



MANAGEMENT of Natura 2000 habitats  
Northern Atlantic wet heaths with *Erica  
tetralix*  
4010

*Directive 92/43/EEC on the conservation of natural habitats and  
of wild fauna and flora*

The European Commission (DG ENV B2) commissioned the Management of Natura 2000 habitats. 4010 Northern Atlantic wet heaths with *Erica tetralix*

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# Contents

<b>Summary</b> .....	<b>1</b>
<b>1. Description of habitat and related species</b> .....	<b>1</b>
Distribution.....	1
Northern Atlantic wet heaths in Natura 2000 sites .....	1
Main habitat features, ecology and variability .....	2
Ecological requirements.....	3
Main subtypes identified.....	3
Species that depend on the habitat.....	4
Related habitats .....	5
Ecological services and benefits of the habitat .....	6
Trends .....	6
Threats.....	7
Overgrazing .....	7
Grazing abandonment or under stocking.....	7
Uncontrolled burning .....	8
Artificial drainage.....	8
Nitrogen deposition.....	8
Afforestation.....	9
Invasive species .....	9
Recreation .....	9
Climate change effects .....	9
<b>2. Conservation management</b> .....	<b>10</b>
General recommendations .....	10
Active management .....	10
Grazing .....	10
Burning.....	12
Cutting (by mowing) .....	13
Grazing combined with controlled burning and complementary cutting .....	14
Scrub removal and Sod cutting .....	14
Habitat Restoration .....	14
Other relevant measures.....	15
Monitoring .....	15
Special requirements driven by relevant species.....	17
Cost estimates and potential sources of EU financing.....	18
Management of grazing .....	19
Cutting.....	19
Burning.....	19
Habitat restoration, anti-erosion measures .....	19
Bracken control .....	20
Monitoring .....	20
Potential sources of EU financing.....	21
Acknowledgements.....	21
<b>3. References</b> .....	<b>22</b>

## 4010 | Northern Atlantic wet heaths with *Erica tetralix*



Heathland in New Forest, UK, including North Atlantic wet heaths. This site is grazed by ponies and cattle. Photo: Steve Humble.



40 – Temperate heaths and scrubs

EUNIS classification:

F4.11 - Northern wet heaths

### Summary

North Atlantic wet heath is a natural or more commonly semi-natural habitat of humid, peaty or semi-peaty character. The habitat is dominated by dwarf shrub species and usually occurs on acidic, nutrient-poor substrates, such as shallow peats (<0.5m) or sandy soils with impeded drainage. Wet heath generally has a water table that is above or at ground level for at least some of the year.

The community includes mixtures of *Erica tetralix* (cross-leaved heath), *Trichophorum cespitosus* (deer grass), *Calluna vulgaris* (heather) and *Molinia caerulea* (purple moor-grass), and in some cases over an under-storey of mosses, often including carpets of *Sphagnum* species (bog mosses).

The community is restricted in its distribution to the Atlantic fringe between Scandinavia and Normandy. The majority of the wet heath resource in the EU is in the UK and Ireland (85%) and it spans upland (up to 600m) and lowland altitudes (below 300m). In the UK wet heath is usually found in the wetter climates of the north and west, and in Sweden it is restricted to regions with similar climate conditions in south-western parts of the country. These areas tend to have relatively high rainfall (generally between 60 to 110 cm per year) and more importantly, an even spread of rainfall throughout the year,

Wet heath is thought to be a naturally occurring community with interaction between species formed over millions of years by abiotic factors such as climate and soil conditions. Conditions such as soil acidity, low nutrient status and waterlogged conditions, and possibly grazing from large herbivores may have arrested succession to woodland, resulting in the maintenance of an open dwarf shrub community.

Its present variability is however related to human activities. The open heathland complex found across Europe is due to agricultural practices such as domestic grazing, burning, turf collection and cutting, which began to be developed around 6000 years ago.

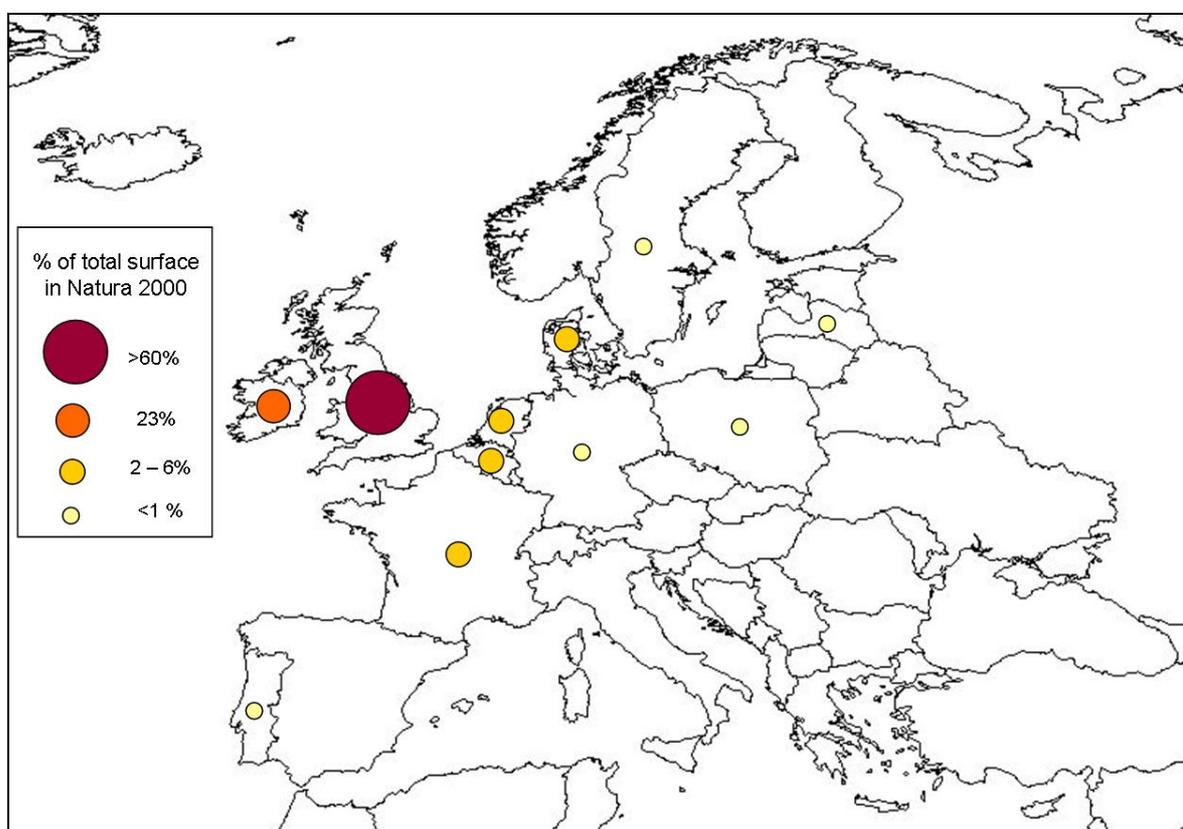
Traditional forms of management remain a key requirement for the maintenance of wet heath within a wider heathland complex. These practices combine to stop succession to woodland once areas were cleared; with balanced grazing as the main management concept while additional or complementary measures such as controlled burning or cutting are recommended to be applied much more restrictively.

## 1. Description of habitat and related species

North Atlantic wet heath is a natural, or more commonly, a semi-natural habitat of humid, peaty or semi-peaty soils. Typically, it is shaped by traditional farming methods such as turf cutting for fuel, grazing and cutting forage for animals. The heathland landscape is dominated by dwarf shrubs such as heather and *Erica* species, and wet heath in particular has a water table that is at, or above ground level for at least some of the year.

### Distribution

North Atlantic wet heath is restricted in its distribution to the Atlantic fringe between Scandinavia and Normandy. The majority of the wet heath resource in the EU is in the UK and Ireland (85%) and it spans upland (up to 600m) and lowland altitudes (below 300m). In the UK wet heath is usually found in the wetter climates of the north and west, and in Sweden it is restricted to regions in south-western parts of the country with similar climate conditions.



Percentage distribution of the total surface of Northern Atlantic wet heaths with *Erica tetralix* in Natura 2000

### Northern Atlantic wet heaths with *Erica tetralix* in Natura 2000 sites

The following data have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover indicated for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Biogeographical region	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface in Natura 2000
Atlantic	334	155,906	95.61
Continental	172	5,729	3.51
Mediterranean	1	888	0.55
Boreal	17	543	0.33
Countries	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface IN Natura 2000
United Kingdom	71	99,370	60.94
Ireland	36	37,898	23.24
France	49	9,187	5.64
The Netherlands	51	5,152	3.16
Denmark	31	3,862	2.37
Belgium	67	3,576	2.19
Germany	167	1,578	0.97
Portugal	1	888	0.54
Sweden	42	815	0.50
Poland	7	574	0.35
Latvia	2	166	0.10
<b>TOTAL</b>	<b>524</b>	<b>163,066</b>	<b>100</b>

### Main habitat features, ecology and variability

North Atlantic wet heath is dominated by dwarf shrub species and usually occurs on acidic, nutrient-poor substrates, such as shallow peats (<0.5m) or sandy soils with impeded drainage. The community includes mixtures of *Erica tetralix* (cross-leaved heath), *Trichophorum cespitosus* (deer grass), *Calluna vulgaris* (heather) and *Molinia caerulea* (purple moor-grass), and in some cases an under-storey of mosses, often including carpets of *Sphagnum* species (bog mosses) (JNCC 2008a, HC 2008).

Wet heath is a naturally occurring community, having been formed over millions of years, due, in part, to the interactions of abiotic factors such as climate and soil conditions, competition between species, and possibly also as a consequence of grazing from large herbivores (Tubbs 2001, Luxmoore & Fenton 2005). Its present variability is however related to human activities.

The open heathland complex found across Europe is due to agricultural practices such as domestic grazing, burning and cutting, which began to be developed around 6000 years ago. These practices arrested succession to woodland once the areas were cleared. Without traditional forms of management some areas would no doubt have succeeded to scrub and then back to open woodland. However, the reduction of soil nutrient levels through removal of any former canopy, coupled with leaching of nutrients in areas of high rainfall means that many areas may no longer support significant tree growth.

In the UK, large areas of wet heath are found in western and northern Britain, although fragmented areas can be found in the south and east (Rodwell 1991). It is defined by >25% cover of ericoid dwarf shrubs in wet situations and where peat depth does not exceed 0.5 m. It is often found as a transitional community within a mosaic of dry heath and blanket mire (Backshall *et al.* 2001).

Details of interpretation may differ between countries; for example for Sweden, the borders are set at maximum 30% of shrubs and trees and a peat depth not exceeding 0.3m (Naturvårdsverket 1997). In Flanders (Belgium), a maximum of 5% tree and shrub cover is required for good conservation status; and 5-30% tree and shrub cover is considered to be of moderate conservation status. In all situations, peat depth does not exceed 0.2m.

Other plant species associated with wet heathlands include, in addition to the ones mentioned above, *Drosera* spp, *Erica* spp, *Gentiana pneumonanthe*, *Hammarbya paludosa*, *Lycopodiella inundata*, *Narthecium ossifragum*, *Rhynchospora alba*, *Rhynchospora fusca* and *Sphagnum* spp.

## Ecological requirements

Wet heath is a community of acid, nutrient poor soils that are at least seasonally water logged; drainage and peat cutting have extended its range on to once deeper and wetter peat (Rodwell 1991). Wet heath often occupies areas of impeded drainage on lower valley sides and less steeply-sloping ground. Clearly drainage is a key factor, and wet heaths can develop when there are layers of clay within sandy strata or when iron oxide is deposited in the B-horizons of podsol to form impermeable iron-pans.

In the north of Belgium and the Netherlands, wet heath is often situated in continental dunes within local depressions. These depressions are the result of former erosion by wind, and are often found where the water table is a ground level (then erosion stops). Under these conditions it is not necessary that an impermeable layer is present, although (when old enough) a podsol with iron-pan may have developed.

Wet heath can occur naturally, due to abiotic factors such as the soil acidity, low nutrient status and waterlogged soil conditions, with succession to woodland being potentially arrested by these factors (Gimingham 1992). However, grazing, cutting and burning remain key requirements for the maintenance of wet heath within a wider heathland complex.

The habitat is restricted to the oceanic and sub-oceanic climates in the north of the Northern Atlantic region, below the alpine zone. These areas have relatively high rainfall (generally between 60 to 110 cm per year) and more importantly, an even spread of rainfall throughout the year, with a high number of rain days (typically above 115 per year - if a 'rain day' is defined as one in which there is at least 1 mm).

Relative humidity remains moderately high, even in the driest months. The proximity of the Atlantic Ocean (including the Gulf Stream influence) also has a buffering effect on temperatures, preventing winters from becoming very cold and summers from becoming very hot. Mild winter temperatures are undoubtedly important for many of the individual plant and animal species that characterise heaths in the south-west of England and in western Ireland (Gimingham 1972).

## Main subtypes identified

For the UK, key subtypes identified are based on the UK National Vegetation Classification for Mires and Heaths (Rodwell 1991). These represent the Northern Atlantic wet heaths with *Erica tetralix* as described by habitat account for priority habitats in Europe (JNCC 2008a, EC 2007). The information below is taken from the website at:

<http://www.jncc.gov.uk/protectedsites/sacselection/habitat.asp?FeatureIntCode=H4010>.

M15 *Scirpus* – *Erica* wet heath is found in areas with a moderate to high rainfall, and is the typical form of wet heath in the north and west of the UK. *Erica tetralix* and *Calluna vulgaris* are typically accompanied by abundant *Trichophorum cespitosum* and *Molinia caerulea*. In the far north-west of Scotland, *Erica cinerea* (bell heather) and *Racomitrium lanuginosum* (woolly fringe-moss) are also characteristic, along with an abundance of Atlantic bryophytes. In the north, there may be a high cover of *Cladonia* lichens. At high altitude northern and montane species are represented. Where there is movement of mildly base-rich water through the peat, *Carex* spp. (sedges) and a wide range of species favoured by flushing occur. The latter includes distinctive variants that are often characterised by abundant *Myrica gale* (bog-myrtle), or *Schoenus nigricans* (black bog-rush).

M16 *Erica* – *Sphagnum* wet heath is characteristic of drier climates in the south and east, and is usually dominated by mixtures of *Erica tetralix*, *Calluna vulgaris* and *Molinia caerulea*. The bog-moss *Sphagnum compactum* is typically abundant, while on Orkney and at high altitude in the eastern Scottish Highlands, *Cladonia* lichens are abundant. In the south, species with a mainly southern distribution in Britain, such as *Gentiana pneumonanthe* (marsh gentian), *Rhynchospora fusca* (brown beak-sedge) and *Cirsium dissectum* (meadow thistle), enrich wet heaths. At high altitude in northern Scotland, forms of the community occur which are rich in northern and montane species, and often also have an abundance of *Cladonia* lichens.

On the Lizard in Cornwall, *Erica vagans* (Cornish heath) growing with *Schoenus nigricans*, *Erica tetralix* and *Molinia caerulea* forms a distinctive and unique form of wet heath (H5 *Erica* – *Schoenus* heath), found nowhere else in Europe.

A further very local wet heath type is M14 *Schoenus – Narthecium* mire, which is mainly associated with transitions from heath to valley bog at a small number of lowland sites in southern Britain.

For France, three sub-types have been identified and related to geographical variation (Gaudillat & Haury 2002):

- A subtype dominated by *Calluna vulgaris* and *Ulex minor* in the northern parts of the country and in Normandy.
- A subtype dominated by *Erica tetralix* and *Ulex minor* located more inland than the above mentioned subtype.
- A subtype dominated by *Erica tetralix* and *Erica scoparia* in more central parts of the country.

For Scandinavia, the 4010 sites are predominantly *Erica tetralix* heath with *Erica tetralix* and *Trichophorum cespitosum* as dominating species. Other characteristic species are *Calluna vulgaris*, *Carex panicea*, *Drosera rotundifolia*, *Gentiana pneumonanthe*, *Juncus squarrosus*, *Molinia caerulea*, *Myrica gale*, *Narthecium ossifragum*, *Pedicularis sylvatica* and various *Sphagnum* species (Påhlsson 1998).

In the Netherlands and Belgium subtypes are identified that are related to geographical position and to the nutrient status of the soil:

- subtype with *Empetrum nigrum*, *Carex trinervis*, *Salix repens* and *Oxycoccus macrocarpus* in acid coastal dune slacks with the groundwater near (or above in winter) the surface. Distribution: boreo-atlantic; southern part Baltic Sea – The Netherlands
- subtype with orchids, *Pedicularis sylvatica*, *Danthonia decumbens* on acidified, moderately nutrient rich loamy sand soils
- local subtypes, associated with successional phases and micro-climate (Schaminée *et al.* 1995).

## Species that depend on the habitat

### *Tetrao tetrix* (black grouse)

The black grouse is listed in Annex I of the Birds Directive and ranges between the upper limit of the North Atlantic region and the high altitude grasslands. It requires a mosaic of habitats including open scrub woodlands, clear-felled areas with well-developed field and shrub layers, moorland edge allotments and unimproved grassland, which include wet heath as a food source of both plants and invertebrates (UKBP 2008a).

### *Coenagrion mercuriale* (southern damselfly)

The southern damselfly is listed in Annex 2 of the Habitats Directive. This globally threatened damselfly breeds in heathland streams and runnels and, more rarely, wet (rhos) pasture, chalk streams and calcareous mires (UKBP 2008b). Most sites are on wet heath and the larvae live in flushes and shallow runnels, often less than 10 cm deep, with slow-flowing water. Adults fly from June to August. Females lay eggs onto submerged plants, and the predatory aquatic larvae probably take two years to mature (JNCC 2008b).

### *Maculinea alcon* (alcon large blue butterfly)

The alcon large blue butterfly is restricted to wet heathland communities. The females only lay eggs on the *Gentiana pneumonanthe* (marsh gentian) on which the caterpillars live for about 10 days. Like other blue butterflies the alcon large blue has an intimate relationship with ants (*Myrmica* spp.) and in the 4th larval stage, they are fed in the ant nest by ant workers until the next spring. Pupation takes place in June and butterflies hatch from the pupae in the beginning of July. The alcon large blue is vulnerable all over Europe and threatened in most NW-European countries (Maes *et al.* 2008).

### *Plebejus argus* (silver studded blue butterfly)

The silver-studded blue butterfly occurs on lowland heathland, calcareous grassland and peatland habitats such as wet heath. In all habitats, the species requires the presence of ant species of the genus *Lasius* (see alcon large blue above), open ground for breeding, and either bare soil or short vegetation. Suitable conditions, such as 2-5 year re-growth of heather and open conditions are usually maintained by grazing or a burning regime.

It is found throughout Europe except Scandinavia, occurring in a wide range of habitat, including alpine grassland, meadows, forest clearings and xerophytic scrubland. However, it is declining in the west of mainland Europe (Belgium, the Netherlands and Denmark) and in the UK the range decline is estimated at 80% (UKBP 2008c).

### *Bruchia vogesiaca* (bruchia moss)

Bruchia moss is listed in Annex 2 of the Habitats Directive. It often occurs in areas with an oceanic or sub-oceanic climate and has a very restricted ecology. It grows in small niches, including bare turned tussocks, on the banks of small intermittent rivulets and always on well-humidified black organic soils. It is strongly dependent on humidity and avoids areas with high January temperature (Sergio & Draper 2002).

### Other species

Other bird species listed in Annex 1 of the Birds Directive that utilise wet heath but have a wider range than just wet heathland communities include *Falco columbarius* (merlin), *Circus cyaneus* (hen harrier), *Circus pygargus* (Montague's harrier), *Sylvia undata* (dartford warbler) and *Pluvialis apricaria* (golden plover). Merlin, hen harrier and Montague's harrier, being predator species, utilise the open heathland area as a hunting ground for small mammals and birds and as a breeding site. Dartford warblers tend to have territories in dry heath, but are known to utilise wet heath communities. Golden plover use peatlands, including wet heath, for breeding.

Other species that depend on wet heath, which have restricted distribution due to their habitat requirements include *Lagopus lagopus* (red grouse – UK Biodiversity Action Plan (UKBAP) priority species), *Numenius arquata* (curlew), *Coenonympha tullia* (large heath butterfly - UKBAP priority species) and *Lycopodiella inundata* (marsh clubmoss - Annex 5 and UKBAP priority species).

## Related habitats

Within the overall heathland complex, North Atlantic wet heaths occur in several types of ecological gradient. In the drier lowland areas, wet heaths are local and often restricted to the transition zone between 4030 European dry heaths and constantly wet valley mires. In the uplands they occur most frequently in gradients between dry heath or other dry, acid habitats and 7130 Blanket bogs. At high altitude in regions with warmer climates wet heaths occur in mosaics with 4060 Alpine and Boreal heaths. In Scandinavia, however, the distribution of wet heaths and Alpine/Boreal heaths do not overlap.

### 4020 Temperate Atlantic wet heaths with *Erica ciliaris* and *Erica tetralix*

Temperate Atlantic wet heaths with *Erica ciliaris* (Dorset heath) and *Erica tetralix* are characteristic of the western Mediterranean region and within the EU are found in France, Spain and Portugal and parts of the south west of England. These hygrophilous heaths are found in areas with a temperate oceanic climate, and with a more stringent dominance of *Erica ciliaris* than the Northern Atlantic wet heaths (e.g. Gaudillat & Haury 2002).

### 4030 European dry heaths

European dry heaths typically occur on freely-draining, acidic to calcareous soils with generally low nutrient content. Dwarf-shrubs dominate the vegetation, with the most common being heather *Calluna vulgaris*, in combination with *Ulex* spp. (gorse), *Vaccinium* spp. and *Erica cinerea*. Nearly all dry heath is semi-natural, having developed through a long history of grazing and burning. Most dry heaths are

managed as extensive grazing for livestock or, in upland areas in the UK and Ireland, as grouse moors (JNCC 2008c).

#### 7130 Blanket bogs

Blanket bogs have formed in areas where there is a climate of high rainfall and a low level of evapotranspiration, allowing peat to develop not only in wet hollows but over large expanses of undulating ground. The term blanket 'bog' strictly applies to that which is exclusively rain-fed. This is a globally restricted peatland habitat confined to cool, wet, typically oceanic climates. Peat depth can be very variable from 0.5m to depths in excess of 5m. There is no agreed minimum depth of peat which can support blanket bog vegetation. Typical plants include peat-forming species, such as *Sphagnum* spp (bog-mosses) and *Eriophorum* spp (cotton grasses), or *Molinia caerulea* in certain circumstances, together with *Calluna vulgaris* and other ericaceous species. (JNCC 2008d, UKBP 2008d).

#### Other bog habitats (7110, 7120, 7140)

Peat depth is decisive if the habitat is to be classified as wet heaths or as any other relevant acid bog habitats (mostly active or degraded raised bogs (\*7110, 7120), transition mires or quaking bogs (7140) (e.g. Naturvårdsverket 1997, Gaudillat & Haury 2002). For Scandinavia, a peat depth of greater than 0.3 m is indicative.

#### 4060 Alpine and boreal heaths

Alpine heaths develop above the natural altitudinal tree-line. Boreal heaths develop below the tree-line in gaps among scrubby high-altitude woods or as replacements for those sub-alpine woods lost due to grazing and burning. On lower slopes, Boreal heaths may grade into floristically-similar European dry heaths. The dominant plants are usually dwarf-shrubs such as *Calluna vulgaris*, *Vaccinium* spp, *Empetrum nigrum* (crowberry) and *Juniperus communis* (juniper), which are low-growing or prostrate owing to poor soils conditions, exposure to high winds or prolonged snow cover at moderately high altitudes.

### **Ecological services and benefits of the habitat**

The diverse environmental, social and cultural ecosystem services provided by wet heaths include carbon storage, biodiversity, water provision, flood protection, aesthetic/recreational value, and economic value from tourism, sporting enterprises and grazing.

Good quality, semi-natural wet heaths play an important role in carbon sequestration, as a habitat which often overlies peat. Peat plays a vital role regulating carbon levels in the atmosphere by acting as a carbon sink. Alongside this, if wet heaths become degraded through loss of vegetation or drainage, flood risk may be exacerbated, and pollutants may be released that were held within soils (MF 2006). Wet heaths also provide habitat for plant and animal species found nowhere else, adding to valuable biodiversity across northern Europe.

Wet heaths, as part of the heathland complex, create valuable economic, recreational and sporting services. As grazing land, heathland supports different forms of livestock such as sheep, cattle and ponies. Heathland is also a beautiful aesthetic landscape, and provides tourism for local communities, particularly from hill walking activities. In addition it provides valuable employment and revenue for local communities from sporting activities such as shooting, particularly in the uplands. In the past and as part of a traditionally managed system, heathlands provide fuel, forage and thatch.

### **Trends**

Wet heath is a naturally occurring dwarf shrub habitat, and prevention of succession to woodland is most likely due to the high water table along with the low nutrient status of the soils (Gimingham 1992). Other heathland species would also have been found naturally within open woodland communities, particularly on 'poorer', low nutrient status soils. However, the extent of heathland across Europe is intimately related to human activities, and the large open heathland complex, which includes wet heath, developed around 6000 years ago.

As early agricultural practices began, woodland areas were cleared for grazing, cutting turf, cutting for fuel and harvesting for fodder, and large open heathland communities began to develop (Gimingham 1992, Webb 1998). For thousands of years people worked the heaths, creating, maintaining and reshaping this unique environment, as a valuable source of livelihood to many communities.

Traditional management has continued to maintain heathland. However, across Europe there is the potential for declines in grazing, burning and cutting which may have a profound impact on the heathland community. During the middle part of the last century, farming methods altered with the development of artificial fertilisers, herbicides and modern forms of machinery for ploughing and drainage. Farmers were encouraged to 'improve' heathland areas through ploughing where possible, but also domestic stock numbers rose significantly with the introduction of farm subsidies. Heathland areas in the UK in particular suffered from overgrazing, and it is only since the headage-based subsidy was replaced in 2005 that numbers of animals on heaths are no longer encouraged to excess. In the future, there is a risk that heathlands that have been overgrazed may no longer be agriculturally viable, and will end up ungrazed.

## Threats

### Overgrazing

A key threat to the habitat is overgrazing. It can lead to the loss of dwarf shrubs, which are substituted by species that are more resistant to grazing, usually facilitating expansion of grassland habitats that are already present.

Dwarf shrubs such as heather species (*Erica* and *Calluna*) go through specific growth phases, from pioneer through to building, then mature, and finally degenerate. The vigour of heather plants is greatest during the first two phases, while stand productivity is greatest when all the heather plants are in the building phase. At this stage the heather canopy attains maximum coverage and density.

Grazing at low densities can impact dwarf shrub growth on heaths by utilising annual growth. It can maintain the plants in the developing or maximum phase of growth and prevent them from passing into the later, degenerate phase. However, too much grazing leads to the loss of dwarf shrub cover (Backshall *et al.* 2001). Heather cover will generally decline if grazing animals utilise more than 40% of the season's growth (as shown for dry heath), potentially allowing other species such as grasses to dominate the habitat (Thompson *et al.* 1995).

However, overgrazing may not occur on a well developed, infertile wet heath (with intact soil and hydrological characteristics) because the vegetation type may be avoided by the animals (unless they are forced to use it, which will be related to stocking rates). Although, a species-rich wet heath, growing on more fertile soil, usually contains a considerable amount of grasses and can be prone to overgrazing, which can cause the expansion of the grasses and herbs. Overgrazing can also impact upland wet heath, growing on a peaty soil that has been (superficially) dried out (De Blust, pers. comm.).

Importantly on wet heath, large numbers of animals trampling on the wet, peaty soils may cause erosion leading to the loss of the characteristic wet heath community.

### Grazing abandonment or under stocking

Along with overgrazing, under-grazing can also be a threat to heathland communities through vegetation succession. Although it is thought that undisturbed wet heath could be maintained without management (see below), most wet heath communities will be reliant on some form of disturbance such as grazing, particularly as part of a heathland mosaic. If none occurs, the dwarf shrubs will move from the building phases of growth into the mature and degenerate phases becoming increasingly 'leggy' with gaps forming in the canopy. This may lead to their replacement by other species, eventually leading to woodland (Gimingham 1992).

In south-west Sweden, quite rapid declines in the abundance of *Pedicularis sylvatica* (lousewort) have been related to grazing abandonment.

### Uncontrolled burning

Burning of heathlands has been an element of the traditional land-use, in order to enhance the grazing conditions for livestock. However, uncontrolled fire (in contrast to controlled or prescribed burning) is primarily detrimental for the conservation status of wet heaths. It may be that wet heath is particularly susceptible to damage by burning, especially with regard to the lower plant flora such as bryophytes. *Sphagnum* spp, which are generally slow colonisers and may have taken many years to establish, may be lost due to burning where fires burn into the moss and litter layer (Gimingham 1992). Intense and hot fires can also cause peat erosion, drying of the habitat and loss of dwarf shrubs allowing different plant communities such as grassland to develop. Natural England (previously English Nature) produced a research note on the detrimental effects of burning, which are highlighted below.

***A Natural England research note highlights the following significant detrimental impacts of fire (from Tucker 2003):***

- Combustion and loss of peat and humus layers by hot fires in dry conditions.
- Increased rates of run-off and erosion, particularly after hot fires and where large or old stands of Heath are burnt, and on steep slopes.
- Reduction in peat accumulation, even under well controlled prescribed burns, and potentially emission of carbon dioxide and other greenhouse gases from carbon stores in peat if these ignite or dry out as a result of hot burns.
- Reduction of structural and species diversity and vegetation composition changes if carried out too frequently or over large areas.
- There will be value of sympathetic burning regimes in certain habitats, notably dry heath, but also recognises that other habitats, notably peatlands (blanket bog and wet heath) can be severely damaged by inappropriate burning.
- Post-fire establishment of invasive species such as *Pteridium aquilinum*, for example where old Calluna stands are burnt.
- Destruction and long-term exclusion of fire sensitive and slow colonising species.
- Removal of cover for ground-nesting wildlife and destruction of birds nests and clutches during spring burning periods.

However, a study into the effect of uncontrolled fires on heathland communities, including wet heath, suggested that, after the initial impact the wet heath, the habitat showed few responses to the fire and all effects were transitory (Bullock and Webb 1995). This suggests that more clarity on the use of fire within a heathland system is required.

It is most likely that regular or hot uncontrolled fires within the same wet heath area could destroy the habitat, or trigger damaging peat erosion on a large scale.

### Artificial drainage

Drainage of wet heaths will undoubtedly have a detrimental effect on wet heath, as it will change the hydrological regime. Drainage could lead to lowering of the water table and ultimately to the loss of wet heath (Backshall *et al.* 2001). This will usually be associated with groundwater extraction (for drinking water), agricultural improvement, forestry or development.

### Nitrogen deposition

The increase of soil nitrogen levels, particularly through increased levels of ammonia in the atmosphere, could threaten wet heath (Dalton and Brand-Hardy 2003, Aerts 1993). To ensure the maintenance of wet

heath it is important that soil conditions remain low in nutrients such as nitrogen. Increasing nitrogen levels will favour more competitive grass species such as *Molinia*, leading to a change in plant community (Barker *et al.* 2004). In addition it is predicted that low intensity grazing may not be sufficient to maintain heathland communities alongside nutrient addition (from the atmosphere) (Hardtle *et al.* 2006, Terry *et al.* 2004).

### **Afforestation**

Planting of tree crops will lead to the loss of open habitat within the heathland complex, including wet heath. This may potentially have a knock on effect of increased predation for adjacent heath breeding birds (Backshall *et al.* 2001) and other heathland animals.

### **Invasive species**

Species such as *Pteridium aquilinum* (bracken) and *Molinia caerulea* can be damaging to extensive heathland areas by forming dense stands of vegetation and litter at the expense of ericaceous species. *Pteridium aquilinum* tends to be more invasive on the drier heathland areas, being less tolerant of wet conditions. *Molinia* can come to dominate wet heath areas, which can be caused by inappropriate management such as overgrazing or burning, nitrogen deposition or lack of management.

### **Recreation**

Recreational activities can also have a negative effect on heath vegetation, but compared to other issues, may be of little conservation significance. However, activities such as hill walking and mountain biking can be detrimental to fragile ecosystems such as wet heath, leading to erosion and loss of vegetation. Management of visitors and their use of the open moorland is crucial to alleviate any harmful effects (Backshall *et al.* 2001).

Development such as housing and roads can cause loss and fragmentation of wet heath communities. This has more of an impact in the lowland heaths, particularly in the south of England and previously in Germany, Belgium and the Netherlands.

### **Climate change effects**

Any predictions regarding climate change have to be, to a certain extent, theoretical, but the general consensus appears to be that wet heath will not be adversely affected, and may even benefit from the predicted milder, wetter winters and drier summers (Berry *et al.* 2002).

The predicted increase in annual rainfall totals in the uplands may encourage the development of wet heath at the expense of dry heath, but this may be offset by increases in evapo-transpiration under warmer conditions and an increase in dry heath in southern areas.

However, it may be that warmer summers and wetter winters could affect the peat soils of upland heath habitats. Higher evapo-transpiration under warmer summers may lower water tables leading to aerobic conditions and increased decomposition. Winter re-wetting may cause greater erosion of these less stable peats. Both factors will exacerbate current erosion and possibly encourage new erosion to occur, leading to a decline in heathland quality and extent (Defra 2001). Any climate change scenarios that show peat soils to be under threat will have longer-term detrimental impacts on wet heath.

## 2. Conservation management

### General recommendations

There is still a debate as to whether wet heaths require any form of management. If all things remain equal, undisturbed wet heath communities may be maintained without management because the prevailing ecological conditions (soil nutrients, hydrology, acidity) restrict successional processes (Burgess *et al.* 1995, Gimingham 1992).

However, as discussed previously, wet heath is usually associated with a wider heathland/mire complex and management becomes essential for maintaining the complex as a whole.

Most of the wet heaths and their nature conservation value are related to the impact of low intensity grazing over a very long period. Thus, grazing is the key form of management that management guidelines tend to identify across various countries in Europe (e.g. Gaudillat & Hauray 2002, Naturvårdsverket 2005, UKBP 2008e). The main issues for wet heath are the number and type of livestock used and timing of grazing.

For other forms of heathland management, such as burning and mowing, a general view is that they may have a detrimental impact on the community. For example in the UK the general recommendation is that burning and mowing should not be used as management on wet heath, while a less restrictive approach has been adopted for Sweden, Belgium and other parts of Europe.

It is recommended that instructions prohibiting or regulating fertilizing, supplementary feeding of livestock, drainage or introduction of non-native species are included in management plans and protection regulations for wet heath sites (Naturvårdsverket 2005).

For case studies of sites with wet heath, which include site management and relevant issues see references: DEFRA 2007a-c, Forestry Commission 2008, JNCC 2008a.

### Active management

The following text is primarily based on experiences from the management of wet heaths in UK and Ireland, which host 85% of the surface area of this habitat in the EU. The management prescriptions within the UK tend to be quite strict; particularly with regard to burning (i.e. if in doubt do not use burning as management on wet heath). However, across the rest of Europe controlled burning (along with vegetation cutting and soil removal (sod cutting)) is considered vital for heathland management (including wet heath).

Given that traditional management includes burning, vegetation cutting and sod removal, it may be that a site-by-site approach is required when developing management prescriptions for wet heath. This should involve site evaluation as to what the community structure is (level of water table, grass to dwarf shrub ratios, general species composition, amount of bare ground etc.), which will determine management tools, such as stocking levels for grazing, use of controlled burning, vegetation cutting and sod removal.

The general text below is based on UK prescriptions for grazing, burning and cutting (mowing), with other European prescriptions such as those used in Sweden and Belgium given as examples presented under separate headings below.

#### Grazing

The main reason for grazing, in terms of conservation, is to arrest successional change, ultimately stopping woodland from colonising the heathland areas. This is especially the case when different types of livestock are used in concert, which will generate variations in habitat structure, encourage species diversity and will be more efficient at maintaining the open heathland flora.

As indicated above, it is likely that light grazing has been a natural feature of wet heaths for thousands of years, and is beneficial for maintenance of the habitat (Burgess *et al.* 1995). For successful management of wet heath, low stocking rates are therefore essential. Heavy grazing should be avoided on good quality wet heath as it can lead to a decline in characteristic dwarf shrub cover in favour of grass, sedge and rush species, as well as excessive poaching and erosion of the underlying peat (English Nature 2004).

Appropriate stocking levels for wet heaths should be determined by taking into consideration its conservation status, other management practices, such as burning, and the numbers of wild herbivores present (Backshall *et al.* 2001).

**Levels of grazing for wet heath as recommended in Northern Ireland (Millsop 2008)**

- No grazing from 1 November to 28/29 February inclusive.
- Overgrazing and/or poaching is not permitted at any time.
- During the remainder of the year the stocking level must not exceed 0.25 LU/ha (LU = Livestock Unit) at any one time [that is, 1.6 sheep per ha].
- Cattle will not normally be permitted on wet heath but where they are the only livestock on the farm they will be allowed to graze during June, July and August at 0.2 LU/ha with the written permission of Department of Agriculture and Rural Development.

**Levels of grazing in England by Backshall *et al.* (2001), with additions by Stainer (*pers. comm.*)**

To maintain wet heath (and blanket bog) in favourable condition:

- undisturbed wet heaths and blanket mires require little management and may be left unmanaged (Burgess *et al.* 1995), but few pristine sites now remain in England;
- Light or no grazing in the autumn or winter, with at most very light grazing in the summer is the ideal grazing regime on most wet heaths and blanket mires;
- year round stocking rates should not exceed 0.25-0.5 ewes/ha or 0.037-0.075 LUs/ha;
- winter stocking rates should be reduced by at least 25%, with all cattle and horses removed where there is a risk of poaching;
- Blanket bog or wet heath dominated by *Molinia* will be better grazed with cattle or ponies in the spring and summer months, as this will reduce the dominance of this grass over time and aid restoration.

To bring wet heath and blanket bog into favourable condition:

- a maximum year round stocking rate of around 0.1 sheep/ha or 0.015 LUs/ha has been recommended, with winter levels lower still or stock removed;
- if the habitat is very degraded a period (several years) of no grazing may be appropriate;
- if bare peat is exposed, it is very difficult to stabilise and any stocking could prevent re-vegetation;
- restoring high water levels may be the most important factor in reversing deterioration of vegetation and peat soils.

Grazing by different animal species should be taken into consideration because different species favour or refuse different sorts of food. For example, goats can be used to tackle areas where *Juncus* spp (rushes) have come to dominate (Gimingham 1992), but this needs to be alongside the use of other animals and should be monitored as to the effects of goats on the habitat as a whole. In some cases, temporary fencing may be an option to enable different management regimes to be implemented (Backshall *et al.* 2001). Also, the use of traditional breeds of cattle is thought to have a greater impact on conservation of

heathland compared to those breeds bred for production, through hardiness and choice of vegetation eaten.

Successful maintenance of wet heath through grazing will require careful management. The most vulnerable periods for poaching, particularly by large animals such as cattle, will be in the winter and it is recommended that no, or very extensive grazing be allowed on wet heath through the winter.

Wet heaths are often seasonally dry in the summer, with a water table up to 10 cm below the soil surface (Burgess *et al* 1995). Allowing light grazing (see stocking rates above) through the summer should not adversely affect the wet heath community. Herbivores, through creating vegetation mosaics, will have a positive effect on the biodiversity of the community and will help control dominant species such as *Molinia caerulea* in certain situations.

Caution needs to be applied in terms of zero or low intensity grazing as it has been suggested that this is not sufficient to maintain heathland communities, and management would also involve regular tree cutting (Bokdam and Gleichman 2000).

In terms of wet heath, it may be that as long as the habitat maintains a suitably high water table, low intensity grazing would be enough. However, open scrub will enhance the wider biodiversity of heaths, and scrub was an integral part of these habitats prior to human management, as shown in the pollen record.

A potential difficulty in terms of grazing for nature conservation, on nature reserves is finding graziers prepared to graze extensively. This has been an issue in the UK and an initiative called the Grazing Animal Project (GAP) was developed to give advice on grazing for conservation and to act as a point of contact for projects trying to find graziers. The GAP website is also the source of a wealth of information on grazing, particularly for conservation (GAP - <http://www.grazinganimalsproject.org.uk/index.html>).

## **Burning**

Burning has been used for centuries to manage vegetation in some EU countries, such as the United Kingdom, and for stimulating new growth of grasses or heather for agriculture, game rearing and wildlife conservation (Backshall *et al.* 2001). However, inappropriate use of this technique can be dangerous for the survival of wet heaths as it can damage bryophyte and lichen flora and increase erosion through the loss of peat soils.

Thus, the general recommendation in the UK is do not burn wet heath communities as regular burning on short cycles will eventually destroy wet heath, favouring grassland species such as *Molinia caerulea* (Backshall 2001). However, this is not considered to be the rule in other countries (see below).

If vegetation is to be managed by burning as part of an overall management structure, then different regimes should be applied to different areas, leaving wet heath for longer periods between burns or left as no-burn zones; this will prevent damage to wet heath and also increase habitat biodiversity by creating a varied structure to the vegetation.

Timing of burns is important to ensure successful management. Burns should be carried out in late winter, early spring with very wet soil conditions, avoiding very windy periods that have a drying effect on vegetation litter and may affect the control of the fire. Only small areas should be burnt at a time, and preventing the outbreak of the fire outside the area by use of firebreaks is also important in controlling the burn.

**Recommendations concerning burning of blanket mire and wet heath in UK (taken from Backshall et al. 2007)**

- As a general rule when managing mires for nature conservation, if in doubt, do not burn.
- Where blanket bog and wet heath is in favourable condition, the ideal option for nature conservation purposes is not to burn at all.
- A 20-year burning regime is the recommended minimum rotation for blanket mires, which may also apply to wet heath, and a burning rotation of 20-30 years may be preferable.
- Where burning is conducted, for conservation purposes it is desirable to convert or maintain sensitive areas (such as wetter, steeper, or higher altitude locations) to no burning areas.
- When conducting any burning on blanket mire or wet heath, follow all the legal requirements, areas to be avoided and other recommendations contained in the previous boxes.
- Large areas of old, tall heather on wet substrates are ideally left un-burnt, because of the risk of very hot fires and little regeneration.
- Areas which contain pools or peat haggings, and close to eroding runnels, should also not be burnt.
- Where accidental fires are likely and extensive areas of old, woody heather exist, burn fire breaks as a precaution or consider cutting fire breaks, but consider the possibly damaging effects of the use of machinery.
- Areas where *Molinia caerulea* is present at more than 20-30% cover are best not burnt, because this may encourage this grass, particularly in the presence of sheep grazing.

**Cutting (by mowing)**

Cutting, like burning, is a drastic event for the vegetation and its associated fauna, particularly on wet heath as heavy machinery can cause compaction and erosion. For these reasons, mowing should, if possible, be avoided on wet heath communities (Backshall et al. 2001).

However, cutting may be the only form of management available, and may need to be considered. When it is used for management, it should be adequately planned and monitored. It is possible to use two different techniques: cutting by hand (depending on the area to be cut) and using mechanical means. Where large areas are to be managed, tractor mounted mowers may be the only viable option, but machinery used in cutting can damage fragile ground, such as the peats of wet heath. To avoid excessive damage, cutting should be carried out in drier months of summer, but this should be after the bird nesting season, not before mid-July (to be assessed in the field). However, this may be in conflict with the fact that heather regeneration is usually better after a spring cut (Backshall et al. 2001).

If cutting is carried out when the ground is still wet, vehicles will need to have low ground pressure tyres and monitoring will be essential to ensure that recovery of wet heath species has occurred post cutting. Removal of all cuttings may increase the speed of regeneration but it is not essential to maintain the habitat (Stainer, pers. comm.).

Cutting is more expensive than burning, but in some particular cases, the sale of cut heather for commercial purposes can reduce the cost (North York Moors National Park 1991). Also heather foraging may be used for heathland restoration projects, with the cuttings sold to the receptor project. Note that foraging will need to be carried out when there will be mature seed available in autumn/early winter.

**Recommendations concerning heather cutting in UK (Backshall et al. 2001)**

- Plan a programme of cutting
- Avoid cutting during the main bird-nesting season
- Regeneration is generally better after spring rather than autumn cutting
- Consider removing cuttings for more rapid regeneration (Stainer, pers. comm.)

### **Grazing combined with controlled burning and complementary cutting**

For south-west Sweden, a different management approach is used. The main concept is grazing in combination with recurrent burning, and it is recommended that the historical land-use traditions regarding the grazing regime are followed. Complementary cutting of overgrowth and more occasional burning may be considered as additional measures, if needed. This should be decided on a site-by-site basis (Naturvårdsverket 2005, Larsson 2007). A higher grazing pressure during late autumn (as well as in winter if practically possible) and early spring is recommended in order to reduce the re-growth of young trees and bushes and the litter layer. In the summer, a lower grazing pressure is thought to be beneficial in order to allow flowering of important nectar and pollen sources of host plants. This management is thought to reflect the traditional management system where winter grazing was common (Larsson 2007).

The use of fire as a tool to maintain the conservation values associated with both wet and dry heaths is seen as essential in Sweden (Larsson 2007), and in accordance with traditional land-use. This is however not uncontrolled burning but recurring prescribed burning in the spring. Ideally, burning takes place in small sections so that the site contains a mosaic of successional stages from newly burnt areas to areas with old heather.

Done properly, it creates a varied vegetation structure and a diverse flora and fauna, and it is probably a more important disturbance factor than grazing. The cessation of burning, however, tends to result in homogenous vegetation dominated by ericoid species and a reduced diversity of species. For example, many of the species on the national red list and associated with heathlands have responded positively to this management, and the lack of burning is believed to be one of the most important factors in the decline of threatened species such as *Gentiana pneumonanthe* (marsh gentian) and alcon blue *Maculinea alcon* (Appelqvist & Bengtsson 2007).

Also in Belgium and the Netherlands, burning is considered to be an important management tool for wet heath, when carried out under controlled conditions, and should be used when appropriate (Kvamme *et al.* 2004).

### **Scrub removal and Sod cutting**

Cutting of trees and shrubs may be required when grazing is not sufficient, to ensure that scrub does not come to dominate the habitat. More important however is sod cutting. This was and is a traditional management technique for heathland, including wet heath. It was used formerly as part of the agricultural use of wet heath for animal bedding and fuel; now it is used as a means to maintain conditions for pioneer vegetation belonging to the wet heath complex. Sod cutting is not only applied as a means to restore degraded wet heath (overgrown by *Molinia*), but also on a small scale, and by hand, to maintain the different successional stages of wet heath.

### **Habitat Restoration**

Generally, it is of higher nature conservation priority and most cost-effective to concentrate effort on restoration by improving the condition of degraded heaths, rather than trying to re-create it where it has completely disappeared (Thompson *et al.* 1995). Also important will be connectivity to wet heaths in good condition; the closer the restoration project is to favourable wet heath, the more likely species dispersal will occur into the restored area.

The first step will be the reduction/removal of the cause of habitat degradation. This may involve removal of excessive nutrients or restoring the hydrological regime. Sod removal has been carried out to reduce nutrient levels with varying degrees of success. A study in Belgium succeeded with wet heath restoration when soil (peat) and established vegetation were removed, rather than just mowed, which had little impact on restoration. The authors found that peat removal reduced cover of the dominant *Molinia* and enabled establishment of *Erica tetralix* and other wet heath species (Jacquemart *et al.* 2003).

Another study in the Netherlands found that restoration of wet heath by sod cutting was hampered by raised levels of ammonium ions originating both from aerial deposition of nitrogen and from

mineralization of organic material (Dorland *et al.* 2003). Also in the Netherlands, experimentation with lime addition on wet heath for restoration purposes are being carried out. The aim is to raise soil pH, which speeds up the conversion of soil ammonium (which at high levels is toxic) into nitrate by microbial nitrification, a process inhibited by soil acidity (Dorland *et al.* 2005). However, this should not be applied 'automatically' and 'everywhere', but only restrictively and on a site-specific basis (e.g. in terms of an impact analysis). Some wet heath types, which have low species richness, have very acid soil conditions naturally. The cation exchange capacity of these soils is very low and will not be increased permanently by a once-only liming. An analysis of the site conditions is necessary before using this technique.

Wet heath is reliant on a high water table and degradation may have been a result of the drying of the habitat, due to drainage. Re-establishing the hydrological regime will be vital for success, such as applying sluice gates or damming ditches, allowing water to stay in the system for longer and re-establishing the natural level of the water table.

Where soil removal is the best option for restoration, seed application of favourable species may be required, and has been shown to have success in restoration projects (Pywell *et al.* 1995). This will be important where no seed bank remains, which should be examined as part of a restoration project before carrying out any seed addition. Seeds can be obtained from adjacent seed-bearing plants or local wet heath communities. A forage harvester or flail mower and baler can be used where conditions are suitable (e.g. relatively flat, no boulders, not too wet) and this material is normally applied at about 600 g per m<sup>2</sup>. Collecting seed, litter and soil from areas of wet heath, either by hand or an industrial vacuum cleaner can provide an alternative source of seed. This material is usually spread at the lower rate of about 200 g per m<sup>2</sup>. If storage of either type of material is required, it should be dried first. (Backshall *et al.* 2001). The different equipment that can be used for harvesting seed can be found at <http://www.floralocale.org/content.asp?did=24045>.

#### **Indicators of restoration success on areas of upland wet heath in UK (DEFRA 2005a)**

- No burning of the area of recovering dwarf shrub heath. No-burn areas should be incorporated into future management plans (Stainer, pers comm.).
- Between February and April no more than 33% of Heather shoots should show evidence of grazing.

By year 5

- Less than 10% of bog-mosses (*Sphagnum*) should be damaged or dead.
- Flowering Heather plants should be frequent between July and September.
- Dwarf shrubs should be at least frequent.
- The cover of scattered scrub should be less than 20%.
- The cover of Bracken should be less than 10%.
- The cover of invasive weeds such as Rhododendron, Creeping and Spear Thistle, docks, should be less than 1%.
- The area of disturbed bare ground should be less than 10%.

By year 10

- At least 2 dwarf shrub species should be frequent.
- The cover of dwarf shrubs should be up to 75% or have increased by at least 20%. Heather should have a diverse age range, with pioneer stage plants covering between 25% and 50% of the area and mature/degenerate plants covering at least 10%

### **Other relevant measures**

#### **Monitoring**

It is vital that monitoring is carried out on the North Atlantic wet heaths, as it will assess whether management being carried out is maintaining the nature conservation interest found within the wet

heath community. More importantly, it will identify when and where degradation is occurring, alerting site managers to assess management needs.

Monitoring on wet heath will need to assess habitat features such as the composition, cover and structure of the vegetation, which in wet heaths can be very variable (JNCC 2006). According to the JNCC common standards monitoring (CSM) guidance, vegetation height is usually 10 - 30 cm, and more rarely 50 cm or more where protected from grazing and burning. Other features highlighted in terms of monitoring include:

- There tends to be a mixture of dwarf-shrubs, graminoids, bryophytes and lichens.
- The presence of *Erica tetralix* at high frequencies is one of the few characteristics which seem to be common to most forms of this feature.
- *Calluna vulgaris*, *Molinia caerulea*, *Trichophorum cespitosum* and *Sphagnum* spp. are often present and sometimes abundant, but relative dominance is influenced by management.

The following table is taken from the Common Standards Monitoring Guidance for Upland habitats in UK – wet heath (JNCC 2006).

Table 1. Methods of assessments for wet heath in UK (JNCC 2006)

Mandatory attributes	Targets	Method of assessment / Comments
Feature extent	1) There should be no measurable decline, in the area of the feature.	Field comparison with baseline map of features, or occurrence of feature at sample points on a systematic sample grid.
Vegetation composition — frequency of indicator species	(1) <i>Erica tetralix</i> should be present within a 20 m radius of the centre of the quadrat.	Target (1) assessed against visual estimate up to 20m from centre of the quadrat.
Vegetation composition — cover.	<p>(1) At least 50% of vegetation cover should consist of species which indicate wet heath (as listed in the guidance) and at least 20% of the vegetation cover should consist of ericoid species*.</p> <p>(2) Less than 20% of vegetation cover should be made up of scattered native trees and scrub. Qualifiers: For target (2) exclude <i>Betula nana</i> and <i>Myrica gale</i>.</p> <p>(3) Less than 10% of vegetation cover should be made up of bracken.</p> <p>(4) Less than 1% of vegetation cover should be made up of non-native species.</p> <p>(5) Less than 1% of vegetation cover should consist of, collectively, <i>Agrostis capillaris</i>, <i>Holcus lanatus</i>, <i>Phragmites australis</i>, <i>Ranunculus repens</i>.</p> <p>(6) Less than 10% of the vegetation cover should consist of <i>Juncus effusus</i>.</p> <p>(7) None of the following should make up more than 75% of vegetation cover: (a) dwarf-shrubs; or (b) graminoids.</p>	<p>Targets (1 and 7) assessed against visual estimate at 4 m<sup>2</sup> scale.</p> <p>Targets (2-4) assessed against visual estimate for as much of the feature as is visible while standing at a sample location.</p> <p>Targets (5 and 6) assessed at two scales, and should be met at both scales:            (a) Against visual estimate at 4 m<sup>2</sup> scale; and            (b) Against visual estimate for as much of the feature as is visible while standing at a sample location.</p> <p>* For the purposes of this recording <i>Empetrum</i> should be regarded as 'ericoid'.</p>

Monitoring protocols such as the JNCC models are set as generic assessments for high quality sites. For monitoring restoration programmes the Defra model could be used (DEFRA 2005a).

For Sweden, it is proposed that the following criteria are investigated for the evaluation of the conservation status of a specific site (e.g. Naturvårdsverket 2005):

- The surface area (in hectares), which should meet the definition of 'Northern Atlantic wet heaths'.
- The percentage of well-managed or well-grazed heath.
- Canopy coverage of trees and scrubs (typical target is ca 1%, but with a wide range between sites, and an upper target of 30%).

A minimum percentage of monitored study plots will have vascular plants characteristic of the habitat (examples of species proposed to be selected for single sites are *Erica tetralix*, *Gentiana pneumonanthe*, *Lycopodiella inundata* and *Pedicularis sylvatica*).

Site specific monitoring protocols rather than generic models could be developed, which take into account what is present on a particular site and what the nature conservation objectives are for that site. These measures of success can be tailored to suit sites, which may differ significantly across the natural range (Hurford and Schneider 2006).

### Special requirements driven by relevant species

In general, the correct management of wet heaths such as extensive grazing, some minimal burning and cutting when required will be sufficient to maintain the important species associated with the habitat. However, all species have particular requirements and the specifics for three species are given below as examples. The key for most rare species will be to get grazing levels right to ensure a varied mosaic of habitat from open ground, dwarf shrub cover to some scattered scrub.

#### Tetrao tetrix

Over-frequent moorland burning and overgrazing can affect the habitat, leading to the formation of impoverished acidic grasslands and resulting in the loss of key food plants (Thom & Court 2000, UKBP 2008a), but the main threats to the species linked to management are connected with the regulation of the grazing inside the habitat.

- *Overgrazing*: the management indications of grazing for the benefit of the black grouse are the same as for the heathland habitat itself. Heavy grazing, especially along the lower edge of the moor, not only erodes the heather line, but it produces a short turf without the cover and food of tall grasses and herbs (Black Grouse UK 2008). In addition, the reproduction areas of the black grouse may need to be excluded from grazing to avoid damages to the eggs and to chicks between April and July, although extensive grazing will usually produce suitable breeding conditions.

#### Coenagrion mercuriale

A lack of appropriate levels of grazing to maintain open habitat, lack of ditch management to ensure water levels are maintained, and deepening of water channels resulting in loss of suitable habitat due are the key issues in terms of site management for southern damselfly (UKBP 2008b, Hampshire Biodiversity Partnership 2000).

- *Undergrazing and overgrazing*: both these management issues can affect the survival of southern damselfly. Sites need a certain level of poaching of flush areas, preferably by cattle (although ponies are also important). Sites thus need to be in active grazing management, particularly in order to control the dominance of purple moor grass and black bog rush, western gorse and willow scrub (Devon Biodiversity Action Plan 2005). A balance in grazing is required, as too much poaching will lead to the loss of food plants.
- *Site hydrology*: a need for shallow, open water streams (runnels) is vital for this species survival (Devon Biodiversity Action Plan 2005). If areas become overgrown and potentially dry up through lack of management (grazing etc.), or dry up due to water extraction, this will lead to the loss of this species.

### Maculinea alcon

The alcon blue butterfly and its host species *Gentiana pneumonanthe* (marsh gentian) are declining in all parts of their European distribution range. In Sweden, both species are associated with wet heath mosaics influenced by grazing and burning that help to maintain suitable "micro-habitats" for the host ant species (Appelqvist & Bengtsson 2007).

- *Undergrazing and overgrazing:* Lack of grazing has led to the scrubbing over of suitable open heathland resulting in a change of ant species communities and unfavourable conditions for both marsh gentian and alcon blue. Active afforestation has had the same effect. Overgrazing in the summer on the other hand, has in some places, led to a severe reduction in the number of stems of marsh gentian. The number of suitable egg laying sites for the alcon blue has thus been reduced.
- *Lack of burning:* The marsh gentian is a perennial plant species able to survive for a long time even under suboptimal conditions. In the long term however, regeneration from seed is necessary. The marsh gentian produces a large amount of very tiny seeds unable to germinate in a closed sward of grasses or dwarf shrubs. Burning seems to be the most important factor for creating patches of bare ground suitable for germination.

### Cost estimates and potential sources of EU financing

In the UK the biodiversity partnership estimates that the overall cost of maintaining and enhancing existing heathland at approximately £95 (approx. €126 in February 2008) per hectare, per year, up to 2010. The data are based on targets where 58,000 hectares of existing heathland habitat will be appropriately maintained and improved and 6,000 hectares of heathland will be re-established through to 2010 (UKBP 2008d).

A guide to payments for upland and lowland heathland from Environmental Stewardship programme in England is given below. These are based on management of good quality sites, which has been developed in light of the EU Common Agricultural Policy reform to single farm payments and cross-compliance.

Table 2. Extracted from *Higher Level Stewardship: Payments for Land Management Options, Supplements and Capital Items (DEFRA 2005b)*

MOORLAND AND UPLAND ROUGH GRAZING OPTIONS	Payments. £/ha (€/ha, February 2008)
Maintenance of moorland	40 (52)
Restoration of moorland	40 (52)
Creation of Upland heathland	60 (78)
Maintenance of rough grazing for birds	80 (104)
Restoration of rough grazing for birds	80 (104)
Shepherding supplement	5 (7)
Seasonal livestock exclusion supplement	10 (13)
Moorland re-wetting supplement	10 (13)
Supplement for management of heather, gorse and grass by burning, cutting or swiping	7 (9)
<b>LOWLAND HEATHLAND OPTIONS</b>	
Maintenance of lowland heathland	200 (260)
Restoration of heathland from neglected sites	200 (260)
Restoration of forestry areas to lowland heathland	200 (260)
Creation of lowland heathland from arable or improved grassland	450 (585)
Creation of lowland heathland on worked mineral sites	150 (195)

For Sweden, the current approximate compensation levels (February 2008) within the agri-environmental scheme is €120-270/ha for grazing and €120-380/ha for mowing, with the highest level for sites of high conservation value. Also, landowners may in certain cases, qualify for a maximum compensation of around €380/ha (February 2008) for restoration measures such as cutting of overgrown heaths and grasslands, if it is followed up by regular grazing or mowing.

A further breakdown of the costs associated with heathland management is given below. These are just estimates as costs will vary both from place to place and by project. The prices below will however give a guideline.

### **Management of grazing**

The following costs are from a local government authority site manager in the UK who manages a lowland heathland site, which give a guide to site management costs in 2008 (Barnett, pers. comm.):

- standard stock fencing - £3.50 - £4 (€4.60 – 5.20 ) per metre.
- Annual maintenance costs of fencing per metre – approx. £0.50 (€0.65) per metre
- Water supply - depends on the works the water Company will have to do i.e. distance of trough from mains supply etc. (£1 (€1.3) per metre as a rough rule).
- Water troughs - £35 (€46, 3ft) to £100 (€130, 10ft), installation by qualified plumber c. £100
- Stock checking – employment of someone to do the daily checks, deal with vets, supplementary feeding and worming off-site and move livestock about - cost (incl. anticipated vets fees/worm counts) per animal for Exmoor ponies – approx. £500 (€650)/yr; Cattle – no data, but will most likely be in the same price range.
- To buy livestock for a site – no data - price of livestock varies.
- 'Lay off land' - lease - £400 (€520)/month.

Wet heath sites may need to be left ungrazed in the winter, so costs of moving and/or over-wintering animals in sheds and feeding will be incurred if the landowner/project owns the animals.

### **Cutting**

If cutting is required for management through lack of grazing or as additional management, the following is given as guideline, which is taken from the same source as the grazing information above from the UK (Barnett, pers. comm.):

- £250 – 300 (€325 – 390)/hectare for foraging heather cuttings.
- £150 (€195)/hectare grassland mowing.

Costs can be reduced, if there are large areas to be cut in one section - £200-250 (€260-325)/ha for foraging heather and £75 (€98)/ha for grassland. Costs may be off-set by selling the foragings for restoration projects.

### **Burning**

Estimates on the area of heather to burn varies on a case by case, but a guide for England estimates about 2 ha per person per day, which is calculated using a speed of fire advance of about 2 m per minute, a fire width restricted to 30 m and 6 hours of actual burning time in a day (Backshall *et al.* 2001). Therefore the cost of burning is relatively cheap and corresponds to the cost of the manpower.

### **Habitat restoration, anti-erosion measures**

The cost of these types of actions varies according to the means to be used and products to be obtained. It always includes the cost of elaborating a technical blueprint as well as the manpower, the eventual rental and/or use of mechanical means and the cost of plants/seed to be used for re-vegetation, etc.

## Bracken control

Bracken control can be in the form of cutting, rolling or spraying. In general, no control measure will remove bracken completely, but will reduce cover (Marrs *et al.* 1998). The following is given as guideline, which is taken from the same source as the grazing information above from the UK (Barnett, pers. comm.):.

- Bracken control - large areas (over 2ha.) (using contractor with Quad bike and tow-behind applicator – roller or flail mower) - £250 (€325)/ha.
- plus chemical (Asulox) approx. £200 (€260)/ha.

## Monitoring

Monitoring is often carried out by competent institutions, such as research bodies, universities or specialist ecological consultants. The costs should include the cost of the monitoring program, the researchers and eventually, of the equipment for triangulation of the habitat on the territory and for cartography.

The Centre for Ecology and Hydrology (CEH) in the UK provided a costing for monitoring climate change on biodiversity, which included soil analysis and species monitoring (Morecroft *et al.* 2006).

The actual work was not regarding management practices, but similar staff input would be required, such as species surveys and soil analysis. The table below shows both the initial costs of establishing monitoring at each site and ongoing costs. Monitoring at each site was estimated to cost up to £11,000 (€14,300) to establish and £7,000(€9,100) per year to operate (costs inclusive of equipment, staff time, chemical analysis etc.). Costs will vary on a site-by-site basis depending on the size of the site and the analysis required.

A number of assumptions were made in estimating these costs, the most important ones were that the cost of site-based staff is £150(€195) per day (based on information from conservation agencies) and that of science specialists (e.g. vegetation surveyors) is £171(€222) per day (CEH band 6 rate). These prices will vary, and the cost of a specialist surveyor appears quite low for this project. The cost of a specialist surveyor along with the written report could in actual fact cost up to £300 (€390) per day, with total cost driven by the size, quality and variation of the site and the project scope.

Table 3. Estimated costs of measurements. Total cost, including staff time, chemical analysis and equipment, for each site, unless stated otherwise (taken from Morecroft *et al.* 2006).

Measurement	Local staff time, days		Total cost, £ (€)	
	Initial cost per site	On-going cost per site	Initial cost per site	On-going cost per site
Climate	1	1	6684 (8700)	492 (640)
Wet deposition	1	2	650 (845)	934 (1215)
Ammonia	1	2	250 (325)	842 (1090)
Soil	5		750 (975)	627 (815)
Vegetation (including epiphytic lichens and tree growth)	10		2000 (2600)	1771 (2300)
Butterflies	1	10	150 (195)	1500 (1950)
Birds	1	4	150 (195)	600 (780)
Site management	1	3	150 (195)	450 (585)
Total nitrogen deposition measurement			85.5 (110)	
<b>Total</b>	<b>21</b>	<b>22</b>	<b>10870 (14140)</b>	<b>7216 (9375)</b>
<b>Additional Costs, independent of number of sites</b>				
Remote sensing (all sites)			2565 (3335)	1526 (1984)
Nitrogen deposition			2565 (3335)	885 (1150)
Birds			1710 (2223)	885 (1150)
Butterflies			885 (1150)	885 (1150)
<b>Total</b>			<b>7625 (10043)</b>	<b>4181 (5434)</b>

## Potential sources of EU financing

Among the diverse sources for EU funding, the following funds might primarily be of interest for the management of North Atlantic wet heaths:

- The European Fund for Rural Development (EARDF): This program has a potential to cover several management activities that might be relevant for the wet heaths, although the measures have to be covered in the National Strategy and related measures Rural Development plans (RDPs) in order to be eligible on a national basis. However, costs for grazing of the wet heaths are mostly eligible for agri-environmental subsidies within this program. To some extent, necessary infra-structure, such as fences and shelters may also be eligible under this program. – LEADER projects may be designed to include management of sites in the Natura 2000 network.
- The European Regional Development Fund (ERDF), The Cohesion Fund and Interreg: These funds might be relevant in single cases although activities related to Natura 2000 sites need to be integrated in a broader development context, and for ERDF also be related to productive investments (e.g. infrastructure). The Interreg approach is more flexible, but needs a European objective and partnership. Different geographical levels are defined and all of them have their specific rules, eligibility criteria and objectives.
- The Financial Instrument for the Environment (LIFE+): The 'Nature' component of LIFE+ supports best practice and demonstration projects contributing to the implementation of the Birds and Habitats Directives, but only exceptionally outside Natura 2000 sites. The 'Biodiversity' component is for demonstration and innovation projects, contributing to the objectives of the Commission Communication 'Halting the loss of biodiversity by 2010 – and beyond'. Both the 'Nature' and 'Biodiversity' components emphasise concrete non-recurring management actions (at least 25 % of the budget) and, when needed, compensation payments for restrictions in commercial land-use are eligible under 'Nature'. Recurring management is not eligible under LIFE+.

To identify to what extent management measures required for a specific site are eligible for financial support from various EU funds, further consultation of the "Financing Natura 2000 Guidance Handbook" (Torkler 2007) is recommended:

[http://ec.europa.eu/environment/nature/natura2000/financing/index\\_en.htm](http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm)

.Furthermore an IT-tool is available on the EC web site:

([http://ec.europa.eu/environment/nature/natura2000/financing/index\\_en.htm](http://ec.europa.eu/environment/nature/natura2000/financing/index_en.htm)).

In England the main source of funding for landowners will be Environmental Stewardship and in particular Higher Level Stewardship (HLS) payments (DEFRA 2005c). Success in obtaining HLS grants will be driven by the quality of the habitat present on the land and the potential for restoration. In Wales grants for farmers/landowners are administered under Tir Gofal and in Scotland it is the Rural Stewardship Scheme.

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