

# 10. Management for nature conservation

## 10.1 Introduction

For a long time there seems to have been a presumption in favour of management of moorland for economic returns, whether for grouse or sheep. However, with the increasing recognition of the international importance of the UK blanket bog resource, the quantification of losses in this and heather moorland, and the desirability for 'sustainable' management, in some areas there has been a shift in emphasis towards conservation objectives for management. It is recognised that there is a need for guidelines which will facilitate the integration of wildlife conservation with management for stock or grouse. Such management prescriptions need to take into account the management history of the site, as well as contributory environmental factors such as climate in order to provide a regime which will 'restore' damaged sites, as well as maintain good ones. For example, successful restoration of blanket bog or wet heath badly damaged by management practices may depend on attempting to block ditches, as well as controlling burning and grazing.

## 10.2 Desirable management practices

As is always the case in conservation, appropriate management techniques are largely dependent on the desired objectives. Most of the detailed guidelines for management of upland vegetation have been written with animal production in mind (whether sheep, grouse or deer), and are mainly applicable to the drier types of moorland. Recent agricultural policies have encouraged the overstocking of many hill grazings, but the damaging effects of some practices, both for stock and native flora and fauna, have now been recognised, and recommendations are being sought to help promote the maintenance and indeed improvement and extension of more natural upland vegetation. Again, these are at present, mainly aimed at the drier moorland, although some do include recommendations for wetter areas. The various relevant recommendations and opinions found in the literature are given below, and summarised in Table 10.1. However, the problem of interpreting stocking rates should be stressed again (sec 5.3.2), particularly in relation to type of stock, alternative habitats/food sources available, pressures from 'native' herbivores etc. It should also be noted that the basis for some specific recommendations, for example that blanket bog should never be burnt, is often not clear, and may be based on presumption rather than distinct evidence.

*The Code of Good Upland Management* (MAFF 1992a), *The Heather and Grass Burning Code* (MAFF 1992b) and *The Muirburn Code* (Phillips, Watson & MacDonald 1993) provide a guide to 'good practice' and set out the background and legal situation for the burning of heather moorland. These clearly mainly relate to the drier types of moorland, and all three codes recommend that bogs should not be burned. The latter explains that "heather can maintain itself in these places by layering, if grazing is light, while it is difficult to achieve successful and controlled burning in these situations". Similarly, there should be no need to burn in high-altitude areas where the heather is kept short by climatic conditions. There may be a need to allow patches of tall heather to remain, as these provide nesting sites for Merlins and Hen Harriers. It is curious that the *Code of Good Upland Management* published by The Scottish Office (1992), has more-or-less the same wording as MAFF (1992a) other than the point relating to burning and grazing, which does not give blanket bog as an exception.

*The Muirburn Code* also provides some guidance on the relative merits of cutting *versus* burning. It suggests that burning should be carried out no more frequently than every 8–10 years in the drier east, and 15–20 years in the wetter west in order to avoid gradual replacement of the heather by coarse grasses such as ‘white bent’ or ‘blow grass’ *Molinia caerulea*. If peaty blanket bogs are burned more frequently than every 15–20 years, it suggests that there can be a spread of deergrass *Scirpus cespitosus* and cotton-sedge *Eriophorum vaginatum* at the expense of heather. Fires can be difficult to control on blanket bog – either much material is left unburnt and heather regeneration is poor, or the fire burns uncontrollably, which can be disastrous. An Information Sheet<sup>1</sup> produced by The Peak District Moorland Management Project provides guidance on the prevention, or at least limitation, of damaging moorland fires, particularly those resulting from a careless public. In particular, this recommends that the moors should be managed by rotational burning in the winter or cutting, to create irregular fire breaks close to public access paths which will help to limit the spread of fires in the summer (see also Anderson, 1986).

Gimingham (1972) cites McVean & Lockie (1969) in expressing the view that management by burning is inappropriate in the more highly oceanic conditions of western Britain, because it has been responsible for the extensive spread of species such as *Nardus stricta* and *Scirpus cespitosus* which are of low nutrient content and palatability to grazing animals. This is particularly so in the short growing season in the north, where regeneration is slow, increasing the danger of peat erosion and ‘hagging’.

The general opinion seems to be that blanket bog vegetation should be burnt on a longer cycle than drier northern heath, or not burnt at all (see Coulson *et al.* 1992) (although it is not clear where wet heath fits in). The reasons for this are given as follows: (a) burning tends to favour the dominance of monocotyledons, such as *Molinia*, *E. vaginatum* or *Scirpus cespitosus* over *Calluna*; (b) there will be a general decline in species richness, with particular losses of *Sphagnum* spp.; (c) the loss of nutrients from burning on blanket bog may be more detrimental than in northern heath<sup>2</sup>; (d) there is no evidence that burning will increase the grazing potential for sheep or increase grouse populations; (e) severe fires often cause the loss of the bog acrotelm, forming a low-permeability surface layer, thereby reducing water infiltration and exacerbating water run-off and erosion. Coulson *et al.* (1992) recommend that there is a strong case for banning burning blanket bog. If used at all, they suggest that the use of fire needs to be controlled carefully, as both low and high intensity fires can have detrimental effects and should be avoided where possible. RSPB (1995) state that “if management objectives for a site are to conserve or enhance an active peatland ecosystem, burning should not be used to control the vegetation”.

Usher & Thompson (1993), in their review of the conservation importance of upland heathlands, concluded that (i) burning on blanket bog should be minimised; (ii) variable burning cycles to improve habitat complexity should be used; (iii) wet flushes should be conserved; (iv) upland heathland margins should be burnt less intensively; and (v) scattered mosaics of scrub and woodland should be established. The mosaic structure of upland heathlands (at different scales) is critical for wildlife conservation, particularly with respect to maintaining diversity of invertebrate assemblages and vertebrate species.

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<sup>1</sup> Peak District Moorland Management Project, Information Sheet No. 3: Preventing Damaging Moorland Fires.

<sup>2</sup> the evidence that this will necessarily be detrimental is unclear

Phillips & Watson (1995) agreed with Usher & Thompson (1993) that burning blanket bogs in the same manner as dry heathlands can reduce their conservation value. However, they considered that the adverse effects from frequent and hot fires were mainly due to shepherds and deer stalkers rather than grouse keepers, and suggested that for grouse, blanket bog should still be burned, if infrequently (< 20 years).

In Scotland, where there is often intense pressure from land managers to burn, the following criteria and conditions have been applied to some areas in which it is agreed that burning may be acceptable to SNH (A. Coupar; *cit.* A. MacDonald, 1995, *unpublished filenotes*):

1. Burning restricted to 1 Dec to 8 March;
2. Heather must cover > 70% of the ground and be > 25 cm tall;
3. Minimum burning rotation of 12 years (with limitations on the amount which can be burnt in any 3 year period); [*A. MacDonald suggests that this could be extended to 20 years*]
4. No burned patches > 2 ha in extent;
5. Every reasonable effort to be made to avoid damage to underlying moss layer, particularly where *Sphagnum* present.

It is recognised that the limitation of burning under appropriate weather and ground conditions (for example when there is still sufficient moisture in the moss layer to prevent it being seriously heated or burnt) is likely to be the most difficult aspect of muirburn control to explain and enforce, particularly in areas where there is a perception amongst land managers that moss 'ought' to be removed.

Advice to landowners in the Peak Park (Yalden, undated) is that active shepherding may help considerably in alleviating the problems of overgrazing by increasing the use of better-vegetated areas, and reducing the use of over-grazed areas. The 'Grazing Index' (English Nature 1995) has been developed to help determine when heather moorland is being overgrazed (although this does not yet apply to 'wet' blanket bog). As part of their moorland restoration project in the Peak District, Phillips, Yalden & Tallis (1981) recommended a moorland grazing level of 1 ewe ha<sup>-1</sup> with the objective of encouraging recovery of the vegetation damaged by heavy grazing (> 2.5 ewes ha<sup>-1</sup>). Based on this project, Tallis (undated) provides a simplified code for farmers which suggests that in order to revegetate damaged land, stocking levels should be reduced to 1 ewe and follower ha<sup>-1</sup>, with a substantial proportion removed during the winter (at least in January, February and March, and preferably from September onwards).

The guide produced by Macaulay Land Use Research Institute (*Heather Moorland - a guide to grazing management* (Scottish Agricultural Colleges 1989)) provides advice on appropriate stocking rates (ranging from 0.69 to 2.38 ha ewe<sup>-1</sup>) for upland grazings varying in habitat composition (but with some blanket bog), with and without burning management, stressing the importance for grazing pressure of the variation in availability of alternative habitats. The computer modelling work currently being carried out at MLURI should help considerably in determining appropriate management of different types of upland moorland.

Use of cattle gives a higher risk of trampling damage (5.2.1), but Gimingham (1995) considered that cattle could be used in some circumstances to manage heather moor (*type unspecified*). Grant *et al.* (1987) also suggest that use of cattle could be considered in wet areas, at least in summer, for example, where large areas of *Molinia* and *Calluna* occur

together and there are problems associated with the use of sheep grazing and burning management, or in areas where *Nardus*-dominated grassland is mixed with *Calluna*. However, these authors considered that there is a need for more work to investigate the interactions between burning and grazing on both these associations, and on sites having various ratios of the dominant species, before management options to meet particular objectives can be proposed.

Based on the draft of review by Mowforth & Sydes (1989), Rowell (1988) suggested the following management regime for *Calluna*-dominated blanket bog:

- Density of 0.25–0.37 sheep ha<sup>-1</sup>, preferably in summer only. Lower stocking rates would be required for all year stocking regime.
- Raking by shepherds to ensure even distribution across the moor.
- Access to improved pastures, using the two-pasture system, especially when the quality of the grazing is important in the sheep diet.

However, it was recognised that the recommendations were based on a limited number of examples, and that rates could vary considerably according to local conditions and objectives. Light grazing could be beneficial on many blanket bogs, especially in areas which may become more isolated from native grazers by forestry and fences. It was recommended that burning of blanket bog should be avoided, indeed, it is specifically emphasised that “burning should not be used as a management tool in NVC communities M17 and M18, in any other *Sphagnum*-rich community, and particularly not in any bog system with pools and ridges”.

Thompson *et al.* (1995c, quoting Sydes & Miller 1988), suggest that sheep stocking rates at more than 0.5 ewes ha<sup>-1</sup> on western / northern blanket bogs could cause a change from heather moorland to grassland or sedge-dominated bog. They further suggest that bird species richness and diversity would be greater over upland areas in the absence of any burning, particularly if scrub and woodland developed in open mosaics, although recognise that this could reduce the abundance of some key moorland birds. These authors provide some suggestions for management which should help to favour the overall conservation interest on grouse moors (refer to Usher & Thompson (1993) and Thompson, MacDonald & Hudson 1995b) for more details):

1. less emphasis on ‘bags’ of grouse and more on maintaining a broader mixture of moorland birds;
2. total cessation of illegal persecution of birds of prey;
3. cessation of gripping and a marked reduction in burning over blanket bog;
4. an overall reduction in burn size, especially in width and with more variation in size of burned and unburned mosaics.
5. a reduction in the proportion of moorland burned within the burning cycle to leave a greater amount of unburned heather (especially on north-facing slopes at high altitude);
6. a shift in vegetation succession towards scrub on suitable parts of moorland (especially at high altitude where grazing-related impacts are probably least, and so most readily reversible, and along the edges of sheltered gorges where woodland may already be established).

Thompson *et al.* (1995c) also provide some idealised management prescriptions for enhancing moorland grazed by sheep, where the current state of the heather is either good, poor or suppressed. The latter requires the most complex prescription, and is least certain of

success. However, these prescriptions apply largely to 'dry' heather moorland, and it is stressed that there would need to be a reduction in stocking rates and lengthening of time periods in the wetter north and west.

The Tir Cymen experimental scheme has been set up by CCW (CCW 1992). It provides management guidelines on a 'whole-farm' basis in order to promote positive management, in particular, for the benefit of wildlife, landscape, archaeology and geology, and provides incentive payments. The guidelines for moorland areas are summarised below:

1. No disturbance through agricultural practices, including use of fertilisers, herbicides *etc.*
2. No new drainage or major modifications to existing drains
3. No new fences, peat cutting, tracks *etc.*
4. Supplementary feeding of stock to be avoided unless essential
5. Regular shepherding encouraged, to ensure sheep make full use of the whole moor, and avoid localise overgrazing
6. Restricted rotational heather burning. Avoid burning blanket bog or mires.
7. Land to be made available for public access
8. *For moorland and heathland with > 25% heather:* 10 year grazing regime to be agreed and established which sustains or improves quality and diversity of the moorland vegetation. Recommends that heather on wet ground and blanket bogs should be grazed at no more than 0.5–1 ewe ha<sup>-1</sup> and stock should be removed between 15 October and 15 March.
9. *For moorland and heathland with < 25% heather and nutrient poor, acidic land:* 10 year management programme to be prepared and implemented for grazing and control of coarse grass and scrub. May be necessary to have only light summer sheep grazing (no more than 1.5 ewe ha<sup>-1</sup> during April–July only) and to cut scrub, *Molinia* and old heather. Cattle should not be grazed on this moorland.

NCC (1989)<sup>1</sup> provides guidelines for the appropriate management of the Dartmoor Commons, which include areas of blanket bog. They recommend that these areas should not be burnt at all and that consideration should be given to the reduction in stocking densities, particularly of outwintering cattle.

RSPB (1995) also provide guidelines on appropriate management of blanket bog and wet heath by grazing with a conservation objective. They emphasise that monitoring is required to maintain or set the optimum regime, that shepherding may be required (see 5.3.6), that the animals may require supplementary veterinary care due to the harsh environment and that additional fencing may be required to protect the animals and adjoining habitats. The latter will also provide for closer stock control. It is suggested that the hardy sheep breeds best suited to grazing peatlands are: Scottish Blackface, Swaledale, Welsh Mountain, Hebridean and Moorsnucker<sup>2</sup>, with stocking rates at 1–1.5 ha<sup>-1</sup> for wet heath, 0.25–0.37 ha<sup>-1</sup> for dry

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<sup>1</sup> This document was prepared at the same time as the Dartmoor Commoners Council was preparing its formal Regulations, under the Dartmoor Commons Act 1985. These Regulations have not been seen.

<sup>2</sup> This breed is sometimes used by conservationists on lowland peatlands in northern Germany to help reduce dominance by *Molinia* and prevent tree invasion. However, they are usually carefully shepherded and may be prevented from entering *Sphagnum*-rich areas for fear of trampling damage (S.C. Shaw, *pers. comm.*). They may be less suitable for the upland environment?

degraded bog and  $< 0.25 \text{ ha}^{-1}$  on blanket bog. Clearly, local factors and objectives must also be taken into account, and natural grazing pressures assessed. It is suggested that use of cattle is inappropriate on wet bogs or sites which contain sensitive plant communities, although may be useful in drier sites, and/or for short-term control of selected communities or species, e.g. *Molinia*, *Nardus* and *Juncus squarrosus*. Breeds such as Galloway or Highland are likely to be most suitable.

Cotton & Hale (1994) report on management trials on Ilkley Moor, and suggested that flailing vegetation may be a useful alternative to burning, in situations where the latter is considered unacceptable. This treatment may not be suitable for wet blanket bog, although has been used with some success as an adjunct to burning in some wet areas on the North York Moors (NYMNP 1986; 1991), and in particular for creating fire breaks (and for production of heather brushings for sale or use in restoration projects).

On Exmoor, management agreements can be set up which regulate, *inter alia*, the stocking levels (generally not exceeding  $2 \text{ ewes ha}^{-1}$ ), types of stock and timing of grazing, with detailed patterns established according to the characteristics of each individual site (B. Williams, *in* Snowdonia National Park 1984). Burning and cutting of the vegetation are also covered in agreements.

Rawes & Hobbs (1979) suggest that a stocking density of  $0.37 \text{ ewes ha}^{-1}$  (without burning) would be optimal to maintain blanket bog, producing a good food supply for sheep and grouse without adversely affecting the blanket bog vegetation, but that rates of  $> 0.55 \text{ ewes ha}^{-1}$  would lead to a degradation of the vegetation.

Within individual sites, it would be useful to map those areas considered to be most at risk from erosion in order to target resources for its prevention more effectively. Similarly, management plans/agreements drawn up for upland sites would benefit from mapping of areas considered to be at risk from fire and/or overgrazing so that these can be protected within the context of wider management for grouse or sheep.

### 10.3 Possible conflicts

As noted above, appropriate management recommendations depend to a large extent on the objectives, and this may lead to some conflicts, for example between optimum management for animal production (including grouse) and conservation management. There may also be conflict between optimum management for sheep and that for grouse, and even between optimum conservation management for birds/invertebrates and vegetation (i.e. structure vs. floristics). An interesting example is provided by RSPB (1995), in which an article in *British Wildlife* (*unsourced*) is cited which reported that *Sphagnum* growth, which was threatening to 'overwhelm' heather on Dartmoor, could be curtailed by second burning. Clearly this will be inimical to the development of a 'natural' cover of *Sphagnum* typical of blanket bog! Similarly, in some areas, there may be a perception amongst land managers that a fire has not been successful unless the litter and moss layers have been burnt off, although there is little actual evidence that this achieves better re-growth of *Calluna* (A. MacDonald (SNH), 1995, *unpublished filenotes*).

Maintenance of *Calluna*-dominated vegetation is often considered to be essential to maintain the upland bird interest (e.g. on Berwyn), and its extension would in many cases be considered desirable. However, the mosaics of vegetation-types present, which include less valued habitats such as bracken, grasslands and scrub, also appear to be important for many

of the desired bird species. The optimum mixture of habitats has not yet been quantified (except for red grouse). When heather is well-managed and regularly burnt to maintain the building phase, there is inevitably a progressive reduction in floristic diversity, with, as a consequence, a reduction in the diversity of invertebrates (Gimingham 1985) and other species of interest such as reptiles. A patch-work of uneven-aged stands may be more appropriate for maintenance of diversity, although may be labour-intensive and may still be floristically poor. Lack of management may lead to the development of scrub, although in some circumstances this could be considered to be beneficial in increasing habitat diversity.

Frequent burning may improve grazing for sheep (and hence loss of heather) by promoting the growth of *E. vaginatum* over *Calluna*, while for grouse, a longer burning cycle may be preferable. However, neither result may be appropriate for the maintenance of floristic diversity. Watson & Lance (1984) suggest that an integrated management strategy should be developed to suit both sheep and grouse, in the interest of preventing further degradation of heather moorland, and stresses that in fact, that grazing at moderate levels can be helpful on grouse moors in retarding the maturation of the heather.

**Table 10.1 Summary table of burning or grazing recommendations for blanket bog (BB) (see text for details).**

[No specific recommendations have been found for wet heath]

	Burning	Grazing	Comments
MAFF 1992a, b	Bogs should not be burned		Comments mainly relate to 'dry' heather moorland
Phillips <i>et al</i> 1993	Bogs should not be burned, or at least not > 15–20 years.		Comments mainly relate to 'dry' heather moorland
Scottish Office 1992a	Blanket bogs not mentioned		Comments mainly relate to 'dry' heather moorland
Usher & Thompson (1993)	(i) burning on BB minimised; (ii) variable burning cycles used; (iii) wet flushes conserved; (iv) upland heathland margins burnt less intensively; and (v) scattered mosaics of scrub & woodland established		
Peak District National Park (Phillips <i>et al.</i> 1981; Yalden, Tallis undated)	Limited rotational burning and burning of firebreaks may be necessary close to public access points/paths	Active shepherding Restoration of damaged areas: 1 ewe & follower ha <sup>-1</sup> ; removed in winter	
Rowell (1988)	Burning of BB should be avoided, & should not be used in M17 or M18, in any other <i>Sphagnum</i> -rich community, and particularly not in any bog system with pools and ridges.	Density of 0.25–0.37 sheep ha <sup>-1</sup> , preferably in summer only. Lower stocking rates would be required for all year stocking regime. Raking by shepherds Access to improved pastures, using two-pasture system, especially when quality of grazing is important in sheep diet.	Stocking rates could vary considerably according to local conditions and objectives
Thompson <i>et al</i> (1995c)	Marked reduction in burning over BB (allow development of mosaics)	Sheep stocking rates should be less than 0.5 ewes ha <sup>-1</sup> on western / northern blanket bogs	
Tir Cymen (CCW 1992)	Avoid burning BB or mires	Regular shepherding <i>For moorland and heathland with &gt; 25% heather.</i> 10 yr. grazing regime to be agreed and established. Heather on wet ground and BB should be grazed at not > than 0.5–1 ewe ha <sup>-1</sup> ; stock should be removed between 15 Oct. & 15 Mar.	
NCC (1989)	BB areas should not be burnt at all	Consider reduction in stocking densities, particularly of outwintering cattle	Dartmoor Commons



	Burning	Grazing	Comments
RSPB (1995)	"if management objectives for a site are to conserve or enhance an active peatland ecosystem, burning should not be used to control the vegetation".	Shepherding, supplementary veterinary care & additional fencing may be required. Stocking rates: wet heath: 1–1.5 ha <sup>-1</sup> ; dry degraded bog: 0.25–0.37 ha <sup>-1</sup> ; BB: < 0.25 ha <sup>-1</sup> . Local factors & objectives should be taken into account & natural grazing pressures assessed. Use of cattle inappropriate on wet bogs or sites with sensitive plant communities, although may be useful in drier sites, and/or for short-term control of selected communities or spp. e.g. <i>Molinia</i> , <i>Nardus</i> and <i>J. squarrosus</i> .	
Coulson et al (1992)	BB vegetation should be burnt on a long cycle (with careful control) or not at all – recommend banning on BB.		
SAC 1989		appropriate stocking rates 0.69 – 2.38 ha ewe <sup>-1</sup> for upland grazings	
Rawes & Hobbs (1979)		0.37 ewes ha <sup>-1</sup> (without burning)	
SNH (unpub.)	<ol style="list-style-type: none"> <li>1. Burning restricted to 1 Dec to 8 March;</li> <li>2. Heather must cover &gt; 70% of the ground and be &gt; 25 cm tall;</li> <li>3. Minimum burning rotation of 12 years (with limitations on the amount which can be burnt in any 3 year period); [extend to 20 years]</li> <li>4. No burned patches &gt; 2 ha in extent;</li> <li>5. Every reasonable effort to be made to avoid damage to underlying moss layer, particularly where <i>Sphagnum</i> present.</li> </ol>		The limitation of burning under appropriate weather and ground conditions is likely to be the most difficult aspect of muirburn control to explain and enforce

# 11. Further research requirements

## 11.1 Introduction

This section aims to give an indication of work currently in progress and to highlight areas where further research would be desirable in order for EN and CCW to be able to provide advice to land managers and advisors on the best practices with respect to the maintenance and enhancement of the conservation value of blanket bog and upland wet heath.

There is undoubtedly a lot more practical knowledge amongst the practitioners of blanket bog and wet heath management than can be gleaned from the literature, and it is important that this information is pulled together as far as possible before further work is commissioned. In addition, there seems to have been some overlap in work being carried out by the three country agencies, and there is a need for careful assessment of work in progress.

## 11.2 Work in progress

Time constraints have meant that it has only been possible to include a limited amount of information concerning current relevant work, and the following details should not be taken as a complete statement of work currently in progress. In addition to those groups mentioned below, it is known that the following are involved in research and survey in the uplands:

RSPB;

University of Newcastle, Department of Geography;

University of Exeter, Department of Applied Plant Science;

Queen's University, Belfast, Department of Applied Plant Science;

Institute of Ecology and Resource Management, University of Edinburgh;

Department of Environmental Science, University of Bradford;

Department of Geography, University of Newcastle upon Tyne;

Department of Biological Sciences, University of Durham;

School of Biological Sciences, University of Manchester;

Department of Animal & Plant Sciences, University of Sheffield

University of Plymouth;

British Geological Survey;

Forestry Commission;

School of Biological Sciences, University of Wales;

University College of North Wales (Bangor);

Department of Zoology, University of Aberdeen;

ITE (Bangor, Banchory);

Exmoor National Park;

The Heather Trust.

## *ADAS*

ADAS (1992) provides details of a research programme “The Hills and Uplands Project”, based at Redesdale, which involves collaborative study between ADAS, University of Newcastle and MLURI (see also ADAS 1993). Parts of this project which are of particular relevance in the current context are:

1. Investigation of appropriate management for the regeneration and subsequent maintenance of heather, in particular by reducing stocking intensity, either on a year-round or seasonal basis. Both vegetation and invertebrate responses are being monitored. Experiments are due to run for up to 10 years.
2. Investigation of the effects of sheep grazing intensity on a wet heather moor, with co-dominant *Molinia* and *Eriophorum*, with a view to formulating ecologically-sound management guidelines for wet moorlands. Plots have been established on recently burnt and unburnt areas. Further plots have been established in Scotland to widen the range of wet moorlands and stand conditions studied.
3. Investigation of the effects of two seasonal grazing exclusion periods on the utilisation and regeneration of degraded heather (*Calluna/Eriophorum* community).
4. At Pwllpeiran, a programme of simulated burning using a flail mower is being undertaken, with botanical and invertebrate changes being studied.

Two Peak District ESA's are currently being resurveyed, which may also provide some useful information.

## *British Trust for Ornithology (BTO)*

Currently undertaking an analysis of upland bird distributions using the distribution data from the Breeding Bird Atlas 1993 and the ITE Land Cover data 1990.

A review of information and literature concerning the implications of overgrazing for upland birds is currently being undertaken, covering aspects of the ecology of upland birds, and their relationships to management, and grazing in particular (see Appendix 1 for proposed contents list of the report).

## *Countryside Council for Wales*

Monitoring of blanket mire is currently being carried out on Elenydd and Berwyn pSACs.

An overall review of Welsh upland vegetation, to include consideration of the impacts of burning and grazing on vegetation, will (eventually) lead to setting of management objectives for different parts of Wales.

## *English Nature*

Three studies are in progress on the breeding ecology of Twite, Curlew and Golden Plover.

Permanent management plots at Moor House NNR (Cumbria) have been maintained and monitored in collaboration with ITE (Merlewood).

### *Game Conservancy*

Project title: *The effects of burning on the productivity of red grouse on blanket bog moorland*

Location: Moor House (Cumbria)

Methods:

1. Detailed study of the breeding biology of grouse on Moor House NNR (unburnt blanket bog) in comparison with neighbouring burnt areas;
2. Techniques for finding nest, estimating hatching success and assessing overall breeding production are well established;
3. Extensive comparisons will be made in other parts of northern England.

### *Institute of Terrestrial Ecology*

The Countryside Survey 1990 contains large amounts of information on grazing in particular, but also contains records of burning made during the period of the field survey. Currently, these data are in the initial stages of analysis, which will be carried out over the next three years under the work programme "Ecological Factors Controlling Biodiversity in the British Countryside (ECOFAC)".

Permanent management plots at Moor House NNR (Cumbria) have been maintained and monitored in collaboration with English Nature.

### *Joint Nature Conservation Committee*

We know of no work currently being funded by JNCC which is of relevance to the current issues of management of blanket bog and wet heath.

### *Macaulay Land Use Research Institute*

MLURI is one of the main institutions currently carrying out work relevant to management in the uplands.

### *North York Moors National Park*

The Moorland Management Programme (NYMNP 1991) provides details of ongoing and proposed projects in the North York Moors National Park, many of which are of relevance to management and restoration of upland peatlands.

### *Peak District National Park*

Final report is in preparation for the Moorland Management Project in the Peak Park, which is tying together all the various monitoring and research projects which have been carried out, analysing the information on the incidence of fires and the extent of bare ground, and, in general, updating previous reports. Due to be published in 1997.

### *Scottish Natural Heritage*

Involved in research and survey in the uplands. A review is currently being funded by SNH/Scottish Office (SOAFD) entitled: *A review of the impact of vertebrate herbivores on the natural heritage of the Scottish uplands*. The main objectives of this study are:

- (a) to collate existing published and unpublished information on the impact of vertebrate herbivores including sheep, red deer, cattle, goats and rabbits on upland ground layer vegetation, shrubs, woodlands, invertebrates, birds, mammals and other animals, soils, landscape and recreation potential;
- (b) To analyse the information and draw conclusions about the likely impacts of different densities of vertebrate herbivores on different habitat types and in different SNH regions and biogeographical zones in the uplands of Scotland.

### *Snowdonia National Park*

Currently monitoring several areas in the Park to determine the effects of different grazing regimes, particularly on wet heath. Concerned with monitoring a range of different management agreements on a variety of different habitats; includes monitoring of agreements designed to enhance dwarf-heath shrub cover in upland areas in Snowdonia – a significant component of these habitats will be dominated by *E. tetralix* wet heath.

## **11.3 Aspects of further work required**

### **11.3.1 General**

1. One of the main conclusions to be reached from the current review is that there needs to be a much greater emphasis on the distinction between ‘wet’ and ‘dry’ upland habitats, as these are often lumped together as ‘moorland’, despite their ecological differences.
2. Much of the information reviewed here has been based on a limited range of experiments and observations, largely from northern England and Scotland. There is little available from Wales or the south-west. A wider geographic coverage would be desirable.
3. This review highlights that there is still debate over the optimal management for conservation of the flora and fauna of blanket bog and wet heath, and, indeed, what the management requirements are, particularly on the more western examples. In addition to the implications for vegetation, there is a need for more studies on the interactions between vegetation management and the invertebrate and bird faunas (see below). SNH have highlighted the problems in advising on appropriate management of wet heaths, as these may represent degraded bog (where elimination of burning could help in restoration), or form part of a more natural transition, where burning may be permissible. More detailed guidelines of the pros and cons of burning in these situations are required (T. Keatinge, in A. MacDonald, 1995, *unpublished filenotes*)
4. Gimingham (1995) suggested that there should be research into most practical and cost-effective methods of achieving a mosaic of uneven-aged stands, perhaps with some scrub/trees, to include species typical of both early and later stages of the succession. Possibly achieved through cutting and burning at different frequencies. [This is probably of more relevance to drier types of moorland.]

5. Some long-term research on impacts and the time course for *recovery* from poor grazing and burning practices would be worthwhile (P. Immirzi, *pers. comm.*).
6. Further work is required on the mutual benefits that can be achieved by integrated management for agriculture and wildlife.
7. Stevenson *et al.* (in press) suggest that a more intensive study of the relationship between burning frequency and the presence or absence of possibly fire-sensitive species e.g. *Listera cordata* or Lycopodiaceae is required to assess more definitely whether or not old-stand heather is a valuable reservoir for these species. [This presumably applies to both 'dry' and wet heath].
8. More work is required on the long-term impacts of burning on the nutrient budgets and cycling on blanket bog/wet heath, particularly in relation to geographic location (and hence atmospheric inputs). For example, Stevenson *et al.* (in press) suggest that more work is required on the effects of burning; for example, it is still uncertain whether serial burning might have an effect on P stores in areas where P deposition is low. Coulson *et al.* (1992) suggest that the magnitude of any effect needs to be clearly demonstrated, in order to fully convince moor managers that any benefits derived from an increase in nutrients released by burning is only short-lived. Similarly, there is a need for further work on the impacts of increases in nutrient availability through atmospheric pollutants on blanket bogs and wet heaths, and implications for management.
9. Further work is required to determine optimum stocking rates under different conditions (and in different regions), and by different breeds of sheep, cattle and ponies. Also optimum stocking rates (and breeds) for improvement or restoration of damaged areas (coupled with other restoration techniques).
10. Thompson & Miles (1995) summarise the apparent shifts between communities under burning, heavy grazing or drainage, excluding natural zonation found with altitude, drainage and aspect. It is acknowledged that further work is required to verify the nature of these relationships, the factors involved and the actual 'natural' condition of the different communities in different areas of the country.
11. Thompson & Miles (1995) highlight the continuing debate over the effects of burning on moorland, and the necessity of burning, particularly as layering is known to rejuvenate heather in some circumstances (as on blanket bog, see 7.3.1). They list five questions with implications for burning management on blanket bog / wet heath which require further work in order to be answered:
  - a) Does burning eliminate, or select against, layering so that muirburn is viewed as the best means of maintaining heather?
  - b) Under what conditions is layering continuous?
  - c) What are the characteristics of stands maintained in a dynamic steady state by layering?
  - d) What densities of red grouse, and other moorland birds, can occur on unburnt compared with burnt moorland?
  - e) Given that fire (apart from cutting) is the main factor that will prevent tree invasion while still maintaining a heather cover, are the majority of layering stands liable to change to woodland?

### 11.3.2 Invertebrates

1. Much of the work carried out on the invertebrates of blanket bog and upland wet heath has taken place over a limited area of northern England. More geographically widespread survey of blanket bog/upland wet heath faunas is needed, using standardised recording methods. This should also pay particular attention to the floristic composition and management histories of the sites, so that inter-relationships between these and invertebrate species/assemblages can be elucidated. Integrated food-web studies, relating vegetation responses to management to invertebrates and birds would also be of considerable value.
2. A tabulation of individual species recorded from blanket bog, detailing their conservation status, broad ecological characteristics as far as is known, their geographical distribution in the British Isles and their responses to different managements when established. This would assist in the conservation evaluation of different upland habitats.
3. Most blanket bog from which invertebrates have been recorded has been under some form of management – at least grazing and very often burning as well – for a very long time. Such experimental work as exists thus examines very short-term changes in a possibly very modified fauna. Location and survey of long-unmanaged bog for which to establish a comparative baseline fauna would be useful.
4. Long-term monitoring of blanket bog under different managements – and especially of blanket bog released from all management – should be undertaken.
5. More information is needed on the interactions between vegetation management, invertebrates and their predators (see Thompson & Miles, 1995).
6. Further work is required on the impact of invertebrate herbivores and whether the appreciable consumption of moorland plants by some species should be taken into account when modelling vegetation responses to grazing vertebrates (Coulson *et al.* 1992).

### 11.3.3 Birds

In areas such as the Peak District and north of Scotland, there is still pressure from land managers to burn blanket bog, while the general conservation advice at present is that blanket bogs should not be burnt (e.g. Coulson *et al.* 1992, Bates *et al.* 1993, Brown 1995a). Whilst this may well be sound advice for the flora of blanket bogs, this review shows that there is a distinct lack of quantitative research on the effects of burning blanket bogs on birds other than Red Grouse. At present, there appears to be relatively little hard evidence to suggest that controlled burning would adversely affect the main birds which use blanket bog, apart from Dunlin. Indeed for several species there are indications that limited burning might be beneficial (see Section 8). We therefore recommend that further research is carried out on this subject. This could be done either by carrying out more detailed analysis of existing survey data for areas of burnt and unburnt blanket bog or by detailed ecological studies on the use of blanket bog by key bird species. Brown & Bainbridge (1995), with respect to heather moors, suggest experimental manipulation of burning on a series of paired moorland areas with similar geographical features and predator control. The same approach could be adopted in relation to investigating the effects of burning on blanket bogs.

The results of the continuing EN-funded studies of Golden Plover and Curlew by Mark Whittingham and Glen Robson respectively should be looked at carefully to see if they shed any light on the subject. We also understand that RSPB in Edinburgh have recently initiated a study of surveys from randomly selected 1 km upland squares to attempt to tease apart the effects of the various aspects of upland management on breeding birds (Brown A.F. *pers comm.*).

In addition:

1. The optimum mixtures of habitats for upland birds requires quantification, and for example, whether an expansion of woodland at the expense of moorland would eliminate characteristic moorland breeding birds and give rise to high densities of predators (see Thompson & Miles, 1995).
2. Further work is needed to disentangle the effects of burning management, grazing by sheep, red deer and cattle, and predators/intermediate predators on moorland birds (see Thompson & Miles, 1995). As most of these birds also depend to various extents on non-upland habitats, these authors further suggest that the following fundamental questions need to be addressed in order to provide effective protection:
  - a) What are the key functional habitats used throughout the breeding season – what are they, where do they occur and what area of habitat does a pair require?
  - b) What factors determine higher populations and greater production, in some areas over others – and how much inter-dependency is there between different populations?
  - c) What are the specific effects of landscape change and of predation on bird populations, and at what scale does management influence these?