to raised bog peat, which is dominated by Sphagnum remains and is relatively poorly humified, blanket bog peat is generally reported to be dominated by sedge remains and is relatively well-humified (Walsh and Barry, 1958). Table 1 outlines the main characteristics of blanket bog, raised bog and fen and Figure 1 illustrates the typical structure of these three peatland types.

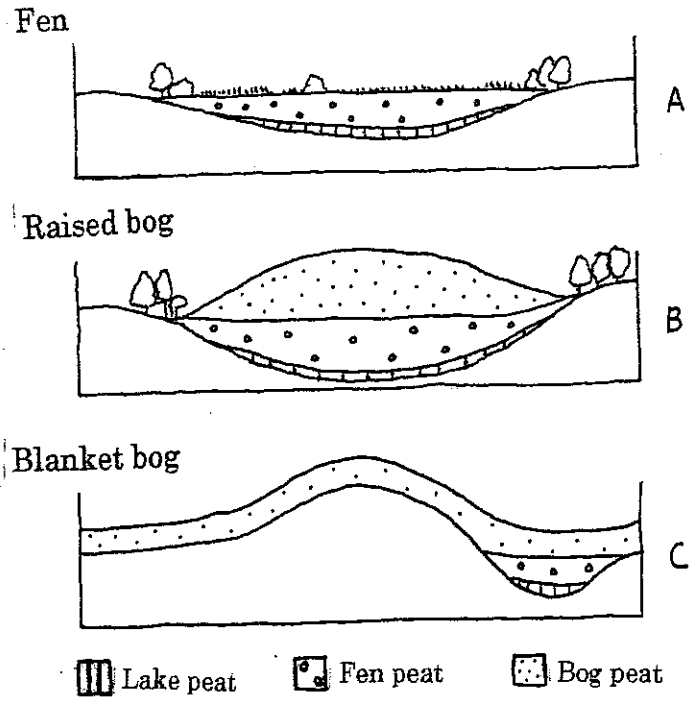


Figure 1. Transverse sections of Irish peatland types (redrawn from Foss, 1987).

Table 1. The main characteristics of blanket bogs, raised bogs and fens in Ireland (based on Foss and O' Connell, 1996).

	Blanket Bog	**Raised Bog**	**Fen**
Distribution	Western lowlands and mountains.	Midlands	Throughout the country.
Morphology	Forms extensive carpet over landscape.	Largely confined to a former lake basin.	Largely confined to basin or lake margin.
Peat depth	Typically between 0.5 and 7.0 metres.	Typically between 3.0 and 9.0 metres.	Typically less than 3 metres.
Nutrient supply	From precipitation.	From precipitation.	From groundwater and precipitation.
Typical pH range	3.5 to 5.0	3.5 to 4.5	5.5 to 7.5
Rainfall	1,200 mm or more per year.	800-1000 mm per year.	Occurs under large range of rainfall regimes.
Characteristic dominant plant species	Lowland - *Molinia caerulea, Schoenus nigricans, Erica tetralix* Upland - *Calluna vulgaris, Trichophorum caespitosum, Eriophorum* spp.	*Calluna vulgaris, Erica tetralix, Narthecium ossifragum, Sphagnum* spp..	*Carex* spp., *Schoenus nigricans, Eriophorum angustifolium* and "brown" mosses.

2.2 The global distribution of blanket bog

Blanket bog has a very restricted, but widespread global occurrence (Figure 2). This is due primarily to the relatively narrow range of climatic conditions in which the habitat can develop. Lindsay *et al.* (1988) state that blanket bog is largely restricted to oceanic areas of the world which have a minimum annual rainfall of 1000 mm, a minimum of 160 wet days and a cool climate, i.e. mean temperature of less than 15°C for the warmest month of the year. However, the formation of blanket bog has been recorded in cooler areas of the world, such as the Falkland islands, where there is relatively low rainfall, i.e. 350-635 mm rain per year. Blanket bog has been recorded from north-western Europe, the eastern coast of Canada, the north American Pacific coast, the north-eastern coast of Asia, the tip of South America, mountainous regions of central Africa and New Zealand and other Southern Pacific islands (Lindsay *et al., op. cit*). In many of these regions blanket bog formation is

very limited in extent and there still remains a degree of debate as to whether the peat soils in some of these regions constitute blanket bog in the strict definition of the term.

The north-west of Europe appears to contain some of the best developed areas of blanket bog in the world (Goodwillie, 1980). In the islands of Ireland and Britain blanket peat initially covered an area of approximately 2.25 million hectares (Tallis and Meade, 1997), however the area of the habitat which remains intact has been greatly reduced due to cutting for fuel and afforestation. The habitat is particularly well developed in the Flow Country in northern Scotland and along the western seaboard of Ireland, where the vegetation is dominated by a mixture of grasses, sedges, dwarf shrubs and Sphagnum mosses. Species such as *Erica tetralix, Eriophorum angustifolium, Drosera rotundifolia, Narthecium ossifragum, Sphagnum capillifolium* and *Sphagnum papillosum* are generally a common component of blanket bogs in both Ireland and Britain, however there are also a number of significant floristic differences between blanket bog in the two regions. The most striking of these are the relative abundance of *Molinia caerulea* and *Schoenus nigricans* in Irish blanket bogs (Doyle, 1982), while *Trichophorum caespitosum* and *Eriophorum vaginatum* tend to assume dominance in British blanket bogs (Rodwell, 1991).

Elsewhere in Europe blanket bog is restricted to much cooler parts of the continent (Goodwillie, 1980). In Iceland the main area of ombrotrophic blanket bog is to be found along the western fringe of the island. Although blanket bog has a widespread distribution along the west coast of Norway, the habitat is small in extent due to the mountainous nature of the terrain (Dierssen, 1982). Small areas of blanket bog also occur in mountainous regions of central Europe such as the Pyrenees and the Austrian Alps, however the genesis of peat soils in these areas is rather different to that in the north-west of Europe. In the Austrian Alps for example, peat is formed on small sloping areas where the micro-climate is cool and moist due to the confluence of warm and cold air (Steiner, 1984).

Along the eastern coast of Canada, blanket bog has a very limited distribution being largely confined to coastal areas of Newfoundland (Zoltai and Pollet, 1983). Within Newfoundland the habitat appears to be best developed on the Avalon Peninsula. Although many plant species are common to both Canadian and north-west European blanket bogs the different species complement of the dwarf shrub layers is striking, with *Calluna vulgaris* and *Erica* spp. being replaced by species such as *Chamaedaphne calyculata* and *Kalmia angustifolia* in Canada.

The presence of blanket bog along the North American Pacific Coast is still the subject of some debate. The region is known to support a wide range of peatland types including raised bogs, flat fens and slope bogs (Wells and Zoltai, 1983), however unconfined peatland

formations which correspond to blanket bog appear to be relatively rare. Plant species such as *Trichophorum caespitosum, Empetrum nigrum, Ledum groenlandicum, Juniperus communis* subsp. *nana* and *Kalmia polifolia* are common in the blanket bogs of Alaska and British Columbia (Banner *et al.*, 1986). Pool systems containing *Menyanthes trifoliata, Eriophorum angustifolium* and *Rhynchospora alba* have also been noted. Blanket bogs in this area are frequently colonised by coniferous trees such as *Pinus contorta* and *Chamaecyparis* spp., which invariably occur in a stunted condition due to severe exposure.

The main locus of blanket bog development in South America is at the southern tip of the continent with one of the best-developed areas of the habitat occurring on the main island of Tierra del Fuego (Pisano, 1983). The most obvious difference between the blanket bog that develops in this region and those of the northern hemisphere is the dominance of cushion plants such as *Dontia fascicularis* and *Astelia pumila,* in the vegetation. These peat-forming cushion plants form large mounds which superficially resemble *Sphagnum* hummocks, thus providing an excellent example of convergent evolution. Areas of Sphagnum peatland, generally dominated by *Sphagnum magellanicum,* also occur and these typically form small nuclei of raised bog within the larger blanket bog complex. Extensive areas of blanket bog also occur on the Falkland Islands in remarkably low rainfall conditions. Here both cushion- and Sphagnum-bogs are present and are largely restricted to waterlogged plateaux in the uplands (Lindsay *et al.*, 1988).

The presence and extent of blanket bog vegetation in New Zealand and in the surrounding Southern Ocean islands is still a matter of some debate (Campbell, 1983). In New Zealand, blanket mire type formations appear to be restricted to high altitudes on the Otago Mountains of the South Island. The available information suggests that cushion mires do occur, however whether these form a continuous unconfined blanket bog complex is unclear. Campbell *op. cit.* also refers to the pakihi of the humid West Coast of the South Island, which covers extensive areas of upland however the peat depth is shallow in places and the habitat occurs as small fragmented units rather than a continuous blanket. Blanket bog may also occur on a number of Southern Ocean Islands, e.g. South Georgia and Gough Island, however the areas are relatively small.

In north-east Asia, peat landforms similar to blanket bog have been described from the Kamchatka peninsula in Russia to Hokkaido in Japan. A large area of ombrotrophic peatland is known to occur in the western Kamchatka province of Russia. Bog in this region is classified as two main types namely wet *Sphagnum* bog and dry *Cladonia* bog (Botch and Masing, 1983), however there appears to be some degree of confusion regarding the status of the peatlands in this area. Some authors have described these peatlands as blanket bog (Botch and Masing, *op. cit.*), while others have described them as domed mires

(Katz, 1971) and peat basins (Nikonov, 1955). In Japan there appear to be a number of areas in the north of the country which support good examples of ombrotrophic blanket bog vegetation. Gore (1983) has described simple unpatterned blanket bog from the slopes of Mount Taisetsu in Hokkaido and from several other mountains on Honshu.

In common with many other regions of the world, the existence of blanket bog in various upland regions of central Africa is somewhat uncertain. Shallow peat soils are known from a number of locations including Mount Kenya and upland areas in Lesotho, however the mires with the closest similarities with blanket bog appear to be the sedge-mires of the Ruwenzori mountain range in Uganda (Thompson and Hamilton, 1983). However, as most of the peatland in upland areas of central Africa are shallow and occur on strongly sloping ground, Lindsay *et al.* (1988) consider them to be examples of sloping fen.

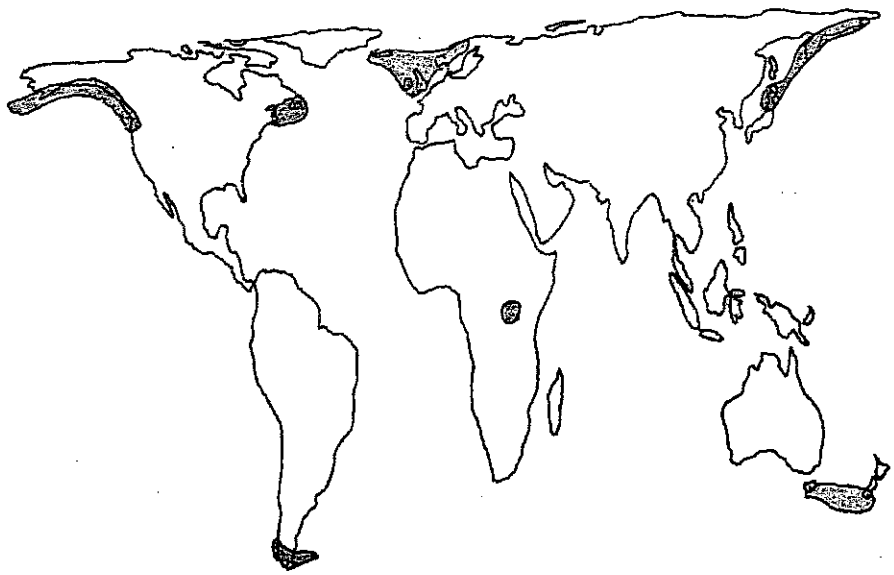


Figure 2. The principal areas of blanket bog formation in the world (redrawn from Lindsay *et al.*, 1988)

2.3 Blanket bog development in Ireland; an overview

There has been some degree of controversy regarding the genesis and the timing of the development of blanket bog in Ireland (O' Connell, 1990). Although dates for blanket bog initiation older than 4,000 years B.P. are known, the widespread expansion of blanket bog over much of the country appears not to have taken place until between 4,000 and 3,000

years before present (B.P.) (O Connell, 1990). In the north of the island most of the dates for blanket bog initiation in the Sperrin uplands are close to 4,000 years B.P. while those for the Antrim Plateau lie within the range of 3,700 to 3,300 years B.P. (Smith, 1975). In the Connemara region the spread of blanket bog took place approximately 4,000 years ago and the expansion of the habitat in this area appears to have been promoted and accelerated by forest clearance carried out by early farmers (O' Connell, 1994). Although the exact sequence of events which lead to the widespread development of blanket bog in Ireland are still rather poorly understood the phenomenon is thought to have been aided by woodland and scrub clearance carried out by early farmers (O' Connell, 1990). Climatic deterioration, which occurred around 4,000 B.P., is frequently cited as one of the factors involved in blanket bog development, however much of the evidence for this deterioration is itself based on the expansion of blanket bog so there is a circular argument (Limbrey, 1975).

The sequence of events which transpire after tree removal are as follows. The removal of the tree canopy leads to a reduction in evapotranspiration rates which, in areas of high rainfall, leads to the waterlogging of the soil. This waterlogging impedes the process of plant decomposition and eventually leads to the initiation of blanket peat formation and growth. There is also evidence that charcoal, produced by the burning of woodland or scrub in order to clear land, impedes soil drainage and thus contributes to the waterlogging of the soil. At Carrownaglough, Co. Mayo, soils cultivated by early farmers are directly overlain by blanket bog and it is thought that, in this location at least, peat accumulation was facilitated by the formation of an impermeable iron pan (O' Connell, 1986). Although climatic deterioration does not appear to have been responsible for the initiation of blanket peat in Ireland, it is clear that once blanket bog began to form, the process was greatly aided by the cool and wet climate which prevailed.

At Céide fields, along the northern coast of Co. Mayo, neolithic field systems dating from c. 5,000 years B.P. are covered by blanket peat up to 4 metres in depth (Molloy and O' Connell, 1995). In the case of this area it appears that blanket bog growth did not take place for a couple of centuries after the field systems were abandoned.

2.4 Blanket bog formation in Ireland: Environmental parameters

2.4.1 Climate

Within the Republic of Ireland, the development of blanket bog is confined to wetter regions of the country where the annual rainfall exceeds 1,200mm, falling on at least 250 days of the year. Figure 3 shows the average monthly rainfall amounts from three weather

stations (i.e. Delphi Lodge, Co. Mayo, Glenties, Co. Donegal and Killarney, Co. Kerry) located in areas of blanket bog formation in the west of Ireland, during the period from 1950 to 1980. Although the actual rainfall amounts vary markedly between the three locations the general pattern of rainfall is similar with relatively high rainfall amounts throughout the year, even during the summer months. In addition to the relatively wet climate, Ireland experiences mild summers where the mean daily air temperature in July (1951-1980) is mostly between 14 and 15.5^0 C (Rohan, 1986). It is this even distribution of heavy rainfall, coupled with relatively cool summers which give rise to the low rates of evapotranspiration necessary for the formation and maintenance of blanket bog. Due to the high levels of rainfall required, blanket bog is most extensive in the more oceanic, wetter and milder western half of the island. In the eastern half of the country blanket bog is confined to the cooler upland areas which are subject to high levels of rainfall.

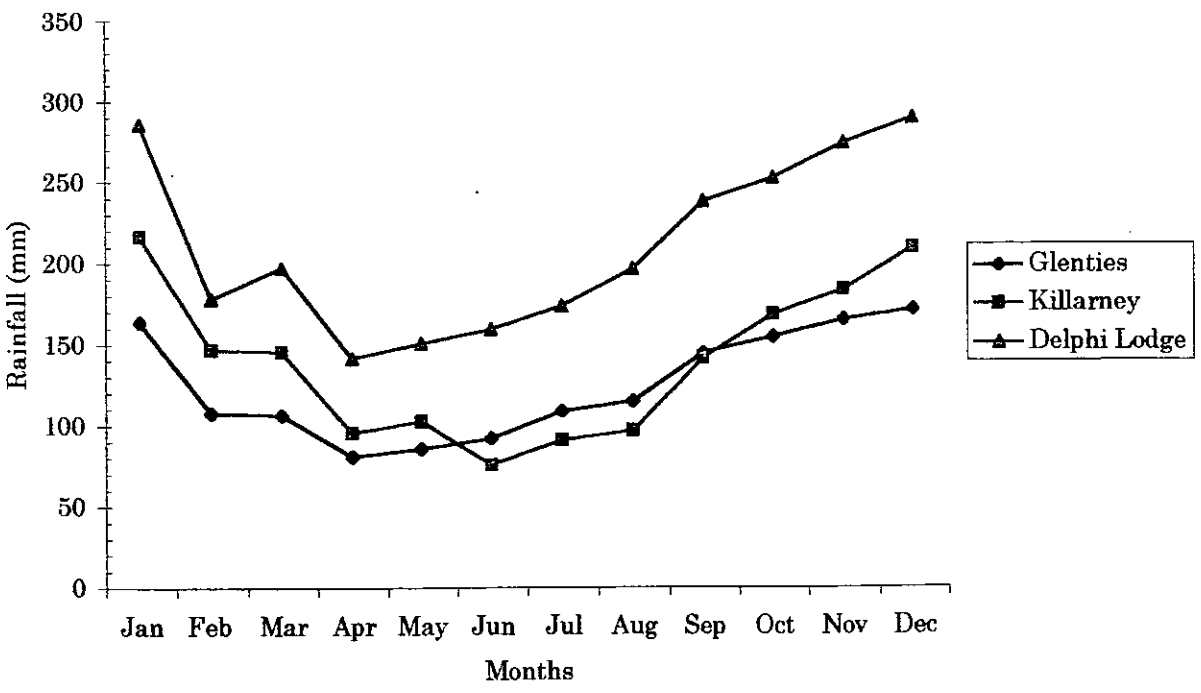


Figure 3. Mean monthly rainfall (1951-80) at three locations within blanket bog areas along the west coast of Ireland (taken from Rohan, 1986).

2.4.2 Geology and topography

After climate, the most important factors influencing the development of blanket bog are topography and geology, both of which are closely related. The topography of an area is a crucial factor in governing the extent and type of blanket bog present and blanket bog

development rarely takes place in areas where the slope exceeds 25^0 from the horizontal. In general, blanket bog is best developed on areas of unyielding, base-poor bedrock such as schist, sandstone, granite and shale, however the habitat can also develop in areas of limestone bedrock provided there is a covering of base-poor drift, e.g. the Ben Bulben Plateau, Co. Sligo. In upland areas, extensive development of blanket bog is favoured on the gently undulating to flat plateaux formed by silicious rocks such as granite, e.g. the Wicklow mountains and shale e.g. the Slieve Blooms. This contrasts with the paucity of mountain blanket bog on steep-sided mountains which have summits of small surface area, e.g. the quartzite peaks of the Twelve Bens, Co. Galway and the Old Red Sandstone peaks of the MacGillycuddy's Reeks, Co. Kerry.

2.5 The chemistry and hydrology of blanket peat

The typical chemical composition of blanket peat is outlined in Table 2. These analyses demonstrate the generally low nutrient status of the material. pH values for ombrotrophic blanket peat are typically in the range of 3.6 to 4.5 (Sparling, 1967), however values as low as 3.4 have been reported (Doyle, 1982). These low pH values are vital in the prevention of plant decomposition. The lowering of the pH of the environment is largely achieved by *Sphagnum* mosses which scavenge ions from the immediate environment and replace them with hydrogen ions. Ombrotrophic blanket bog peat is also very low in available plant nutrients such as phosphorous, nitrogen, potassium and calcium, however elements primarily derived from marine sources in the west of Ireland such as sodium, magnesium and chlorine are considerably higher than in bogs located in less oceanic regions of Ireland and Britain (Table 2). As a result of the low nutrient availability of blanket bogs, plant species have adopted a number of nutrient conservation/acquisition mechanisms. Noteworthy examples of such mechanisms include the retention of leaves throughout the year (e.g. *Calluna vulgaris*), the withdrawal of nutrients from aerial shoots at the end of the growing season (e.g. *Eriophorum* spp., *Molinia caerulea*) and insectivory (e.g. *Drosera* and *Pinguicula* spp.).

In simple terms, an intact bog system can be considered to behave as a large sponge which absorbs and loses water in response to inputs (mainly rainfall) and outputs (mainly evapotranspiration) of water. A deposit of blanket peat can be divided into a living surface layer, known as the acrotelm, and a largely inert bottom layer, known as the catotelm. The acrotelm is typically between 10 cm and 30 cm in depth and consists of the plant material of the bog surface, their root systems and the associated peat soil. The acrotelm plays and important role in regulating the entry and exit of water to and from the peat mass, a function it achieves as a result of its relatively high hydraulic conductivity. A properly

functioning acrotelm reduces evapotranspiration from the bog surface during dry/warm periods, ensuring that the underlying peat is maintained in a waterlogged condition and thus preventing desiccation and subsequent decomposition of peat. As outlined previously, the decomposition of peat is also impeded by the maintenance of a low pH, through the mechanism of ion exchange carried out by *Sphagnum* spp. The maintenance of a healthy acrotelm is essential to the continued growth of the peatland, thus the water table must remain within at least c. 5 cm of the surface for most of the year, if decomposition and subsequent degradation of the peatland is to be avoided. In contrast to the acrotelm, the catotelm is generally many metres thick and it has a low hydraulic conductivity. This low hydraulic conductivity implies that, in an undisturbed area of blanket bog, the catotelm has a high storage capacity and a very low rate of water transmission.

Table 2. The chemical composition of bog peat (top 20 cm) from Glenamoy, Co. Mayo Liffey Head, Co. Wicklow and Kilmackshane, eastern Co. Galway (Walsh and Barry, 1958).

	Glenamoy (Lowland Atlantic blanket bog)	**Liffey Head (Mountain blanket bog)**	**Kilmackshane (Raised bog)**
% H_2O	91.2	93.2	94.8
pH	4.6	4.4	4.7
% ash	2.4	2.4	3.7
Total nitrogen (g/100g)	1.44	0.90	1.8
Soluble phosphorous (µg/100g)	16	16	14
Soluble calcium (µg/100g)	4	5	4
Soluble potassium (µg/100g)	177	130	250
Total sodium (µg/100g)	600	280	500
Total magnesium (µg/100g)	1,000	1,000	1,000

2.6 Blanket bog morphology

Contrary to the view of blanket bogs being large, somewhat monotonous and rather species-poor habitats, they frequently support a number of areas that differ in terms of their hydrology, peat depth and floristic composition. Much of this variation is due to the topography of the underlying ground which in turn influences the depth of peat. Because of this variation, a number of morphological types (also known as mesotopes) of blanket bog may be evident within a blanket bog site. The various mesotopes within an area of blanket bog differ from one and other in terms of peat depth, drainage patterns and hydrology and these differences in turn influence the vegetation present. In general, areas of highland bog contain the greatest diversity of mesotopes because of the frequent co-occurrence of flat and sloping areas within the same site. Conversely, due to their flat or gently rolling nature,

areas of mountain plateau bog or lowland blanket bog do not generally contain a large diversity of mesotopes. Although there appears to be a degree of confusion in the literature regarding the nomenclature of these different mesotopes, a number have been consistently recognised from Irish blanket bogs. Of the blanket bog surveys conducted, the mountain blanket bog survey of Goodwillie and Mooney (1991) is the only one to state the peatland mesotopes that occur within each site surveyed. As the other blanket bog surveys dealt largely with lowland blanket bogs where topographic variation is less and therefore not a conspicuous distinguishing feature, the mesotopes that were present were not always stated. The structure of the different mesotopes encountered within Irish blanket bogs is described briefly in the following sections.

2.6.1 Saddle bog

This type of bog generally occurs at altitudes of between 250 and 500 metres, on the relatively wide saddles which connect mountain peaks. The ground generally slopes away steeply on both sides and there is normally erosion of peat where the saddle gives way to more steeply sloping ground. Possibly the best example of a saddle bog in the country is Knockastumpa to the south of Lauragh village, Co. Kerry which lies at an altitude of between 280 and 300 metres (Goodwillie and Mooney, 1991).

2.6.2 Headwater bog

This type of bog also occurs at high altitude and typically consists of flat, deep peat which is drained by a number of rivers and streams. As the name suggests, headwater bogs often form the sources of rivers and streams. Frequently, headwater bogs receive water from surrounding high ground, which contributes to the wetness of the site. Owing to the good depth of peat in these areas of bog, pool and hollow areas are a common feature. Many of the most extensive and intact remaining examples of headwater bogs occur in the Wicklow mountains with a particularly good example of the mesotope at Liffey Head.

2.6.3 Valley bog (lowland and mountain)

These are small areas of peatland which are confined by steeply sloping ground, streams or lakes. This confining of the peatland often results in the presence of a dome on the bog surface. Thus from a hydrological point of view, these areas may function not unlike lowland raised bogs. Often these small valley bogs are found in topographically suitable areas within larger expanses of lowland and highland blanket bog. Two types of valley bog have been recognised in Ireland, namely lowland and mountain. The main difference between these two types is the tendency for higher *Sphagnum* cover in the lowland type.

Two of the best examples of valley bogs are Derrybeg bog, Co. Donegal, which is situated at the south-western end of the Glenveagh valley, and Owenalough Valley bog which is located to the south-east of Mweelrea hill, Co. Mayo.

2.6.4 Valleyside bog or flushed sloping bog

This type of blanket bog mesotope occurs on sloping ground and is generally much more common and extensive in mountainous regions. Typically such areas are located downslope of areas of saddle or headwater bog. Because of the rather steep slope present, peat depth is often shallow (i.e. c. 1 metre deep) and, as a result, such areas are generally well-drained. Many areas of valleyside bog contain flush vegetation, generally dominated by *Juncus* and *Sphagnum* spp.. Such areas develop close to soakways and water channels, where water movement is most pronounced. Very often the vegetation of valleyside bog is dominated by *Molinia caerulea* with prominent *Calluna vulgaris* and, as a result, the vegetation is quite species-poor. The dominance of these species indicates the lateral movement of water within the peat. *Sphagnum* cover is generally low in these flushed, sloping areas.

2.6.5 Watershed bog

These are areas of blanket peatland which lie on plateau areas at moderate to high altitudes. Water discharges quickly, in all directions from these areas so that they are relatively well-drained. Many areas of this blanket bog mesotope have been severely affected by erosion. Undoubtedly the best remaining example of this type of blanket bog mesotope is to be found at the summit of the Slieve Bloom mountains along the border between Counties Laois and Offaly. Here the vegetation is dominated by extensive swards of lightly-grazed *Calluna vulgaris*.

2.6.6 The structural organisation of the blanket bog habitat

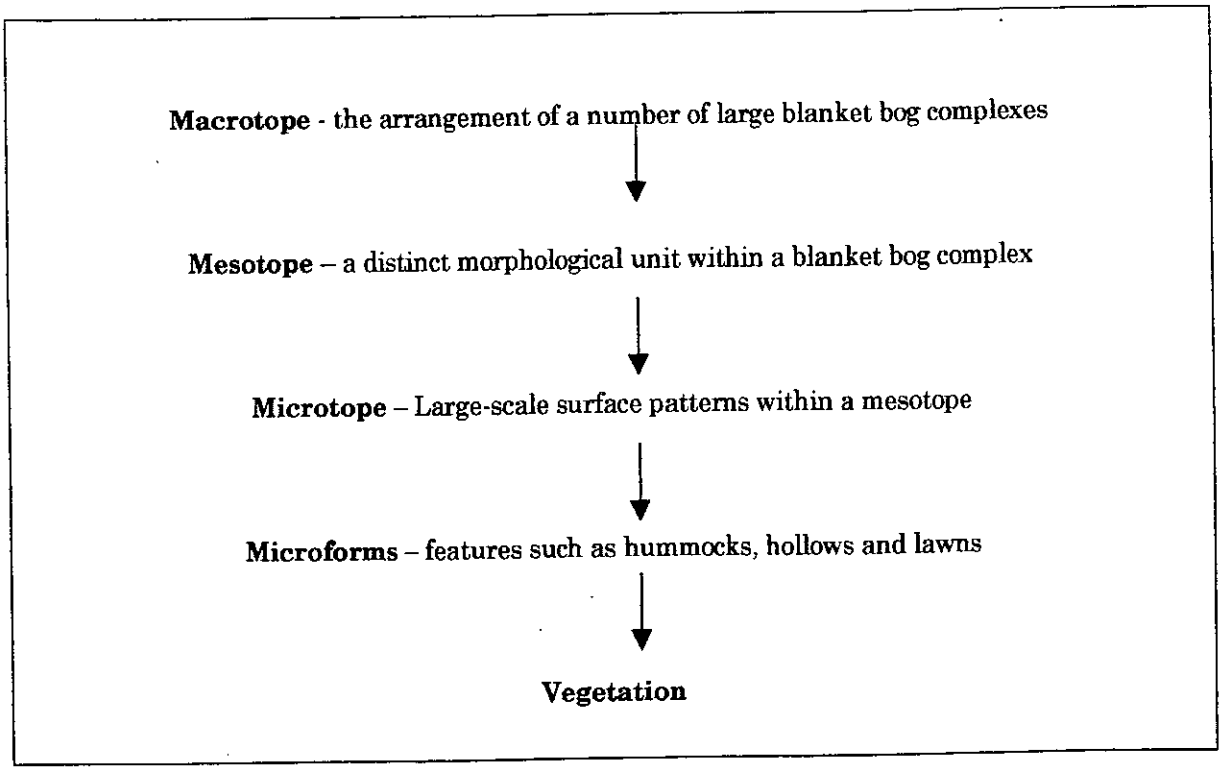
The structure of a blanket bog area can be considered at a variety of levels ranging from the macrotope to vegetation (see Table 3). The macrotope can be described as the largest mire unit which incorporates a number of mesotopes, e.g. flushed slope, saddle bog etc. The consideration of the blanket bog at the macrotope level is important when considering the conservation of an extensive blanket bog landscape.

2.7 The distribution and extent of blanket bog in Ireland

The determination of the exact extent of blanket bog in Ireland is rendered difficult because of the inherent difficulties of defining a minimum depth of accumulated organic material that constitutes blanket peat (Tallis and Meade, 1997). Some authors, e.g. Doyle (1982),

consider that peat of at least 1.5 metres in depth should be considered to constitute blanket bog. The only existing comprehensive attempt to assess the national peatland resource in Ireland was undertaken by Hammond (1979). He estimated that the original extent of blanket bog (all types) in the Republic of Ireland was approximately 774,990 hectares (Table 4) which equates to approximately 11% of the land area. However, this figure includes all areas where the peat depth is greater than 0.45 metres and thus includes some areas of wet heath. This suggests that the area of blanket bog (in the strict definition of the term) may be somewhat overestimated. However, based on the map of peatland distribution produced as part of this study (An Foras Talúntais, 1978) it is also evident that significant areas of blanket peat were not included in this calculation, e.g. areas of blanket peat to the north of Doughruagh hill, Connemara. Thus there are also good reasons for believing that the figure may be an underestimate. Despite these shortcomings, the figures outlined below are the only systematic attempt to estimate the extent of blanket peat and thus they serve as baseline figures for blanket bog distribution in Ireland

Table 3. The various levels of structural organisation within a blanket bog complex (from Lindsay *et al.*, 1988).



A breakdown of the distribution of blanket bog on a county by county basis (Table 5) reveals that Donegal (129,186 ha) contains the largest area of unmodified blanket bog, closely followed by Mayo (126,080 ha) with Galway (77,219 ha), Cork (62,863 ha) and Kerry (47,803 ha) also containing substantial areas. The counties with less than 1,000 hectares of

unmodified blanket bog are Carlow, Kilkenny, Dublin, Roscommon, Offaly and Wexford. Most of these counties are located in the midlands and east of the country.

Figure 4 outlines the distribution of blanket bog in Ireland and it clearly shows that blanket bog is largely restricted to the counties along the western seaboard and upland areas in the midlands and east with annual rainfall in excess of 1200 mm.

By 1946, it was estimated that the area of intact blanket bog had been reduced to approximately 675,190 hectares (87.1% of the original area), mostly due to the hand-cutting of peat and agricultural reclamation (Foss and O'Connell, 1996). From 1946 onwards the decline in the area of intact blanket bog has progressed at a greatly accelerated rate due to the dramatic increase in the level of agricultural reclamation, peat extraction, blanket bog afforestation (1950's onwards) and sheep grazing (1980's onwards). The most dramatic decline appears to have occurred between 1982 and 1996 when it is estimated that the intact area decreased from 517,237 hectares (66.7% of the original area) to c. 128,647 hectares (16.6% of the original area) (Foss and O' Connell, *op. cit.*). However, this most recent figure is probably an underestimate because it only includes areas of blanket bog that lie within Special Areas of Conservation. Observations suggest that there are still large areas of good quality blanket bog which lie outside of proposed Natural Heritage Areas and proposed Special Areas of Conservation. This is particularly true of highland and upland blanket bog types in the Republic of Ireland which have received only a relatively small amount of focussed research and documentation.

The large reduction in the area of intact blanket bog which has occurred since the early 1950's has been primarily due to the afforestation of large tracts of lowland blanket bog in the west of Ireland and the increase in the area of blanket bog subject to mechanised peat-cutting. The introduction of new peat extraction technologies facilitated the utilisation of blanket bog areas which were previously considered to be too difficult to access and cut. In the 1980's there was also a dramatic increase in sheep numbers in Ireland due to the introduction of potentially lucrative headage payments by the European Union. As this subsidy was implemented without any reference to the stock-carrying capacity of land it lead to the stocking of large flocks of sheep, which in turn has lead to the overgrazing and subsequent erosion of large tracts of blanket bog and heath (Bleasdale and Sheehy Skeffington, 1995). This erosion is particularly acute in the mountainous regions of north Connemara and south Mayo. Some of the pNHA's and pSAC's in this area contain significant areas of eroded blanket peat which have been damaged as a result of intensive sheep grazing and trampling to such an extent that these areas cannot now be considered to be actively peat-forming.

By far the most extensive tracts of lowland blanket bog are to be found in the mid-western counties of Mayo and Galway with Donegal, Cork and Kerry also containing significant areas of the habitat (Table 5). The best-developed and most extensive areas of the habitat occur in the north-west of Co. Mayo where there are at least 36,000 hectares of lowland blanket bog of conservation value (approximate areas taken from blanket bog survey reports). The second largest area of relatively intact lowland blanket bog occurs in the Connemara region of Co. Galway which contains approximately 20,000 hectares of the habitat which is of conservation value. Counties Donegal and Kerry also contain significant areas of lowland blanket bog of conservation value.

Perhaps the best-developed area of highland blanket bog occurs in the Ox mountains in western Co. Sligo, where approximately 6,000 hectares of the habitat of conservation interest occur. Ecologically important highland blanket bogs also occur in the uplands of central and south-east Donegal. County Kerry also contains sizeable tracts of highland blanket bog, however in Kerry this type of blanket bog occurs as smaller, more discrete units.

Mountain blanket bog is confined to upland areas above an altitude of 300 metres. This peatland type is widely distributed throughout Ireland but tends to be best developed in the south and east of the country. A common feature of this peatland type is that it is often influenced by severe erosion and this erosion is being exacerbated by excessive levels of sheep grazing at present. Perhaps the most intact example of the habitat occurs on the summits the Slieve Bloom mountain range which lie on the border of counties Offaly and Laois. Other upland areas containing good examples of mountain blanket bog habitat include the Cuilcagh mountains (Counties Cavan and Fermanagh), the uplands of Co. Leitrim, the Slieve Aughty mountains (Counties Galway and Clare), the Wicklow mountains, the Derrynasaggart Mountains (Cork/Kerry border) and Mangerton (Co. Kerry).

Table 4. The area of blanket bog in the Republic of Ireland, after Hammond (1979).

Total Irish peatland area (incl. fen)	= 1,177,670 hectares
Blanket bog area	= 773,860 hectares (66% of total peatland area)
Low-level Atlantic blanket bog	= 337,170 hectares (29% of total blanket bog)
Unmodified	= 243,610 hectares (72% of low level blanket bog)
Modified	= 93,560 hectares (28% of low level blanket bog)
Mountain blanket bog	= 436,690 hectares (37% of total blanket bog)
Unmodified	= 321,060 hectares (74% of mountain blanket bog)
Modified	= 115,630 hectares (26% of mountain blanket bog)

Table 5. A breakdown of blanket bog distribution in the Republic of Ireland on a county-by-county basis, after Hammond (1979). All areas in hectares.

County	Lowland Atlantic blanket bog		Highland and Mountain blanket bog			
	Un-modified	Modified	Un-modified	Modified	Total unmodified	Total
Donegal	57,248	8,361	71,938	11,109	129,186	148,656
Mayo	82,242	39,324	43,838	10,000	126,080	175,404
Galway	64,447	9,292	12,772	10,032	77,219	96,543
Cork	10,683	-	52,180	11,335	62,863	74,198
Kerry	18,341	20,316	29,462	12,748	47,803	80,867
Leitrim	4,512	846	23,842	6,313	28,354	35,513
Clare	-	-	21,756	25,075	21,756	46,831
Sligo	3,452	6,944	14,249	4,917	17,701	29,562
Limerick	2,675	514	11,955	3,683	14,630	18,827
Wicklow	-	-	12,719	2,914	12,719	15,633
Waterford	-	-	9,745	1,598	9,745	11,343
Tipperary	-	-	8,507	6,184	8,507	14,691
Cavan	-	-	2,092	1,093	2,092	3,185
Monaghan	-	-	1,416	-	1,416	1,416
Laois	-	-	1,214	4,027	1,214	5,241
Carlow	-	-	850	-	850	850
Roscommon	-	-	498	692	498	1,190
Dublin	-	-	469	-	469	469
Offaly	-	-	413	2,120	413	2,533
Kilkenny	-	-	405	-	405	405
Wexford	-	-	-	162	0	162
Machine or milled peat areas						**10,053**
Total (ha)	**243,610**	**85,597**	**320,320**	**114,290**	**563,920**	**773,860**

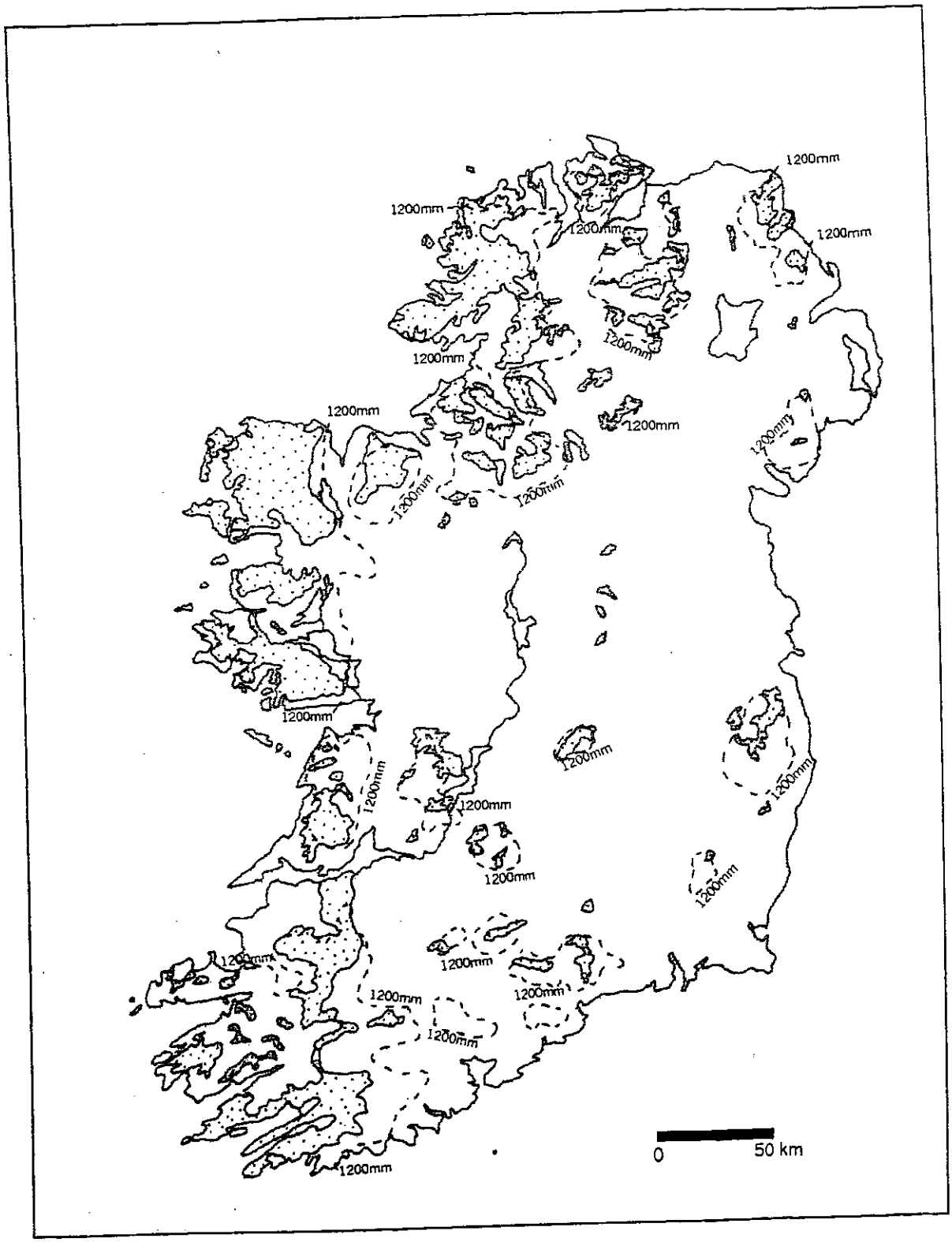


Figure 4. The approximate distribution of blanket bog (all types) in Ireland. Blanket bog is indicated by the stippled areas and the 1200 mm isoyhet is also shown.

2.8 The classification of blanket bog vegetation in Ireland

Throughout Ireland, the structure and vegetation of blanket bog shows much variation. As pointed out in previous sections, much of this floristic variation is due to a suite of interacting factors such as underlying geology, rainfall, altitude and temperature. A number of different schemes for the classification of blanket bog vegetation in Ireland have been suggested. Moore (1962) divided ombrotrophic peatlands in Ireland into three main categories namely raised bog, Atlantic blanket bog and mountain blanket bog. Under this scheme Atlantic blanket bogs are differentiated from mountain blanket bogs and raised bogs by the abundance and/or presence of *Molinia caerulea, Schoenus nigricans, Pleurozia purpurea, Campylopus atrovirens, Potentilla erecta, Polygala serpyllifolia, Pedicularis sylvatica* and *Drosera intermedia*. Plant species listed as characteristic of mountain blanket bogs but absent from low-lying Atlantic blanket bogs include *Vaccinium myrtillus, Empetrum nigrum* and *Diplophyllum albicans*.

In his detailed study of Irish peatlands along an east-west transect, Schouten (1984) classified blanket bog into three main types, namely lowland, highland and mountain. The differences between these types are based upon the observed variation in peatland morphology and floristic composition. Lowland or Atlantic blanket bog is largely confined to the western half of the country where it covers large areas below an altitude of 150 metres. According to Schouten (*op. cit.*) lowland blanket bog is characterised by a low Sphagnum cover (< 10%), a high cover of a surface algae (between 10 and 50%), the dominance of *Schoenus nigricans* and *Molinia caerulea* and the presence of *Eriocaulon aquaticum* and *Lobelia dortmanna* (both of which are confined to pools and lake margins). In addition to the dominant species, *Erica tetralix, Potentilla erecta, Narthecium ossifragum* and *Rhynchospora alba* also prominent in lowland blanket bogs. Hummock/hollow topography is not as well developed as in raised bogs and high Sphagnum cover is restricted to depressions where there is impeded drainage of surface water Schouten (*op. cit.*). In addition to the presence of the species outlined above, plant species such as *Pinguicula lusitanica, Pleurozia purpurea, Polygala serpylifolia* and *Pedicularis sylvatica* tend to be more frequent in this bog type than in others. Perhaps the most striking vegetational feature of lowland blanket bog in the west of Ireland is the abundance of *Schoenus nigricans*, a species confined to base-rich habitat conditions elsewhere in Ireland and Europe.

Highland blanket bog is also primarily confined to the wetter western half of the country and is restricted to altitudes of between 150 and 300 metres. The floristic composition of highland bog is broadly similar to that of lowland blanket bog, however there are some elements of mountain blanket bog in the vegetation. The main floristic differences between

highland and lowland blanket bog are the absence of *Eriocaulon* and *Lobelia* and the presence of the lowland species Schoenus nigricans alongside upland species such as *Empetrum nigrum, Vaccinium myrtillus* and *Diplophyllum albicans*, albeit at a low frequency. This type of bog forms the transition between lowland and mountain blanket bog.

Mountain blanket bog is confined to upland situations generally in excess of 300 metres, however it is best developed at altitudes in excess of 400 metres. Typically the most prominent vascular plant species in the vegetation are *Calluna vulgaris, Vaccinium myrtillus, Erica cinerea, Eriophorum angustifolium, Eriophorum vaginatum, Trichophorum caespitosum* and *Empetrum nigrum*, while the most common bryophytes are *Sphagnum capillifolium, Racomitrium lanuginosum* and *Hypnum cupressiforme*. Schouten (*op. cit.*) further sub-divided mountain blanket bog into western and eastern types. The western type is characterised by a low Sphagnum cover, high surface algae cover and the increased presence of species such as *Molinia caerulea, Euphrasia micrantha, Pedicularis sylvatica, Polygala serpyllifolia* and *Carex panicea*. Eastern mountain blanket bog has a high Sphagnum cover, low surface algae cover and contains *Vaccinium oxycoccus* and *Andromeda polifolia*. Areas of mountain blanket bog in the east of the country also tend to be characterised by more extensive development of *Erica-Sphagnum* vegetation.

2.9 The conservation of blanket bogs

2.9.1 Why conserve blanket bogs?

Blanket bogs have been generally viewed as monotonous landscapes of low agricultural value and good for little else apart from the planting of conifers. Recently however there has been an increasing awareness that the habitat is beneficial both to the environment and to people. A number of authors such as Goodwillie (1980) and Lindsay (1995), have outlined a number of reasons for the conservation of bogs, and these can be summarised as follows:

1. It has been estimated that Ireland contains approximately 8% of the world's blanket bog resource (Foss and O'Connell, 1996) and thus Irish blanket bogs constitute a significant part of the global resource of the habitat.

2. Blanket bogs provide the habitat for a number of rare and endangered plant and animal species. Examples of species found within Irish blanket bogs and considered to be rare in an international context include the Marsh Saxifrage (*Saxifrage hirculus*), Shining

Sicklemoss (*Drepanocladus vernicosus*), Bog Orchid (*Hammarbya paludosa*) and the Greenland White-fronted Goose (*Anser albifrons flavirostris*). Oligotrophic lakes within blanket bog areas support populations of the very rare aquatic plant species *Najas flexilis* and *Pilularia globulifera*. Both of these species are considered to be very rare and declining in Europe (Preston and Croft, 1997).

3. As they grow, the plant species of blanket bog assimilate carbon dioxide in order to produce carbohydrate for food. When they die this carbon is accumulated as peat. Due to this subsequent lack of decomposition this dead plant material effectively acts as a carbon sink. If an area of peatland is drained or cutaway the peat is broken down by micro-organisms and carbon dioxide is released. As carbon dioxide is known to be one of the main greenhouse gases, the exploitation of peatlands thus contributes to the problem of global warming.

4. Contrary to public perception, peatlands have played and important role in the economy of Ireland and this is especially the case in the western half of the country. In addition to providing fuel, blanket bogs provide grazing for livestock, especially in areas where good quality, low-lying agricultural grassland is scarce. If this land-use is to be sustainable in the long term however, blanket bog damaged by overgrazing has to be allowed recover and low stocking rates have to be adhered to.

5. Blanket bogs contain an important record of past environments. This information is contained both in archaeological artefacts preserved in the peat and in pollen which has been deposited for the past millennia. The analysis of pollen in peat cores has revealed much important information regarding the ways in which our ancestors lived and interacted with their environment, see Molloy and O' Connell (1995).

6. Blanket bogs contain a number of plants and animals which are of some commercial use, particularly in the fields of medicine, brewing and food production. A noteworthy example of this is the use of Bog Myrtle (*Myrica gale*) in the brewing industry. Furthermore, it is likely that some plants and animals largely confined to peatland habitats contain substances which will, in the future, provide treatments for diseases.

7. Blanket bog areas frequently form the catchment for some of Ireland's most important Salmonid rivers, e.g. the Moy in north Co. Mayo. Any interference with the habitat, e.g. overgrazing and afforestation, can cause increased rates of peat erosion into the rivers and

result in the destruction of spawning grounds of salmon and trout (Whelan, 1996). Furthermore, oligotrophic lakes within blanket bog areas provide habitat for the rare and declining fish species Arctic Charr (Whilde, 1993).

Because of the relatively scarcity of the habitat in a European context, active blanket bog has been listed as a "priority" habitat for conservation in Annex 1 of the Habitats Directive. This implies that member states of the European Union have a responsibility to conserve a very significant and representative sample of sites containing the habitat and to put them forward as part of the E.U.-wide Natura 2000 network. In addition to the conservation value of the blanket bog habitat itself, some of the more extensive blanket bogs sites often contain good examples of the other Annex 1 habitats outlined in Table 6.

Table 6. Annex 1 habitats found within larger expanses of blanket bog.

(1) Oligotrophic waters containing very few minerals of Atlantic sandy plains with Amphibious vegetation: *Lobelia, Littorella* and *Isoetes.*
(2) Dystrophic lakes.
(3) Floating vegetation of *Ranunculus* of plain, sub-mountainous rivers.
(4) Northern Atlantic wet heaths with *Erica tetralix.*
(5) Dry heaths.
(6) Juniper formations.
(7) Transition mires and quaking bogs.
(8) Depressions on peat substrates (*Rhynchosporion*).
(9) Alkaline fens.

In view of the fact that Ireland contains a significant proportion of the world blanket bog resource it is imperative that a significant representation of this habitat should be conserved. In 1987, the government declared that it was committed to acquiring a minimum of 10,000 hectares of active raised bog and 40,000 hectares of active blanket bog for conservation purposes (Treacy, 1990). Assuming that the estimate of the original extent of blanket bog in the Republic of Ireland by Hammond (1979), i.e. 774,990 hectares, is reasonably accurate, then 40,000 hectares equates to the conservation of 5.2% of the original blanket bog area. In 1998 approximately 35,400 hectares, or 88% of the blanket bog conservation target area, had been acquired in the Republic of Ireland (Foss, 1998). Most of this area has been acquired by the National Parks and Wildlife with the aid of E.U.

funding, however a number of important sites have also been acquired due to the efforts of smaller conservation bodies such as the Irish Peatland Conservation Council and the Dutch Society for the Protection of Irish Bogs. Despite the relative success in the acquisition of blanket bog for conservation, this target of 40,000 hectares is considered inadequate to represent the range of variation evident within the habitat. In the following sections areas of blanket bog contained within the various types of protected site throughout the Republic of Ireland are outlined.

2.9.2 Blanket bog within Statutory Nature Reserves

Statutory Nature Reserves are regarded as the most rigorous mechanism in Ireland for the protection of wildlife and their associated habitats (Hickie, 1997). Species and habitats within Nature Reserves are strictly protected under the 1976 Wildlife Act and at present there are 78 Nature Reserves in the country, covering a total area of approximately 18,000 hectares (Stapleton *et al.*, 2000). Thirteen of these Nature Reserves contain a considerable proportion of blanket bog and their area amounts to approximately 11,500 hectares (Table 7). It must be pointed out however that this figure is the total area of the sites and because sites often include other habitats such as oligotrophic lake, wet heath and flush, the area of blanket bog within these Nature Reserves is probably somewhat less than 11,500 hectares. Although most of these areas are protected from obvious damaging operations such as peat-cutting and afforestation, blanket bog areas within some are still subject to damaging operations such as drying-out caused by previous damage and overgrazing by sheep. Most of the Nature Reserves dominated by blanket bog lie within larger Special Areas of Conservation.

Table 7. Statutory Nature Reserves containing blanket bog

Name	County	Bog type	Area (ha)
Bealacooan	Galway	Lowland	198
Cummeragh River Bog	Kerry	Lowland	46
Easkey Bog	Sligo	Highland	1,184
Eirk Bog	Kerry	Lowland	16
Glenealo Valley	Wicklow	Mountain	1,958
Knockmoyle/Sheskin	Mayo	Lowland	1,863
Leam West Bog	Galway	Lowland/Highland	498
Lough Barra Bog	Donegal	Lowland	1,121
Meenachullion	Donegal	Highland	194
Mount Brandon	Kerry	Mountain	462
Owenboy	Mayo	Lowland	596
Pettigo Plateau	Donegal	Lowland/Highland	1,072
Slieve Bloom Mountains	Laois/Offaly	Mountain	2,312
		Total area (ha)	**11,520**

2.9.3 Blanket bog within National Parks

At present there are five National Parks in Ireland namely Killarney, Wicklow, Glenveagh, Connemara and the Burren. In addition to these established National Parks, a substantial area of land at Owenduff in north-west Mayo has been acquired by NPW with a view to forming a National Park in the near future. Although the land within National Parks is effectively protected by virtue of state ownership, only Killarney National Park is legally protected (by the Bourn Vincent Memorial Park Act, 1936 (Hickie, 1997)). It is estimated that these National Parks contain approximately 18,500 hectares of blanket bog (Table 8) with Wicklow, Mayo and Glenveagh containing the largest areas of the habitat. It is thought however that this estimate may be on the low side, particularly in the case of Connemara National Park. The condition of the blanket bog habitat within National Parks is variable ranging from good to very poor. Overgrazing is a particularly serious problem at Owenduff, while burning remains a significant ongoing problem in Wicklow.

Table 8. Blanket bog areas within National Parks (from Hickie 1997 and Foss and O' Connell, 1996).

Name	County	Total area (ha)	Estimated area of blanket bog (ha)
Killarney	Kerry	10,289	567*
Glenveagh	Donegal	16,548	3,675
Wicklow	Wicklow	15,913	5,860
Mayo	Mayo	10,000?	8,952
Connemara	Galway	2,957	400*
		Total	**18,487**
* = Area probably underestimated			

2.9.4 Other blanket bog sites owned by NPW

In addition to blanket bog areas occurring within Nature reserves and National Parks, approximately a further 7,600 hectares of land, in which blanket bog is generally the dominant habitat, is owned by National Parks and Wildlife (Table 9). Although these areas are regularly monitored by wildlife rangers to ensure that serious damage does not take place, there is little active management of these sites.

Table 9. Blanket bogs owned by NPW, outside of Nature Reserves and National Parks.

Name	County	Owner	Area (ha)
Aillenaveagh	Galway	NPW	52
Altnabrocky	Mayo	NPW	750
Arkeen More	Galway	NPW	65
Aughness	Mayo	NPW	174
Bealacooan	Galway	NPW/IPCC	1274
Belderg More	Mayo	NPW	60
Bellacorrick	Mayo	NPW	78
Carrickatimpaun	Donegal	NPW	35
Cartron/Curraun Plateau	Mayo	NPW	245
Clonaslee	Laois	NPW	47
Coolturk	Mayo	NPW	41
Corravokeen	Mayo	NPW	32
Croagh Patrick	Mayo	NPW	362
Crockastroller	Mayo	NPW	1,200
Derrintin	Mayo	NPW	46
Derrygoolin/Woodford Forest	Galway	NPW	50
Durlough/Leamgowra	Donegal	NPW	20
Eirk	Kerry	NPW	16
Fiddandarry	Mayo	NPW	449
Formoyle/Corravokeen	Mayo	NPW	32
Glenamoy	Mayo	NPW	379
Lettershinnagh	Galway	NPW	560
Letterunshin	Sligo	NPW	203
Maumakeogh	Mayo	NPW	235
Powerscourt/Lough Bray	Wicklow	NPW	880
Rushen	Donegal	NPW	121
Sralagagh West	Wicklow	NPW	175
		Total Area (ha)	**7581**

2.9.5 Blanket bog within proposed Special Areas of Conservation

It has been estimated that there are approximately 145,000 hectares of active blanket bog within proposed Special Areas of Conservation which have been selected for the high quality of blanket bog habitat present. This figure is based on conservative estimates of the active blanket bog area made during the compilation of Natura 2000 forms for the sites. Table 10 outlines the area and the dominant type of the blanket bog within these sites. The sites selected are thought to constitute the best examples of the three different types of blanket bog which occur in Ireland, however it is acknowledged that some good quality upland blanket bog sites remain to be surveyed. Although many sites contain only one type of blanket bog, e.g. The Slieve Bloom Mountains, some of the more extensive sites, e.g.

Cloghernagore Bog and Glenveagh National Park, may contain areas of two blanket bog types.

At first glance, the amount of blanket bog within pSACs appears to be high in comparison with the areas surveyed during the blanket bog surveys (c. 100,000 hectares). It must be kept in mind however that the boundaries of many blanket bog sites were expanded during the Natural Heritage Area surveys to include adjoining areas of blanket bog. As mentioned previously, however there are a number of factors which render the estimation of the exact area of active blanket bog problematic. The most significant of these factors are the difficulty in differentiating blanket bog from other closely related habitats such as wet heath and the difficulty in differentiating between eroded, non-active, blanket bog and active blanket bog present within sites. Both of these factors can lead to the overestimation of the area of active blanket bog within a site. Based on observations carried out during fieldwork by Mooney and Goodwillie (1991) it seems likely that the areas of active blanket bog within some upland proposed pSACs, e.g. Galty Mountains, have been overestimated due to erosion.

2.9.6 Blanket bog within proposed Natural Heritage Areas

A large area of blanket bog occurs within proposed Natural Heritage Areas (see Table 11), however the extent of the habitat has not been quantified as yet. Some of these pNHAs are dominated by blanket bog, e.g. Bangor-Erris Bog, while in other pNHAs blanket bog is not the dominant habitat, e.g. Bulbin Mountain. In general, these sites are small in size (mostly less than 300 ha) and they tend to be isolated from the larger intact blanket bog areas. In common with pSACs the quality of the blanket bog habitat within these sites is variable, ranging from poor to good.

Table 10. Special Areas of Conservation selected for active blanket bog.

Site name	pSAC no.	County	Estimated area of active bog (Ha)	Dominant blanket bog types
Arroo Mountain	1403	Leitrim	707	Mountain
Bellacorrick Bog Complex	1922	Mayo	6122	Lowland
Caha Mountains	93	Cork/ Kerry	820	Mountain
Carrowmore Lake Complex	476	Mayo	2225	Lowland
Cloghernagore Bog and Glenveagh National Park	2047	Donegal	18143	Lowland, Highland
Coguish Bog	1938	Donegal	513	Highland
Connemara Bog Complex	2034	Galway	32115	Lowland, Highland
Coolvoy Bog	1107	Donegal	255	Lowland
Croaghonagh Bog	129	Donegal	?	Highland
Cuilcagh-Anierin Uplands	584	Cavan/Leitrim	5652	Mountain
Derryclogher (Knockboy) Bog	1873	Cork	223	Mountain
Dunragh Loughs/Pettigo Plateau	1125	Donegal	1050	Lowland, Highland
Fawnboy Bog/Lough Nacung	140	Donegal	428	Lowland
Galty Mountains	646	Tipperary	835	Mountain
Gannivegil Bog	142	Donegal	1172	Lowland
Glanmore Bog	1879	Kerry	94	Lowland
Glenamoy Bog Complex	500	Mayo	7464	Lowland
Glendree Bog	1912	Clare	238	Highland
Keeper Hill	1513	Tipperary	128	Mountain
Killarney National Park, MacGillycuddys Reeks and Caragh River Catchment	365	Kerry/Cork	2996	Lowland, Mountain
Lough Gall Bog	522	Mayo	198	Lowland
Lough Colagh and Breesy Hill	2164	Donegal	377	Lowland
Lough Hoe Bog	633	Sligo	1222	Mountain, Highland
Lough Nabrickeagh Bog	634	Sligo	239	Highland
Lough Nillan Bog (Carricktalicvc)	165	Donegal	2620	Highland, Mountain
Loughatorick South Bog	308	Clare/Galway	648	Mountain
Magheradrumman Bog	168	Donegal	559	Highland
Maulagowna Bog	1881	Kerry	183	Mountain
Maumturk Mountains	2008	Galway	?	Lowland, Mountain
Meenaguse/Ardbane Bog	172	Donegal	461	Highland
Meentygrannagh Bog	173	Donegal	438	Highland, lowland
Mount Brandon	375	Kerry	2259	Mountain
Mullaganish Bog	1890	Kerry/Cork	67	Mountain
Mweelrea/Erriff/Sheeffry Complex	1932	Mayo	11311	Lowland , Highland
Owendoo and Clogheravaddy Bogs	2046	Donegal	708	Highland
Owenduff/Nephin Complex	534	Mayo	12783	Lowland, Highland
Ox Mountain Bogs	2006	Sligo/Mayo	6170	Lowland, Highland Mountain
Poolagoona Bog	2126	Galway	16	Lowland
Slieve Bloom Mountains	412	Laois and Offaly	3265	Mountain
Slieve Fyagh Bog	542	Mayo	2210	Lowland, Mountain
Slieve League	189	Donegal	567	Lowland, Mountain
Slieve Mish Mountains	2185	Kerry	490	Mountain, Highland
Slieve Tooey/Tormore Island/ Loughros Beg Bay	190	Donegal	3302	Lowland, Mountain
Sonnagh Bog	1913	Galway	343	Highland
Tamur Bog	1992	Donegal	613	Lowland
Twelve Bens/Garraun Complex	2031	Galway	7012	Lowland
West of Ardara/Mass Road	197	Donegal	846	Lowland
Wicklow Mountains	2122	Wicklow/Dublin	8,000	Mountain

Table 11. Proposed Natural Heritage Areas containing significant areas of blanket bog.

Site Name	pNHA no.	County	Grid reference
Altaconey Bog	459	Mayo	F 96 08
Ardagh Bog	1222	Roscommon	M 77 92
Arduns Bog	1088	Donegal	B 86 20
Ballagh Bog	1886	Kerry/Cork	W 08 68
Bangor-Erris Bog	1473	Mayo	F 83 19
Barleart and Lackagh	2032	Leitrim	G 94 35
Benbulbin Plateau/Largy Bog	623	Leitrim/Sligo	M 18 34
Blackrock's Cross Bog	976	Cavan	H 15 23
Bulbin Mountain	120	Donegal	C 35 41
Cape Clear Island	101	Cork	V 96 22
Carlingford Mountain	453	Louth	J 17 13
Carna Heath	1241	Galway	L 79 32
Cashelnaveen Bog	122	Donegal	H 05 88
Clare Island	477	Mayo	L 69 85
Coguish Bog	1938	Donegal	G 65 83
Comeragh Mountains	1952	Waterford	S 25 18
Corraun Plateau	485	Mayo	L 77 96
Croaghaun/Slievemore	1955	Mayo	F 56 06
Croaghonagh Bog	129	Donegal	H 06 89
Cronaguiggy Bog	1176	Donegal	B 82 18
Crowdoo Bog	1878	Donegal	G 65 85
Derreenatra	2105	Cork	V 95 33
Derriscligh Bog	1114	Donegal	C 10 27
Derryfad Bog	1117	Donegal	C 08 27
Doughill Bog	1948	Kerry	V 89 69
Dromlusk	352	Kerry	V 70 81
Drumeasan Bog	1122	Donegal	C 09 30
Durrus Bog	1048	Cork	V 84 40
Eshbrack Bog	1603	Monaghan	H 55 43
Evishbreedy Bog	1127	Donegal	C 44 36
Galwolie Bog	1132	Donegal	B 82 03
Glendrea	1912	Clare	R 51 88
Killaturly Turlough	511	Mayo	M 41 98
Knockroe Bog	366	Kerry	V 61 79
Lough Fad Bog	1159	Donegal	H 04 07
Maumtrasna Mountain Complex	735	Mayo/Galway	L 95 60
Meenybraddan Bog	1177	Donegal	G 80 84
Muckish Mountain	1179	Donegal	B 99 28
Pollatomish Bog	1548	Mayo	F 84 32
Slaheny River	383	Kerry	W 01 66
Tawnymackan Bog	548	Mayo	L 97 77
Tristia Bog	1566	Mayo	F 78 24
Tullaghan Bay	1567	Mayo	F 81 18
Ummerantary Bog	1570	Mayo	G 03 31

CHAPTER 3. PLANT COMMUNITIES OF BLANKET BOG

3.1 Introduction

Areas of blanket bog are often comprised of a complex mosaic of different plant communities. The occurrence, composition and extent of these communities is dependent on various environmental factors such as peat depth, slope, height of watertable, mineral content of flushing water and the influence of damaging operations such as grazing and burning. In the following sections of this report, the composition, structure and associated habitat of these various plant communities are outlined. These accounts are largely based on information contained in the blanket bog survey reports and from other sources in both the published and unpublished literature. In addition to comparing this vegetation with vegetation research carried out in Ireland, the closest equivalent community described in the British National Vegetation Classification (NVC) scheme (Rodwell 1991, 1995) is outlined. These synonymous vegetation types are given at the beginning of the sections.

In the following vegetation descriptions the species lists given are compiled using the species lists of a selection of sites surveyed as part of the blanket bog surveys. In the case of lowland blanket bog vegetation types, the species lists are based on data from 48 sites in counties Mayo and Galway. These include 19 sites from the Connemara region of Co. Galway (Douglas and Grogan, 1987) and 29 sites from western Co. Mayo (Foss and McGee, 1987). The percentage occurrence of species in a particular habitat/vegetation type is show by the Roman numerals opposite the species name as follows:

I = species present in the particular habitat in between 1 and 20% of sites

II = species present in the particular habitat in between 21 and 40% of sites

III = species present in the particular habitat in between 41 and 60% of sites

IV = species present in the particular habitat in between 61 and 80% of sites

V = species present in the particular habitat in between 81 and 100% of sites

3.2 Lowland blanket bog

3.2.1 Ombrotrophic lowland blanket bog

Synonymy

Pleurozio purpureae-Ericetum tetralicis (Braun-Blanquet et Tüxen 1952) Moore 1968

Scirpus caespitosus – Eriophorum vaginatum blanket mire, *Drosera rotundifolia – Sphagnum* sub-community (M17a)

In areas of lowland blanket bog in the west of Ireland, this vegetation is dominant over large areas. Generally the vegetation is dominated by the graminoid species *Molinia caerulea* and *Schoenus nigricans*, with the dwarf ericoid shrubs *Erica tetralix* and *Calluna vulgaris* also frequent. The relative cover of these species in the vegetation is dependent on a complex suite of factors, the most important of which appear to be peat depth, degree of water movement and grazing intensity. Other common vascular plant species in the vegetation include *Potentilla erecta, Carex panicea, Eriophorum angustifolium, Pedicularis sylvatica, Trichophorum caespitosum, Rhynchospora alba, Narthecium ossifragum* and *Polygala serpyllifolia. Eriophorum vaginatum,* a common and conspicuous species of lowland blanket bog in Scotland, is much less prominent in Irish lowland blanket bog. In shallower areas of blanket bog which are transitional to wet heath, plant species such as *Calluna vulgaris, Carex panicea, Hypnum cupressiforme* and *Leucobryum glaucum* are more prominent in the vegetation.

Although the moss cover in lowland blanket bogs is not as well-developed as in the raised bogs of the midlands, species such as *Sphagnum capillifolium, Sphagnum papillosum, Campylopus atrovirens, Racomitrium lanuginosum* and *Hypnum cupressiforme* are common and ground cover of mosses generally exceeds 30%. Occasionally there are areas where well-developed hummocks of *Sphagnum imbricatum* and *S. fuscum* are present, however these are generally rare in blanket bog. In the more undisturbed, waterlogged, deep peat areas there can be well-developed Sphagnum carpets (mostly *S. papillosum, S. magellanicum* and *S. cuspidatum*) accompanied by *Eriophorum angustifolium* and *Rhynchospora alba.* This vegetation is transitional to the Scheuchzerietum palustris. Perhaps one of the most conspicuous species of Atlantic blanket bog is the purple liverwort *Pleurozia purpurea,* which is also one of the character species of the association. Another striking feature of blanket bog is the presence of extensive carpets of mucilaginous algae (*Zygogonium* spp.) in wet areas. These algal carpets perform an important role in the prevention of the desiccation of surface peat during dry periods.

Within areas of well-developed, undisturbed lowland blanket bog, there is usually a microtopographical structure evident in the vegetation. This microtopography can be divided into three main components, i.e. hummocks, ridges (also known as lawns or flats)

and pools (see Figure 5) (Foss and O'Connell, 1996). Each zone is characterised by the dominance of a group of species. Hummocks are generally formed by *Sphagnum capillifolium*, with *Sphagnum imbricatum* and *Sphagnum fuscum* occasionally present. The larger hummocks are often capped by a luxuriant growth of the moss *Racomitrium lanuginosum*. The vegetation forming the hummocks is typically between 30 and 70 cm above the average water table of the bog. Associated vascular plants on Sphagnum hummocks are scarce, however *Molinia caerulea, Calluna vulgaris, Eriophorum angustifolium* and *Drosera rotundifolia* are often present on the sides and tops of hummock. Lawns are the gently sloping or flat areas between hummocks and pools. Here the habitat conditions are much wetter than in the hummocks with the vegetation lying between 5 and 30 cm above the average water table of the bog. In Atlantic lowland blanket bog, lawn areas are in general dominated by blanket bog species such as *Molinia caerulea, Erica tetralix, Schoenus nigricans* and various Sphagnum spp. however there can be a wide variety of vegetation differences within lawn areas due to subtle differences in microtopography. In areas of deep peat there are frequently well-developed Sphagnum lawns dominated by *Sphagnum papillosum* and *S. magellanicum*. In addition there are may be lawn areas dominated by the moss *Campylopus atrovirens*. In the lower, wetter areas of ridges the vegetation is dominated by *Rhynchospora alba* and also supports other species typical of very wet conditions such as *Menyanthes trifoliata, Sphagnum cuspidatum, Drosera anglica* and *Eriophorum angustifolium*. Bare peat and occasionally surface water may be frequent in such areas and in terms of vegetation composition such areas resemble very shallow pools. Pool vegetation is typically sparse and contains a limited number of species, the most frequent of which include *Menyanthes trifoliata, Sphagnum cuspidatum, Sphagnum auriculatum, Drosera anglica, Eriophorum angustifolium* and *Eriocaulon aquaticum*.

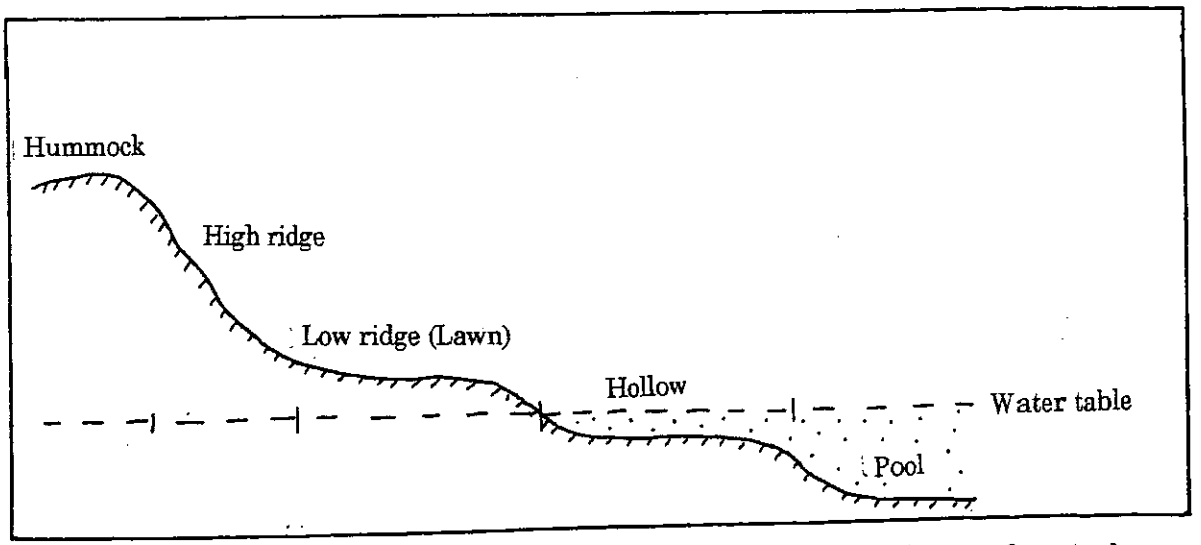


Figure 5. The generalised distribution of surface features on a blanket bog surface (redrawn from Foss and O'Connell, 1996).

The vegetation of Atlantic lowland blanket bog has been studied by a number of authors, with the work of Doyle (1982) the most comprehensive. He identified 5 sub-associations of the Pleurozio purpureae-Ericetum tetralicis from blanket bog areas of Mayo and Galway. These are as follows:

(i) A typical sub-association

(ii) Zygogonietosum – characterised by a well developed cover of mucilaginous algal material

(iii) Juncetosum – a sub-association of flushed or disturbed peats characterised by the increased presence of *Juncus bulbosus, Eleocharis multicaulis* and *Carex panicea*

(iv) Droseretosum – a sub-association of very wet, flushed peats characterised by the presence of *Drosera intermedia, Carex limosa* and *Riccardia pinguis*

(v) Scirpetosum – a sub-association of shallower, drier peat areas characterised by the increased presence and cover of *Scirpus caespitosus.*

Areas of ombrotrophic lowland blanket bog provide the locus for a number of rare plant species. The most common grouping are a number of rare heather species including *Erica mackaiana* (Connemara, Mayo and Donegal), *Erica ciliaris* (Connemara only) and *Erica erigena* (Connemara and Mayo). It must be pointed out however that *E. mackaiana* is largely restricted to relatively well drained areas of blanket bog along lake edges and in areas of blanket bog which are disturbed or partially drained (Van Doorslaer, 1990). *Erica erigena* also displays a preference for better drained areas of blanket bog close to lake edges and may also be found growing in flush vegetation dominated by *Schoenus nigricans* which is closely associated with blanket bog (Foss, 1986). A small number of lowland blanket bog sites contain *Vaccinium oxycoccus,* a species which is relatively abundant in raised bogs, and the blanket bog surveys have significantly increased the known distribution of this species. Lowland blanket bogs also contain a number of nationally rare Sphagnum species including *Sphagnum recurvum* var. *tenue, Sphagnum pulchrum, Sphagnum strictum* and *S. subsecundum.*

Because of its rarity on a world-wide and European scale, active blanket bog is listed as a 'priority' Habitat in Annex 1 of the European Union Habitats Directive (Ramão, 1996) and thus the habitat is of high conservation value.

Table 12. List of vascular plant, moss and liverwort species recorded from ombrotrophic lowland blanket bog (Terrestrial zones only). Species list taken from blanket bog survey reports.

Vascular plants	**Constancy**		**Constancy**
Calluna vulgaris	V	*Cladonia uncialis*	V
Carex echinata	V	*Hypnum cupressiforme*	V
Carex panicea	V	*Odontoschisma sphagni*	V
Drosera anglica	V	*Pleurozia purpurea*	V
Drosera intermedia	V	*Racomitrium lanuginosum*	V
Drosera rotundifolia	V	*Sphagnum auriculatum*	V
Erica tetralix	V	*Sphagnum capillifolium*	V
Eriophorum angustifolium	V	*Sphagnum cuspidatum*	V
Eriophorum vaginatum	V	*Sphagnum magellanicum*	V
Molinia caerulea	V	*Sphagnum papillosum*	V
Myrica gale	V	*Sphagnum subnitens*	V
Narthecium ossifragum	V	*Sphagnum tenellum*	V
Pedicularis sylvatica	V	*Campylopus brevipilus*	IV
Polygala serpyllifolia	V	*Kurzia pauciflora*	IV
Potentilla erecta	V	*Sphagnum imbricatum*	IV
Rhynchospora alba	V	*Aulocomium palustre*	III
Schoenus nigricans	V	*Breutelia chrysocoma*	III
Trichophorum caespitosum	V	*Campylopus introflexus*	III
Dactylorhiza maculata	IV	*Cephalozia connivens*	III
Eleocharis multicaulis	IV	*Cladopodiella fluitans*	III
Juncus bulbosus	IV	*Hylocomium splendens*	III
Pinguicula vulgaris	IV	*Sphagnum palustre*	III
Succisa pratensis	III	*Calypogeia fissa*	II
Pinguicula lusitanica	II	*Diplophyllum albicans*	II
Erica mackaiana	I	*Mylia anomala*	II
Huperzia selago	I	*Sphagnum compactum*	II
Rhynchospora fusca	I	*Sphagnum fuscum*	II
Vaccinium oxycoccus	I	*Thuidium tamariscinum*	II
		Pseudoscleropodium purum	I
Mosses, Liverworts and Lichens		*Sphagnum pulchrum*	I
Campylopus atrovirens	V	*Sphagnum strictum*	I
Cladonia ciliata	V	*Sphagnum subsecundum*	I
Cladonia portentosa	V	*Sphagnum molle*	I

3.2.2 Pools

Synonymy

Sphagno tenelli-Rhynchosporetum albae Dierssen 1982

Sphagnum cuspidatum /recurvum bog pool (M2)

Pool systems are a common feature of blanket bogs and are particularly associated with areas of deep, quaking peat. Pools can be divided into two main types, namely large, deep, steep-sided pools with little colonising vegetation (subsequently referred to as deep pools) and smaller, shallower pools which often have a high proportion of their surface colonised by Sphagnum (subsequently referred to as shallow pools).

Deep pools are particularly well developed in the extensive blanket bog areas of North Mayo, but such features also occur in parts of Co. Galway, e.g. Bealacooan bog, to the north of Inverin. Typically, individual pools are elongate in shape and measure 1 to 5 metres wide by 3 to 15 metres long. Occasionally the pools can take the form of small peat-bottomed dystrophic lakes covering areas of 0.5 of a hectare or more. One of the most characteristic features of these pools is that the pool edge is steep, thus leading to an abrupt transition between the surrounding intact bog surface and open water. Water depth is also substantial in blanket bog pools and can often exceed 2 metres. The vegetation of deep pools is typically sparse (Table 13), owing to the inherent difficulties in the colonisation of large exposed areas of open water which are prone to wave action. Occasionally the pool surface may be colonised by small quaking *Sphagnum* rafts which grow from the sheltered pool edge. These rafts are generally dominated by *Sphagnum cuspidatum* and *S. auriculatum* var. *auriculatum* and they provide a surface on which vascular plants can become established and grow. Vascular plant species have a relatively low cover, however *Eriophorum angustifolium, Drosera intermedia, Eriocaulon aquaticum, Menyanthes trifoliata* and *Molinia caerulea* are frequently encountered both along the pool margins, where they are rooted in soft peat, or in *Sphagnum* rafts. Occasionally *Vaccinium oxycoccus*, a very rare species in Atlantic blanket bogs, can be found growing on *Sphagnum* rafts along the edges of these pools.

A feature of some of the larger bog pool systems in Co. Mayo is that they often contain small, undisturbed islands which support dwarf shrub communities markedly different in terms of species composition to that of the surrounding blanket bog. Typically the vegetation of such islands is dominated by the tall woody shoots of *Calluna vulgaris* with *Molinia caerulea* and *Cladonia portentosa* also frequent and conspicuous. In addition, pool islands support a range of plant species rare in surrounding areas of ombrotrophic blanket peat. These include low-growing woody species such as *Juniperus communis* and *Empetrum nigrum*, herbs such as *Succisa pratensis* and *Holcus lanatus* and a wide range of bryophytes such as *Pleurozium schreberi, Dicranum scoparium, Frullania tamarisci, Hylocomium splendens* and *Aulacomium palustre* (Doyle *et al.*, 1987). The factors responsible for the restriction of this large number of plant species to pool islands are complex, however the better drainage of the peat soils and the prolonged absence of grazing and fire are thought to be among the most important (Doyle *et al., op. cit.*).

Shallow pools are more widely distributed throughout areas of lowland blanket bog. This pool type is characterised by a gently sloping edge, a shallow depth of standing water and a greater degree of colonisation by *Sphagnum* moss and vascular plant species, in comparison with the deep pools. Along the margins of these pools there is frequently a zonation of

Sphagnum species evident. The shallow pools are generally smaller in size and rarely exceed $10m^2$ in area. Frequently, the depth of standing water in these pools does not exceed 20cm, a factor which facilitates a higher degree of plant colonisation. It must also be noted however that vegetation cover in such shallow pools can often be low due to frequent episodes of wetting and drying out. During dry periods in which surface water is absent, the bed of such pools is frequently carpeted by a thick algal mat which forms a protective skin and effectively retards the dessication process. In places, a number of shallow, elongate pools may be interconnected and the ground between them may be dominated by hummock-forming species of *Sphagnum* such as *Sphagnum imbricatum* and *S. fuscum*, however the formation of extensive pool/hummock complexes is more commonly a feature of midland raised bogs. Although there are differences in the extent of vegetation colonising pools, there do not appear to be any major differences in the species composition of shallow bog pools and deep bog pools.

Table 13. List of vascular plant, moss and liverwort species recorded from, and largely confined to pools in ombrotrophic lowland blanket bog (Aquatic zones only). Species list taken from blanket bog survey reports.

Vascular plants	**Constancy**
Drosera anglica	V
Eriophorum angustifolium	V
Menyanthes trifoliata	V
Potamogeton polygonifolius	V
Rhynchospora alba	V
Drosera intermedia	IV
Eleocharis multicaulis	IV
Juncus bulbosus	IV
Utricularia intermedia	IV
Carex rostrata	III
Eriocaulon aquaticum	II
Nymphaea alba	II
Utricularia minor	II
Eleogiton fluitans	I
Rhynchospora fusca	I
Mosses and Liverworts	
Sphagnum auriculatum var. *auriculatum*	V
Sphagnum cuspidatum	V
Cladopodiella fluitans	III

Blanket bog pools form an intrinsic component of the 'priority' Annex 1 habitat active blanket bog. Some of the larger pools may be classified as dystrophic lakes which is a habitat (non-priority) listed in Annex 1 of the Habitats Directive (Ramão, 1996).

3.2.3 Oligotrophic lakes

Large oligotrophic water-bodies are a common feature of blanket bog areas and such lakes are particularly common and well-developed in the blanket bogs of Connemara, Co. Galway. These lakes are generally greater than 2 hectares in size, generally have rock outcropping along the shores and often have a firm, stony lake shore. Oligotrophic lakes within blanket bog areas contain a variety of species-poor vegetation types which add to the floristic diversity of a blanket bog site. Floating vegetation in open water areas of these lakes, if present, typically consists of *Nymphaea alba* and/or *Potamogeton natans*. The main emergent species growing in the deep water is typically *Schoenoplectus lacustris*, which is often accompanied by scattered shoots of *Equisetum fluviatile*. Close to the lake shore the vegetation is more varied and there may be extensive areas of species-poor swamp dominated by pure stands or various mixtures *Cladium mariscus, Phragmites australis, Equisetum fluviatile, Carex lasiocarpa* and *Carex rostrata*. In shallow, sheltered bays this vegetation may form a relatively extensive quaking raft which can in places reach widths in excess of 30 metres. The low-growing vegetation of lakeshore is generally dominated by low-growing species such as *Littorella uniflora, Lobelia dortmanna, Ranunculus flammula, Eriophorum angustifolium, Hypericum elodes, Juncus articulatus* and *Eriocaulon aquaticum*. These species frequently dominate in the understorey of the taller swamp species such as *Phragmites australis* and *Cladium mariscus*. The protected plant species *Deschampsia setacea* and *Eriophorum gracile* grow along the shores of oligotrophic blanket bog lakes in the Connemara region of Co. Galway and the relatively uncommon vascular species *Rhynchospora fusca* is also commonly encountered along lake edges in the region. The following table outlines the composition and constancy of plant species in lowland oligotrophic lakes. It must be noted however that the species lists from lakes were generally not exhaustive and thus the occurrence of emergent and aquatic species such as *Schoenoplectus lacustris* and *Potamogeton natans* may be underestimated.

The area occupied by oligotrophic lakes within the surveyed blanket bog sites is easily assessed by the examination of aerial photographs. For the purposes of the this study, the abundance of the habitat within a site was rated on a four point scale as follows:

None – Lakes absent from site.

Low - Lakes covering less than 5% of the site area.

Moderate - Lakes covering between 5 and 25% of the site area.

High - Lakes covering more than 25% of the site area.

Table 14. List of vascular plant, moss and liverwort species and their constancy recorded from, the margins of larger oligotrophic lakes in ombrotrophic lowland blanket bog. Species list taken from blanket bog survey reports.

Vascular plants	**Constancy**		**Constancy**
Drosera anglica	V	*Potentilla palustris*	II
Eriophorum angustifolium	V	*Utricularia minor*	II
Menyanthes trifoliata	V	*Deschampsia setacea*	I
Molinia caerulea	V	*Eleogiton fluitans*	I
Potamogeton polygonifolius	V	*Eriophorum gracile*	I
Eleocharis multicaulis	IV	*Isoetes lacustris*	I
Juncus bulbosus	IV	*Littorella uniflora*	I
Ranunculus flammula	IV	*Lobelia dortmanna*	I
Utricularia intermedia	IV	*Potamogeton natans*	I
Carex rostrata	III	*Rhynchospora fusca*	I
Phragmites australis	III	*Salix cinerea* subsp. *oleofolia*	I
Carex lasiocarpa	II	*Schoenoplectus lacustris*	I
Cladium mariscus	II	*Sparganium emersum*	I
Equisetum fluviatile	II		
Eriocaulon aquaticum	II	**Mosses**	
Hypericum elodes	II	*Sphagnum auriculatum* var. *auric.*	V
Nymphaea alba	II	*Sphagnum cuspidatum*	V

One of the most striking aspects of the results illustrated in the following figure is the complete absence of lake systems from lowland blanket bog sites in Co. Kerry. In the case of some sites however this appears to be an artefact of the survey strategy because oligotrophic lakes bordering bog areas were often excluded from the survey area. Lowland blanket bog sites in County Galway sites clearly contain the best-developed areas of oligotrophic lakes (i.e. 32% of sites in the high category) with a relatively large number of Co. Donegal sites (15%) also showing a high rating for oligotrophic lakes. Sites in Co. Mayo on the other hand contain relatively small areas of oligotrophic lake and this is undoubtedly due to the past patterns of glaciation in the area. It appears oligotrophic lakes is positively associated with areas of granite bedrock and this is supported by the large numbers of such lakes in Connemara, Co. Galway and west Donegal.

Blanket bog sites that contain good examples of oligotrophic lakes include Munga, Bealacooan and Lettershinna in Co. Galway and Cloghernagore, Meenagrillagh and Oughtcarn in County Donegal.

Lowland oligotrophic lakes containing *Lobelia dortmanna, Littorella uniflora* and *Isoetes lacustris* are listed in Annex 1 of the E.U. Habitats Directive (Ramão, 1996) and are thus of high conservation value.

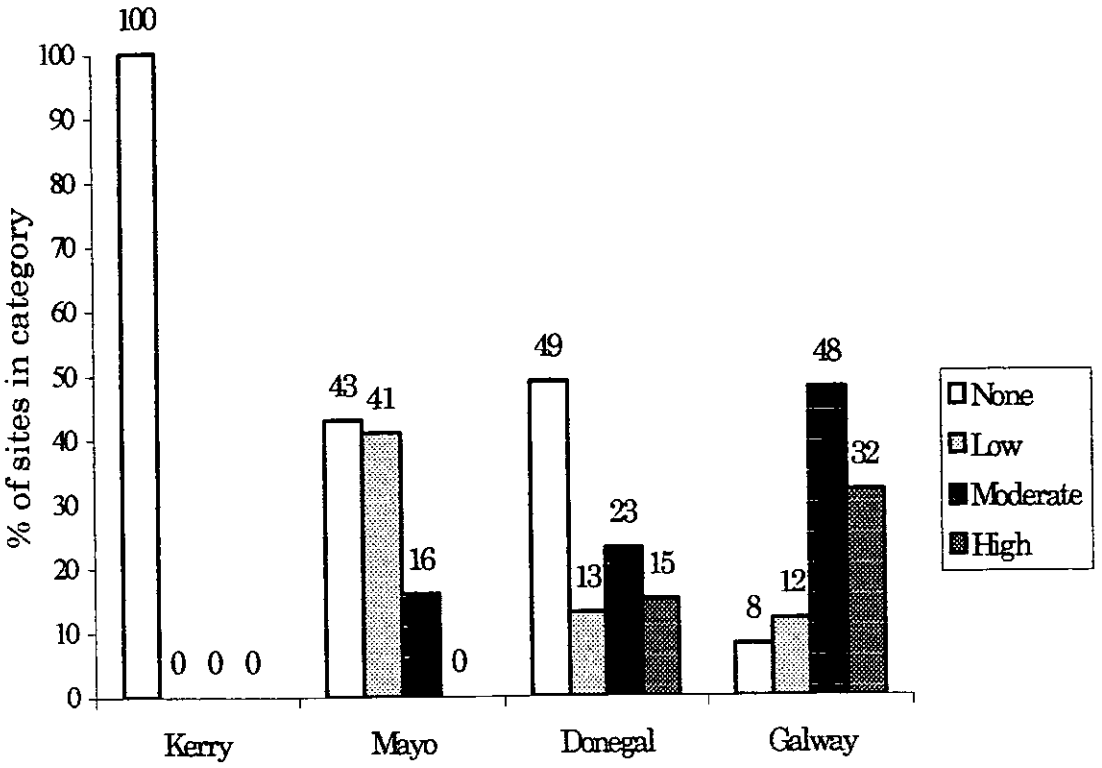


Figure 6. The abundance of oligotrophic lakes throughout lowland blanket bog sites surveyed in counties Kerry, Mayo, Donegal and Galway

3.2.4 Swallow-holes and drainage channels

Synonymy

Calluno-Ericetum cinereae Lemée 1938

Calluna vulgaris – Erica cinerea Heath (H10)

Within extensive areas of lowland blanket bogs there are occasional areas where the peat has subsided, due to subterranean drainage, to form swallow-holes or linear drainage channels. These swallow-holes generally indicate the entrances to subterranean drains within blanket bogs. Swallow-holes can be up to 3 metres in depth and the side-walls are often steep. The cracking and subsequent subsidence of peat leads to its oxidation and the better-drained nature of the substrate is reflected in the vegetation, which is dominated by plant species typical of less waterlogged conditions. Although swallow-hole features have been recorded from most counties, the habitat has been most frequently noted in Co. Mayo where many of the best examples occur. Blanket bog sites that contain good examples of swallow-holes include Srahlahy, Derry Upper and Derrinkee in Co. Mayo.

Calluna vulgaris is invariably the dominant species in the vegetation, sometimes forming extensive monodominant carpets, however the well-drained nature of the substrate leads to

the presence of species which are otherwise uncommon in areas of blanket bog. *Calluna* is generally accompanied by a limited range of herb species including *Trichophorum caespitosum*, *Juncus effusus*, *Holcus lanatus* and *Anthoxanthum odoratum*. In Connemara and south Mayo the attractive, large-flowered heather, *Daboecia cantabrica*, is a frequent component of this vegetation. Species of fern such as *Dryopteris dilatata*, *Pteridium aquilinum* and *Osmunda regalis* thrive in the well-drained conditions, as do woody climbers such as *Rubus fruticosus* and *Lonicera periclymenum*. In some instances there may be limited scrub development which may include *Betula pubescens*, *Salix aurita*, *Sorbus aucuparia*, *Quercus petraea* and *Ilex aquifolium*, however these trees rarely exceed a couple of metres in height due to grazing and/or severe wind-pruning. The moss component of the habitat is rather species-poor with species typical of relatively well-drained conditions dominating. The most prominent species is usually *Hypnum cupressiforme* however *Thuidium tamariscinum*, *Hylocomium splendens*, *Pleurozium schreberi* and *Plagiothecium undulatum* are also frequently encountered.

Table 15. List of vascular plant, moss and liverwort species recorded from swallow-holes and drainage channels within lowland blanket bog. Species list taken from blanket bog survey reports.

Vascular plants	**Constancy**		**Constancy**
Calluna vulgaris	V	*Hypericum pulchrum*	I
Carex panicea	V	*Ilex aquifolium*	I
Molinia caerulea	V	*Lonicera periclymenum*	I
Myrica gale	V	*Polypodium vulgare*	I
Potentilla erecta	V	*Quercus petraea*	I
Trichophorum caespitosum	V	*Salix cinerea* subsp. *oleifolia*	I
Anthoxanthum odoratum	IV	*Sorbus aucuparia*	I
Erica cinerea	IV		
Juncus effusus	IV	**Mosses and Liverworts**	
Agrostis canina	III	*Hypnum cupressiforme*	V
Blechnum spicant	III	*Sphagnum capillifolium*	V
Holcus lanatus	III	*Sphagnum cuspidatum*	V
Succisa pratensis	III	*Pleurozium schreberi*	IV
Athyrium filix-femina	II	*Sphagnum recurvum* var. *mucronatum*	IV
Dryopteris dilatata	II	*Hylocomium splendens*	III
Luzula multiflora	II	*Sphagnum palustre*	III
Osmunda regalis	II	*Rhytidiadelphus loreus*	II
Pteridium aquilinum	II	*Rhytidiadelphus squarrosus*	II
Rubus fruticosus	II	*Thuidium tamariscinum*	II
Betula pubescens	I	*Plagiothecium undulatum*	II
Crataegus monogyna	I	*Mnium hornum*	I
Digitalis purpurea	I	*Pseudoscleropodium purum*	I
Dryopteris carthusiana	I		

3.2.5 Lowland heath

Many areas of lowland blanket bog contain areas where peat depth is relatively shallow, i.e. <1 metre deep. Such areas are referred to as heath and in Ireland the habitat can be divided into two main categories, namely wet heath and dry heath. Wet heath tends to occur on damp acid soils where the peat depth is between 30 and 100cm while dry heath is largely restricted to better-drained peat soils less than 30 cm in depth. The main floristic differences between the two types of heath is the dominance of *Erica tetralix, Trichophorum caespitosum,* and *Molinia caerulea* in wet heaths while *Calluna vulgaris* and *Erica cinerea* are typically the most conspicuous species of dry heath. It must be pointed out however that the separation between these two types of heath is not always well-defined and there can be a degree of ecological and floristic overlap. Table 16 outlines the main differences between wet and dry heath. Due to the fact that the blanket bog surveys were primarily directed towards the description of blanket bog vegetation, there are only occasional descriptions of wet and dry heath vegetation in the reports. Most of the information in the following sections was obtained from other published and unpublished sources.

Table 16. The main differences between wet and dry heath in Ireland.

	Wet heath	**Dry heath**
Peat depth	Generally between 30 and 100cm.	Generally less than 30cm.
Dominant/characteristic plant species	*Molinia caerulea, Erica tetralix, Calluna vulgaris, Narthecium ossifragum, Myrica gale, Trichophorum caespitosum*	*Calluna vulgaris, Ulex* spp., *Erica cinerea, Carex binervis, Agrostis* spp., *Hypnum cupressiforme.*
Distribution	Most frequent in the west and south	Most frequent in the north and east

3.2.5.1 Wet heath

Synonymy

Narthecio-Ericetum tetralicis Moore (1964) 1968

Scirpus caespitosus-Erica tetralix wet heath (M15)

Apart from the descriptions provided by Moore (1968) there have been few published descriptions of wet heath vegetation in Ireland. Although Moore's description of the Narthecio-Ericetum tetralicis was based mainly on relevés taken from Scotland it is clear

from vegetation descriptions given in blanket bog reports that similar vegetation is widespread throughout western Ireland. Throughout blanket bog areas, wet heath typically occurs on sloping ground where there is some, albeit slow, lateral movement of water. Moore (*op. cit.*) mentions that the community is most frequently associated with shallow peats on sloping ground or on cutaway blanket bog that has been abandoned. The vegetation of wet heath is characterised by the prominence of *Erica tetralix, Trichophorum caespitosum* and *Molinia caerulea,* accompanied by abundant *Calluna vulgaris, Sphagnum papillosum, Eriophorum angustifolium, Narthecium ossifragum, Hypnum cupressiforme, Potentilla erecta* and *Carex panicea.* The main floristic difference between this vegetation and that of the closely related Pleurozio purpureae – Ericetum tetralicis, which occurs on deeper peats, is the abundance of *Schoenus nigricans, Pleurozia purpurea, Racomitrium lanuginosum* and *Campylopus atrovirens* in the latter. More recent research carried out in the Killarney region of Co. Kerry (Mhic Daeid, 1976) and the Connemara region of Co. Galway (Bleasdale, 1995) has revealed the presence of wet heath vegetation with a similar floristic composition to that described by Moore (1968). A recent vegetation survey carried out in areas of blanket bog to the west of Galway City has revealed the presence of wet heath vegetation dominated by *Trichophorum caespitosum, Erica tetralix* and *Calluna vulgaris,* accompanied by moss species such as *Sphagnum tenellum* and *Leucobryum glaucum* (Conaghan,2000).

Wet heaths with *Erica tetralix* have been listed in Annex 1 of the E.U. Habitats Directive (Ramão, 1996) and thus is habitat is of high conservation value.

3.2.5.2 Dry heath

Synonymy (*Calluna vulgaris*-dominated heath)

Calluno-Ericetum cinereae Lemée 1938

Calluna vulgaris – Erica cinerea Heath (H10)

Synonymy (*Ulex gallii*-dominated heath)

Ulici-Ericetum cinereae Bridgewater 1970

Calluna vulgaris-Ulex gallii Heath (H8)

Although extensive areas of lowland dry heath vegetation are generally not found in association with lowland blanket bog in the west of Ireland, small areas of such vegetation can often be found in rocky or cutaway areas adjacent to blanket bog or wet heath. Dry heath vegetation dominated by *Calluna vulgaris* can become particularly dominant in areas of blanket bog which have are influenced by drainage such as areas of cutaway and swallow-holes. Although further research is still required to clarify the range and extent of dry heath vegetation in Ireland, two main types have been recognised as being present in

lowland regions of the west of Ireland. These two main types are, vegetation dominated by *Calluna vulgaris* and vegetation dominated by *Ulex gallii* and *Erica cinerea* (White and Doyle, 1982).

Throughout Ireland dry heath vegetation dominated by *Calluna vulgaris* is widespread, particularly in upland areas. Although the degree of species-richness varies considerably depending on the dominance of *Calluna vulgaris*, the species is generally accompanied by *Erica cinerea, Carex binervis, Potentilla erecta, Galium saxatile, Anthoxanthum odoratum, Danthonia decumbens, Agrostis* spp., and *Deschampsia flexuosa* (McKee, 2000). Mosses are relatively frequent with *Hypnum cupressiforme, Rhytidiadelphus squarrosus, Hylocomium splendens* and *Pleurozium schreberi* locally common.

In the southern half of the country, dry heath vegetation characterised by a dominance of *Ulex gallii* and *Erica cinerea* is more typically encountered at low altitudes within blanket bog regions. Associated species are generally similar to those previously listed for dry heath dominated by *Calluna vulgaris*. In the Connemara region and south-west Mayo the spectacular, and nationally rather rare, heather species *Daboecia cantabrica* is a conspicuous feature of the vegetation (Conaghan, 1989).

European dry heaths have been listed in Annex 1 of the E.U. Habitats Directive (Ramão, 1996) and thus is habitat is of high conservation value.

3.2.6 Blanket bog flushes

Within blanket bog there occasionally occur areas that are influenced by high rates of lateral water movement within the surface layers of peat. Such areas are known as blanket bog flushes. In sloping areas blanket bog flushes are often confined to narrow channels generally not more than a couple of metres in width, however in flatter areas the surface water can fan out to form more extensive flushed areas. Often the vegetation of such areas forms an unstable floating raft above a soft, watery peat. As a result of water movement within surface peats, the flush habitat is better aerated and more nutrient-rich than the surrounding ombrotrophic bog. If flushing water comes into contact with base-rich bedrock or glacial till underlying the peat the water will have a much higher pH, electrical conductivity and ionic content than the water associated with flushes in areas with a base-poor geology. Typically the surface water of blanket bog flushes has a pH that ranges between 5.0 and 7.5 and dissolved calcium levels ranging between 5 and 50 mg/l (Lockhart, 1991). These levels are high in comparison with the surface waters of ombrotrophic blanket bog which typically have a pH of between 3.5 and 4.5 and dissolved calcium values of less than 3 mg/l (O' Connor, 2000). The main factors influencing the composition of flush

vegetation are the rate and volume of water flow, the height of the watertable and degree of base-enrichment of the flushing water.

Because of the different hydrological regime present, the vegetation of flushes is dominated by plant species intolerant of the strongly acid and anaerobic conditions present in the surrounding ombrotrophic bog. In areas of lowland blanket bog, the first indications of lateral water movement may be indicated by the increased presence and vigour of species-poor mixtures of *Molinia caerulea, Myrica gale* and *Schoenus nigricans*. In more well-defined flush areas, tall-growing members of the Cyperaceae and Gramineae, such as *Schoenus nigricans, Phragmites australis, Cladium mariscus* and *Carex lasiocarpa* are generally the dominant species. When *Phragmites australis* and *Cladium mariscus* occur in flushes, frequently their cover can be sufficiently high to result in the exclusion of practically all other plant species. In addition to the dominant species, vascular species such as *Carex rostrata, Carex limosa, Carex panicea, Eriophorum angustifolium, Juncus subnodulosus* and *Molinia caerulea* are common and may even attain dominance locally. Among the most frequently encountered low-growing vascular plant species of blanket bog flushes are *Menyanthes trifoliata, Potamogeton polygonifolius, Eleocharis multicaulis, Juncus bulbosus, Pinguicula vulgaris, Carex demissa* and *Anagallis tenella*, while diminutive species such as *Pinguicula lusitanica, Selaginella selaginoides* and *Linum catharticum* are frequently found growing at the bases of *Schoenus* tussocks. In a number of sites in Co. Mayo low (i.e. < 2m), scattered individuals of *Betula pubescens* are a prominent feature of blanket bog flushes (Cross, 1987, Lockhart 1991), however the occurrence of tree species in flushes is uncommon. Due to the fact that base-rich outcrops are generally rare within areas of highland/mountain blanket bog the vascular component of flushed upland areas is typically dominated by the acidophilous species *Juncus effusus* and/or *Juncus acutiflorus*, while *Sphagnum recurvum, S. palustre* and *S. auriculatum* are the dominant mosses.

The bryophyte component of flushes is often poorly developed and is frequently absent, especially under conditions of strong water flow and vigorous growth of tall vascular species. In flushes influenced by relatively base-poor water *Sphagnum auriculatum* and *Calliergon cuspidatum* may be the only species present, however in flushes influenced by more base-rich water a large number of "brown moss" species may be present. The most frequent and conspicuous of these include *Drepanocladus revolvens, Scorpidium scorpioides, Campylium stellatum, Fissidens adianthoides, Bryum pseudotriquetrum* and *Philonotis fontana*. Table 17 lists the vascular plant, moss and liverwort species recorded from flushed areas within lowland blanket bog sites in the west of Ireland, during the blanket bog surveys.

In addition to supporting a greater diversity of plant species than surrounding areas of ombrotrophic blanket bog, flushes provide the locus for a relatively large number of nationally rare vascular plant, moss and liverwort species. Base-rich blanket bog flushes near Bellacorrick in Co. Mayo are especially significant in this respect. Protected vascular plants such as *Hammarbya paludosa* and *Saxifraga hirculus* have recently been recorded from blanket bog flushes in Co. Mayo (Lockhart 1989a, 1991), while *Eriophorum gracile* has been recorded from blanket bog flushes in Co. Galway (Conaghan, 1995). In addition to rare vascular plants, a number of very rare moss and liverwort species have been recorded from flush habitats, especially in Co. Mayo. These include *Paludella squarrosa* (Lockhart, 1999), *Sphagnum warnstorfii* and *Leiocolea rutheana* (Lockhart, 1991), *Tomenthypnum nitens* (Lockhart 1987, 1988) and *Sphagnum subsecundum* (Douglas and Grogan, 1988). The composition and phytosociology of blanket bog flushes has been studied by a number of authors with the most thorough study being that of Lockhart (1991) who studied the vegetation and hydrochemistry of a large number of lowland blanket bog flushes in Counties Mayo and Galway. Table 18 outlines the different flush communities recorded during his survey. In addition, the vegetation of blanket bog flushes has been described as part of more wide-ranging studies of blanket bog ecology or regional vegetation, e.g. Mhic Daeid (1976), Weekes (1990), Doyle (1990), Bleasdale and Conaghan (1995) and Conaghan (1995).

Table 17. List of vascular plant, moss and liverwort species recorded from flushed areas within lowland blanket bog. Species list taken from blanket bog survey reports.

Vascular plants	**Constancy**	**Vascular plants**	**Constancy**
Carex limosa	V	*Carex hostiana*	I
Carex panicea	V	*Carex lepidocarpa*	I
Drosera anglica	V	*Carex pulicaris*	I
Drosera intermedia	V	*Eleogiton fluitans*	I
Erica tetralix	V	*Equisetum palustre*	I
Eriophorum angustifolium	V	*Erica erigena*	I
Menyanthes trifoliata	V	*Eriophorum gracile*	I
Molinia caerulea	V	*Eriophorum latifolium*	I
Myrica gale	V	*Euphrasia* spp.	I
Rhynchospora alba	V	*Galium palustre*	I
Schoenus nigricans	V	*Glyceria fluitans*	I
Carex echinata	IV	*Juncus conglomeratus*	I
Eleocharis multicaulis	IV	*Juncus subnodulosus*	I
Juncus bulbosus	IV	*Linum catharticum*	I
Juncus effusus	IV	*Lychnis flos-cuculi*	I
Pinguicula vulgaris	IV	*Myosostis laxa*	I
Potamogeton polygonifolius	IV	*Pedicularis palustris*	I
Ranunculus flammula	IV	*Saxifraga hirculus*	I
Anagallis tenella	III	*Selaginella selaginoides*	I
Carex nigra	III	*Senecio aquaticus*	I
Carex rostrata	III	*Sparganium emersum*	I
Juncus articulatus	III	*Vaccinium oxycoccus*	I
Phragmites australis	III	*Valeriana officinalis*	I
Utricularia intermedia	III		
Viola palustris	III	**Mosses and Liverworts**	
Cardamine pratensis	II	*Sphagnum subnitens*	V
Carex demissa	II	*Sphagnum auriculatum* var. *auric.*	V
Carex lasiocarpa	II	*Aulacomium palustre*	IV
Carex paniculata	II	*Sphagnum recurvum* var. *mucronatum*	IV
Cirsium dissectum	II	*Polytrichum commune*	III
Cladium mariscus	II	*Aneura pinguis*	II
Epilobium obscurum	II	*Pellia epipylla*	II
Equisetum fluviatile	II	*Sphagnum auriculatum* var. *inund.*	II
Hydrocotyle vulgaris	II	*Bryum pseudotriquetrum*	I
Hypericum elodes	II	*Calliergon cuspidatum*	I
Melampyrum pratense	II	*Calliergon stramineum*	I
Pinguicula lusitanica	II	*Campylium stellatum*	I
Potentilla palustris	II	*Ctenidium molluscum*	I
Rhynchospora fusca	II	*Drepanocladus fluitans*	I
Rumex acetosa	II	*Drepanocladus revolvens*	I
Triglochin palustris	II	*Tomenthypnum nitens*	I
Angelica sylvestris	I	*Philonotis fontana*	I
Betula pubescens	I	*Scorpidium scorpioides*	I
Caltha palustris	I	*Sphagnum recurvum* var. *tenue*	I
Carex dioica	I		

Table 18. An outline of lowland blanket bog flush communities recorded from Galway and Mayo, the dominant/characteristic species of the vegetation and the equivalent community outlined in the British National Vegetation Classification scheme. Information from Lockhart (1991).

Community	Dominant/characteristic species	NVC equivalent
Caricetum lasiocarpae	*Carex lasiocarpa, Menyanthes trifoliata*	*Carex lasiocarpa* community not recognised
Caricetum limosae	*Carex limosa*	*Carex limosa* community not recognised
Caricetum paniculatae	*Carex paniculata*	*Carex paniculata* sedge-swamp (S3)
Cladietum mariscii	*Cladium mariscus*	*Cladium mariscus* swamp and sedge-beds (S2)
Drosera intermedia community	*Drosera intermedia*	*Drosera intermedia* community not recognised
Eleocharetum multicaulis	*Eleocharis multicaulis, Hypericum elodes, Potamogeton polygonifolius*	*Hypericum elodes – Potamogeton polygonifolius* soakway (M29)
Hammarbya paludosa community	*Hammarbya paludosa*	*Hammarbya paludosa* community not recognised
Juncetum subnodulosi	*Juncus subnodulosus, Molinia caerulea, Schoenus nigricans, Scorpidium scorpioides*	*Schoenus nigricans – Juncus subnodulosus mire* (M13) *pro parte*
Molinia caerulea community	*Molinia caerulea*	*Molinia caerulea – Potentilla erecta* mire, *Erica tetralix* sub-community (M25)
Montia fontana community	*Montia fontana*	*Ranunculus flammula - Montia fontana* rill (M35) pro-parte
Phragmites australis reedbeds	*Phragmites australis*	*Phragmites australis* swamp (S4)
Saxifraga hirculus community	*Saxifraga hirculus*	*Saxifraga hirculus* community not recognised
Schoenetum nigricantis	*Schoenus nigricans, Molinia caerulea, Myrica gale, Eriophorum angustifolium, Erica tetralix, Campylium stellatum.*	*Schoenus nigricans – Narthecium ossifragum* mire (M14)
Sphagneto-Juncetum effusi	*Juncus effusus, Carex nigra, Sphagnum recurvum, Sphagnum palustre*	*Carex echinata – Sphagnum recurvum/auriculatum* mire (M6)
Sphagno tenelli-Rhynchosporetum albae	*Rhynchospora alba*	*Sphagnum cuspidatum/ recurvum* bog pool community, *Rhynchospora alba* sub-community (M2a)
Sphagnum teres – Calliergon stramineum community	*Sphagnum teres, Calliergon stramineum*	*Carex rostrata-Sphagnum warnstorfii* mire (M8) pro. parte

The presence and sometimes the extent of blanket bog flushes was noted in the blanket bog surveys. For the purposes of the this study, the relative abundance/importance of the habitat within a site was rated on a three point scale as follows:

None/low - Flushed areas absent or covering less than 1% of the site area.

Moderate - Flushed areas relatively common, cover of habitat between 1 and 5% of the site area.

High - Flushed areas covering either more than 5% of the site area, or between 1 and 5% of area, with important rare plant species present.

From the following figure, it can be observed that of the lowland blanket bog sites surveyed, the sites in Co. Mayo contain the largest proportion with a high cover of flush habitat, i.e. 25%, however it must also be noted that Mayo contains a relatively high proportion of sites with low cover of flushes (57%). Most of the Mayo sites with well-developed flush areas are clustered just to the west of Crossmolina where the blanket bog overlies lime-rich glacial drift and supports populations of rare species such as *Saxifraga hirculus, Tomenthypnum nitens* and *Leiocolea rutheana.* County Galway contains the largest proportion of sites in the moderate category (52%) which demonstrates that flushed areas are frequent. The county with the lowest proportion of sites with well-developed areas of flush habitat is Kerry and this is presumably due to the lack of suitable base-rich substrate within the region generally.

Figure 7. The abundance of blanket bog flushes throughout lowland blanket bog sites surveyed in counties Kerry, Mayo, Donegal and Galway.

Blanket bog sites that contain good examples of flushes include Brackloon, Rathavisteen and Doobehy in Co. Mayo, Bunscannif in Co. Galway and Meentygrannagh in Co. Donegal. The conservation value of blanket bog flushes is high with base-rich flushes corresponding to the Annex 1 habitat alkaline fen while some of the more base-poor, quaking flushes have a vegetation composition which suggests that they are good examples of transition mires and quaking bogs.

3.2.7 River and stream bank vegetation

Most areas of blanket bog contain a number of rivers and streams, which are the natural drainage systems of the peatland. The vascular plant composition of these rivers and streams is generally poor, being limited to a few aquatic species such as *Juncus bulbosus* var. *fluitans*, however mosses and liverworts are generally abundant. In upland areas, where the gradient is steep, streams flow quickly and, as a result, the direction of flow is usually straight and the channel width is mostly less than a couple of metres. At lower altitudes the path of these rivers/streams tends to meander and in this terrain, extensive flood-plain banks can form. These gently undulating banks tend to be dominated by grassy vegetation, which is grazed by sheep and cattle. Such areas tend to be dominated by relatively species-poor acid grassland vegetation in which *Nardus stricta, Agrostis canina, Agrostis capillaris, Galium saxatile, Potentilla erecta* and the mosses *Rhytidiadelphus loreus* and *Rhytidiadelphus squarrosus* are prominent. In Co. Mayo, many of the lowland blanket bogs contain relatively species-rich stream bank vegetation which experiences

intermittent flooding. Frequent species of this habitat include *Molinia caerulea, Angelica sylvestris, Succisa pratensis, Holcus lanatus, Bellis perennis, Filipendula ulmaria, Agrostis stolonifera, Achillea millefolium, Juncus effusus, Ranunculus repens, Ranunculus acris, Cynosurus cristatus* and *Potentilla anserina.* This vegetation is often ungrazed and has a luxuriant appearance. This habitat provides a locus for plant species that would otherwise be absent from the blanket bog landscape and thus their presence adds greatly to the species-richness of sites. Because river bank vegetation appears to have been infrequently surveyed during the blanket bog reports the following plant list is based on recent observations by the author in Co. Mayo.

Table 19. List of vascular plant and moss species recorded from the margins of rivers and streams in ombrotrophic lowland blanket bog. Species list taken from blanket bog survey reports.

Vascular plants

Achillea millefolium
Agrostis stolonifera
Anagallis tenella
Angelica sylvestris
Anthoxanthum odoratum
Bellis perennis
Centaurea nigra
Cerastium fontanum
Cirsium dissectum
Cirsium palustre
Cynosurus cristatus
Digitalis purpurea
Euphrasia spp.
Filipendula ulmaria
Galium saxatile
Holcus lanatus
Hypochoeris radicata
Juncus effusus
Linum catharticum
Lotus corniculatus
Lotus uliginosus
Molinia caerulea
Nardus stricta
Plantago lanceolata
Potentilla anserina
Ranunculus acris
Ranunculus repens
Succisa pratensis
Trifolium repens

Mosses
Calliergon cuspidatum

3.3 Mountain blanket bog

3.3.1 Ombrotrophic mountain blanket bog

Synonymy

Vaccinio-Ericetum tetralicis Moore 1962

Calluna vulgaris – Eriophorum vaginatum blanket mire (M19)

This type of peatland is largely confined to flat or gently sloping upland areas over 300 metres in altitude, however the habitat is generally best developed above 400 metres.

Areas of peat supporting this vegetation are mostly greater than 1.5 metres in depth and the vegetation type often occurs as extensive unbroken tracts with few other associated vegetation types. The vegetation of mountain blanket bog is relatively species-poor and is generally dominated by *Calluna vulgaris*, particularly in areas where grazing intensity is low. At most sites *Calluna* is accompanied by a high cover of *Eriophorum angustifolium, Eriophorum vaginatum, Erica tetralix* and *Trichophorum caespitosum* and it is not unusual for any of these species to assume local dominance in the vegetation. The dominance of *Eriophorum angustifolium* indicates that the vegetation occurs on deeper and hence wetter areas of peat, whereas a dominance of *Calluna* often indicates that the peat is shallower and drier. In the more high level sites species such as *Juncus squarrosus, Empetrum nigrum, Vaccinium myrtillus* and *Luzula sylvatica* tend to be prominent in the vegetation and may even be locally dominant. In the eastern half of the country, mountain blanket bog vegetation frequently includes *Vaccinium oxycoccus* and *Andromeda polifolia.* These species are much more common on the low-level raised bogs of the midlands and it is interesting to note that they are only very rarely encountered on high-level mountain blanket bogs in the western half of the country. Grasses are generally a relatively minor component of mountain blanket bog vegetation, however *Agrostis canina, Molinia caerulea* and *Deschampsia flexuosa* are frequently present. Low growing herbs are scarce with only *Potentilla erecta* and *Galium saxatile* occurring with any degree of frequency.

In areas of blanket bog which are wet and intact, the bryophyte layer can be well developed. The dominant moss species is usually *Sphagnum capillifolium* with *Sphagnum papillosum, Hypnum cupressiforme* and *Racomitrium lanuginosum* all frequent. Where blanket bog has been affected drying out, the bryophyte layer is usually very species-poor and dominated by *Hypnum cupressiforme*, accompanied by small amounts of *Sphagnum capillifolium.* Lichens of the genus *Cladonia* are frequent in the vegetation with *Cladonia uncialis* generally the most common. The rare boreal lichen *Cetraria islandica* is a noteworthy component of mountain blanket bog vegetation in Co's Galway, Kerry and Wicklow (Bleasdale, 1995). In areas of intact mountain blanket bog the liverwort flora is particularly well-developed (see Table 20) due mainly to the cool and moist conditions present. *Diplophyllum albicans* is the most frequently encountered species and is thought to be especially characteristic of Mountain blanket bog (Schouten, 1984). Species of the genus *Calypogeia* and *Lophozia* are also common (Moore, 1962).

The Vaccinio-Ericetum tetralicis has been previously described in Ireland by a number of authors. In the upland areas of Connemara Bleasdale (1995) noted the presence of a typical variant and a variant characterised by a high cover of *Juncus squarrosus.* In the Wicklow mountains Moore (1962) divided the association into three sub-associations,

namely a typical sub-association, a *Juncus squarrosus* sub-association (indicative of drier soil conditions) and a *Narthecium ossifragum* association (indicative of wetter soil conditions).

It appears that high-level mountain blanket bog is particularly susceptible to peat erosion. Some degree of erosion can be found in almost all areas of mountain blanket bog and the phenomenon is characterised by the formation of extensive areas of haggs (blocks of intact peat) and gullies (the intervening areas of sloping bare peat). A number of authors, e.g. McGee (1988) and Bleasdale (1995), have noted that the rate of peat erosion in upland areas has been accelerated by recent overgrazing and severe damage appears to be more widespread in areas of mountain blanket bog than in lowland blanket bog. At present, relatively few extensive areas of intact mountain blanket bog remain. The best remaining, relatively intact examples of the habitat include the Slieve Bloom mountains (Co's Laois and Offaly), the Wicklow mountains, Caherbarnagh/Mullaganish Mountains (Co's Cork and Kerry) and the Cuilcagh Mountains (Co's Cavan and Fermanagh). Because of the incomplete nature of total species lists for sites visited as part of the mountain blanket bog survey (Goodwillie and Mooney, 1991) the list present in Table 20 is based on a total of 49 relevés collected from Co. Wicklow (Moore, 1962), Co. Kerry (Mhic Daeid, 1976) and Connemara (Bleasdale, 1995).

Active mountain blanket bog is of high conservation value and is listed as a 'priority' habitat in Annex 1 of the E.U. Habitats Directive (Ramão, 1996).

Table 20. List of vascular plant, moss and liverwort species recorded from ombrotrophic mountain blanket bog (Terrestrial zones only).

Vascular plants	**Constancy**		**Constancy**
Calluna vulgaris	V	*Calypogeia trichomanis*	I
Empetrum nigrum	V	*Campylopus paradoxus*	I
Eriophorum angustifolium	V	*Campylopus pyriformis*	I
Eriophorum vaginatum	V	*Cephalozia bicuspida*	I
Vaccinium myrtillus	V	*Cephalozia connivens*	I
Erica tetralix	III	*Cephaloziella hampeana*	I
Trichophorum caespitosum	III	*Cetraria islandica*	I
Deschampsia flexuosa	II	*Cladonia arbuscula*	I
Juncus squarrosus	II	*Cladonia coccifera*	I
Narthecium ossifragum	II	*Cladonia furcata*	I
Potentilla erecta	II	*Cladonia gracilis*	I
Agrostis canina	I	*Cladonia leocophea*	I
Andromeda polifolia	I	*Cladonia rangiferina*	I
Carex bigelowii	I	*Cladonia squamosa*	I
Carex binervis	I	*Dicranum scoparium*	I
Drosera rotundifolia	I	*Hylocomium splendens*	I
Erica cinerea	I	*Isothecium myosuroides*	I
Festuca vivipara	I	*Lepidozia setacea*	I
Galium saxatile	I	*Leucobryum glaucum*	I
Listera cordata	I	*Lophocolea bidentata*	I
Luzula multiflora	I	*Lophozia incisa*	I
Luzula sylvatica	I	*Mylia taylori*	I
Molinia caerulea	I	*Omphalina luteolilacina*	I
Pinguicula grandiflora	I	*Peltigera canina*	I
Vaccinium oxycoccus	I	*Plagiochila spinulosa*	I
Vaccinium vitis-idaea	I	*Plagiothecium undulatum*	I
		Pleurozia purpurea	I
Mosses, Liverworts and Lichens		*Pleurozium schreberi*	I
Sphagnum capillifolium	V	*Pohlia nutans*	I
Hypnum cupressiforme	III	*Polytichum alpinum*	I
Racomitrium lanuginosum	III	*Polytrichum commune*	I
Sphagnum papillosum	III	*Polytrichum formosum*	I
Aulocomium palustre	II	*Polytrichum juniperinum*	I
Calypogeia mullerana	II	*Polytrichum piliferum*	I
Campylopus flexuosus	II	*Pseudoscleropodium purum*	I
Cladonia sylvatica	II	*Ptilidium ciliare*	I
Cladonia uncialis	II	*Rhytidiadelphus squarrosus*	I
Diplophyllum albicans	II	*Riccardia multifida*	I
Lophozia ventricosa	II	*Saccogyna viticulosa*	I
Odontoschisma sphagni	II	*Scapania gracilis*	I
Rhytidiadelphus loreus	II	*Sphagnum compactum*	I
Sphagnum cuspidatum	II	*Sphagnum contortum*	I
Sphagnum tenellum	II	*Sphagnum magellanicum*	I
Aneura pinguis	I	*Thuidium tamariscinum*	I
Bazzania tricrenata	I	*Tritomaria quinquedentata*	I

3.3.2 Mountain blanket bog pools

Although most areas of mountain blanket peat are dominated by extensive unbroken tracts of ombrotrophic vegetation, there are occasionally areas that contain well-developed, usually large, dystrophic pools. Well-developed pool areas in mountain blanket bog appear to be rare with the best-developed pool areas occurring at Sally Gap and Kippure (Co. Wicklow), Slieve Fyagh (Co. Mayo) and on the Cuilcagh Mountains (Counties Cavan and Fermanagh). Typically these pools have a surface area of between 4 and 16m^2, however larger pools have been recorded. The vegetation of these pools is poorly developed with many of the larger ones containing little vegetation apart from a narrow fringe of Sphagnum (*S. cuspidatum* and/or *S. auriculatum*) and perhaps small amounts of *Eriophorum angustifolium*. Smaller pools often have a more luxuriant vegetation cover which includes *Sphagnum cuspidatum, Sphagnum auriculatum, Eriophorum angustifolium, Carex rostrata* and *Juncus bulbosus*.

3.3.3 Alpine heath

Synonymy

Lycopodio alpini – Rhacomitrietum lanuginosi (Armstrong, Calvert et Ingold 1930) Braun-Blanquet et Tüxen 1952

Calluna vulgaris – Juniperus communis subsp. *nana* heath (H15)

At altitudes in excess of 400 metres in the west of Ireland, shallow peat is occasionally colonised by Alpine heath vegetation. This low-growing, dwarf shrub-dominated vegetation forms the transition between the Vaccinio-Ericetum tetralicis, which dominates deep peats at high altitude, and the Rhacomitreo-Callunetum which occurs on very exposed skeletal peats close to mountain summits (Bleasdale, 1995). The vegetation is mostly dominated by *Calluna vulgaris*, accompanied by a high cover of other prostrate shrubs such as *Arctostaphylos uva-ursi, Juniperus communis* subsp. *nana, Empetrum nigrum* and *Erica cinerea*. Within Ireland *Arctostaphylos* and *Juniperus* are relatively rare and the species are largely restricted to the Alpine heath habitat (Perring and Walters 1962, Webb *et al.* 1996). Herb species are relatively uncommon and limited to scattered occurrences of *Potentilla erecta, Molinia caerulea* and *Vaccinium myrtillus*. The bryophyte component of the habitat appears to be very well developed (Table 21). The most frequent mosses are *Racomitrium lanuginosum, Hypnum cupressiforme, Dicranum scoparium* and *Breutelia chrysocoma*. Liverworts such as *Plagiochila spinulosa, Frullania tamarisci, Diplophyllum albicans* and *Scapania gracilis* are also a frequent component of the vegetation, as are lichens of the genus *Cladonia*. In Ireland this vegetation type appears to be largely confined to the north-west of the country and has been recorded from upland areas in

Connemara (Bleasdale, 1995) and Donegal (Weekes, 1990). During the 1989 blanket bog survey of Co. Mayo the vegetation was recorded close to the summit of the Curraun Plateau near Achill (Douglas *et al.*, 1989c). The following species-list is based on 8 Alpine heath quadrats, dominated by *Calluna vulgaris* and *Arctostaphylos uva-ursi*, recorded from the summit of Knockbrack hill, north-west Connemara (Bleasdale, 1995).

Table 21. List of vascular plant and moss species recorded from Alpine heath vegetation in Connemara. Species list taken from Bleasdale (1995).

Vascular plants	**Constancy**	**Mosses, liverworts and lichens**	**Constancy**
Arctostaphylos uva-ursi	V	*Plagiochila spinulosa*	V
Calluna vulgaris	V	*Breutelia chrysocoma*	IV
Empetrum nigrum	V	*Cladonia uncialis*	IV
Erica cinerea	V	*Diplophyllum albicans*	IV
Juniperus communis nana	V	*Rhytidadelphus loreus*	IV
Potentilla erecta	V	*Scapania gracilis*	IV
Trichophorum caespitosum	V	*Cladonia arbuscula*	III
Deschampsia flexuosa	IV	*Cladonia portentosa*	III
Daboecia cantabrica	II	*Brachythecium rutabulum*	II
Dactylorhiza maculata	II	*Cladonia gracilis*	II
Euphrasia spp.	II	*Herberta adunca*	II
Hymenophyllum wilsonii	II	*Hylocomium splendens*	II
Molinia caerulea	II	*Lejunea patens*	II
Solidago virgaurea	II	*Pleurozia purpurea*	II
Vaccinium myrtillus	II	*Sphagnum capillifolium*	II
		Plagiothecium undulatum	I
Mosses, liverworts and lichens	**Constancy**	*Pleurozium schreberi*	I
Cladonia rangiferina	V	*Rhytidiadelphus triquetrus*	I
Dicranum scoparium	V	*Saccogyna viticulosa*	I
Frullania tamarisci	V	*Sphenolobus helleranus*	I
Hypnum cupressiforme	V		

Alpine heath is listed in Annex 1 of the E.U. Habitats Directive (Ramão, 1996) and thus is considered to be of high conservation value.

3.4 Rare plant species occurring within areas of blanket bog

Areas of blanket bog support a relatively large number of plants which can be considered to be rare in a national context. While many of these species are not wholly confined to habitats within blanket bog, blanket bog landscapes constitute the headquarters for many species. For purposes of this report, plant species are considered to be rare if they have been recently recorded from less than 50 10-kilometre squares (c. 12% of the 10 kilometre squares in the Republic of Ireland). These species can be divided into different categories on the basis of their relative degree of rarity. Eleven species are sufficiently rare to warrant protection under the 1999 Flora Protection Order. Of these species eight are vascular plants, two are mosses and there is one liverwort. Most of these species have been recently recorded from 10 or less ten-kilometre squares within in the Republic of Ireland and even within these squares the species is usually uncommon. In addition to their protection under the Flora Protection Order *Saxifraga hirculus, Najas flexilis* and *Drepanocladus vernicosus* are listed in Annex 2 of the E.U. Habitats Directive because of their rare and declining distribution within the European Union. Scarce species are species which have only been recently recorded from between 11 and 25, 10k squares and six vascular plant species listed on the provisional list of scarce species occur in blanket bog areas. The third category of species have, for the purposes of this report, been termed uncommon species and include those that have been recently recorded from between 26 and 50, ten-kilometre squares.

A list of rare species associated with blanket bog is presented in Table 22, along with a brief outline of their status and ecology. This is followed by Table 23, which outlines sites in which rare plant species were recorded during the blanket bog surveys. As can be seen from this table, the blanket bog surveys have contributed greatly to our knowledge of the ecology and distribution of these species. Among the more noteworthy discoveries made during the blanket bog surveys include the new records for *Eriophorum gracile* (Lettershinna, Co. Galway), *Saxifraga hirculus* (Largan More, Co. Mayo), *Drepanocladus vernicosus* and *Sphagnum subsecundum* (Bunscannif, Co. Galway), *Sphagnum pulchrum* (numerous sites in Galway and a few in counties Kerry, Mayo and Donegal) and *Tomenthypnum nitens* (Altnabrocky, Co. Mayo and Meentygrannagh, Co. Donegal).

When these rare species are considered in terms of ecological preferences it is immediately apparent that a large number are confined to blanket bog flushes, with many others restricted to very wet areas such as pools and oligotrophic lakes. The preference of many rare species for wetter, base-enriched areas of blanket bog has resulted in the decline of many of these species due to drainage and related activities.

Table 22. The status and ecology of rare plant species in blanket bog and related habitats. Information on the distribution and ecology of higher plants taken from Webb *et al.* (1996). Information on the distribution and ecology of mosses and liverworts taken from Hill *et al.* (1991, 1992 and 1994).

Species	Status	Ecology within blanket bog areas
Saxifraga hirculus	Protected under the 1999 Flora Protection Order. Listed on Annex 2 of the Habitats Directive.	Base-rich flushes.
Hammarbya paludosa	Protected under the 1999 Flora Protection Order.	Base-poor flushes dominated by Sphagnum.
Eriophorum gracile	Protected under the 1999 Flora Protection Order.	Moderately base-rich bog flushes and lake margins.
Deschampsia setacea	Protected under the 1999 Flora Protection Order.	Bare muddy areas along oligotrophic lake margins.
Pilularia globulifera	Protected under the 1999 Flora Protection Order.	Peaty ground along margins of oligotrophic lakes.
Najas flexilis	Protected under the 1999 Flora Protection Order. Listed on Annex 2 of the Habitats Directive.	Deep water in lowland oligotrophic lakes.
Lycopodiella inundata	Protected under the 1999 Flora Protection Order	Bog pools and the swampy margins of oligotrophic lakes
Hypericum canadense	Protected under the 1999 Flora Protection Order.	Margins of streams and lakes in peatland areas.
Paludella squarrosa	Protected under the 1999 Flora Protection Order.	Base-rich flushes.
Drepanocladus vernicosus	Protected under the 1999 Flora Protection Order. Listed on Annex 2 of the Habitats Directive.	Slightly base-enriched flushes.
Leiocolea rutheana	Protected under the 1999 Flora Protection Order.	Base-rich flushes.
Erica ciliaris	Formerly protected, however the species is not listed in the 1999 Flora Protection Order.	Ombrotrophic lowland blanket bog.
Erica mackaiana	Listed as threatened in the Irish Red Data Book.	Oligotrophic blanket bog. Most frequent in better drained areas such as old cutaway and lake margins.
Luronium natans	Listed on the provisional list of scarce species.	Deep water in lowland oligotrophic lakes.
Isoetes echinospora	Listed on the provisional list of scarce species.	Shallow water in oligotrophic lakes.
Subularia aquatica	Listed on the provisional list of scarce species.	Margins of lowland oligotrophic lakes.
Vaccinium vitis-idaea	Listed on the provisional list of scarce species.	Oligotrophic mountain blanket bog. Mostly encountered on eroding bog or rock outcrops.
Diphasiastrum alpinum	Listed on the provisional list of scarce species.	Rocky/heathy areas within ombrotrophic mountain blanket bog.
Carum verticillatum	Listed on the provisional list of scarce species.	Margins of small streams within blanket bog areas.
Vaccinium oxycoccus	Although this species is locally common in raised bog and in some mountain blanket bogs, it is relatively rare in lowland and highland bogs.	Sphagnum lawns/hummocks along the edges of bog pools or base-rich flushes in blanket bog
Tomenthypnum nitens	A rare moss species which has been recorded from only 5 10-k squares in the Republic of Ireland.	Base-rich flushes and fens.
Campylopus shawii	A rare moss species which has only been recorded from only 11 10-k squares in the Republic of Ireland.	Flushed or damp heathy areas or wet areas of blanket bog.

Table 22 continued Species	Status	Ecology within blanket bog areas
Calliergon trifarium	A rare moss species which has only been recorded from only 2 10-k squares in the Republic of Ireland.	Moderately base-rich flushes, ground often scoured by flowing water.
Sphagnum teres	A rare moss species which has been recorded from only 5 10-k squares in the Republic of Ireland.	Wet, moderately base-rich flushes.
Sphagnum subsecundum	A rare moss species which has only been recorded from only 4 10-k squares in the Republic of Ireland.	Wet, moderately base-rich flushes and swamps.
Sphagnum strictum	A rare moss species which has been recorded from only 19 10-k squares in the Republic of Ireland.	Shallow lowland blanket bog and wet heath in hyper-oceanic areas.
Sphagnum pulchrum	A rare moss species which has only been recorded from 31 10-k squares (Douglas, 1987). The known distribution of this species has been significantly increased as a result of the blanket bog surveys.	Wet hollows and pools in lowland blanket bog.
Sphagnum molle	A rare moss species which has been recorded from only 31 10-k squares in the Republic of Ireland.	Wet heath and shallow blanket bogs
Sphagnum recurvum var. *tenue*	A rare moss species which has been recorded from approximately 20, 10-k squares in the Republic of Ireland. The known distribution of this species has been significantly increased as a result of the blanket bog surveys.	Nutrient-poor flushes in lowland blanket bog.
Sphagnum warnstorfii	A rare moss species which has been recorded from only 2 10-k squares in the Republic of Ireland.	Base-rich flushes within areas of blanket bog or fens.
Sphagnum platyphyllum	A rare moss species which has been recorded from only 3 10-k squares in the Republic of Ireland.	Base-rich flushes within areas of heath or blanket bog.

3.4.1 Protected vascular plant species

The following sections outline the distribution and ecology of vascular plant species protected under the 1999 Flora Protection Order. The occurrence of these species within sites surveyed during the blanket bog surveys can be determined from the database of blanket bog sites which has been constructed (see Chapter 6).

3.4.1.1 *Saxifraga hirculus*

In Ireland, this yellow-flowered saxifrage grows in wet peatland habitats influenced by base-rich water. The species has been recorded from Counties Mayo, Antrim, Tipperary, Offaly, Laois and Westmeath (Curtis and McGough 1988) however since 1970 the species has only been recorded from Mayo and Antrim (Lockhart 1989a, Hackney 1992). In Mayo *S. hirculus* has been recorded from 4 flush systems within extensive blanket bog areas (Lockhart *op. cit.*), however it appears likely that one of these sites has subsequently been

destroyed by afforestation. In such areas the species is influenced by waters with a high pH (5.89 to 6.86) and conductivity (68 to 255µS/cm), with a variable concentration of dissolved calcium (1.5 to 44.4 mg l^{-1}). Plant species frequently associated with *Saxifraga hirculus* in Mayo include *Menyanthes trifoliata, Tomenthypnum nitens, Potentilla palustris, Potamogeton polygonifolius, Cardamine pratensis, Holcus lanatus, Calliergon cuspidatum, Galium palustre, Agrostis stolonifera* and *Caltha palustris*. In addition to being a protected species in the Republic of Ireland *Saxifraga hirculus* is listed on Annex 2 of the Habitats Directive, because of its rare and declining status within the European Union.

3.4.1.2 *Hammarbya paludosa*

This diminutive orchid is restricted to base-poor flushes in upland areas throughout Ireland. Although the species has been recorded from at least 35, 10-k squares in the past, there have been comparatively few recent records (Curtis and McGough, 1988). The species is generally restricted to very wet, base-poor flushes within more extensive areas of upland grassland or blanket bog where the characteristic associated species include *Juncus effusus, Agrostis stolonifera, Carex nigra, Ranunculus flammula* and *Sphagnum recurvum* (Lockhart, 1991). Despite the scarcity of recent records it is likely that the species is under-recorded in many parts of the country. The species is known to be very rare and declining throughout Europe and, as a result of this rarity, the species is listed on the Berne Convention.

3.4.1.3 *Eriophorum gracile*

Eriophorum gracile is confined to very wet habitats including oligotrophic lake margins, blanket bog flushes and base-rich fen. The headquarters of the species in Ireland are the lakes and bogs of Connemara, where it has been recorded from 20 sites spread throughout seven 10-k squares (Conaghan, 1995). In addition to Connemara, the species has been recently recorded from two sites in Co. Kerry and one site in counties Cork, Offaly and Westmeath. In Connemara, the largest populations of the species occur on floating rafts of vegetation which develop along lake margins. Typical associates in this habitat include *Phragmites australis, Equisetum fluviatile, Potentilla palustris, Hypericum elodes, Hydrocotyle vulgaris, Ranunculus flammula* and *Carex lasiocarpa.* In blanket bog flushes the species is typically found growing with *Carex limosa, Carex lasiocarpa, Juncus subnodulosus, Potamogeton polygonifolius* and *Juncus bulbosus.* In most of the Connemara sites the species is influenced by water which is only slightly base-enriched, i.e. pH 5.4 to 6.0 and dissolved calcium 1.5 to 14.6 mg/l (Conaghan, 1995). In the midlands and east of the country however the habitat of the species consists of base-rich fen where typical plant

associates include *Schoenus nigricans, Scorpidium scorpioides, Carex lepidocarpa* and *Menyanthes trifoliata.*

3.4.1.4 *Deschampsia setacea*

This attractive grass species is largely confined to peaty lake margins in the blanket bog areas of Connemara, where it is known from a large number of sites lying in 8, 10-km squares (Curtis and McGough, 1988). As a result of fieldwork carried out within the past decade, the species has been recorded from a number of new locations in the region (M. O' Connor pers. comm.). The habitat of the species is characteristically open and often scoured by wave action or flowing water. Along these lake margins the species has been recorded growing in base-poor oligotrophic waters where frequent associates include *Littorella uniflora, Juncus bulbosus, Eriocaulon aquaticum, Phragmites australis, Ranunculus flammula* and *Lobelia dortmanna* (O' Connor, 2000).

3.4.1.5 *Pilularia globulifera*

Pilularia globulifera is a diminutive aquatic fern which grows along the peaty margins of lowland oligotrophic lakes. At many sites the species can grow at a considerable depth of water and the presence of the species in these sites can only be confirmed by diving. The species is confined to the west and north of Ireland and appears to be most common in Connemara and south Mayo (Preston and Croft, 1997). The species has been recorded from a total of 22, 10-k squares in the past, however only 11 of these are based on post-1970 records (Preston and Croft, *op. cit.*). Due to the aquatic habitat of the species, associated plant species are generally scarce and have a low cover, however *Apium inundatum, Hydrocotyle vulgaris* and *Ranunculus flammula* are occasionally found growing with the species (Preston and Croft, *op. cit.*).

3.4.1.6 *Najas flexilis*

Najas flexilis is a submerged aquatic species which grows in nutrient-poor lakes in five counties along the western seaboard of Ireland. The majority of known sites for the species occur in Kerry, Galway and Donegal with single locations known in counties Mayo and Leitrim. The species has been recorded from 27, 10-k squares, 24 of which are post-1970 records (Preston and Croft, 1997). The species grows in water depths usually in excess of 1.5 metres and occurs in two types of lake namely base-poor oligotrophic lakes within areas of blanket bog and base-enriched (but unproductive) lakes found in association with sand dunes or machairs. Although comparatively little is known regarding associated plant species, *Najas flexilis* is often found growing in relatively shallow water with *Potamogeton*

praelongus, Callitriche hermaphrodatica and *Nitella flexilis* (Preston and Croft *op. cit.*). In addition to being a protected species in the Republic of Ireland, the species is listed on Annex 2 of the Habitats Directive because of its rare and declining status within the European Union.

3.4.1.7 *Lycopodiella inundata*

Lycopodiella inundata is a low, sprawling species of clubmoss which is chiefly confined to the west of the country. The species has been recorded from a total of 18, 10-k squares, ten of which are based on post-1970 records (Curtis and McGough, 1988). The principal stronghold of the species is the east Connemara region where it has been seen in at least 8 sites since 1970. The favoured habitats of the species consist of wet areas of bogs (especially pool areas) and swampy lake margins. There is comparatively little published data regarding the ecology of this species in Ireland, however McKee (1999) has recorded the species from the damp margins of a flush at Glensaul, Co. Mayo where *L. inundata* is accompanied by blanket bog species including *Nardus stricta, Narthecium ossifragum, Trichophorum caespitosum, Anagallis tenella, Calluna vulgaris, Erica tetralix, Carex panicea, Drosera rotundifolia* and *Potentilla erecta.*

3.4.1.8 *Hypericum canadense*

Hypericum canadense is a member of a small group of plants occurring in Ireland that have an amphi-Atlantic distribution, i.e. grow mainly in America with small populations in western Europe. In Ireland the species is confined to two small areas, lying over three 10-k squares, one near Lough Mask, Co. Mayo and one near Glengarriff, Co. Cork (Curtis and McGough, 1988). The preferred habitat of the species is wet, boggy areas near lake margins and heath where species typical of acid, waterlogged conditions, such as *Eleocharis multicaulis, Hypericum elodes, Hydrocotyle vulgaris, Trichophorum caespitosum, Anagallis tenella, Juncus acutiflorus, Juncus effusus* and *Agrostis stolonifera,* are typical associates (McKee, 1999).

3.4.2 Threatened vascular plant species

The following sections outline the distribution and ecology of species listed as threatened in the Irish Red Data Book (Curtis and McGough, 1988).

3.4.2.1 *Erica ciliaris*

Erica ciliaris is known from only one site in Ireland, namely Roundstone bog, Connemara, where just five plants are known from one roadside location. Here the species grows

amongst typical lowland blanket bog species such as *Molinia caerulea, Erica tetralix, Potentilla erecta* and *Trichophorum caespitosum* (personal observation). There is some degree of hybridisation evident between *E. ciliaris* and *E. tetralix* evident at this site which is a future threat to the species. Some sources, e.g. Curtis and McGough (1988), note that there is a suspicion that the species may be have been deliberately planted at this site.

3.4.2.2 *Erica mackaiana*

This relatively uncommon heather, similar in morphology to the abundant *E. tetralix*, is confined to the north-west of Ireland. The species is most common in blanket bog to the north of Errisbeg hill, Co. Galway where it colonises a range of ombrotrophic lowland blanket bog habitats. Recent research Van Doorslaer (1990) has revealed that the species is most common in somewhat better-drained blanket bog habitats such as hand-cut peat banks and the margins of lakes and streams. The species appears to largely avoid intact ombrotrophic blanket bog, where the hybrid with *Erica tetralix* (*Erica x stuartii*) is more common. In addition to the Galway populations, the species has been recorded from blanket bog to the east of Bellacorrick, Co. Mayo (Douglas *et al.* 1989c) and from around Lough Nacung, Co. Donegal (Douglas *et al.* 1990, Van Doorslaer 1990) where it is locally abundant along the edge of the lake.

3.4.3 Protected bryophytes

The following sections consider the ecology of bryophytes (mosses and liverworts) protected under the 1999 Flora Protection Order.

3.4.3.1 *Paludella squarrosa*

Paludella squarrosa is a very rare species of flushed blanket bog which grows at just one site in Co. Mayo, where it was discovered in 1999 (Lockhart, 1999). At this site (Formoyle) the species grows in an extensive base-rich flush where it is accompanied by plant species indicative of base-rich conditions such as *Tomenthypnum nitens, Sphagnum contortum, Aulocomium palustre, Molinia caerulea, Vaccinium oxycoccus, Aneura pinguis, Calliergon cuspidatum* and *Schoenus nigricans*. At the site the species is influenced by upwelling water which has a high pH (6.50 - 7.67) and high concentrations of dissolved calcium (27.8 – 66.7 mg l^{-1}). Previous to this discovery, the species was only known in Ireland as a Pleistocene subfossil, having been recorded from the basal layers of raised bogs in Co. Derry (Smith, 1958) and Kildare (Barry and Synnott, 1987). *Paludella squarrosa* was previously recorded from three sites in England, however the species had become extinct by 1916 (Hill *et al.*, 1994).

3.4.3.2 *Drepanocladus vernicosus*

In the Republic of Ireland *Drepanocladus vernicosus* is a very rare species of mildly base-enriched flushes and flooded lake margins (Dr. N. Lockhart pers. comm.). In such habitats frequently associated species include *Sphagnum recurvum, Juncus acutiflorus, Agrostis stolonifera, Carex paniculata* and *Polytrichum commune inter alia.* At some its more base-enriched sites however the species has been noted growing in close association with rare plant species such as *Saxifraga hirculus* and *Tomenthypnum nitens* (Dr. N. Lockhart pers. comm.). Previously the species has been recorded from 19, 10k squares, mostly in the midlands and west of the country (Hill *et al.*, 1994), however at present the species has recently only been definitely confirmed from 6 sites spread over 5 10-km squares (Dr. N. Lockhart pers. comm.). In addition to being a protected species in the Republic of Ireland the species is listed on Annex 2 of the Habitats Directive, because of its rare and declining status within the European Union.

3.4.3.3 *Leiocolea rutheana*

In Ireland this relatively large liverwort is known from only two blanket bog flushes in Co. Mayo (Brackloon and Formoyle, Lockhart 1989b, 1999). The species characteristically grows in bryophyte carpets and is accompanied by plant species indicative of base-enrichment such as *Schoenus nigricans, Campylium stellatum, Tomenthypnum nitens, Sphagnum contortum, Ctenidium molluscum, Menyanthes trifoliata, Phragmites australis, Carex lepidocarpa* and *Eriophorum latifolium.* Associated surface water has a high pH (6.20 – 6.75), high concentrations of dissolved calcium (20.6 – 48.7mg l^{-1}) and very low concentrations of ortho-phosphate (0.004 to 0.007 mg l^{-1}). The species was formerly recorded at five localities in Norfolk, south-east England and one in Berkshire however it is thought to have become extinct at a number of these localities (Lockhart, 1989b).

3.5 The distribution of important blanket bog features in relation to bog type and location

Within the descriptions outlined in the blanket bog site reports the presence of various blanket bog features and vegetation types are noted and described. This information is useful in that it enables the study of the relationship between blanket bog features and variables such as the type of blanket bog or geographical location. In the following sections the distribution of swallow-holes, heath, Rhynchosporion vegetation, Juniper formations and dystrophic lakes is investigated. As was previously noted in this report heath, Rhynchosporion vegetation, Juniper formations and dystrophic lakes are listed in Annex 1 of the Habitats Directive.

Although these habitats are frequently recorded, it must be noted that, in the case of some sites, the occurrence of some of these habitats may not have been recorded due to differences in the styles of reporting. As a result of this possible lack of documentation of certain habitats the observations presented in the following sections should be treated with a degree of caution, however they do indicate some interesting trends.

Table 24. The distribution of selected blanket bog features/vegetation types in relation to bog type.

	Swallow-holes	Heath	Rhynchosporion vegetation	Juniper formations	Dystrophic lakes
% occurrence in lowland sites	19	37	53	9	23
% occurrence in highland sites	9	50	10	2	1
% occurrence in mountain sites	16	74	0	0	6
% occurrence in all sites surveyed	16	49	29	5	13

3.5.1 Swallow holes

In the blanket bog reports the presence of swallow holes was frequently noted. Since swallow-holes are a particularly striking feature of a peatland area, it is unlikely that they

were omitted from the reports. From Table 24 it is evident that swallow-holes were only recorded from 16% of sites and thus they must be considered a relatively rare feature of blanket bog areas. The feature appears to be almost equally as common in lowland and mountain bogs, but appears to be rarer in highland blanket bogs. This apparent rarity in highland blanket bogs is possibly explained by the observation that swallow-holes are generally best developed on areas of flat deep peat which are rarer in highland blanket bogs which are often associated with relatively shallow peats on sloping hillsides. Table 25 indicates that swallow-holes are most commonly found in the blanket bogs of counties Sligo, Mayo and Wicklow and appear to be a very rare feature of the blanket bogs of Cork and Kerry.

Table 25. The distribution of selected blanket bog features/vegetation types in relation to the occurrence in sites of selected counties.

	Swallow-holes	Heath	Rhynchosporion vegetation	Juniper formations	Dystrophic lakes
% occurrence in Mayo sites	28	28	48	8	29
% occurrence in Galway sites	14	32	79	11	39
% occurrence in Donegal sites	13	54	14	6	4
% occurrence in Kerry sites	2	47	29	2	0
% occurrence in Wicklow sites	27	73	0	0	0
% occurrence in Sligo sites	38	88	50	0	6
% occurrence in Cork sites	0	56	0	0	0

3.5.2 Heath

For the purposes of this study the different types of heath present, i.e. wet, dry and Alpine, were not differentiated. In general areas of heath are relatively common and were noted in

49% of the sites surveyed. Table 24 clearly shows that the increased presence of heath within blanket bog sites is positively related to increasing altitude. Counties Wicklow and Sligo have the highest proportion of sites containing heath while Mayo and Galway have the lowest proportion (Table 25). This observation simply reflects the relatively low numbers of mountain blanket bog sites surveyed in Mayo and Galway. In addition, it is important to note that the occurrence of heath may not have always been noted in the lowland blanket bog reports because of the close floristic similarity between wet heath vegetation and that of blanket bog.

3.5.3 Rhynchosporion vegetation

Rhynchosporion vegetation, i.e. quaking bog vegetation dominated by *Rhynchospora alba*, was recorded in 29% of the sites surveyed and thus is relatively uncommon. Table 24 clearly shows that the habitat is largely restricted to lowland blanket bog sites (53%) while relatively few highland and mountain bog sites contain the habitat. When the distribution of the habitat between counties is considered, it is equally striking that the habitat appears to be much more common in Galway than in other counties (Table 25), however the ecological reasons for this observation are not obvious. The apparent absence of the habitat from Wicklow and Cork is due to the fact that there are relatively few bogs of low altitude in those counties.

3.5.4 Juniper formations

The occurrence of vegetation with prominent *Juniperus communis* subsp. *nana* on acid substrates (not including high-altitude Alpine heath) is very rare habitat which was recorded from only 5% of sites surveyed. From Tables 24 and 25 it can be observed that the habitat is very restricted in its distribution, being is largely confined to a small proportion of lowland blanket bogs in counties Galway and Mayo. The main reason for this distribution may be linked to the fact that the habitat is invariably associated with islands within well-developed, large blanket bog pool systems.

3.5.5 Dystrophic lakes

Dystrophic lakes were only noted as occurring in 13% of the blanket bog sites surveyed and thus must be considered as a relatively rare feature. Whilst it is admittedly difficult to separate dystrophic lakes from larger blanket bog pools the available evidence does appear to suggest that this habitat is largely restricted to areas of lowland blanket bog in counties Galway and Mayo.

CHAPTER 4. DAMAGING ACTIVITIES AFFECTING BLANKET BOGS

4.1 Introduction

The blanket bog habitat has long been subject to damage mainly due to peat-cutting and agricultural reclamation (Feehan and O' Donovan, 1996). Over the past fifty years however it has been widely acknowledged that the extent and intensity of damage has greatly increased due mainly to the intensification of practices such as peatland afforestation, mechanised peat extraction and overstocking by sheep (Foss and O' Connell, 1996). In the following sections of this chapter the impacts of the main damaging activities are outlined and discussed.

4.2 Afforestation

Afforestation is one of the principal reasons for loss of blanket bog habitat in the Republic of Ireland (Foss, 1998). By 1982 approximately 18% (c. 140,000 hectares) of the original blanket bog area had been lost to afforestation (Feehan and O' Donovan, 1996), while Foss (1998) estimated that approximately 27% (c. 209,300 hectares) of the habitat had been afforested by the mid-1990's. The main agency responsible for tree planting and maintenance in the Republic of Ireland is the state forestry body (now a semi-state body known as Coillte Teoranta).

Extensive, large-scale afforestation in the Republic of Ireland commenced in the early 1950's and from this time to the early 1980's between 5,000 and 10,000 hectares of trees (mostly conifers) were planted each year (Tomlinson, 1997). A large amount of this planting was carried out on areas of lowland blanket peat in counties along the Atlantic seaboard (especially Galway, Mayo and Kerry), however substantial areas of upland blanket bog in the Wicklow mountains, the Slieve Bloom mountains, the Slieve Aughty Mountains and other mountain ranges in the south-west of the country were planted. Recent figures from Coillte indicate that 37% (i.e. 187,092 hectares) of the land in their possession can be classified as either virgin blanket bog or cutover blanket bog and approximately 152,000 hectares of these habitats have been planted with conifers, mostly Sitka Spruce and Lodgepole Pine (Coillte, 1999).

The main reasons for widespread afforestation of blanket bogs were the relatively low cost of blanket bog and the perceived low agricultural value of the habitat. The piecemeal

afforestation of extensive tracts of blanket bog has lead to the fragmentation of the habitat into smaller isolated units and this fragmentation has been particularly severe in the eastern half of Connemara, the north-east of Co. Mayo and along the border between Kerry and Cork. Since the mid-1980's there has been a dramatic increase in the area of forestry planted by private forestry companies and much of this planting has been grant-aided by the European Union. It has been estimated that, at present, private companies plant almost twice as much land as Coillte each year (Johnson, 1998). However since the late 1990's there has been a significant reduction in the area of intact blanket bog planted due mainly to an E.U. stipulation that afforestation in receipt of E.U. grant aid must not damage the natural environment. In addition, there is a growing acceptance by Coillte that deep, intact blanket peat produces low-quality timber which is of limited use and low financial return. In spite of these factors however areas of intact blanket bog of ecological interest which lie outside of pNHA's and pSAC's continue to be planted by private forestry companies, with the aid of government or E.U. grant assistance.

The afforestation of a blanket bog area generally proceeds as follows. Prior to the planting of conifers, the area is fenced off and drained. At sites where there is a deep peat soil, drainage is achieved by the insertion of a network of drains that are typically up to 1 metre in depth and between 3 and 5 metres apart. This drainage has the immediate effect of lowering the water table of the area which, in turn, leads to the oxidation and decomposition of peat over a period of time. Conifer saplings are then planted on the upturned peat sods which have been removed from the drain, a technique which further isolates the young trees from the anaerobic, waterlogged environment of the blanket bog. The process by which the peat excavated from the drain is placed on the surface and used as a planting medium for the young tree saplings is known as "mounding". Areas of young bogland forestry are also fertilised with rock phosphate in order to give the young saplings a better start and in the case of large areas this fertiliser may be spread by light aircraft.

The main ecological effects of afforestation on blanket bogs are as follows:

(1) The virtual elimination of the native blanket bog flora and fauna - When areas of blanket bog are first afforested they are fenced off, drained and fertilised in order to improve growing conditions for conifer saplings. These measures lead to the initial dominance of bog plant species which are tolerant of lower and more fluctuating water tables, such as *Molinia caerulea, Calluna vulgaris* and *Potentilla erecta* (Doyle and Moore, 1982). Plant species of smaller stature and which demand a constantly high water table, e.g. *Drosera* spp., *Narthecium ossifragum* and *Rhynchospora alba,* disappear rapidly primarily as a result of shading by, and competition from, taller plant species. After a period of between 6 to 10 years the young conifer trees begin to shade out the already

depauperate blanket bog flora and after approximately 15 years the blanket bog vegetation is virtually eliminated. In very wet areas of blanket bog where drainage attempts have been only partially successful, saplings may die or become severely stunted. In such areas the native vegetation may survive in a largely unaltered state for a long period of time.

(2) The fragmentation of the blanket bog landscape – The loss of large tracts of open blanket bog because of afforestation has lead to the decline of a number of bird species. In Scotland it has been shown that ground-nesting species such as golden plover, snipe and grouse are particularly affected by the loss of peatland habitat (Thompson *et al.*, 1998). Furthermore, the development of large areas of tall coniferous woodland encourages the spread and proliferation of predator species not typical of blanket bog areas such as the fox and the rook.

(3) Decline in the water quality of streams within afforested areas – It has been demonstrated that the afforestation of blanket bog areas has a detrimental effect on the water quality of streams and rivers (O' Halloran *et al.*, 1996). The drainage of a peatland area leads to an increase in the amount of peat solids which enter rivers and streams, which in turn contributes to the silting up of the spawning beds of salmon and trout. Mature conifer plantations have also been implicated in increasing the acidity and aluminium concentrations of stream waters (Omerod *et al.* 1993). This increased acidity and aluminium concentration in turn leads to a decrease in the numbers of salmonids and a decrease in the numbers and diversity of invertebrates. This decline in invertebrate numbers has been tentatively linked to the decline of certain bird species in blanket bog/upland rivers, such as the Dipper (Fielding and Haworth, 1999).

4.3 Peat extraction

It has been estimated by that approximately 48% of the blanket bog habitat has been lost or severely damaged by peat extraction (Foss, 1998). Most of this cutting has been carried out by private individuals for domestic consumption and in the past, cutting by hand was the main method of extraction. For purposes of this overview, peat extraction is divided into three main types namely hand-cutting by private individuals, machine-cutting by private individuals and industrial extraction by Bord na Mona.

Hand-cutting of blanket bog peat by private individuals has, in the past, been the most common method of peat extraction in blanket bog areas however at present the area cut by mechanical methods (see below) is much larger. Hand-cutting of blanket bog involves the extraction of peat in the form of individual pieces of turf from a face-bank with the aid of a turf spade or slean. Each year a width of peat (generally around 1 metre) is cut from the face-bank and the turf is placed on both the uncut bank and cut surface to dry. Prior to

cutting, the growing vegetation of the blanket bog (known as a sod or scraw) is removed and thrown back onto the cut surface of previous years. If these sods remain undisturbed there may be limited regeneration of modified dry heath vegetation dominated by *Calluna vulgaris* and various grasses, e.g. *Agrostis* spp., *Molinia caerulea*. If an area of turbary is abandoned at an early stage, flooding of old cuttings may occur and, in time, these may become recolonized by bog species typical of wet, acid conditions such as *Sphagnum cuspidatum, Eriophorum angustifolium, Drosera* spp. and *Utricularia* spp.. Although secondary habitats such as these can never replicate all of the elements of intact blanket bog, they do provide habitat for a variety of blanket bog flora and fauna and thus have a considerable conservation value. Because of the long history of peat cutting by hand the process is the single biggest reason for loss of blanket bog habitat in Ireland. Foss (1998) estimated that approximately 45% of blanket bog has been modified or lost to extraction of peat by private individuals and most of this area was initially cut by hand.

Up until the mid-1970's almost all of the private peat extraction in blanket bogs was carried out by hand. From the mid-1970's onwards however there was a rapid increase in the use of mechanical extraction of peat by tractor-powered devices. The mechanical extraction of peat in blanket bogs has been encouraged to a large extent by the grant-aiding of machinery under the 1981 Turf Development Act. In addition to making the cutting of peat a largely labour-free task, the mechanisation of peat extraction has also enabled more remote areas of blanket bog to be accessed and has facilitated the extraction of larger volumes of peat. The first of the mechanical devices to come into common use was the tractor-mounted Difco machine (also popularly known as the sausage machine) which extracts peat from a narrow and deep trench. Peat is then extruded from pipes to form long cylindrical peat 'sausages', a process which is not dissimilar to squeezing toothpaste from a tube. This method of extraction causes severe disruption to the hydrology of the peatland area and furthermore, the blanketing of the bog vegetation by the extruded peat results in the death of much of this vegetation. If an area of blanket bog is very wet, cutting by Difco machine can often be carried out only once, which leads to a great waste of the peat resource. The advent of the Difco machine was also significant in that it allowed the cutting of blanket peat areas previously considered too remote to access.

From the mid-1980's onwards there has been a dramatic rise in the use of the excavator and hopper method of peat extraction on both blanket and raised bogs. This method involves the excavation of large blocks of face-bank peat by an excavator and the placing of this peat in a tractor-mounted hopper, which compacts and extrudes the peat in the form of long 'sausages'.

Large-scale industrial extraction of blanket peat by Bord na Mona is largely confined to an area of approximately 7000 hectares north and west of Bellacorrick in county Mayo. At this location milled peat is used to power an electricity generating station. This large-scale extraction of blanket peat has resulted in a bleak landscape of undulating peat surfaces largely devoid of vegetation, however revegetation of certain types of bog vegetation is occurring in small, abandoned areas of cutaway, albeit at a very slow rate (Farrell and Doyle, 1998). In the past, areas of blanket bog in counties Donegal and Galway were cut for sod peat production in order to supply small power stations, however these power stations are no longer in use (Feehan and O' Donovan, 1996).

4.4 Sheep farming

The years since the introduction of the Ewe Premium in 1980 have seen a dramatic increase in the numbers of sheep in the Republic of Ireland. This rise in numbers has been due to the payment of a subsidy per sheep, a practise which encourages the accumulation of larger sheep flocks. In 1980 there were approximately 3.1 million sheep in the country and this figure rose to a high of approximately 9 million in 1991 (Redmond, 2000). Since then there has been a slight drop in sheep numbers, which lie around 8 million at present. The increase in sheep numbers has been particularly marked along the western seaboard of Ireland (Bleasdale, 1995), where blanket bog is most extensive and well-developed, and this increase has been implicated in the overgrazing and subsequent erosion of blanket peat in the region (Bleasdale and Sheehy Skeffington 1995, MacGowan and Doyle 1997). Peat erosion due to overgrazing by sheep has been particularly acute within blanket bog commonages of counties Galway and Mayo, however damage has also occurred to a lesser degree in other counties such as Waterford, Wicklow, Kerry, Sligo and Donegal. The reasons for the greater incidence of peat erosion in Galway and Mayo are complex, however the fact that there is relatively little good quality permanent pasture on which to overwinter sheep in these areas is a major factor. As a result of the scarcity of good land, sheep are kept out on the blanket bog commonage for a much longer period than in other parts of the country. The very high levels of rain experienced in these areas of the country, i.e. > 1400mm per year, also contributes to an accelerated rate of peat erosion, once damage has been initiated by overgrazing. Grazing damage to blanket bog pNHA's/pSAC's is known to be widespread (Foss and O' Connell, 1996), with at least 50 sites, occupying an area of 54,220 hectares considered to be damaged by overgrazing to some extent. Although many of these sites still retain substantial undamaged areas it is noteworthy that a number of large upland sites, e.g. the Twelve Bens/Garraun Complex and the Mweelrea/Erriff/Sheeffry Complex, are severely affected.

Although it has been demonstrated that peat erosion has been taking place in areas of mountain blanket bog in Co. Wicklow for at least 3000 years and in Co. Donegal for approximately 1500 years (McGee and Bradshaw, 1990) there can be little doubt that much of the present erosion of blanket bog has been initiated by excessive numbers of sheep. Intensive grazing and trampling of bog vegetation by sheep results in the creation of bare peat areas and these bare patches are subsequently enlarged by a combination of continued grazing/trampling and the erosive action of rain and wind. The effects of grazing on blanket bog vegetation in western Ireland have recently been well documented by a number of authors such as Bleasdale (1995), MacGowan and Doyle (1997) and McKee *et al.* (1998). McKee *et al.* (1998) have demonstrated that high levels of sheep grazing in the Maum Turk Mountains, Connemara can produce striking changes in blanket bog/wet heath vegetation. At a low altitude (c. 100m) intact blanket bog/wet heath vegetation dominated by *Molinia caerulea* with frequent *Calluna vulgaris, Erica tetralix, Trichophorum caespitosum* and *Sphagnum capillifolium* is replaced by vegetation dominated by *Nardus stricta* and *Carex panicea.* At an altitude of 350, metres heavy grazing intensity results in a change from vegetation dominated by *Eriophorum vaginatum, Calluna vulgaris, Vaccinium myrtillus* and *Empetrum nigrum* to a much more species-poor vegetation dominated by *Eriophorum vaginatum* while species such as *Vaccinium myrtillus, Empetrum nigrum* and *Deschampsia flexuosa* are either absent or have a greatly reduced cover.

MacGowan and Doyle (1997) studied the changes in species composition of blanket bog in relation to overgrazing in Connemara and found that a large number of plant species have a much reduced cover or are absent in overgrazed areas. Plant species which disappear under heavily grazed conditions include *Pedicularis sylvatica, Pinguicula vulgaris, Pinguicula lusitanica, Sphagnum magellanicum, Sphagnum tenellum, Sphagnum pulchrum, Sphagnum cuspidatum* and *Leucobryum glaucum,* while species such as *Hypnum jutlandicum, Drosera rotundifolia, Drosera anglica, Sphagnum papillosum* and *Calluna vulgaris* have a much reduced cover (see Table 26). The reduction in cover and/or disappearance of these species from overgrazed areas is due to changes in the peat hydrology (i.e. lowering of the water table) and surface stability caused by erosion of surface peat.

In the uplands of County Antrim relatively high levels of sheep grazing, i.e. >1.9 sheep per hectare, have resulted in a change from vegetation dominated by *Calluna vulgaris* and *Eriophorum vaginatum* to a vegetation type dominated by *Molinia caerulea* and *Eriophorum vaginatum* (McAdam, 1995). In the Shetland Islands, Hulme and Birnie (1997), have reported that when an area of blanket bog is heavily grazed by sheep, plant species such as *Calluna vulgaris, Empetrum nigrum, Erica tetralix, Eriophorum vaginatum*

and *Scirpus caespitosus* decline in cover while *Carex panicea, Nardus stricta, Festuca vivipara, Luzula multiflora* and *Potentilla erecta* increase in cover. These observations are in broad agreement with observations in the west of Ireland.

Thus, in summary, the main effect of high levels of sheep grazing on wet peat soils is to reduce the cover of dwarf shrubs such as *Calluna vulgaris* and *Erica tetralix*. At the same time there is an increase in the cover of graminoid species such as *Molinia caerulea* and *Eriophorum vaginatum*. If these high levels of grazing are continued for an extended period of time, erosion of surface peat occurs and rhizomatous species such as *Nardus stricta* and *Eriophorum angustifolium* are among the few plant species to colonise and persist.

Table 26. The frequency of occurrence of plant species in intact and eroded areas of blanket bog outlined by MacGowan and Doyle (1997). The symbols denote the frequency of species as follows: V = Occurrence of in 81- 100% of quadrats; IV = Occurrence in 61 – 80% of quadrats; III = Occurrence in 41 – 60% of quadrats; II = Occurrence in 21 – 40% of quadrats; I = Occurrence in 11 – 20% of quadrats; + = Occurrence in 6 –10% of quadrats. Species recorded from < 5% of quadrats are omitted from this table.

Species	Frequency of occurrence in intact areas	Frequency of occurrence in overgrazed areas
Species with a much decreased frequency of occurrence in eroded areas		
Calluna vulgaris	V	III
Potentilla erecta	V	III
Hypnum jutlandicum	IV	II
Drosera rotundifolia	IV	I
Drosera anglica	III	I
Campylopus paradoxus	III	+
Sphagnum papillosum	III	+
Odontoschisma sphagni	II	+
Pedicularis sylvatica	II	absent
Sphagnum magellanicum	II	absent
Sphagnum tenellum	II	absent
Sphagnum pulchrum	I	absent
Sphagnum auriculatum	I	absent
Leucobryum glaucum	I	absent
Sphagnum palustre	I	absent
Species with an increased cover in eroded areas		
Zygogonium ericetorum	III	V
Eriophorum angustifolium	I	V
Erica cinerea	absent	I
Juncus bulbosus	absent	+
Cephalozia lunifolia	absent	+
Hypnum cupressiforme	absent	+
Kurzia pauciflora	absent	+
Cladonia pyxidata	absent	+
Nardus stricta	absent	+

There has been much debate recently as to the desirable stocking levels of sheep on blanket bog. In general, there appears to be little consensus even between various conservation bodies in Britain where stocking densities of between 0.25 and 1 sheep per hectare of blanket bog have been suggested (see Shaw and Wheeler, 1997). In Ireland, there are no specific stocking densities suggested for blanket bog areas under the Rural Environment Protection Scheme (REPS). The determination of the correct stocking densities for areas of blanket bog is extremely problematic because within each blanket bog commonage there can exist a mosaic of different soil and vegetation types which have a different susceptibility to grazing pressure (Bleasdale, 1995). Furthermore, the distribution of sheep within an area of blanket bog may be uneven due to factors such as accessibility and the siting of supplementary feeding areas. In Britain there is general agreement that, in the case of areas of relatively uniform lowland blanket bog, stocking densities should be in the region of 0.3 sheep per hectare and no higher than 0.4 sheep per hectare (Burgess *et al.*, 1995). Higher densities, i.e. up to 1 sheep per hectare, may be permitted in blanket bog areas where sheep are only grazed during the summer months (Burgess *et al.*, 1995), however in many blanket bog areas in the west of Ireland there is a scarcity of good quality agricultural pasture on which to overwinter sheep. In Ireland there has been little large-scale experimentation on the effects of grazing on blanket bog and related habitats. Much of the research has been directed towards observing the effects of grazing in areas where the stocking densities of sheep (both past and present) are unknown and observing the recovery of vegetation within grazing exclosures. It is becoming increasingly apparent that areas of blanket bog which contain more than 5-10% bare peat will require the exclusion of all or most of the grazing animals in order to facilitate the recovery of the vegetation (Dúchas and DAF, 1999).

4.4.1 Extent of current grazing damage on blanket bogs

Because of the damage which recent overgrazing has caused within commonage areas, a damage assessment survey, known as the Commonage Framework Plan survey, has been instigated jointly by the Department of Agriculture and Food and Dúchas, The Heritage Service. This survey was initiated in 1999 and the eventual aim is to survey and assess the condition of most commonage areas in the Republic of Ireland. The primary aim of the survey is to assess and document the condition of commonage areas (and proposed SAC's, NHA's and SPA's) and, arising from this, to recommend a destocking level for each commonage or site surveyed. Within the scheme, damage is assessed according to a 6 point scale ranging from U (undamaged) to S* (very severely damaged) and each point on this

scale has an associated destocking level. The criteria for the assessment of this damage and the resultant destocking levels are shown in Table 27.

Table 27. An outline of damage assessment categories and suggested destocking levels utilised in the Commonage Framework Plans (Dúchas and DAF, 1999).

Damage category	Condition of vegetation/amount of bare soil	Suggested destocking level
Undamaged (U)	Vegetation not grazed or only very lightly grazed. No bare ground present.	0% destocking
Moderate to undamaged (MU)	<5% bare ground. Grazing usually evident, but damage only just detectable.	30% destocking
Moderately damaged (MM)	<5% bare ground. Signs of damage intermediate in intensity between MU and MS.	50% destocking
Moderate to severely damaged (MS)	<5% bare ground. Damage widespread and obvious.	65% destocking
Severely Damaged (S)	>5% bare ground. Damage due to grazing obvious and widespread.	85% destocking
Very Severely Damaged (S*)	>10% bare ground with abundant evidence of high grazing levels.	100% destocking

In addition to mapping the extent and severity of grazing damage within commonages, the habitats occurring within these areas were also indicated. The following habitats were recognised during the surveys:

(I) - Blanket bog
(II) - Wet heath
(III) - Dry heath
(IV) - Upland grassland
(V) - Other habitats, e.g. woodland.

In each Commonage Framework Plan survey the area is walked by an agricultural assessor and an environmental assessor and the composition and condition of the vegetation is assessed. Within any given commonage there may exist a mosaic of different habitats and

damage categories, however in the final analysis the damage is weighted to give a destocking level for the commonage as a whole. In addition to this work the vegetation composition of a number of discrete areas within the commonage (usually 10m x 10m in size) are surveyed in detail and photographs taken. It is hoped that such areas will provide some basis for future monitoring of the condition of the commonage. In the future the stock density alterations (if any) suggested as a result of this work will be taken into account by planners when advising on the appropriate stocking levels for commonages and designated sites. The future monitoring of the effect of stock reductions within damaged areas will be essential in order to assess whether recovery of the soil and vegetation does occur.

In the following sections the preliminary results of grazing damage from commonages in Counties Galway, Mayo, Donegal and Kerry are presented. For each county two figures are calculated, the condition of the total commonage area and the condition of the commonage areas that are known to comprise blanket bog or vegetation mosaics that include blanket bog. At this stage in the analysis only a small proportion of the total commonage areas have been looked at, however the general trends are of interest and are deserving of comment.

4.4.1.1 The condition of blanket bog commonage areas in Co. Galway

The condition of 14,961 hectares of blanket bog commonage in Co. Galway has been assessed (see following figure). These results show that 42.2% of the area is categorised as undamaged, while 22.7% falls within the MU category. This suggests that 64.9% of the commonage area surveyed is either undamaged or only slightly damaged and 35.1% is moderately to severely damaged. In addition it is important to note that substantial areas are considered to be severely and very severely damaged with figures for categories S and S* of 7.7 and 7.0% respectively. Damage statistics for commonage areas that contain blanket bog are broadly similar to those for all habitats within the commonage.

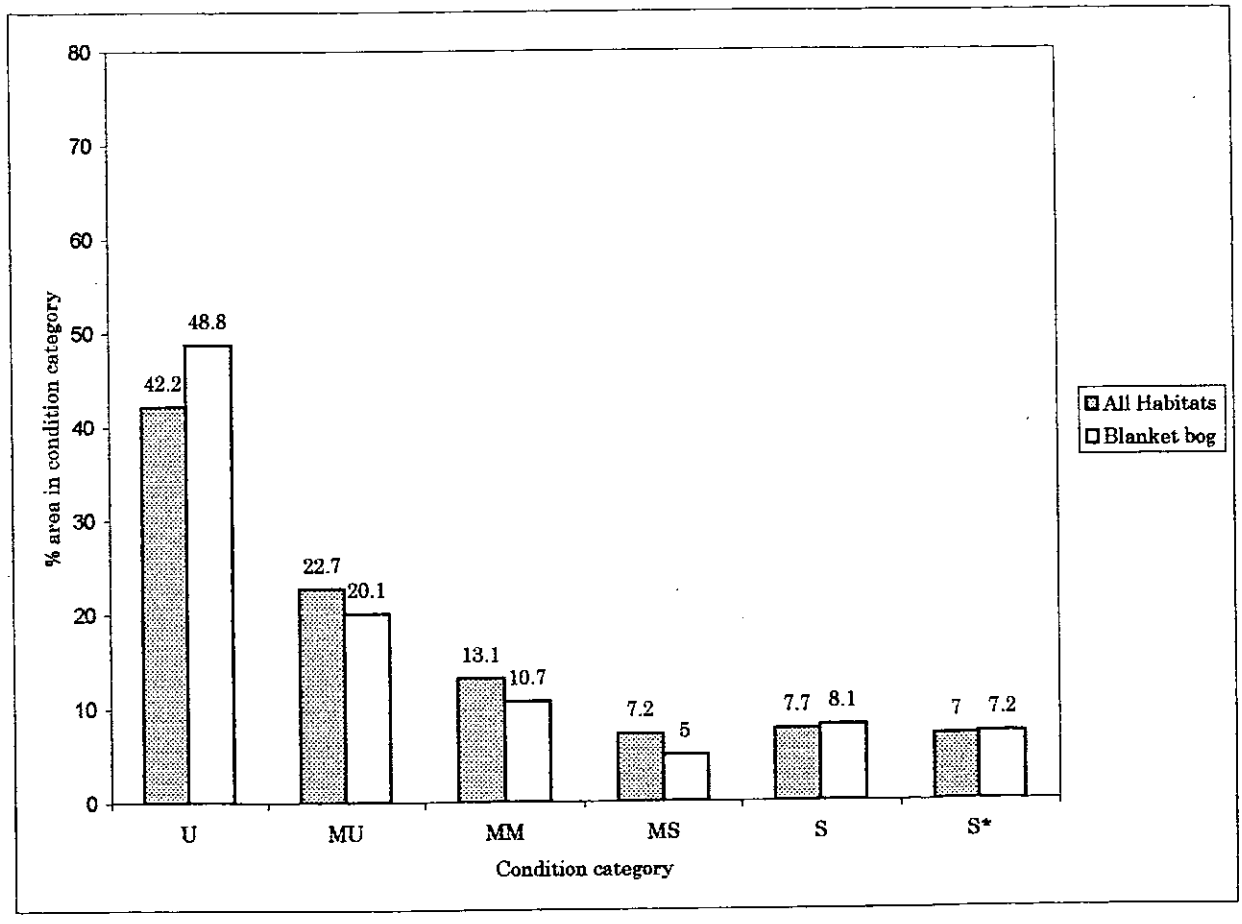


Figure 8. The condition of a selection of commonage areas in Co. Galway in relation to grazing damage. Data from commonage framework surveys carried out by Dúchas and Department of Agriculture and Food.

4.4.1.2 The condition of blanket bog commonage areas in Co. Mayo

The condition of 16,479 hectares of blanket bog commonage in Co. Mayo has been assessed (see following figure). The results for Mayo show that a relatively small proportion (33.4%) of the total commonage area surveyed is classified as undamaged, while 27.8% falls within the MU category, giving a total of 61.2% of the area classed as undamaged or only slightly damaged. When compared with County Galway, it would appear that the commonage areas surveyed in Mayo are generally more damaged and this is most evident in the higher percentage of commonage area in the damage categories MS to S*. Another striking observation of the Mayo figures is that areas of commonage that contain blanket bog have a much higher proportion of area in the undamaged (U) category.

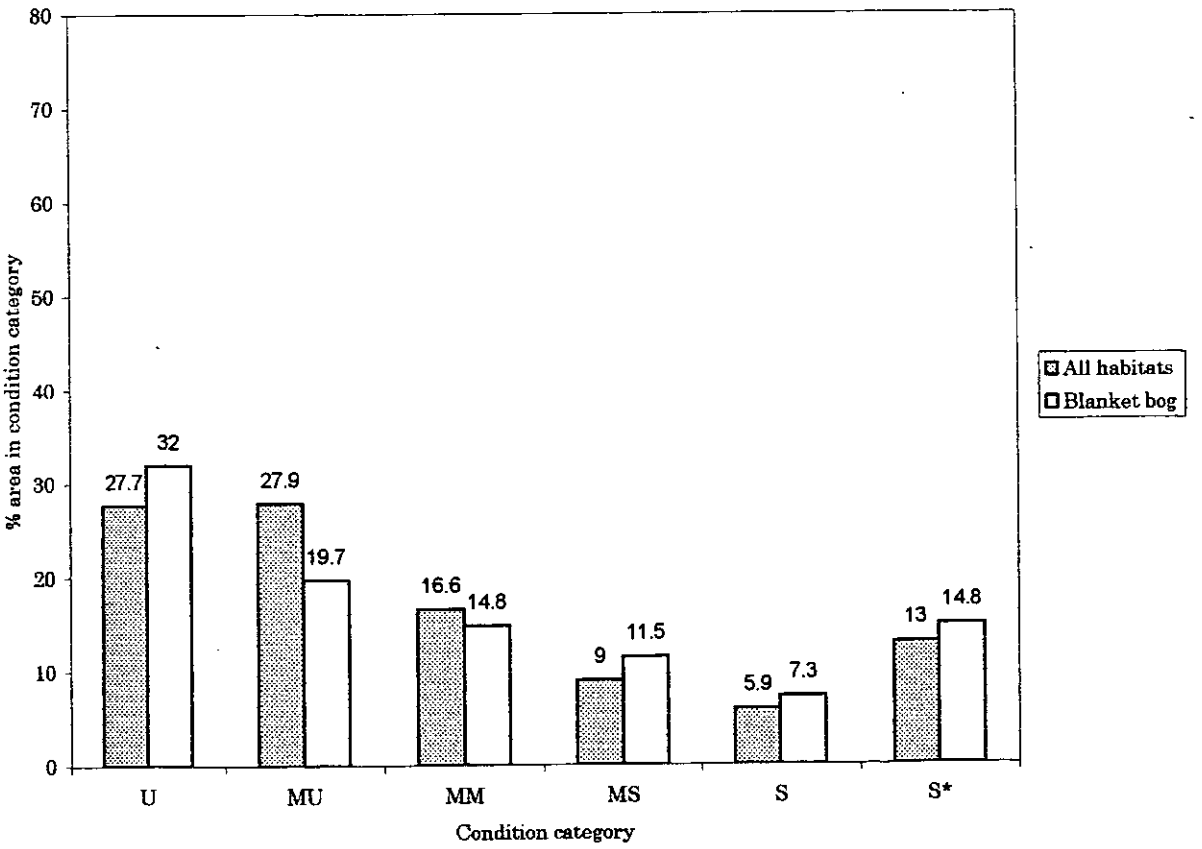


Figure 9. The condition of a selection of commonage areas in Co. Mayo in relation to grazing damage. Data from commonage framework surveys carried out by Dúchas and Department of Agriculture and Food.

4.4.1.3 The condition of blanket bog commonage areas in Co. Donegal

The condition of 21,756 hectares of blanket bog commonage in Co. Donegal has been assessed (see following figure). The most striking aspects of the results for the county are the very large proportion of commonage area classified as undamaged (72.1%) and the very low area of severe and very severe damage (<2%). A total of 92% of the commonage area surveyed is considered to be undamaged or only slightly damaged. The for undamaged commonage is much higher than those for counties Galway and Mayo and suggest that overgrazing is much less of a problem in
county Donegal. There is generally little difference between the figures for commonage areas containing blanket bog and those for the entire commonage area.

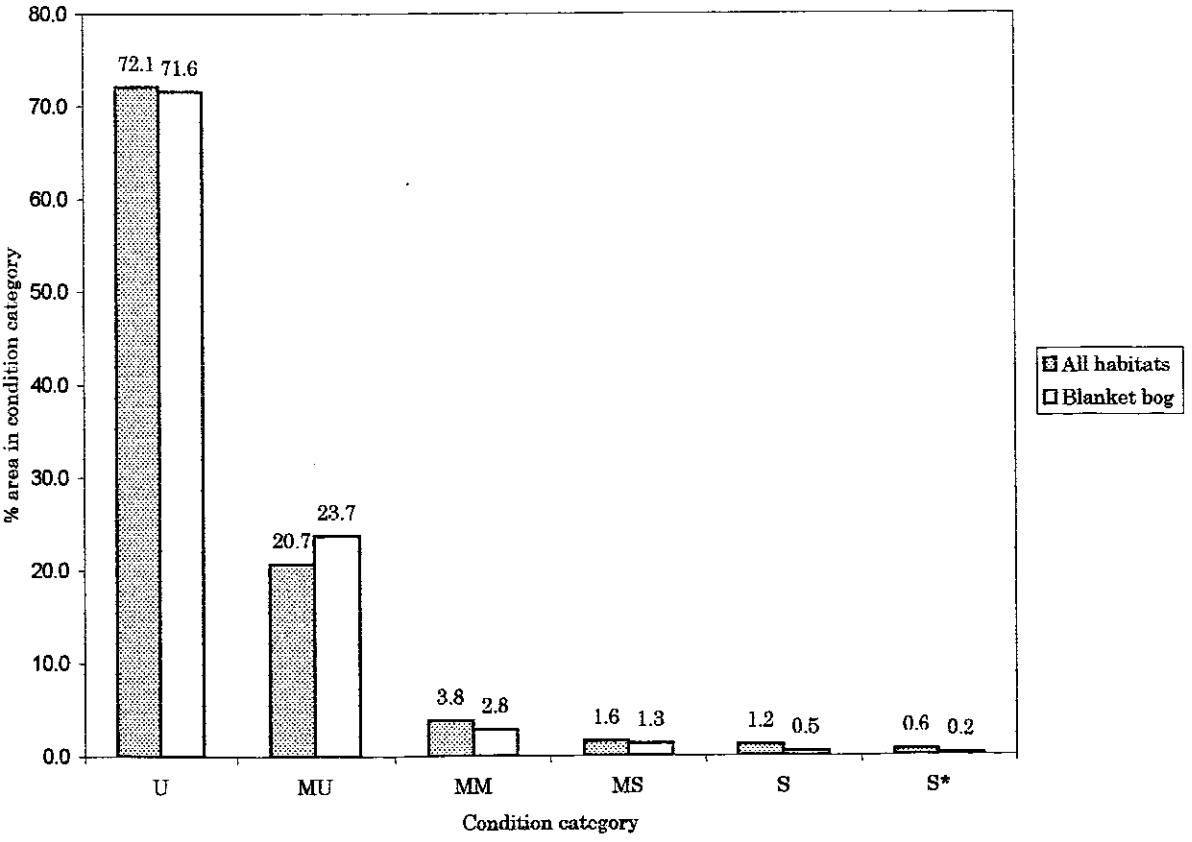


Figure 10. The condition of a selection of commonage areas in Co. Donegal in relation to grazing damage. Data from commonage framework surveys carried out by Dúchas and Department of Agriculture and Food.

4.4.1.4 The condition of blanket bog commonage areas in Co. Kerry

The condition of 6,945 hectares of blanket bog commonage in Co. Kerry has been assessed (see following figure). The proportion of commonage area within the undamaged and the moderate to undamaged categories is quite high (76.8% of total commonage area and 82.2% of areas dominated by blanket bog). In addition, the level of damage to commonage areas containing some blanket bog is relatively low. The general picture in this county suggests that erosion due to overgrazing by livestock is less severe than observed in Galway and Mayo, however the level of damage is higher than in Donegal.

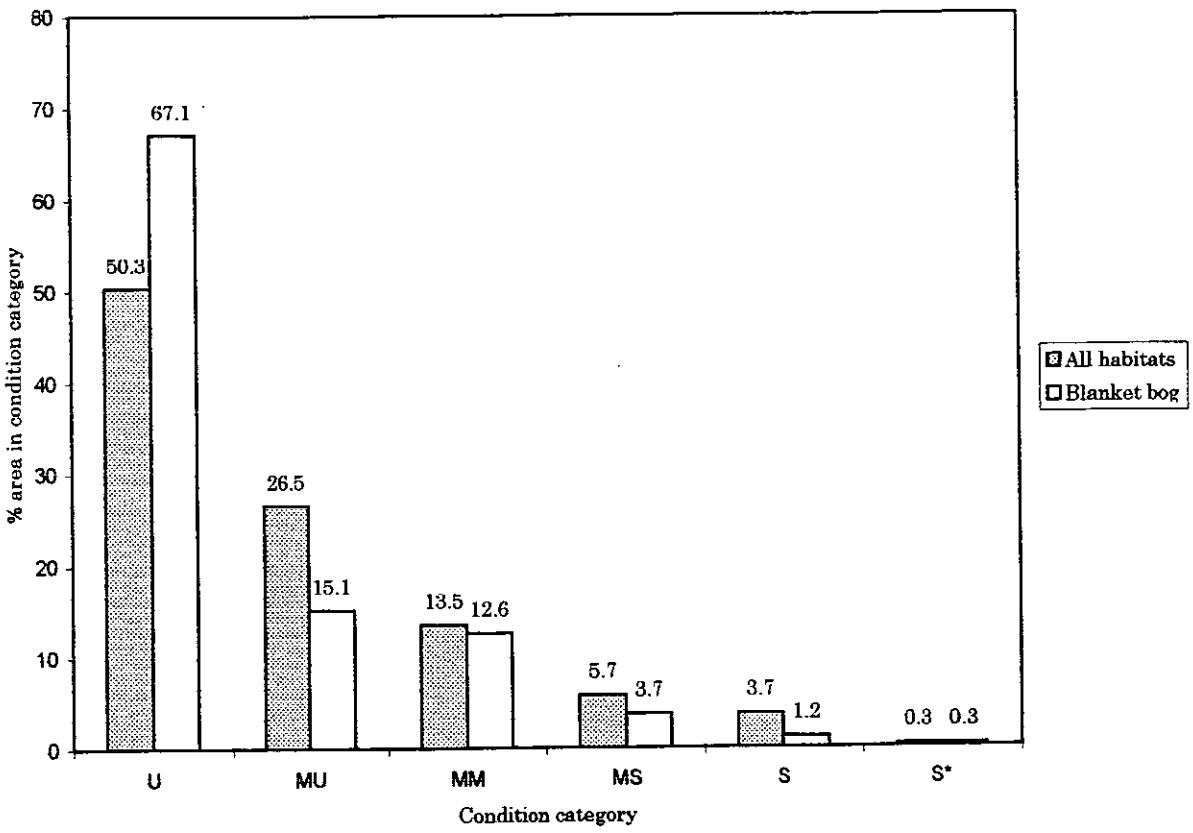


Figure 11. The condition of a selection of commonage areas in Co. Kerry in relation to grazing damage. Data from commonage framework surveys carried out by Dúchas and Department of Agriculture and Food.

4.5 Agricultural reclamation

Although the reclamation of blanket bog for agricultural purposes has generally not been widely recognised as a major factor in the loss of blanket bog habitat in Ireland, there can be little doubt that this long established landuse has been responsible for the destruction of substantial areas of the habitat (Feehan and O'Donovan, 1996). The reclamation of blanket bog and heath areas for agricultural purposes is one of the oldest forms of peatland use. There is evidence that reclamation of peatlands was taking place as early as the 16th century and the utilisation of bog areas for rough grazing must have been taking place long before this (Feehan and O' Donovan *op. cit.*). In general, due to the shallow nature of the peat present, areas of wet and dry heath have traditionally been favoured for reclamation much more than blanket bog which is associated with deeper peats. In the west of Ireland the reclamation of small areas of adjoining blanket bog has traditionally been a popular way of increasing the size of an agricultural holding. At present such areas are mainly used as rough grazing for cattle and sheep however, in the past, reclaimed peatland was also used successfully for growing a limited range of crops such as potatoes and oats. In order to successfully reclaim an area of blanket bog, the area has to be first ploughed and in many areas a deep ploughing technique is used. Deep ploughing improves soil drainage and permeability by breaking the impermeable iron pan layer associated with peat soils. In order to facilitate drainage within the reclaimed area drains have to be dug and these may be either open or covered. After the initial reclamation works the area is generally reseeded with a mixture of agricultural grasses and clovers, however the maintenance of good quality grasslands on such nutrient-poor, peaty soils requires the regular application of fertilisers (Feehan and O' Donovan *op. cit.*). Although areas of blanket bog and heath can be reclaimed initially with relative ease, such areas will quickly revert to rushy pasture dominated by *Juncus effusus* if they are neglected for any length of time. At present the area of blanket bog being reclaimed for agricultural purposes in the west of Ireland is relatively small due to the relatively expensive nature of the work.

4.6 Burning

In areas of deep, wet lowland blanket bog burning is a relatively infrequent occurrence and, as a result, the action does not normally pose a serious threat to the integrity of such areas. The relatively low frequency of fire on areas of deep blanket bog is primarily due to the low cover of dwarf woody shrubs, especially *Calluna vulgaris*, and the relative dampness of the bog surface, even during the summer months. However, burning can be a serious problem in areas of lowland blanket bog which have a relatively shallow, i.e. <2m, peat depth (and thus have a drier surface) or have had their water table lowered by drainage. Burning is

also more frequent in areas of upland blanket bog, such as the Wicklow Mountains, and heath areas adjoining lowland blanket bog, where drier conditions exist and the cover of woody dwarf shrubs, especially *Calluna vulgaris*, is high. In the case of lowland blanket bog and heath, the effects of burning have been little documented, however there is some information regarding the effects of fire on the vegetation of the drier upland blanket bog areas in Ireland.

McFerran *et al.* (1995) studied the regeneration pathway of *Calluna*-dominated vegetation after fire at an upland site to the south-east of Ballycastle, County Antrim (altitude 240 to 260m). They found that there was a marked increase in the frequency of species such as *Molinia caerulea, Vaccinium myrtillus, Deschampsia caespitosa* and *Eriophorum vaginatum* in the years following burning. They also observed that, even in the absence of grazing, it took *Calluna vulgaris* a considerable time to reassume dominance. From this work it is reasonable to speculate that species such as *Molinia* and *Eriophorum vaginatum* may attain dominance, at the expense of *Calluna*, in burned areas that are subsequently grazed by livestock.

According to Brooks and Stoneman (1997), the main effects of fire on bog vegetation are as follows:

(1) The combustion of both live plant biomass and dead litter - This may result in the exposure of bare peat which may in turn lead to erosion. The removal of the litter layer in this way will also contribute to the drying out of the bog surface.

(2) The desiccation of surface peat by burning increases the firmness of peat, which in turn reduces the water holding capacity.

(3) Burning leads to a decrease in the cover of bog mosses which form high hummocks, e.g. *Sphagnum imbricatum* and vascular plant species typical of very wet conditions, e.g. *Vaccinium oxycoccus* and *Drosera anglica.*

(4) The process also encourages the dominance of tussock-forming graminoid species, i.e. *Eriophorum vaginatum* and *Molinia caerulea*, while in the long term, particularly in areas of mountain blanket bog, the dominance of *Calluna vulgaris* may result.

In summary the main effects of burning are the creation of bare peat areas, the reduction in the water holding capacity of the peat and the ultimate dominance of bog species more typical of dry conditions at the expense of those characteristic of wet, waterlogged conditions. It must be noted that the severity of burning varies greatly and is dependent on a complex suite of factors such as bog wetness, wind strength, amount of accumulated litter and the frequency of burning. A number of authorities including Shaw and Wheeler (1997), Brooks and Stoneman (1997) suggest that in general, the burning of blanket bogs should not be used as a management tool.

4.7 Windfarm development

Within the past five years the development of windfarms for the production of electricity has become a significant threat to existing areas of intact blanket bog and heath (Douglas, 1998). Due to the current competitive nature of the AER (Alternative Energy Requirement) Scheme in Ireland upland areas above an altitude of 200 metres, located primarily in the western half of the country, have been targeted for development. In addition, the perceived low agricultural value of such land is an important factor influencing the siting of wind farms in upland areas dominated by blanket bog and heath. In view of the fact that the assessment of the upland blanket bog resource by the National Parks and Wildlife is incomplete, many good-quality highland and mountain blanket bog have yet to be surveyed, documented and assessed. This observation is particularly relevant to upland areas of East Donegal, North Leitrim and North Cork which have received little in the way of focussed habitat survey in the past. As a consequence, unless remaining areas are urgently surveyed, some areas of high-quality blanket bog/wet heath habitat will be irretrievably damaged by wind-farm development. In recent years at least one high quality mountain blanket bog/wet heath site in Co. Donegal, i.e. Barnesmore, has been significantly fragmented and severely damaged by a 25 turbine development (C. Douglas, 1998).

At present windfarm developments in Ireland generally comprise between 5 and 20, 70 metre tall (including blades) wind turbines, each producing 0.5 megawatts (MW) of power. The short-term future aim is that the amount of wind power produced in Ireland should be developed at 100MW per annum up to 2010 (Department of Public Enterprise, 2000). This will reduce reliance on fossil fuels, hence reducing carbon emissions and avoiding costly future carbon taxes. If the 1000MW target is to be met by 2010 it will necessitate for example, the construction of one hundred wind farms, each containing 20, 0.5MW turbines. Since many wind farms currently only contain between 5 and 15 turbines, it is possible that the number of wind farms eventually constructed to attain production goals will greatly exceed one hundred. The construction of a wind farm requires both considerable area and construction works. Turbines have to be placed at least 200m apart which implies that a 20 turbine wind-farm will require a site area of at least 2 km^2. Each wind turbine is sited on a substantial cement foundation which measures approximately 7 metres square and contains approximately 110 cubic metres of cement (Douglas, 1998). In areas of intact blanket bog, the siting and maintenance of the turbines requires the construction of a network of gravel roads, similar in quality to forestry roads. This road building in particular causes much damage to the hydrology of the blanket bog and effects the stability of peat deposits resulting in peat slides or bog bursts. In addition to the damage caused to the vegetation of blanket bog through direct physical damage and serious changes to the

hydrology of the bog there is evidence that wind farms have a detrimental effect on the behaviour and feeding habits of upland birds such as the golden plover and grouse. Clearly more research is needed in order to fully assess and quantify the scale of this disturbance. At present wind farm developments do not require a full environmental impact assessment although most planning applications are accompanied by an environmental impact statement. In the future it is imperative that the ecological value of land on which any wind-farm development is proposed is assessed by qualified personnel. In addition, such developments, if sited in uplands should be confined to areas of low ecological value or areas with an existing road infrastructure such as areas of cutaway bog or clear-felled coniferous forestry.

4.8 Overall assessment of damaging operations affecting blanket bogs

The following table outlines the main impacts and the extent and future trends of the main damaging operations that affect blanket bog areas. In the historical past, hand-cutting of peat and reclamation have been the main causes of habitat loss. Within the past thirty years afforestation, mechanical extraction of peat and erosion due to the overstocking of sheep have emerged as the most significant causes of habitat loss. These are likely to continue, especially on peatlands which lie outside of protected areas such as Nature Reserves, proposed Natural Heritage Areas and proposed Special Areas of Conservation. The unsympathetic siting of wind farms is also becoming an increasing problem in blanket bog areas.

Table 28. An overview of the main damages influencing blanket bog areas, the main ecological effects, approximate extent and likely future trends (Figure based on estimates given in Foss (1998)).

Damage type	Main ecological effects	Approximate percentage of original blanket bog area affected	Likely future trends of damage
Extraction of peat (Hand-cutting)	Severe damage to hydrology of peatland, however some plant survival. Regeneration to *Calluna* heath and wet Sphagnum pools in places.	45%	Rapidly declining in intensity. Has been replaced by mechanical extraction in most areas.
Afforestation	Complete elimination of resident flora and fauna within 15-20 years. Also detrimental effect on aquatic life of rivers and streams. Leads to fragmentation of remaining blanket bog areas.	27%	Now unlikely within peatland SAC/NHA areas. Set to continue on undesignated peatlands, especially those developments funded by the private sector.
Overstocking	Where very severe, complete erosion of peat occurs with very poor prospects for recovery. Spread of unpalatable species, e.g. *Nardus stricta*. Detrimental effect on aquatic life of rivers and streams due to peat run-off.	10-15%	Intensity set to decline when destocking recommendations are implemented.
Burning	Repeated burning leads to high cover of graminoids and low Sphagnum cover. Generally not a common occurrence in deep peat areas.	<5%	Future incidence uncertain. Risk greatest in areas close to urban areas, e.g. Wicklow Mountains.
Agricultural reclamation	Usually results in the total elimination of the resident peatland flora and fauna.	<5%	Probably declining in intensity mainly due to the discontinuation of grant aid for the practice
Mechanical peat extraction	Severe damage to hydrology of peatland, however some of the less specialised plant species may survive.	3%	Increasing in intensity. Practice dependent on fuel prices.
Wind farm development	Although much intact surface can remain, roadway and turbine base construction leads to severe hydrological damage of peatland and can also lead to peat slippage. Can cause the displacement of resident bird populations.	<<1%	Intensity of development set to increase very rapidly.

CHAPTER 5. A REVIEW OF BLANKET BOG SURVEYS IN THE REPUBLIC OF IRELAND

5.1 Introduction

Although only a relatively small proportion of the estimated original blanket bog areas within the country was surveyed by the National Parks and Wildlife Service during the years 1987, 1989, 1990 and 1991, it is thought that the sites surveyed constituted the majority of the best extant examples of the different blanket bog types. Due to constraints of manpower and time the site surveys were of necessity brief, however adequate information was gathered to enable the description and subsequent assessment and ranking of sites. Although the approach varied slightly from year to year, the same basic information was gathered and assessed in all surveys. Essential information gathered included an outline of the habitats present, the condition of site and the plant and animal species present. Particular attention was paid to the possible occurrence of protected or rare animal and plant species associated with the blanket bog habitat, e.g. *Anser albifrons flavirostris, Pluvialis apicaria, Saxifraga hirculus* and *Eriophorum gracile.* The accounts contained in the reports outline the composition and condition of sites and also contain detailed notes which describe the structure and composition of vegetation. During the surveys particular attention was paid to areas of sites which contain well-developed surface features such as pool areas, flushes and swallow holes. In addition to a site description, the boundary of the site surveyed is outlined on accompanying 6-inch maps and/or aerial photographs. The ultimate aim of the surveys was to rank the quality of the sites according to a 5 point scale which ranges from A to C (see Table 29). Although this ranking system is rather subjective, in practice it is relatively easy to classify sites into one of the five categories. An important point to note concerning this ranking system is that the size of the site is not an important factor, thus small sites of less that 10 ha in extent and of good quality and condition can receive a high rating.

The surveys were concentrated in the north-western counties of Mayo, Galway and Donegal where the largest extant areas of blanket bog occur. Relatively large areas of the habitat were also surveyed in counties such as Sligo, Kerry, Wicklow and Cork. The highland/mountain blanket bog survey conducted by Goodwillie and Mooney in 1991 was more wide-ranging in its geographical range, with sites in 12 counties throughout the island visited. Summary details of the surveys are outlined in Table 30.

Table 29. The classification criteria used for sites studied in blanket bog surveys.

	[illegible]	[illegible]	[illegible]	[illegible]
Category A	Very good	Very High	Very High	Very High
Category Bi	Mostly good	High/good	High	High
Category Bii	Occasionally disturbed	Moderate	Moderate	Moderate
Category Biii	Mostly disturbed	Low	Low	Moderate/low
Category C	Very disturbed	Very low	Very low	Low

Table 30. An overview of the blanket bog surveys conducted in the Republic of Ireland between 1987 and 1991. * = Area surveyed larger, however some details regarding site size is missing.

Year	Survey staff	Counties covered	No. of sites surveyed	Area (ha) surveyed
1987	C. Douglas, H. Grogan	Galway	18	8568
1987	P. Foss, E. McGee, C. Douglas, H. Grogan	Mayo	28	16936
1989	C. Douglas, L. Garvey, L. Kelly, A. O' Sullivan	Galway Clare	8 1	3828 230
1989	C. Douglas, L. Garvey, L. Kelly, A. O' Sullivan, L. van Doorslaer	Mayo	36	20255
1989	C. Douglas, L. Garvey, L. Kelly, A. O' Sullivan	Sligo Kerry	8 15	8608 2128
1990	C. Douglas, Dunnells, D., L. Scally, M. Wyse Jackson	Donegal Cavan Leitrim Roscommon	63 2 6 1	19315 1636 1156 198
1991	R. Goodwillie, E. Mooney, C. Douglas	Donegal Wicklow Kerry Galway Cork Laois Waterford Offaly Dublin Tipperary Wexford Limerick	31 11 34 2 9 5 7 1 1 1 1 1	6265* 3159* 2703* 2430 1828 947 479 144 143 51 58 11

5.2 General analysis of area surveyed

In the years 1987 and 1989-1991 a total of 101,280 hectares of blanket bog were surveyed in 18 counties (Table 31). When the areas of the different bog types surveyed are calculated, it is clear that lowland bog accounts for the greatest area with 63,140 ha (63% of total) surveyed. Highland bog is the next most common blanket bog type with 23,910 ha (23% of total), while mountain blanket bog accounts for the smallest area of the three types with 14,230 ha (14% of total) surveyed. It must be noted that the areas given for the different blanket bog types are approximate, as a site may contain more than one type of blanket bog.

Table 31. A breakdown of blanket bog surveyed by the National Parks and Wildlife Service, during the period 1987 to 1991, on the basis of bog type and county. * = Area surveyed larger, however some details regarding site size is missing.

County	Lowland bog (Ha)	Highland bog (Ha)	Mountain bog (Ha)	Total Area surveyed (Ha)
Mayo	32,154	4,485	552	37,191
Donegal	13,882	10,695*	1,003	25,580*
Galway	12,301	2,525	-	14,826
Sligo	2,531	4,659	1,418	8,608
Kerry	2,272	1,156*	1,403*	4,831*
Wicklow	-	-	3,159*	3,159*
Cork	-	390	1,438	1,828
Cavan	-	-	1,636	1,636
Leitrim	-	-	1,360	1,360
Laois	-	-	947	947
Waterford	-	-	479	479
Clare	-	-	230	230
Roscommon	-	-	198	198
Offaly	-	-	144	144
Dublin	-	-	143	143
Wexford	-	-	58	58
Tipperary	-	-	51	51
Limerick	-	-	11	11
Total	63,140	23,910	14,230	101,280

It is important to note that, in the case of many counties, the total area of blanket bog surveyed is much less than the actual area of blanket bog. A striking example of this is

provided by looking at the area details for blanket bog within the Slieve Bloom mountains which straddle counties Offaly and Laois. A total of 1091 hectares of blanket bog (in both counties) was surveyed by Goodwillie and Mooney in 1991, while the area of blanket bog present within the Slieve Bloom Mountains proposed SAC has been estimated at 3,265 hectares, or just over 3 times the area visited during the relevant bog survey. In addition, a number of previously surveyed areas of blanket bog, e.g. Roundstone bog, Co. Galway and parts of the Owenduff area, Co. Mayo, were not surveyed because they had been already surveyed and documented in the 1970's and early 1980's.

Perhaps the most striking observation of the survey results is the great variation in the area of blanket bog surveyed within counties. The total areas surveyed reflects, in a general way, the relative amounts of blanket bog habitat present in the different counties and gives a good impression of the distribution of the habitat. In Co. Mayo for example 37,191 hectares were surveyed, while at the other end of the scale, a mere 11 hectares were surveyed in Co. Limerick. Although the survey figures are not accurate estimates of the total amount of blanket bog they do give a good indication of the extent of the habitat present within each county. The three counties with the largest areas of blanket bog surveyed were Mayo (37,191ha), Donegal (25,580ha) and Galway (14,826). These three counties contain approximately 77% of the blanket bog surveyed and are clearly the headquarters of the habitat in the Republic of Ireland. The most important counties after these three, in terms of blanket bog area surveyed, are Sligo, Kerry and Wicklow. Six counties contain less than 230 hectares of bog surveyed and these are mostly located in the middle and east of the country where blanket bog is generally scarce and intact blanket bog is rarer still.

When lowland blanket bog is considered (see Figure 12), it is clear that County Mayo contains by far the largest area of the bog type surveyed (51% of the total). Donegal and Galway also contain large areas of this bog type, i.e. 22 and 19% of the total respectively, while Sligo and Kerry contain 4% each.

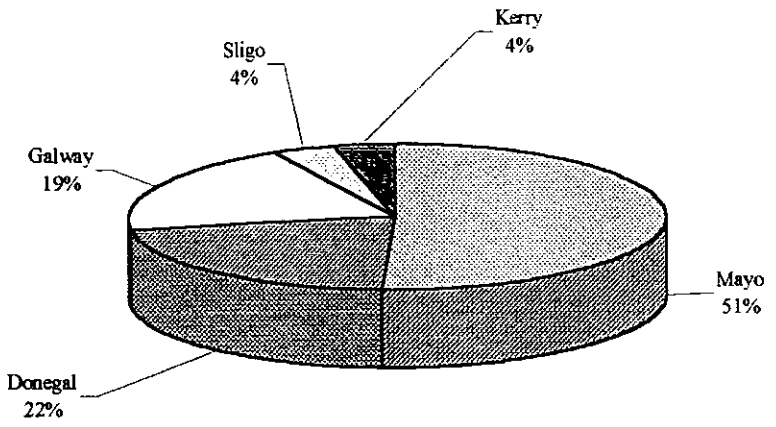


Figure 12. Breakdown of lowland blanket bog area surveyed on a county-by-county basis.

When highland blanket bog is considered (see Figure 13) it becomes apparent that Co. Donegal contains the largest area of bog type surveyed (44% of total area) with Sligo and Mayo containing the next largest areas of the type (19%). Galway also contains a significant area of this intermediate blanket bog type.

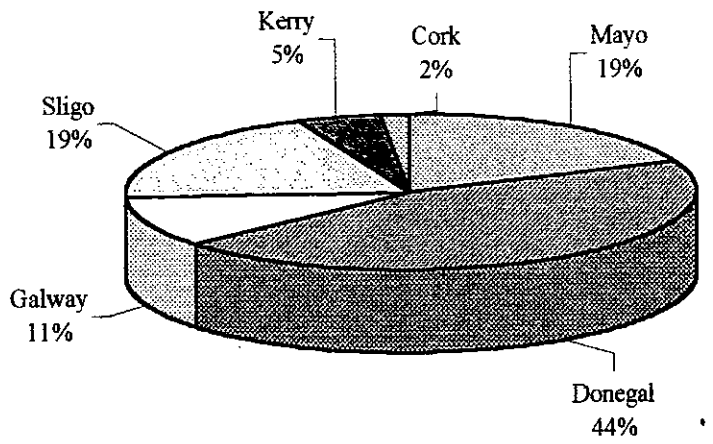


Figure 13. Breakdown of highland blanket bog surveyed on a county-by-county basis.

Of the three bog types identified in Ireland, mountain blanket bog has the widest geographical spread. This type of bog has been surveyed in 12 counties, however the total area of the habitat is small in comparison with lowland and highland bog. County Wicklow supports the largest area of mountain blanket bog surveyed (26% of total), with significant areas of the bog type also occurring in Cavan, Sligo, Kerry, Leitrim, Cork and Laois. The relative scarcity of mountain blanket bog in north-western counties such as Galway, Mayo

and Donegal is particularly striking and this can be attributed to the generally unsuitable morphology of the hills, coupled with the high rate of mountain blanket bog erosion which is evident in these areas, e.g. the Maumtrasna plateau in counties Mayo and Galway.

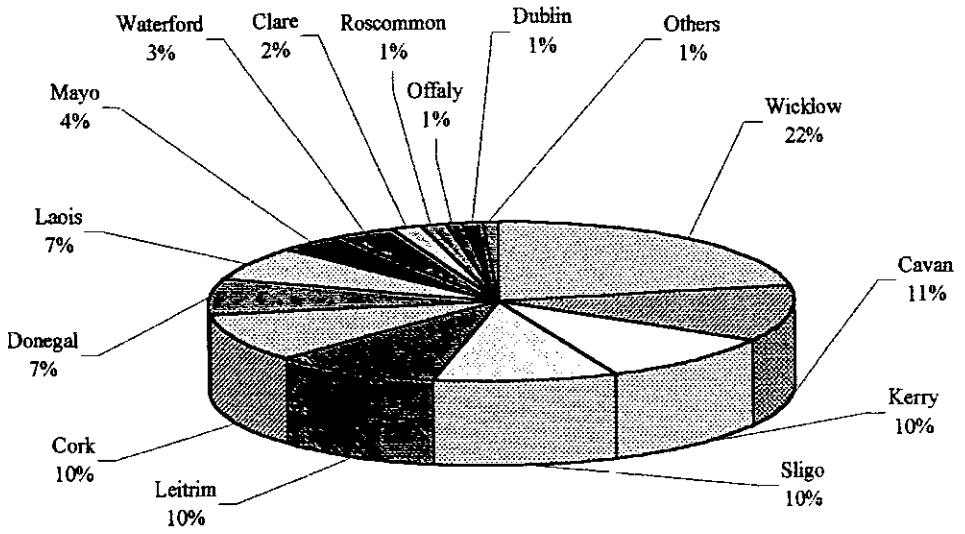


Figure 14. Breakdown of mountain blanket bog surveyed on a county-by-county basis.

5.3 Analysis of survey on a county-by-county basis

There now follows a review of the areas of the different blanket bog types surveyed on a county by county basis. In addition to known areas of blanket bog, the possible locations of extant areas of unsurveyed blanket bog within counties are also briefly discussed. A complete list of unsurveyed blanket bogs with possible conservation potential is presented in a separate report. The following accounts are accompanied by a table which outlines the estimated area of intact blanket bog in the county (after Hammond, 1979) and also indicates the area surveyed and the percentage of unmodified blanket bog surveyed. From this data it is possible to get a good idea of which counties and blanket bog types require the most urgent survey.

5.3.1 County Mayo

County Mayo contains 37,191 hectares of surveyed blanket bog, which is by far the largest area of any county within the Republic of Ireland. In addition, a large area of blanket bog of high conservation value at Owenduff had been surveyed prior to the blanket bog surveys and thus was not revisited. This figure of 37,191 hectares equates to approximately 37% of blanket bog surveyed nationally. Approximately 86% of the bog area surveyed within the county is of the lowland type. Most of the lowland bog area occurs in the north-west of the

county in the low-lying area to the north of the Nephin Beg mountain range and to the west of the road which links Crossmolina and Ballycastle. The quality of the blanket bog in this region is exceptional, with many areas containing well-developed pool systems and extensive, species-rich flushes. There are also a number of smaller areas of lowland blanket bog in the south-west of the county, along the northern side of the Mweelrea and Sheeffry mountains. Highland and mountain blanket bog have a much more restricted occurrence within the county, accounting for a mere 12% and 1% of the blanket bog area surveyed respectively. There do not appear to be many remaining extensive areas of good quality blanket bog to survey within the county, however small areas of intact mountain blanket bog may still exist in areas such as Achill island and on the extensive Maumtrasna plateau. An extensive area of unsurveyed highland/mountain blanket bog is known from Inagh townland along the north coast of the county (Dúchas, pers. comm.).

Table 32. A comparison between the area of unmodified blanket bog in Co. Mayo and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	82,242	32,154	39
Highland and Mountain blanket bog	43,838	5,037	11
Totals	126, 080	37,191	29

5.3.2 County Donegal

County Donegal contains the second largest area of blanket bog surveyed with 25,580 ha (25%) of the blanket bog surveyed nationally. Of this total, 54% is lowland bog, 42% is highland bog and only 4% is mountain bog. Most of the blanket bog is to be found in the mountainous west and south-west of the county, with substantial areas also occurring in the south-east, close to the border with Co. Fermanagh. The relatively large amount of highland blanket bog within the county is particularly striking and this is due in part, to the fact that the hills form gradual slopes which results in a relatively large area of uplands within an altitude range of 150 to 300 metres. Areas of intact mountain blanket bog (plateau type) are apparently very rare within the county and this rarity appears to be due

to a combination of scarcity of the habitat due to topographical factors and ongoing peat erosion. There is still scope for blanket bog survey in the county and possible areas of mountain blanket bog should be specifically targeted. Upland areas to the east and south of Barnesmore gap are known to support extensive areas of blanket bog and wet heath (Dúchas, pers. comm.). The hills of the Inishowen peninsula, though largely dominated by *Calluna* heath, support small pockets of intact blanket bog and are deserving of future survey.

Table 33. A comparison between the area of unmodified blanket bog in Co. Donegal and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	57,248	13,882	24
Highland and Mountain blanket bog	71,938	11,698	16
Totals	129,186	25,580	20

5.3.3 County Galway

County Galway contains 14,826ha of surveyed blanket bog, all of which lies in the Connemara region in the west of the County. In common with Co. Mayo lowland blanket bog predominates, comprising 83% of total surveyed, with highland blanket bog accounting for the remaining 17%. Lowland blanket bog is widely distributed throughout the area, however highland blanket bog is largely confined to upland areas to the east of the road that links Cashla and Maam Cross. Mountain blanket bog is very rare within the county however, small areas of intact mountain blanket bog occur in the Slieve Aughty mountain range in the east of the county and, in addition, small areas of intact plateau bog may occur in the Maumturk and Maumtrasna mountain ranges. It must be noted that a large portion of the extensive area of blanket bog to the north of Errisbeg hill (popularly known as Roundstone bog) was not surveyed between 1987 and 1991. If this area is included in the calculations, the area of high-quality lowland blanket bog in the county is in the region of 17,000 hectares.

Table 34. A comparison between the area of unmodified blanket bog in Co. Galway and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	64,447	12,301	19
Highland and Mountain blanket bog	12,772	2,525	20
Totals	77,219	14,826	19

5.3.4 County Sligo

Within Co. Sligo the largest areas of good quality blanket bog (8,608 ha) are to be found in the Ox mountains, located in the west of the county. Due to the gentle slopes of these mountains, much of this blanket bog is of the highland type (54% of total) with smaller areas of lowland (29% of total) and mountain (17% of total) also present. Although county Donegal probably supports the largest area of highland blanket bog surveyed, the areas of highland blanket bog in Sligo are thought to be the best examples of the type in the country due to their very wet nature and largely intact state. Elsewhere in county Sligo intact areas of blanket bog have a very restricted distribution. Small areas of intact mountain bog occur on the Ben Bulben Plateau, the Bricklieve mountains and on Carrane hill, which lies along the border with Co. Leitrim, however these areas have not been surveyed to assess their composition and quality.

Table 35. A comparison between the area of unmodified blanket bog in Co. Sligo and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	3,452	2,531	73
Highland and Mountain blanket bog	14,249	6,077	43
Totals	17,701	8,608	49

5.3.5 County Kerry

Blanket bog appears to have a restricted distribution in Co. Kerry. At first glance this is somewhat surprising in view of the upland nature of much of the county, however it must be pointed out that the many of the mountain areas are steeply sloping, a feature which favours the formation of heath vegetation rather than blanket bog. In addition large areas of blanket bog/wet heath have been afforested recently, especially in the east and south of the county. There are just under 5,000 hectares of blanket bog surveyed in the county of which 2,272ha (47%) are lowland, 1,256ha (24%) are highland and 1,403ha (29%) are mountain. Lowland blanket bog is generally confined to narrow valleys between mountains and many of the best examples of this bog type are to be found along the eastern side of the Macgillycuddys Reeks, close to Killarney. The county appears to possess one of the largest areas of mountain blanket bog in the country, however much of this bog type is in poor condition because of erosion. It is considered likely that there still exist sizeable tracts of unsurveyed highland and upland blanket bog, particularly in areas such as the Derrynasaggart mountains and the Dingle peninsula.

Table 36. A comparison between the area of unmodified blanket bog in Co. Kerry and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	18,341	2,272	12
Highland and Mountain blanket bog	29,462	2,559	9
Totals	47,803	4,831	10

5.3.6 County Wicklow

County Wicklow possesses the largest area of relatively intact mountain blanket bog surveyed in the country, i.e. 3,159 hectares or 26% of the national total of mountain blanket bog surveyed. All of this bog occurs on the extensive Wicklow mountain plateau which dominates the northern two-thirds of the county and most of this upland area has been incorporated into the Wicklow Mountains Proposed Special Area of Conservation. The best-

developed areas of the habitat occur around Kippure and Sally Gap, however there are also a number of other extensive sites of reasonably good quality such as Table Mountain and Ballynultagh. In addition to large areas of relatively intact mountain blanket bog, the county contains large areas of eroding blanket bog and *Calluna* heath. Areas of lowland and/or highland blanket bog appear to be very rare in the county.

Table 37. A comparison between the area of unmodified blanket bog in Co. Wicklow and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat absent	0	0
Highland and Mountain blanket bog	12,719	3,159	25

5.3.7 County Cork

When the large area of unmodified blanket bog estimated to occur in Co. Cork is considered (62,863 ha), it is surprising to observe that only a very small proportion of that area has been surveyed (c. 3%). It must be noted however that a large area of the blanket bog habitat has been lost to afforestation in the recent past. In addition, much of what Hammond (1979) classified as blanket bog is in fact wet and dry heath which are abundant in the west of the county. Of the 1,828 hectares that have been surveyed, 390ha (21%) is classified as highland blanket bog with the remaining 1,438ha (79%) consisting of mountain blanket bog. While it is probable that there few remaining large areas of intact lowland blanket bog left in the county, further survey of the areas to the west of Glengarriff and the Mizen peninsula may reveal the presence of smaller, relatively intact areas of the habitat. The peatland distribution map compiled by Hammond suggests that there is a large area of high-level blanket peat to the north-east of Bantry (the Shehy mountains). Although afforestation has undoubtedly resulted in the destruction of much of the blanket bog in this area, it is deserving of further survey.

Table 38. A comparison between the area of unmodified blanket bog in Co. Cork and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	10,683	0	0
Highland and Mountain blanket bog	52,180	1,828	4
Totals	62,863	1,828	3

5.3.8 County Cavan

Most of the remaining blanket bog of conservation value in county Cavan (total 1,636 ha surveyed) lies within two sites in the north-west of the county, along the border with Co. Fermanagh. The more extensive and better preserved of these sites, Lough Cratty bog, is a continuation of the Cuilcagh Mountain blanket bog in Co. Fermanagh. This area of blanket bog is considered to be the best remaining area of intact mountain blanket bog in the northern half of the Republic of Ireland. Outside of these two remaining upland areas, blanket bog is very rare within the county. A large proportion of the blanket bog resource within the county (78%) appears to have been surveyed already (see following table).

Table 39. A comparison between the area of unmodified blanket bog in Co. Cavan and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	2,092	1,636	78

5.3.9 County Leitrim

Approximately 1,360 hectares of blanket bog have been surveyed in county Leitrim, all of which falls into the category of mountain blanket bog. Most of the surveyed blanket bog area is concentrated in the south-eastern half of the county and, in general, much of it appears to be of rather low quality and in poor condition. However, recent survey work by the National Parks and Wildlife Service in upland areas to the south-east of Manorhamilton has identified significant areas of high quality mountain blanket bog and wet heath. Areas of intact mountain blanket bog on the extensive Truskmore/Arroo mountain plateau and the uplands near Arigna require survey.

Table 40. A comparison between the area of unmodified blanket bog in Co. Leitrim and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	4,512	0	0
Highland and Mountain blanket bog	23,842	1,360	6
Totals	28,354	1,360	5

5.3.10 County Laois

All of the blanket bog surveyed within Co. Laois (c. 947 hectares) is restricted to the summit plateau and slopes of the Slieve Bloom mountains in the western end of the county along the border of Co. Offaly. Although the slopes of this mountain range have been largely afforested with conifers, the summit plateau has not been planted and still retains high quality unmodified mountain blanket bog vegetation dominated by dense, unbroken swards of *Calluna vulgaris*. The low intensity of peat erosion is due to the absence of burning and the low levels of grazing by sheep. Despite the high level of afforestation which has taken place on the mountain range in the past the area is considered to constitute the best remaining example of intact mountain blanket bog in the Republic of Ireland.

Table 41. A comparison between the area of unmodified blanket bog in Co. Laois and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	1,214	947	78

5.3.11 County Waterford

Within Co. Waterford there are 479 hectares of surveyed blanket bog, all of which is in the mountain blanket bog category. Most of this area has been severely affected by erosion and it is unlikely that intact areas of blanket bog exceeding 50 hectares in extent still exist in the county. From the survey of Goodwillie and Mooney (1991), it appears that only a couple of small areas on the Comeragh mountain plateau are sufficiently intact to warrant ecological interest, however further survey of this extensive upland region is required. The conservation value of these intact blanket bog areas is high due to their position, close to the south-eastern limit of blanket bog formation in the Republic of Ireland.

Table 42. A comparison between the area of unmodified blanket bog in Co. Waterford and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	9,745	479	5

5.3.12 County Clare

Only one site in Co. Clare site was surveyed as part of the blanket bog surveys. The area is a 230 hectare mountain blanket bog site in the Slieve Aughty mountains along the border

with Co. Galway. It is probably the only relatively intact area of the peatland type in the county and is the only large fragment of mountain blanket bog in the area which has escaped afforestation. Although most of the blanket bog in the south-west of the county of County Clare is known to have been cut away in the past for domestic peat use there is a possibility that isolated fragments of good quality lowland and/or highland blanket bog still exist. Further detailed survey of this area is recommended.

Table 43. A comparison between the area of unmodified blanket bog in Co. Clare and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	21,756	230	1

5.3.13 County Roscommon

Blanket bog is a very scarce habitat in Co. Roscommon, with only one site of 198 hectares in extent having been surveyed. The site is a reasonably good example of the habitat and is located near Arigna in the north of the county, close to the border with counties Leitrim and Sligo. There have been wind farm developments close to this blanket bog area and it is not clear as yet whether the area surveyed has been damaged by the development. The area surveyed is probably the only intact area of blanket bog in the county.

Table 44. A comparison between the area of unmodified blanket bog in Co. Roscommon and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	498	198	40

5.3.14 County Offaly

The only areas of blanket bog in Co. Offaly occur on the summit of the Slieve Bloom mountain range, along the border with Co. Laois. The blanket bog on the summit of this range is known to be the best area of mountain blanket bog in the Republic of Ireland. Although the area of intact blanket bog surveyed, i.e. 144 ha, is much smaller than that surveyed on the Laois side of the border, the areas of the habitat within Co. Offaly appear to be of a similarly high quality.

Table 45. A comparison between the area of unmodified blanket bog in Co. Offaly and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	413	144	35

5.3.15 County Dublin

Only one area of relatively intact surveyed blanket bog occurs within Co. Dublin, located on the northern slopes of Kippure hill. The site is an area of mountain blanket bog measuring 143 hectares in extent. At the time of survey, i.e. 1991, the area was noted to have been largely intact, however the surface appeared to be have been burned in the recent past. As a result it was rather disturbed and dry.

Table 46. A comparison between the area of unmodified blanket bog in Co. Dublin and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	469	143	30

5.3.16 County Wexford

One small area (58ha) of mountain blanket bog has been surveyed in Co. Wexford. This area is located close to the summit of Mount Leinster, along the border with Co. Carlow. Most of the site is suffering from erosion and the actual intact area of blanket bog is only a couple of hectares. Probably the only remaining area of relatively intact blanket peat in the county. It is of interest to note that Hammond (1979) estimated that there was no unmodified blanket bog within the county and only 162 hectares of modified habitat.

Table 47. A comparison between the area of unmodified blanket bog in Co. Wexford and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	0	143	100

5.3.17 County Tipperary

Within Co. Tipperary blanket bog appears to be rare outside of the summit of the Galty mountain range. A total of 51 hectares of blanket bog was surveyed in this mountain range, however the actual area of intact surface is much less than this. It is possible that further small intact areas of mountain blanket bog on the Galtys remain to be surveyed. The estimate of the amount of unmodified blanket bog within the county given by Hammond (1979) appears to have been greatly overestimated.

Table 48. A comparison between the area of unmodified blanket bog in Co. Tipperary and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	Habitat not present	0	0
Highland and Mountain blanket bog	8,507	51	<1

5.3.18 County Limerick

The only surveyed area of blanket bog in Co. Limerick occurs on the Limerick side of Galty Mountains, where approximately 11 hectares have been surveyed. The quality of the blanket bog present appears to be poor with much erosion evident. Small areas of intact mountain blanket bog located in the midst of afforested areas may remain to be surveyed on the Ballyhoura mountains and in the upland areas to the west of Newcastle West.

Table 49. A comparison between the area of unmodified blanket bog in Co. Limerick and the area surveyed during the blanket bog reports.

	Estimated area of unmodified blanket bog (ha) in the county (Hammond, 1979)	Total area surveyed in blanket bog surveys (ha)	Percentage of unmodified blanket bog area surveyed
Lowland blanket bog	2,675	0	0
Highland and Mountain blanket bog	11,995	11	<1
Totals	14,670	11	<1

5.3.19 Counties containing blanket bog which were not surveyed

The following table outlines counties considered to contain areas of unmodified blanket bog (after Hammond, 1981), but which were not surveyed as part of the blanket bog surveys.

Table 50. Counties containing areas of blanket bog which were not surveyed.

County	Area of unmodified lowland blanket bog (ha)	Area of unmodified montane blanket bog (ha)	Comments
Carlow	0	850	Located close to the summit of the Blackstairs Mountains
Kilkenny	0	405	Located close to the summit of Brandon hill
Monaghan	0	1,416	Located on the southern and eastern slopes of Slieve Beagh (Eshbrack bog). This area was surveyed in some detail for the Natural Heritage Area survey and adjoins a candidate SAC in Northern Ireland (Slieve Beagh SSSI).

5.3.20 Comparison of county areas surveyed

The expression of the area of blanket bog surveyed as a percentage of the estimated total of the area of unmodified blanket bog within each county makes it possible to identify which counties have been relatively well surveyed and those which have not. In the following table the counties are listed in order of decreasing percentage of unmodified blanket bog surveyed. While these results should be interpreted with caution (see following discussion) they do show that counties such as Laois, Cavan and Wexford are relatively well surveyed while Clare, Limerick, Tipperary, Carlow, Kilkenny and Monaghan have had 1% or less of their unmodified peatland area surveyed. When the counties which contain the largest areas of unmodified blanket bog are considered it can be noted that Mayo has the largest surveyed percentage of surveyed area (29%) while Cork is the least area surveyed (3%). The main recommendation to arise from Table 49 is that counties with a large area of unmodified blanket bog coupled with a low percentage area surveyed, i.e. Cork, Leitrim, Clare and Kerry, should be prioritised for future surveys.

Table 51. An overview of the degree of blanket bog survey carried out within different counties.

County	Area (in hectares) of unmodified bog estimated by Hammond (1979)	% area of unmodified blanket bog surveyed	Notes
Wexford	0	100	Area surveyed larger than estimated intact area
Laois	1,214	78	Possible underestimate of unmodifed area
Cavan	2,092	78	Possible underestimate of unmodifed area
Roscommon	498	40	
Offaly	413	35	Possible underestimate of unmodifed area
Dublin	469	30	
Mayo	126,080	29	
Wicklow	12,719	25	
Donegal	129,186	20	
Galway	77,219	19	
Kerry	47,803	10	
Waterford	9,745	5	Large proportion of estimated total blanket bog is heath dominated by *Calluna*.
Leitrim	28,354	5	
Cork	62,863	3	Large proportion of estimated total blanket bog is dry heath dominated by *Calluna*.
Clare	21,756	1	
Limerick	14,630	<1	
Tipperary	8,507	<1	
Carlow	850	0	
Kilkenny	405	0	
Monaghan	1,416	0	

5.4 General discussion

Perhaps the most striking observation regarding the blanket bog survey statistics generally is that the area of blanket bog surveyed is much smaller than the unmodified area of the habitat estimated by Hammond in the mid-1970's. In the case of lowland blanket bog, 26% of the estimated total has been surveyed while the figure for montane, i.e. highland + mountain, is much lower, at a mere 12% of the estimated total. The main question to arise as a result of this observation is does the observation imply that the area of blanket bog has been greatly undersurveyed or is the figure for unmodified blanket bog proposed by Hammond an overestimate? Because the apparent discrepancy is much larger for montane blanket bogs we will discuss the possible reasons only for this type of bog, however a similar reasoning applies to lowland blanket bog.

In order to explore the possible reasons for the apparent discrepancy in the figures we must first examine the criteria used by Hammond to define unmodified blanket bog. Hammond's definition appears to have been rather wide in that he included all areas of peat soils greater than 0.45m in depth, that were not cutaway or afforested. This definition, while useful for agricultural purposes, is of limited use for the purpose of identifying good quality blanket bogs for conservation. When the peatland distribution map is examined it is appears that a large proportion of the estimated area of montane blanket bog, in particular,

may actually consist of closely related habitats on shallow peat soils such as wet heath and dry heath e.g. the Slieve Tooey area of Co. Donegal. While these heath habitats often occur as a mosaic with blanket bog and are of interest in their own right, areas dominated by these shallow peat deposits were generally not surveyed during the blanket bog surveys. In addition to the possible incorporation of related peatland habitats within the category montane blanket bog, it is clear that Hammond's calculation makes no allowance for areas of blanket bog which have been degraded by erosion. A number of workers, e.g. McGee and Bradshaw (1990), Goodwillie and Mooney (1991), have noted that many mountain blanket bog sites often occur as small islands of intact peat which are surrounded by large areas of eroding blanket bog. Indeed the same is true of substantial areas of lowland blanket bog in the west of Ireland which have been degraded by the overstocking of sheep. Therefore it is likely that a very large proportion of the blanket bog in the Republic of Ireland included in Hammond's estimated "unmodified" total has been eroded so severely that it is now of greatly reduced conservation interest. Finally, it must be pointed out that substantial areas of blanket bog have been cutaway and afforested since the time of Hammond's survey, i.e. the early to mid-1970's, and the recent damage from these sources undoubtedly accounts for a sizeable decline in the area of the habitat (Foss, 1998).

With regards to survey efforts, there can be little doubt that substantial areas of good quality highland and mountain blanket bog remain to be surveyed by the National Parks and Wildlife Service. Surveys of upland areas in advance of wind-farm construction in Donegal and Kerry have demonstrated that significant areas of good quality highland/mountain blanket bog, e.g. south-east of Barnesmore gap, remain to be surveyed. In addition, site surveys carried out by permanent and contract staff of the NPWS since the blanket bog surveys have revealed the presence of additional high quality areas. Because of the apparent lack of comprehensive coverage there is an urgent need for a further survey of upland areas that are suspected of containing substantial areas of largely intact highland/upland blanket bog. The initial identification and selection of good quality upland sites could be achieved by the inspection of recent aerial photographs and once possible sites have been identified, a ground survey could commence.

CHAPTER 6. BLANKET BOG SURVEY DATABASE

6.1 Introduction

The blanket bog reports constitute a significant body of work, however the fact that there are seven separate reports makes the retrieval and comparison of site information rather time-consuming. In order to make site survey details more accessible, they were entered into an Microsoft Access database. One of the main benefits of this is that it allows the rapid selection of sites for a specific criterion or field. For example, it is possible to select all of the sites which lie within a specific pSAC or Nature Reserve. In addition using Access, it is possible to select all sites which contain good examples of specific morphological features, e.g. swallow holes, or specific rare plant species, e.g. *Vaccinium oxycoccus* or *Saxifraga hirculus*. A copy of the blanket bog survey database can be found on the diskette which is lodged with Catríona Douglas, National Parks and Wildlife Research Section, Dúchas.

6.2 The fields specified

A total 34 fields were specified in the database. These fields are listed and discussed in the subsequent subsections.

6.2.1 Site name

The site name is the name given in the relevant blanket bog report. In most cases the site is named after the largest townland within the site. In cases where different sites were given the same name in different surveys or the same name is given to sites located in different counties, they are referred to, for example, as Cashel (Donegal) or Cashel (Galway). The sites are listed in alphabetical order within the database spreadsheet.

6.2.2 Site number

For purposes of identification within the database, sites are given a number from 1 to 291. This number is allocated according to alphabetical order.

6.2.3 Protective ownership

If a site, or part of a site, falls with a Nature Reserve, National Park or any other such protected area, this is indicated. In the case of National Parks the name of the Park is given.

6.2.4 County

In the case of sites which straddle the borders between two or more counties, all of the counties are listed in order of decreasing proportion of blanket bog area.

6.2.5 Type

Sites are classified as lowland (<150m), highland (150-300m) or mountain (>300m) blanket bog. In cases where there are more than one type of bog present, only the dominant type is listed.

6.2.6 Morphology

Sites are categorised into the main morphological types, for example watershed, valley, flushed slope and saddle. Sites containing a large number of morphological types are indicated by the term "morphologically diverse".

6.2.7 Grid reference

The grid reference of the site is given to the nearest 1 km square, e.g. M 23 45. In the case of extensive sites the grid reference given is that of the 1km square closest to the middle of the site.

6.2.8 Survey date

The year in which the survey was carried out is given.

6.2.9 Size

The size of site is given in hectares. In most cases the area given is identical to the area of intact blanket bog, however the areas for many upland sites surveyed by Goodwillie and Mooney (1991) often include eroded areas of bog surrounding a smaller intact core.

6.2.10 Altitude

Altitude is presented as a range indicating the minimum and maximum altitude of the site in metres above sea-level.

6.2.11 Solid geology

The dominant solid geology of the site is listed, however it is acknowledged that in the case of extensive sites the bedrock geology may be more complicated.

6.2.12 pNHA/pSAC status of site

If any area of the site falls within a proposed Natural Heritage Area or proposed Special Area of Conservation it is indicated.

6.2.13 pNHA/pSAC name(s)

The official name of the pNHA/SAC is listed.

6.2.14 pNHA/pSAC number(s)

The pNHA/SAC number (up to 4 digits) is listed.

6.2.15 Townland(s)

All of the townlands that fall within the site boundary are listed

6.2.16 Six-inch Ordnance Survey map number(s)

The numbers of the six-inch to the mile scale Ordnance Survey maps are given. In cases where the area of the site falls within the one county, letters denoting the county are omitted.

6.2.17 Discovery Map number(s)

The number(s) of the Ordnance Survey 1:50,000 maps, within which the site lies, is/are listed.

6.2.18 1970's Ordnance Survey Aerial photograph number(s)

The majority of the black and white aerial photographs listed in this field were taken in the mid-1970's and are at a scale of approximately 1:30,000.

6.2.19 1995 Ordnance Survey Aerial photograph number(s)

These black and white aerial photographs were taken in 1995 and are at a scale of approximately 1:40,000.

6.2.20 Previous site ranking

This field outlines the ranking of the site on the five-point scale A, BI, BII, BIII and C. Category A sites are generally extensive, intact and diverse sites, worthy of immediate protection while category C sites are generally less extensive, badly damaged and not worthy of protection. For a more complete definition of the criteria used in this assessment see Table 27.

6.2.21 Protected/Annex 2 plant species

Plant species protected by law in Ireland under the 1999 Flora Protection Order, e.g. *Eriophorum gracile*, or listed in Annex 2 of the E.U. Habitats Directive, e.g. *Saxifraga Hirculus*, are listed. For a fuller discussion of these species see section 3.4.

6.2.22 Threatened/rare plant species

Plant species known to be threatened or scarce in Ireland, e.g. *Erica mackaiana*, are listed. Many of these species are listed in the Irish Red Data Book (Curtis and McGough, 1988). In addition, locally rare plant species such as *Vaccinium oxycoccus*, are listed. For a fuller description and discussion of these species see section 3.4.

6.2.23 Incidental animal observations

During the blanket bog surveys incidental sitings of important animal species were generally noted. However, it is important to note that this was a botanical and thus a systematic survey of animals was not undertaken. Examples of animals noted include bird species such as Greenland White-fronted Goose (*Anser albifrons flavirostris*), Golden Plover (*Pluvialis apicaria*) and Grouse (*Lagopus lagopus*), and animal species such Otter (*Lutra lutra*) and Hare (*Lepus timidus*).

6.2.24 Presence of pool systems

The presence of pool systems within a site is rated on a four-point scale as follows:

Low. Pool systems absent or covering less than 5% of the site area.

Moderate. Pool systems covering between 5 and 25% of the site area.

High. Pool systems covering between 26 and 50% of the site area.

Very High. Pool systems covering between 51 and 100% of the site area.

6.2.25 Presence of lowland oligotrophic lakes

The presence of lowland oligotrophic lakes within a site is rated on a four-point scale as follows:

None – Lakes absent from site.

Low - Lakes covering less than 5% of the site area.

Moderate - Lakes covering between 5 and 25% of the site area.

High - Lakes covering more than 25% of the site area.

This habitat is listed on Annex 1 of the Habitats Directive.

6.2.26 Presence of flushed areas

The presence of blanket bog flushes within a site is rated on a three-point scale as follows:

None/low - Flushed areas absent or covering less than 1% of the site area.

Moderate - Flushed areas relative common, cover of habitat between 1 and 5% of the site area.

High - Flushed areas covering either more than 5% of the site area, or <5% of area with important rare plant species present.

6.2.27 Presence of swallow-holes

The presence of swallow-hole areas within a site is indicated.

6.2.28 Presence of heath

The presence of heath vegetation, i.e. wet, dry and Alpine, within sites is indicated. This habitat is listed on Annex 1 of the Habitats Directive.

6.2.29 Presence of Rhynchosporion vegetation

The presence of Rhynchosporion vegetation, i.e. wet and quaking flat areas dominated by *Rhynchospora alba*, within sites is indicated. This habitat is listed on Annex 1 of the Habitats Directive.

6.2.30 Presence of dystrophic lakes

The presence of dystrophic lakes within sites is indicated. This habitat is listed on Annex 1 of the Habitats Directive.

6.2.31 Presence of Juniper formations

The presence of vegetation containing prominent *Juniperus communis* subsp. *nana* within sites is indicated. This habitat is listed on Annex 1 of the Habitats Directive.

6.2.32 Burning damage

Damage to the site caused by burning is indicated is either absent, of low extent or of high extent.

6.2.33 Peat cutting/drainage damage

Damage caused by peat cutting and/or drainage due to afforestation is indicated as absent, of low extent or of high extent.

6.2.34 Grazing damage

Damage caused by overgrazing (mostly by sheep), is indicated as absent, of low extent or of high extent.

CHAPTER 7. GENERAL CONCLUSIONS AND PROPOSALS FOR FURTHER STUDY

7.1 General conclusions

The main conclusions of this study are as follows:

- It has been estimated that the Republic of Ireland contains approximately 8% of the global blanket bog resource, thus making the country one of the important areas for the habitat in the world. It is one of the most important and widespread habitats in the country, supporting a large number of specialised plant and animal species which are adapted to the wet, acid and nutrient-poor environment.

- The blanket bog habitat supports a number of nationally rare animal and plant species including *Anser albifrons flavirostris* (Greenland White-fronted Goose), *Circus cyaneus* (Hen Harrier), *Saxifraga hirculus* (Marsh Saxifrage) and *Eriophorum gracile* (Slender Cotton-grass). A number of these species are considered to be threatened and diminishing in a European context and, as a result, are listed in a number of Directives and Conventions.

- The original area of blanket bog in the Republic of Ireland is thought to have been in the region of 775,000 hectares, however at present it has been estimated that only 140,000 hectares (18% of the original area) has been incorporated within pSACs. Ryan and Cross (1984) suggested that there was approximately 517,000 hectares (67% of the original area) of relatively intact blanket bog remaining in the early 1980's however there is no reliable estimate of what area of the original resource remains in a relatively intact state at present. The estimation of the amount of intact blanket bog remaining is problematic due to a number of factors, most notably the difficulty in differentiating blanket bog from heath and the recent damage caused by the overstocking of sheep.

- The loss of blanket bog habitat has been greatly accelerated in the past fifty years. This has been due to a number of causes, most significantly peat extraction, coniferous

afforestation (since the 1950's), overstocking by sheep (since the 1980's) and agricultural reclamation. Threats to the habitat that seem likely to increase in the near future include windfarm construction (mostly in upland sites) and amenity uses such as walking and motorbike scrambling.

- Although the ecological importance of Ireland's blanket bog resource is becoming increasingly recognised, widespread damage to the habitat is still taking place. Even within protected areas such as Nature Reserves and National Parks, blanket bog areas are suffering ongoing damage to their structural integrity and biodiversity, mainly due to overstocking by sheep. Damage from overstocking is also occurring within proposed NHA's and proposed SAC's, however damage due to peat extraction and afforestation has probably declined over the last decade due to increased awareness in The Forest Service and Coillte Teoranta of site designation.

- The blanket bog surveys carried out by the Wildlife Service in the 1980's and 1990's have revealed much information regarding the extent, composition and condition of many of the most important known blanket bog sites. In addition, these surveys resulted in the discovery of many previously unknown high quality blanket bog sites and new records for rare plant species. Subsequently, this information proved to be of great value when considering the selection of blanket bog sites for candidate National Heritage Areas and candidate Special Areas of Conservation.

- The blanket bog surveys have revealed that the largest remaining areas of intact lowland blanket bog are to be found in the counties of Mayo, Galway and Donegal. Counties Sligo and Donegal appear to contain the largest areas of highland blanket bog, while counties Wicklow, Kerry, Laois and Cavan appear to be the main centres of distribution for intact mountain blanket bog. A comparison of areas surveyed vis-à-vis the estimated areas of intact blanket bog given by Hammond (1979) has revealed that survey data is incomplete, particularly in upland areas.

7.2 Conservation recommendations

The main conservation recommendations arising from this study are as follows:

- It is essential that a reasonably accurate estimate of the of the remaining 'intact' blanket bog resource is obtained and, in addition, the protection status of such areas should be reviewed.

- The deterioration in quality of blanket bog habitat evident throughout the country should be arrested as quickly as possible. Priority should be given to the protection and rehabilitation/enhancement of areas within Nature Reserves, National Parks, pSACs and pNHAs, however it must also be recognised that unsurveyed areas of blanket bog with high conservation value still occur outside of such areas. These areas should also be afforded some measure of protection from development, particularly in view of the relatively small amount of intact blanket bog remaining in the country.

- Every possible measure should be taken to ensure the continued existence of a representative area of intact blanket bog in Ireland. The state acquisition target of 40,000 hectares should be revised upwards as it represents only 5% of the original habitat resource. Although approximately 36,000 hectares of blanket bog has been acquired by the state for conservation purposes, only 30% of this area lies within Nature Reserves. It is recommended that all areas of blanket bog owned by the state should be designated as Nature Reserves in order to confer some degree of legal protection.

- Some of the blanket bog sites within the ownership of the state are rather small, i.e. <100 hectares. Areas of relatively intact blanket bog adjoining these small sites should be purchased with a view to increasing the site area and hence improving the conservation value of such sites. This measure will improve the future survival prospects for the resident plant and animal populations.

With regard to the main damaging operations affecting blanket bog, the following guidelines are suggested:

- Afforestation - The planting of trees in areas containing and adjoining active blanket bog should be prevented. Planting on peatlands is environmentally unsustainable and is often economically unsustainable. Furthermore, the ecological value and potential buffering value of habitats associated with blanket bog, e.g. cutaway blanket bog, wet heath and dry heath, should be assessed prior to making any decision on forestry proposals.

- Peat-cutting – Although small-scale domestic extraction of peat in blanket bog areas should be allowed to continue if they are not damaging (or potentially damaging) the ecological interest of the site, large-scale commercial peat-cutting in areas of active

blanket bog should be controlled. The prohibition of the use of Difco machines within pSAC's should be maintained.

- Grazing - The numbers of sheep and cattle grazing blanket bog commonages damaged by overgrazing should be reduced according to the destocking rates recommended in the recently initiated Commonage Framework Plans. The future monitoring of destocked peatlands in order to evaluate the efficacy of destocking measures is absolutely vital. This monitoring should be carried out on a representative selection of sites and should be subject to independent scientific review.

- Windfarms - In view of the fact that such proposed developments are invariably located in areas of upland blanket bog or heath, the ecological value of upland areas should be assessed thoroughly prior to the assessment of planning applications. In addition, government policy regarding the siting of windfarms in peat-dominated uplands should be urgently reviewed.

7.3 Recommendations for future survey/study

Although some recent research has been directed towards the better understanding of how blanket bogs function, much research still remains to be carried out. The main subjects for future survey are as follows:

- A resurvey of the blanket bog resource - While much is known regarding the floristic composition of blanket bogs, there is an urgent need for an assessment of the present extent and quality of blanket bogs in the Republic of Ireland. This will be a major research project which will take a number of years to complete, however the results would reveal much important information regarding the present extent and condition of this important wildlife habitat. At present the extent of peatland cover in Ireland is being assessed as part of the Irish Forest Soils Project being carried out at present by Teagasc at Kinsealy, Co. Dublin. When completed, this information may provide accurate statistics on the area of relatively intact blanket bog and other habitat categories of interest such as afforested blanket bog and cutaway blanket bog. However there is an urgent need nonetheless for a dedicated research project directed towards assessing the extent and quality of blanket bog.

- The composition, condition and management of blanket bog within Nature Reserves and National Parks - There is an urgent need to determine and map the extent, composition

and condition of blanket bog areas occurring within state-owned protected areas such as Statutory Nature Reserves and National Parks. In addition, each of these sites should have a management plan drawn up and implemented. These management plans should also evaluate land use on any private land which adjoins such peatlands, with a view to determining possible impacts on these protected areas.

- The assessment of areas of active blanket bog within pNHA's and pSAC's - As there appears to be a lack of definitive information regarding the area of active blanket bog within many pNHA's and pSAC's, it is necessary to determine the area of the habitat. A combination of ground and aerial survey techniques will be required to assess the extent of such areas accurately.

- Survey of heath habitats – To date there has been little specific study of the habitats that occur in association with blanket bog, i.e. wet heath, dry heath and alpine heath. These Annex 1 habitats occur in areas with a shallow peat depth and they often form complex mosaics within, and interesting vegetational transitions to, adjacent areas of blanket bog. A more detailed knowledge of the floristic composition and distribution of such closely related habitats is required in order to fully appreciate the ecological value of sites. The ecological information contained in the ongoing Commonage Framework Plan Survey may provide a useful starting point for any such future surveys.

- The further survey of lowland blanket bog areas - Despite the blanket bog surveys of the late 1980's and early 1990's a further survey of lowland blanket bog areas is required. Although the coverage of lowland sites was relatively comprehensive, a small number of lowland blanket bog sites still require survey, especially in counties Galway and Donegal. The extent of these areas however is generally small.

- The further investigation of upland blanket bog areas - Although the survey of Goodwillie and Mooney (1991) identified and described many of the better known, high-quality highland and mountain blanket bog sites there is a need for further assessment of blanket bog and associated habitats in the uplands of Ireland. The existence of unsurveyed, high-quality blanket bog areas located outside of pNHA's and pSAC's has been demonstrated by recent surveys of upland areas proposed for windfarm development in the west and north of the country. A comparison of areas surveyed vis-à-vis the estimated area of unmodified blanket bog suggests that the upland areas

within counties Cork, Leitrim, Clare, Donegal and Kerry should be considered a priority for future surveys.

- The preliminary survey of cutaway blanket bog areas – A preliminary assessment of the cutaway blanket bog resource in Ireland should be undertaken. Many extensive areas of cutaway have been virtually abandoned and most of these areas are undergoing the process of revegetation at present. The abandonment of cutaway areas has enabled the development of diverse secondary peatland habitats such as dry heath and flooded cutaway, which are of considerable ecological interest.

- A comprehensive research project directed towards the investigation of ecohydrological characteristics associated with blanket bogs is required. This study is necessary in order to identify appropriate management actions/responses. Long term monitoring studies are needed to evaluate trends in the condition of blanket bog habitats and to evaluate the efficacy of conservation measures within protected areas.

within counties Cork, Leitrim, Clare, Donegal and Kerry should be considered a priority for future surveys. A list of potential blanket bog for survey is presented in Appendix 1.

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