5 THE POSSIBLE NATURE CONSERVATION BENEFITS OF SHEEP EXTENSIFICATION

This section focuses on the possible prescriptions for improving both the type and extent of the nature conservation benefits from upland sheep. Our purpose at this stage is to indicate in a qualitative way what can and cannot be achieved through relatively simple and crude measures and then comparing these with a more sophisticated and targeted approach. Five broad options are identified:

1) Use of advice to improve grazing efficiency
2) Global reduction in numbers of breeding ewes by 20 per cent
3) Reduction in breeding flock to meet specified stocking rate targets on rough grazing
4) As (3) but with stocking rate targets zoned across the country
5) Targeted reduction in seasonal stocking rates plus a package of positive measures to maintain, enhance or restore the nature conservation resource

It was felt useful to set the weaker options (1) and (2) above as bench marks against which the stronger options may be judged. It hardly needs saying that the environmental effects of any one or combination of the measures are complex and difficult to identify, let alone evaluate. Our approach is to first identify the direct impact of a given prescription on vegetation and then consider the indirect effects resulting from 'knock-on' effects within the farming system (see Figure 5.1).

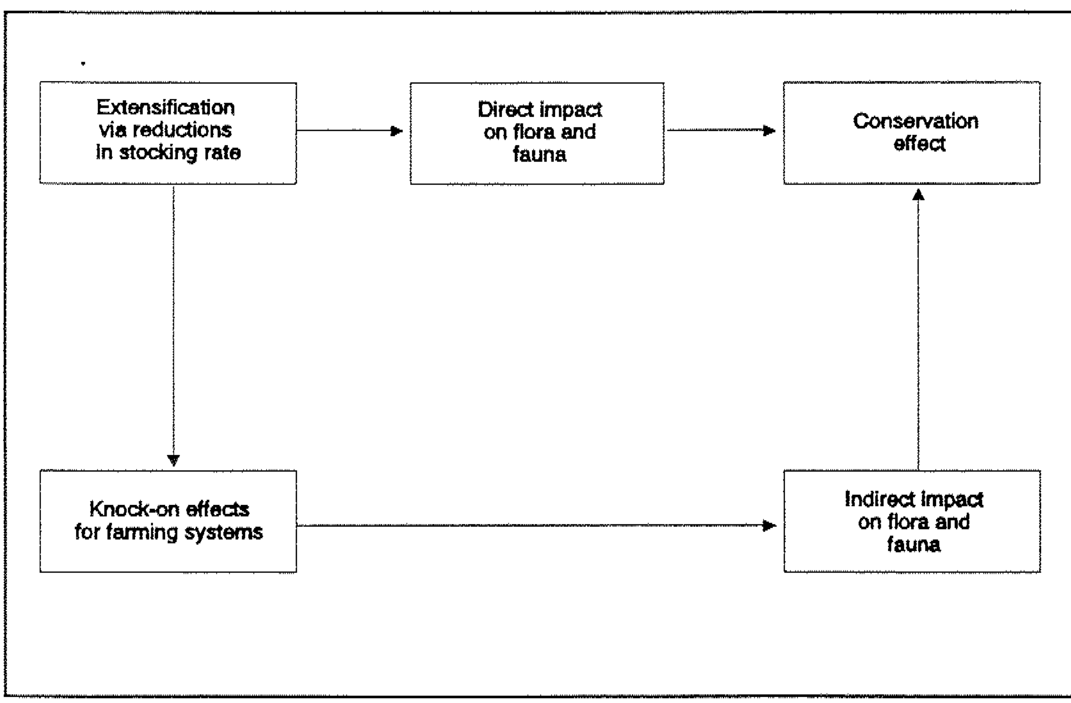


Figure 5.1: Direct and indirect nature conservation effects of sheep extensification

5.1 Direct impact on vegetation

5.1.1 Use of advice to improve grazing efficiency

With the general remarks from section 4.2 in mind we begin by considering the relatively simple expedient of using advice and voluntary codes to encourage extensification of sorts by improving grazing efficiency and influencing the way existing numbers of stock are distributed over a holding. As indicated above, how far environmental degradation in the uplands is a result of declining standards and grazing management is a debatable point. It can be argued that more intensive systems actually require more careful management of stock not less. Nonetheless, Evans & Felton (1987) argue that for a given number of stock, overgrazing impacts could be reduced, chiefly by keeping stock away from sensitive areas at critical times and by avoiding foddering.

Optimum levels of grazing for nature conservation relate to the composition of the indigenous vegetation, grazing intensity, seasonality of grazing patterns, shepherding practices, burning regime, the presence of other grazers, eg, ruminants cattle and deer or others such as rabbits. The following aspects may be included under advice:

- Cease supplementary feeding, or when not feasible, rotate feeding stations/nutrient blocks to reduce localised degeneration of Ericaceous moorland, control pattern of grazing and halt conversion of heathland vegetation to grassland.

- Reduce/eliminate the effects of foddering which causes localised overgrazing and soil enrichment and is incompatible with efficient grazing. More sensitive placement of supplementary winter feed or preferably off-wintering or away wintering/housing facilities to promote moorland vegetation regeneration in damaged areas.

- Improved shepherding and raking to achieve more even utilization of herbage and reduce the effects of localised overgrazing.

- Encourage rotational burning regimes where necessary to promote regeneration and stimulate mosaic of vegetation stands. Burning is not always essential and should not be carried out on the long unburned Bryophyte rich montane heaths (and on blanket bog).

- Fencing for a prescribed period in woodland subject to high stocking rates. However, some light grazing is often important for upland wopdland regeneration (Mitchell and Kirby, 1990).

- Protection of other grazing sensitive habitats by seasonal de-stocking where appropriate, eg, high altitude blanket bog and montane moss heaths.

In nature conservation terms, the main impact of advice will be in areas where localised overgrazing is identified as a problem. In contrast, it is likely that there would be very little impact of advice alone on moorland vegetation currently heavily overstocked. This means that, at best, this prescription would affect the current moorland reserve stocked at, or near to, optimum levels (ie, <2 ewe/ha). Data on heather condition and stocking rates have been provided by Felton & Marsden (1990) and are presented in Table 5.1. These data suggest that the greatest nature conservation impacts of this prescription are likely to be confined to about 29% of the moorland resource.

Table 5.1: Stocking rates and condition of heather moorland (From Felton & Marsden 1990)

Stocking rate	Condition of heather	Area of moorland (ha)	% of moorland
<1 ewe/ha	Undergrazed	101,500	7
1.0-1.5 ewe/ha	Good	144,000	10
1.5-2.0 ewe/ha		180,000	12
2.0-2.5 ewe/ha	Poor	232,000	16
2.5-3.0 ewe/ha		232,000	16
3.0-3.5 ewe/ha	Suppressed	146,500	10
3.5-4.0 ewe/ha		100,000	7
>4.0 ewe/ha	Absent	319,000	22

Grazing sensitive habitats like woodland at the moorland edge, would benefit from reduced grazing through fencing or by implementation of rotational grazing regimes (Kirby & Mitchell, 1990).

Like all approaches which rely on advice alone however, the impact in practice is likely to be highly selective, depending on the farmer's situation, attitude to nature conservation and his ability to act on the advice provided. The fact that commercial pressures led farmers to intensify in the first place suggests that only financial incentives or government regulation are likely to be really effective in changing management methods. Farmers with a shooting interest are likely to be favourably disposed towards advice since a reduction in heather by overgrazing with sheep can contribute to a reduction in the grouse numbers supported on an area (Evans & Felton 1987). In such situations there is a direct incentive to adopt the advice option.

5.1.2 Global reduction in numbers of breeding ewes by 20 per cent

This is the crudest form of extensification measure which could be adopted and was the effective objective of the ill-fated MAFF pilot extensification scheme. Given that generalised over-grazing is the result of flocks that exceed the carrying capacity of the land, a 'global' reduction in sheep numbers might be seen as an attractive and administratively easy option.

By definition the maximum impacts of this option would occur on those moors already overstocked by around 20 per cent. Using the data in Table 5.1 again this would coincide with the 12 per cent of moorland currently grazed at 1.5-2 ewe/ha. However, in general, the benefits of this option would vary considerably. At one extreme there would be little or no beneficial effects on moorland where stock numbers are already more than 20 per cent greater than optimal (eg, from Table 5.1 the 71 per cent of moorland currently grazed at more than 2 ewe/ha). Perhaps most importantly under this option, ecological damage to the most suppressed part of the resource would continue apace. At the other extreme, in situations where stocking rates are already optimum, further reductions could lead to undergrazing (eg, from Table 5.1 the 17 per cent of moorland currently grazed at <1.5 ewe/ha). This aspect may be most important in the grouse moors of north-east England.

Finally, a key objection is that global reduction in stocking rates does not address the fundamental ecological link between the grazing system and the conservation resource. As Evans & Felton (1987) state: "it is not certain that controlling stock numbers within reasonable limits without improving management would increase or maintain the nature conservation interest in upland areas".

A combination of options (1), advice, and (2), global reductions in stocking rates, could offer additional benefits, especially over the use of (2) alone. The most obvious benefit would be the ability to influence the management of the reduced flock; targeting the sheep away from sensitive areas (eg, bog and woodland). In addition it could be possible to effect a more appropriate seasonal distribution of stock on the holding, for example, reducing autumn/winter stocking of the most overgrazed moorland.

5.1.3 Reduction in breeding flock to meet specified stocking rate targets on semi-natural vegetation

Reducing stock numbers to achieve prescribed stocking rates is what most people have in mind when they discuss sheep extensification for nature conservation. The key issue here, of course, is the stocking rates themselves and how far they should relate to vegetation type and seasonality of grazing. As we have seen, setting blanket stocking rate targets is unrealistic as well as ecologically dubious since different vegetation types have differing capacities to tolerate different intensities and seasonalities of grazing. As a conservation measure, stocking rate reductions need to be targeted at the areas of semi-natural vegetation on a holding and are best implemented in the context of a whole farm plan to avoid displacement effects.

Consider first the question of the stocking rates themselves. In a general review of moorland management Mowforth & Sydes (1989) recommended a maximum stocking rate of 2.0 sheep/ha on heather moor. Agriculturally optimum stocking rates within the range 1.5-2.0 ewe/ha have been suggested for hill farming systems in Cumbria (Edwards 1988). These stocking rates are compatible with the rates suggested by Felton & Marsden (1990): "Moorland stocked at less than 2 ewe/ha with suitable off-wintering and management practices can support heather in good condition". Grazing-sensitive vegetation, like blanket bog, is intolerant of such high stocking rates. Mowforth (1989) recommends 0.37 sheep/ha for bog. High altitude blanket mire is even more sensitive and research by Rawes (1983) at Moor House suggested that stocking rates of just 0.01-0.3 ewe/ha suppresses vegetation regeneration.

Setting stocking rates for the maintenance of a resource in good condition is one thing but setting stocking rates to restore a degraded resource is quite another. To allow the regeneration of overgrazed moorland communities stocking rates need to be set considerably below the above levels. A maximum average of around 0.5 sheep/ha for suppressed heather moor and 0.1 sheep/ha on suppressed blanket bog have been suggested in these cases (Evans & Felton, 1987).

There are at least two important caveats to the above discussion. Firstly, very degraded moorland habitats may require periods of rest by off-wintering/in-wintering. Secondly, sudden extreme reduction in grazing may not be beneficial in nature conservation terms since dramatic shifts in grazing pressure can encourage spread of invasive species, for example: bracken, purple moor grass and mat grass. Where vegetation is currently overgrazed consideration should be given to gradual removal of stock rather than blanket removal.

For example, Thompson *et al* (1992) provide management prescriptions for enhancing Ericaçeous moorland grazed by sheep (Table 5.2). Where heather is in good condition they recommend a final stocking rate of 1.5-2 ewe/ha with 50 per cent off-wintering. At the other extreme where heather is in suppressed condition following overgrazing (eg, 3-4 ewe/ha) they recommend a phased grazing programme starting with summer grazing only for five years then followed by reintroduction of sheep grazing at 0.5-0.75 ewe/ha (years 6-10). When the heather has returned to good condition the final stocking rate may be introduced.

Table 5.2: Examples of management prescriptions for enhancing the nature conservation value of moorland grazed by sheep.

Current state			Proposed prescriptions	
Heather condition	Annual average stocking rate (ewe/hectare)		Ewe/hectare	plus off-wintering (O-W)*
Good	<2.0	(1)	0.75 - 1.5	and zero O-W
		(2)	1.5 - 2.0	and 50 per cent O-W
Poor	2 - 3	(1)	0.5 - 0.75	(for years 1-5) and 100 per cent O-W
		(2)	1.5	(for >5 years) and 50 per cent O-W
Suppressed	3 - 4	(1)	summer graze on grass	(for years 1-5) and 100 per cent O-W
		(2)	1.5	(for years 11-15) and 50 per cent O-W

* Off-wintered sheep are put on inbye land or housed

Source: Thompson *et al* (1992)

The conclusion from this section is that paying farmers to reduce stocking rates to 1.5, 0.5 or 0.1 ewes per hectare will produce conservation benefits of different types and magnitudes. Again using data from Table 5.1 as a general guide, bringing stocking rates on semi-natural vegetation down to 1.5 ewes/hectare could have a widespread but rather uneven effect. It would ease grazing pressure on the moorland resource currently overgrazed (about 71% of the moorland resource) and, by putting a lid on future increases in stocking of moorland currently optimally grazed (about 12% by area), would be a helpful development. However, such a marginal reduction would be unlikely to create the conditions for regeneration of currently severely overgrazed and severely degraded moorland. The need here is for more substantial reductions in stocking rates or, as discussed above, the complete removal of stock in certain seasons. Payments to achieve a 0.5 ewes/hectare stocking rate are best targeted at the Ericaceous moorland currently in poor condition (about 32% of the moorland resource, Table 5.1) while the 0.1 ewe/hectare target should be reserved for the moorland resource thought to be severely overgrazed and suppressed (about 17% of the moorland resource, Table 5.1).

Acid grasslands of the *Festuca/Agrostis* type can tolerate high stocking rates. Thus, all the grazing options suggested here would tend to encourage heather regeneration in the grassland and succession from acid grassland to heathland. The presence of acid grasslands within the moorland mosaic contributes to habitat diversity (Table 3.1) and provides additional habitat for invertebrates and some moorland birds.

The costs of the lower stocking rates, if introduced globally, could include increased chance of invasion by mat grass and purple moor grass or bracken where these species are currently a component of the vegetation or adjacent habitats, especially at stocking rates of 0.5 ewe/ha or 0.1 ewe/ha. On the other hand, the stocking rate of 1.5 ewe/ha represents an excessive level for upland mires and would result in damage to many types of vegetation on the wetter peat substrates. Loss of bryophyte diversity would be expected in communities such as blanket mire, as would conversion to cotton grass or mat grass dominated heath. Conversely, stocking rates of 0.5 ewe/ha or 0.1 ewe/ha might sustain such vegetation. However, again it is emphasised that the precise impact would depend on the mix of vegetation types in the moorland mosaic. Sheep only graze blanket mire as a last resort, and so if there is grassland and heathland vegetation available then these will entice the sheep away from the more sensitive and less palatable vegetation types. Thus even if a moorland unit is stocked at 1.5 ewe/ha the effective stocking rates on the bog vegetation within the moorland mosaic may be much less than this, with resulting conservation benefits.

Currently overgrazed woodland and scrub would benefit from effective stocking rates of 0.5 ewe/ha and certainly from 0.1 ewe/ha and may require 0 ewe/ha initially. The lower grazing levels would allow regeneration of bryophytes and increase in passerines (Mitchell and Kirby, 1990).

Despite the benefits outlined above, a key shortcoming of this option is the relative inflexibility in dealing with the wide variation in optimum stocking rates which exist over the whole country and the differing responses of different vegetation types in relation to the habitat mix of the holding. This option is again hit and miss; in some places and at some times of year the target stocking rates will be appropriate, whilst in other places and at other times they will be quite inappropriate. But there would be no capacity to deal with the range of grazing prescriptions required to manage Ericaceous moorland and other vegetation types in different conditions, especially in relation to the important questions of seasonal grazing regimes and off-wintering (Table 5.2).

The final two options have been devised to address this issue of stocking system modulation for nature conservation benefit. As a half-way house, option (4) which establishes target stocking rates zoned across the country is proposed. Finally, option (5) goes further and attempts to target key situations/problems.

5.1.4 Reduction in breeding flock to meet specified stocking rate targets as (5.1.3) but with stocking rate targets zoned across the country

If target stocking rates are to be truly effective in delivering ecologically appropriate grazing levels, the option must allow for modulation of the stocking system in terms of seasonality and location of grazing on the moorland unit. The form of zoning must be (i) defensible in nature conservation and scientific terms and (ii) administratively straightforward to implement. The benefits of zoning include more precise delivery of environmental goods through tailoring of grazing and other management treatments to regional farming types, environmental conditions or for specific habitats and species. Clearly, as with option (c), stocking rate reductions must be based on a whole farm system in order to prevent displacement effects through intensified use of enclosed inbye pasture.

Table 5.3: The bird assemblage of moorland

1. Specialists (virtually confined to Ericaceous moorland) n = 1

Red grouse (D = G, F)

2. Breeds mainly on Ericaceous moorland n = 3

Golden plover (D = F)

Merlin (D = G (F?) P)

3. Moorland provides a major breeding habitat n = 16

Greenshank (D = F)	Stonechat (N)	Ring ouzel (D = F, G)
Curlew (N)	Cuckoo (N)	Great skua
Short-eared owl (N)	Teal (N)	Arctic skua
Meadow pipit (N)	Black grouse (D = G)	Whimbrel
Whinchat (N)	Common gull (D)	Wood sandpiper (N)
Dunlin (D = F)	Skylark (N)	

4. Moorland provides locally important breeding habitat n = 14

Twite (N)	Black-headed gull (D = ?)
Wren (N)	Grasshopper warble (N)
Wheatear (N?)	Pied wagtail (N)
Lapwing (D = G?)	Oystercatcher (N)
Common snipe (D = D)	Lesser black-backed gull (D = ?)
Redshank (D = D)	Whitethroat (N)
Common sandpiper (N)	Willow warbler (N)

5. Moorland provides important feed habitat

Greenland white-fronted goose	Red kite
Golden eagle (D = F, P)	Common/hooded crow (F)
Peregrine	Grey wagtail (N)
Raven (D = F, P)	Goshawk (F)
Buzzard (D = P)	Chough
Kestrel (N)	

Notes

D = declining

N = no change

I = increasing

The symbol opposite gives main reason:

= F afforestation

= G grazing pressures causing contraction of Ericaceous moorland

= P persecution

= D drainage

Source: Thompson *et al*

a) Biogeographic zoning

A major climatic trend in UK is one of increasing oceanicity from east to west. A further trend is one of decreasing summer temperatures moving south to north. An ecological consequence of these trends is increased productivity of heathland in the more oceanic regions.

In addition there may be other implications of these climatic trends. For example, in the oceanic south-west seasonality of grazing will need to take the longer growing season into account, burning rotations may need to be shorter (eg 6-10 years in Exmoor and 10-12 years in Aberdeenshire (Mowforth & Sydes 1989)) and timed within a narrower winter band. The climatic variability of biogeographic zones does seem to provide some identifiable and scientific basis for a zoned scheme (MacDonald *et al* 1990).

There is also a nature conservation basis for biogeographic zoning. Certain plant communities (Figure 5.2) and animal species (Figure 5.3) are to a greater or lesser degree confined to certain biogeographic regions (MacDonald *et al* 1990). However, the trends here may not be strong enough upon which to build significant biogeographic variation in extensification prescriptions. This is especially true for the plant communities which show considerable overlap within the biogeographic zones (Figure 5.2). However the variety of communities and the pattern of species dominance within them, including a range of dwarf shrubs not just heather, is a clear indication that management of moorland sub-shrub vegetation should not exclusively aim for increased cover of heather (Macdonald *et al* 1990).

Management prescriptions for specific habitats might be more realistically targeted directly rather than through biogeographic zoning which provides a rather ambiguous divide. Examples are the species-rich heaths and limestone grasslands in the Lake District, and species, eg, moorland birds such as golden plover and merlin (Table 5.3) also in the Lakes. This option is discussed next.

b) Regional zoning

Zoning on a county or other administrative basis with options tailored to local climatic, topographic and landuse characteristics, or zones based on current designations, eg, ESA, LFA, Section 3 maps, etc, would seem to offer an administratively feasible way forward.

Regional zones could allow response to variations in heather productivity, grazing intensity and condition of the Ericaceous moorland resource, all of which vary across the country as well as between moors within an area (Felton & Marsden, 1990). The consultation undertaken by Felton & Marsden (Annex 1 of their report) reveals considerable regional differences in: (i) losses of dwarf shrub vegetation, (ii) the causes

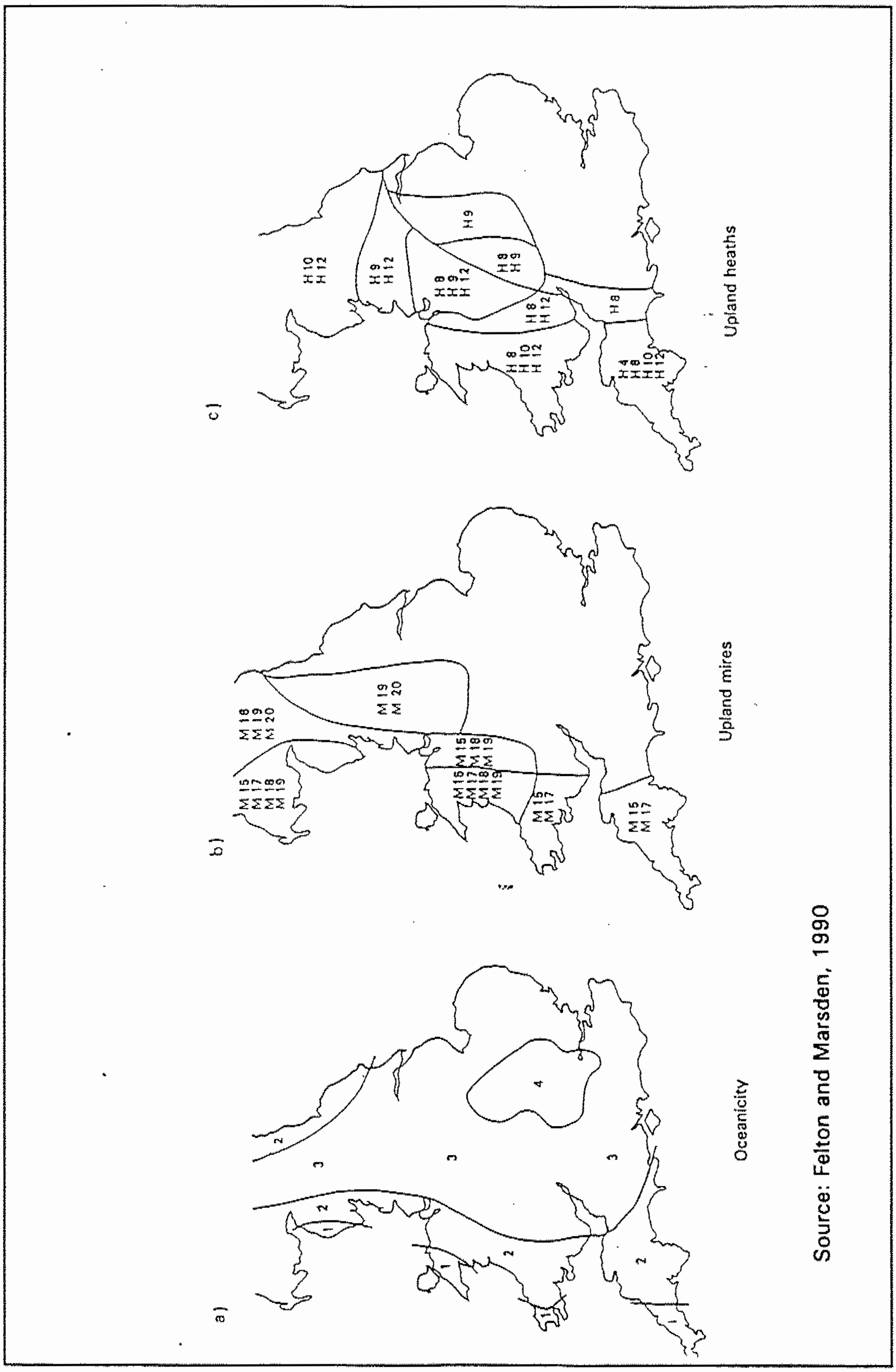
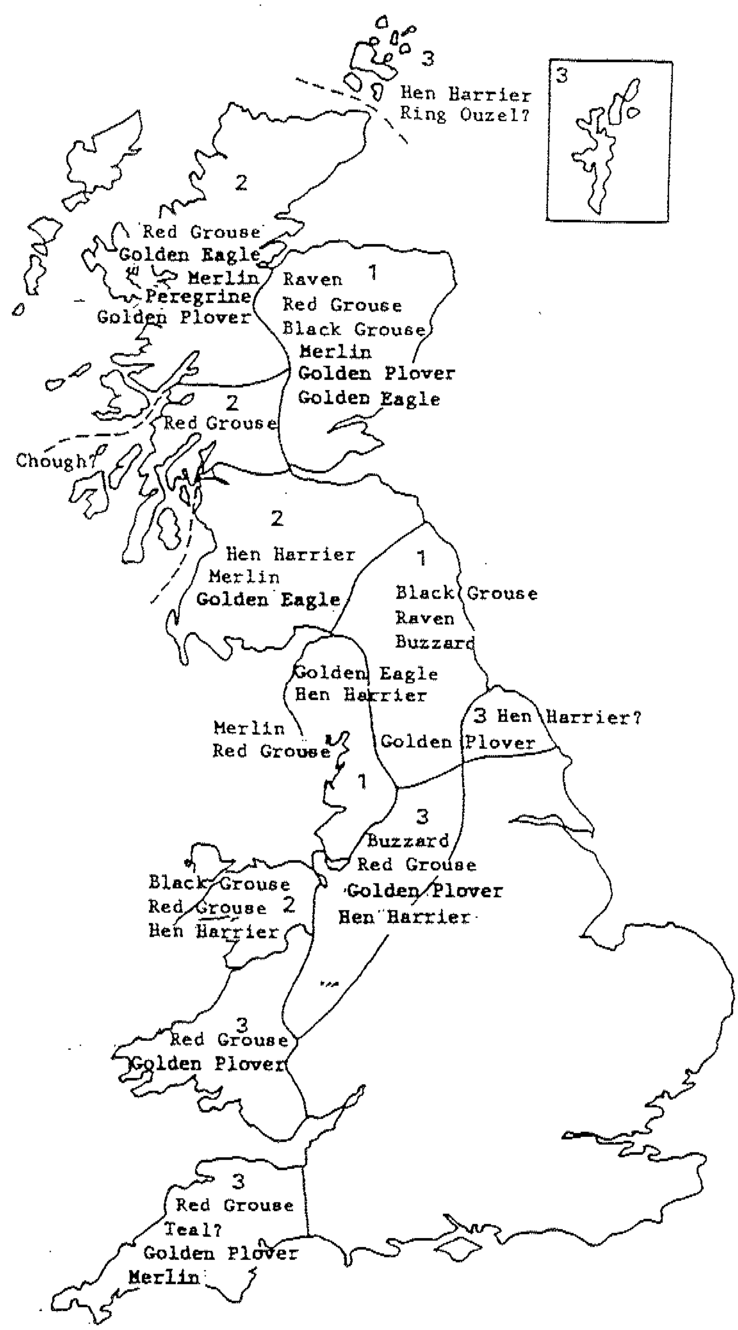


Figure 5.2: Biogeographic zones in England and Wales



Source: Felton and Marsden, 1990

Figure 5.3: Moorland birds

of these losses and (iii) the current condition of heather. Although the latter is not always well quantified and gives no indications of the condition of other vegetation types in the mosaic. For example, losses of dwarf shrub heath in Cumbria between 1940 and 1970 (from NCMS) amount to about 36 per cent and most of this attributable to overgrazing and conversion to acid grassland. Sheep numbers increased by 60 per cent between 1945-85 (Felton & Marsden, 1990). Current levels of overgrazing in Cumbria are considerable with stocking rates varying from 1.6-3.1 ewe/ha. In contrast, in the North East (Durham, North York Moors and Yorkshire Dales) losses of dwarf shrub heath between 1950 and 1988 were 26 per cent, partly attributable to afforestation and partly, and this is a key point, due to bracken encroachment which now covers 30 per cent of the moorland area. Current overgrazing is apparently relatively limited in extent here where moorland is largely managed as grouse moor at relatively low stocking rates. The bracken encroachment may well reflect the large areas of undermanaged heather in this area.

The major drawback of this zoned option is that whilst it does provide for some flexibility in terms of regional stocking rates, it has an inadequate control on the specific grazing systems ie, targeting areas of overgrazing or specific habitat management requirements. There is an inability to closely tailor grazing management to key problem areas. It may not be possible with such an option to solve problems whose root cause is inappropriate management rather than sheep numbers *per se*. The final option addresses this issue through a fully targeted scheme.

5.1.5 Targeted reduction in seasonal stocking rates plus a package of positive measures to maintain, enhance or restore the nature conservation resource

This is the final option and constitutes a fully targeted option along the lines of ESA and Wildlife Enhancement Schemes. This kind of "narrow but deep" option has considerable benefits over the other more "wide and shallow" options as we will discuss below, but it does have one drawback. Narrow and deep targeting cannot, by definition, deliver stocking rate changes over the broad area that options (2) - (4) potentially can do. However, this drawback would be compensated for by the ability to develop locally tailored prescriptions based upon the vegetation cover, plant community mix and animal compliment of the holding. This will include heather dominated moorland as well as communities in which heather is naturally less dominant eg, the southern heaths with western gorse and wavy hair grass, and bog communities.

Ideally, the results of this prescription should be assessed through a reliable monitoring scheme to refine and adjust the prescription through time and also to test compliance. Penalty clauses may be applied as appropriate. The timescale for achieving nature conservation results will depend upon the specific situation. For example, we might expect relatively rapid vegetation changes in recovery of Ericaceous moorland following reduction in stocking rates. The recovery of bryophytes in overgrazed montane heath could take considerably longer as would responses of both heather and bryophytes in blanket bog.

The broad objectives of the targeted option are two fold:

(i) To promote a regime of grazing on a whole farm basis which will reverse the decline in the nature conservation interest of the upland resource while protecting off-moor features and habitats.

(ii) To ensure the continuation of traditional systems of sheep grazing so as to secure the long-term conservation and, where possible, improvement of the resource.

Since the exact details of these prescriptions would necessarily be site specific, the benefits will depend on the locality but would certainly include maintenance and improvement of Ericaceous moorland, bog and woodland communities and increased range of breeding birds.

Other prescriptions might include the following elements: (i) reduction of inputs and production of hay rather than silage (eg, on upland farms in the Yorkshire Dales), (ii) bracken control and heather restoration schemes, (iii) woodland regeneration schemes, (iv) targeting conservation of moorland birds.

5.2 *Indirect impact on vegetation*

Extensification measures clearly affect vegetation and fauna on farms in a number of direct ways, but can also be expected to have indirect effects that are mediated via the farming system. At its simplest level, a farmer facing limits on stocking rates on his rough grazing may adjust his grazing regime to keep more sheep on the lower land, thereby shifting an overgrazing problem from the moorland to the inbye. This is clearly an unsatisfactory situation in nature conservation terms. For example, a survey of grouse moors in Northern England found that sheep stocking levels had not increased between 1975 and 1985 against the general trend (Felton & Marsden, 1990). Ericaceous moorland overgrazing was less of a problem because most of the moors were managed for grouse and therefore sheep numbers are controlled to maintain heather growth. However, undergrazing of the heather moor was a problem locally because removal of flocks from the moor created a vacuum in the hefting system on which shepherding practices are based. In such situations overgrazing was more a feature of the acid grassland intakes.

This last point emphasises a number of indirect effects which can arise from local or more widespread livestock intensification, especially on upland farms. The improvement of inbye land and the gradual retreat of the moorland boundary through the process of intake, leads to loss of wildlife diversity through drainage and reseeding of land. In addition, the intensive use of NPK fertilisers and chemical sprays results in pollution of watercourses and ground water supplies.

The key features of farm extensification schemes designed to alleviate both the direct and indirect negative effects of intensification on nature conservation are summarised in the next section and in Table 5.4.

5.3 The nature conservation impacts of sheep extensification

Prescriptions aimed at reducing the numbers of sheep on moorland address the key problem of declining habitat heterogeneity and loss of the vegetation mosaics which are important for sustaining a diverse range of invertebrate and bird species. Biogeographic variations in the mix of vegetation types, as well as differences in the growth rate and, hence, productivity of the sward, mean that broad stocking-rate strictures will deliver uneven conservation benefits. Furthermore, past and present management practices will be reflected by the current state and condition of the moorland vegetation and should thus be taken into account when determining the appropriate regional stocking rates under an extensification programme.

Reducing the number of sheep permitted to graze moorland is, however, fraught with difficulties when the grazing rights are held in common. Moreover, the important issue of loss of moorland habitat to afforestation is not directly addressed and could, conceivably, be exacerbated by measures to de-stock moorland. Stocking-rate prescriptions also will do little to affect directly the nature conservation interest of enclosed grasslands. Hence, positive encouragement to manage productive grassland in ways that are sympathetic to wildlife must also be considered; agricultural improvement of inbye land would seem to be the root cause of declining nature conservation interest of much of the off-moor upland habitats. Measures to improve grassland productivity need therefore to be constrained in order to foster practices which seek to maintain meadows and pastures in a state of intermediate fertility and productivity. Controls over drainage, re-seeding and fertilisation, combined with measures to regulate the timing of use of fields for grazing and fodder production are considered particularly beneficial. Much may be achieved in this regard through advice on management which favours hay production over silage; greater botanical diversity and improved breeding conditions for wading birds would be obvious consequences. Shepherding practices which seek, ultimately, to ensure efficient use of moorland grazings will bring conservation benefits. Avoidance of local over-grazing (and associated problems of trampling damage, soil enrichment), particularly at sites where feed supplements are provided to hill flocks in winter, would be one objective of providing advice on sympathetic management of moorland sheep. Encouragement for more active raking of flocks to spread grazing pressure and minimise stress on grazing-sensitive communities would be another. To complement this advice on shepherding practices, it is necessary to encourage adoption of burning regimes for moorland vegetation so as to promote varied structures and vegetation mixes. Problems may arise in reconciling management of grouse moors with management for wildlife in this regard (and, indeed in determining stocking levels).

Table 5.4: The nature conservation impacts of sheep extensification

Model Prescription	Purpose	Conservation problems addressed	Conservation problems not addressed	Accompanying measures required
(1) Advice	To improve grazing efficiency on whole farm basis to maintain or enhance conservation value of rough grazing and inbye and to maintain off moor features	Overgrazing of *Calluna*, especially by outwintered flocks, which is often associated with localised trampling of vegetation, soil erosion and nutrient enrichment, especially at foddering sites. Re-introduction of appropriate moor-burning regimes would promote and maintain diversity of structure and composition of moorland vegetation and create a mosaic of communities while arresting the process of scrub invasion of moorland. Advice on pasture management, concentrating on the timing of grazing and mowing and the use of fertiliser for silage production addresses the loss of floristic diversity associated with intensive meadow management which also comprises breeding success of ground nesting birds.	The trend to improve inbye pastures to support breeding and store flocks is unlikely to be reversed simply by advice. Moreover, heavily overgrazed moorland will continue to be degraded despite the best efforts of more active shepherding. Grazing pressure on inbye land which has already been 'improved' and which will continue to need intensive management to maintain its productivity will remain.	Restrictions on implementing further improvements to hay meadows, inbye and allotment to be accompanied by positive encouragement to maintain 'marginal' areas of moorland vegetation (such as blanket bog) and grassland vegetation (such as wet flushes). Encouragement to manage inbye land less intensively (by reducing fertiliser usage in particular) would also be appropriate.
(2) Global reduction in number of breeding ewes by 20 per cent.	To reduce the number of sheep on rough grazing of hill and upland farms to relieve overgrazing of moorland.	Degradation of the structure and species composition of dwarf scrub communities and, especially, loss of *Calluna* heath which leads to loss of mosaic of moorland vegetation communities.	Conservation interest of managed and enclosed grassland. Bracken and scrub encroachment may follow where grazing stress is relaxed and grazing dependent *Agrostis-Festuca* grasslands may be threatened. Shortage of carrion may affect some moorland birds and wintering populations of passerine species such as thrushes, finches and buntings which are closely associated with stock, may decline. Loss of moorland to forestry interests will not diminish (and may even increase). Un-exercised grazing rights on common land remain an unresolved issue.	Encouragement to maintain grazing intensities at optimal ecological levels. Restrictions on improvements to inbye land may be required to offset displacement effects of reducing moorland stocking levels. Additional management practices - such as burning - will be required to complement the reduction in stocking densities.

Model Prescription	Purpose	Conservation problems addressed	Conservation problems not addressed	Accompanying measures required
(3) Reductions in breeding flock to meet specified stock rate targets on semi-natural vegetation.	To reduce stocking rates to appropriate levels for maintenance and restoration of a range of moorland vegetation types particularly on hill farms but also to stimulate upland farmers to utilize their moorland resource more efficiently.	as above	as above	as above
(4) As (3) but with stocking rate targets zoned across the country.	Targeting more appropriate stocking rates to local conditions based on one of the following: biogeographic regions, administrative regions, designated sites, or based on the state of the resource (e.g. vegetation in good, poor or suppressed condition).	as above	as above	as above
(5) Targeted reductions in seasonal stocking rates plus a package of positive measures to maintain, enhance or restore nature conservation.	To promote a regime of grazing on a whole farm basis which will reverse the decline in the nature conservation interest while protecting off moor features and habitat. To ensure the continuation of the traditional systems of sheep grazing so as to secure the long term conservation and enhancement of the resource.	Primarily, the loss of the conservation interest of unenclosed moorland which results from year-round over-grazing and lapse of moorland management practices. The cost of nature conservation resulting from enclosure of moorland and improvement to managed enclosed grassland - manifested by diminished floristic diversity and declining upland bird breeding success is also addressed. Overall, the problem of loss of habitat diversity and species richness on moor and on inbye is tackled through a whole-farm approach focusing on stocking densities, vegetation management and shepherding practices.	The 'unexploded bomb' of dormant grazing rights on common land remains as do political difficulties associated with implementing and monitoring management prescriptions on common land. Management of *Calluna* heath for grouse may continue at the expense of wider nature conservation (and access) interests.	Restrictions on introduction of other livestock as substitutes for sheep. Advice and encouragement for in-wintering of cattle.

6 SUMMARY AND CONCLUSIONS

Upland sheep extensification offers particularly significant nature conservation benefits following a period when intensification has had a widespread impact on the conservation resource. As a tool for addressing the central and most widespread course of habitat degradation and decline in the hills and uplands - over-grazing - it should be effective on a broad front. Indeed, the principle attraction of the proposed extensification scheme is its likely ability to engineer changes in stocking rates on a large number and variety of farms - something which other mechanisms such as Section 15 management agreements and even ESA agreements are unable to achieve. The challenge is to design schemes which strike a balance between breadth of application and ability to bring about lasting and effective changes in grazing regimes and management as well as simply reducing sheep numbers. Our analysis confirms the clear nature conservation advantages of opting for highly targeted schemes which influence grazing and management practices at a detailed level. Realistically, however, the debate about upland sheep extensification concerns what can be achieved through more or less crude reductions in stock numbers and stocking rates on participating farms. We have compared a number of such approaches, the analysis pointing to the indiscriminate nature of the very crudest, most quantitative schemes which merely reduce sheep numbers by a standard percentage. It also underlines, however, the clearer advantage of sheep number reductions made to reach target stocking rates on different parts of the farm and at critical times of the year. Such an approach has the benefit of simplicity - farmers would still be paid on the number of animals removed - but also the merit that it could be designed around target rates that are set with the existing and desirable future state of the vegetation firmly in mind. We stress the importance of distinguishing between the impact on hill and upland farming situations, reductions in critical stocking rates probably have most effect on the moorland vegetation on hill farms.

The nature conservation impact of five extensification options are discussed. The provision of advice to the farmer alone (option (1)) is a very weak option and would be subject to very variable uptake. Global reductions in stocking rates (option (2)) would be administratively simple but the impact would be primarily on the moorland resource currently grazed near optimally - a poor return on expenditure. The impact of option (3), a reduction in breeding flock to meet specified stocking rate targets, depends entirely upon the nature of the targets set. Reduction of stocking rates to 1.5 ewe/ha would be likely to have a significant impact on all moorland currently overgrazed. However this option does not address the variation in optimal stocking rates across the country and for different vegetation mixes and could result in mismatch between expected and actual response. A scheme like option (3) but zoned across the country could address this last problem. Heathland vegetation shows biogeographic trends in productivity being (generally) most productive in the south-west and least productive in the north-east. A biogeographically zoned option could target stocking rates to identifiable areas of higher or lower production. Ideally a degree of flexibility would be required to deal with the condition of the moorland in each zone, ie different target stocking rates for moorland vegetation in good, poor or suppressed condition. Considerable conservation benefits could accrue in terms of regeneration of the moorland vegetation. There would need to be careful modelling of this option using data for vegetation condition and stocking rates for the whole country to ensure adequate match between zones and stocking rate targets. The final option, (5), provides a fully targeted approach to modify the grazing management of the holding to reverse the effects of overgrazing and to promote sustainable management of moorland in good condition. This final option is of the narrow but deep variety typified by the ESA and wildlife enhancement schemes. It offers the surest return in nature conservation terms providing a range of prescriptions which would be tailored to the particular locality and farming system. This return, however, would be confined to relatively small areas.

Whether large conservation benefits from a small area or smaller benefits from a much larger area are preferable will depend on the aggregate benefits and the costs of obtaining them. The likely costs of these options will be explored in phase 2 of the research.

Appendix 1: NVC communities of upland England

CG9	*Sesleria alibicans-Galium sterneri* grassland
CG10	*Festuca ovina-Agrostis capillaris-Thymus praecox* grassland
CG11	*Festuca ovina-A. capillaris-Alchemilla alpina* grass heath
CG14	*Dryas octopetala-Silene acaulis* ledge community
H4	*Ulex gallii-Agrostis curtisii* heath
H8	*Calluna vulgaris-Ulex gallii* heath
H9	*Calluna vulgaris-Deschampsia flexuosa* heath
H10	*Calluna vulgaris-Erica cinerea* heath
H12	*Calluna vulgaris-Vaccinium myrtillus* heath
H18	*Vaccinum myrtillus-Deschampsia flexuosa* heath
H19	*Vaccinium myrtillus-Cladonia arbuscula* heath
H21	*Calluna vulgaris-V. myrtillus-Sphagnum capillifolium* heath
M1	*Sphagnum auriculatum* bog pool community
M2	*Spagnum cuspitatum/recurvum* bog pool community
M3	*Eriophorum angustifolium* bog pool community
M4	*Carex rostrata-Sphagnum recurvum* mire
M5	*Carex rostrata-Sphagnum squarrosum* mire
M6	*Carex echinata-Sphagnum recurvum/auriculatum* mire
M8	*Carex rostrata-Sphagnum warnstorfii* mire
M9	*Carex rostrata-Calliergon cuspidatum/giganteum* mire
M10	*Carex dioica-Pinguicula vulgaris* mire
M11	*Carex demissa-Saxifraga aizoides* mire
M15	*Scirpus cespitosus-Erica tetralix* wet heath
M17	*Scirpus cespitosus-Eriophorum vaginatum* blanket mire
M18	*Erica tetralix-Sphagnum papillosum* raised and blanket mire
M19	*Calluna vulgaris-Eriophorum vaginatum* blanket mire
M20	*Eriophorum vaginatum* blanket and raised mire
M23	*Juncus effusus/acutiflorus-Galium palustre* rush pasture
M25	*Molinia caerulea-Potentilla erecta* mire
M27	*Filipendula ulmaria-Angelica sylvestris* mire
M31	*Anthelia julacea-Sphagnum auriculata* spring
M32	*Philonotus fontana-Saxifraga stellaris* spring
M37	*Cratoneuron commutatum-Festuca rubra* spring
M38	*Cratoneuron commutatum-Carex nigra* spring
MG2	*F. ulmaria-Arrhenatherum elatius* tall-herb grassland
MG3	*Anthoxanthum odaratum-Geranium sylvaticum* meadow
MG4	*Alopecurus pratensis-Sanguisorba officinalis* flood meadow
MG5	*Cynosurus cristatus-Centaurea nigra* meadow and pasture
MG6	*Lolium perenne-Cynosurus cristatus* pasture
MG7	*Lolium perenne* leys and related grasslands

MG8 *Cynosurus cristatus-Caltha palustris* flood pasture
MG9 *Holcus lanatus-Deschampsia cespitosa* coarse grassland
MG10 *Holcus lanatus-Juncus effusus* rush pasture

U2 *Deschampsia flexuosa* grassland
U3 *Agrostis curtisii* grassland
U4 *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland
U5 *Nardus stricta-Galium saxatile* grassland
U6 *Juncus squarrosus-Festuca ovina* grassland
U7 *Nardus stricta-Carex bigelowii* grass heath
U10 *Carex bigelowii-Racomitrium lanuginosum* moss heath
U15 *Saxifraga aizoides-Alchemilla glabra* banks
U16 *Luzula sylvaticum-Vaccinium myrtillus* tall herb community
U17 *Luzula sylvaticum-Geum rivale* tall herb community
U19 *Thelypteris limbosperma-Blechnum spicant* community
U20 *Pteridium aquilinum-Galium saxatile* tall herb community
U21 *Cryptograma crispa-Deschampsia flexuosa*

Appendix 2: Phase 1 categories and NVC communities

Code	Phase 1 category	NVC equivalent
Heather moor		
D.1.1	Dry dwarf heath/shrub acid	H.4/8/9/10/12/18/19/21
D.1.2	Dry dwarf heath/shrub basic	H.8/10
D.2	Wet dwarf shrub heath	M.15
D.4	Montane heath/dwarf heath	U.7/10
D.5	Dry heath/acid grassland mosaic	combinations
D.6	Wet heath/acid grassland mosaic	combinations
Bog		
E.4	Bare peat	
E.1.6.1	Blanket bog	M.2/17/18/19/20
E.1.6.2	Raised bog	M.17/18/19/20
E.1.7	Wet modified bog	M.20/25
E.1.8	Dry modified bog	M.19/20
E.2.1	Flush/spring (acid/neutral)	M.3/4/5/6/7
E.2.2	Flush/spring (basic)	M.10/11
E.2.3	Flush/spring (bryophyte ?)	M.32/37/38
E.3.1	Valley mire	M.4/6/10/11/17/31
E.3.2	Basin mire	M.4/6
E.3.3	Flood plain mire	M.4/6
Marshy grassland		
B.5	Marsh/marshy grassland	MG.8/10 M.23/25/27
Bracken		
C.1	Continuous	W.25
C.1.2	Scattered	U.20
Acid grassland		
B.1.1	Unimproved	U.2/3/4/5/6
B.1.2	Semi-improved	U.2/3/4/5/6
Calcareous grassland		
B.3.1	Unimproved	CG.9/10/11/14
B.3.2	Semi-improved	CG.9/10/11
Neutral grassland		
B.2.1	Unimproved	MG.2/3/4/5/8/9/10
B.2.2	Semi-improved	MG.3/4/5/6
Improved grassland		
B.4	Improved grassland	MG.6/7

Code	Phase 1 category	NVC equivalent
Scrub		
A.2.1	Dense and continuous	W.21/22/23
A.2.2	Scattered	
Woodland		
A.1.1.1	Semi-natural deciduous	W.7/9/11/17/19
Miscellaneous - ledge vegetation, limestone pavement, cliff and scree		
C.2	Upland species rich ledge	U.17
C.3	Other non-ruderal	U.15/16/17/19
IL.1.1.1	Inland cliff (acid/neutral)	U.16
IL.1.2	Inland cliff (basic)	U.16
IL.1.3	Limestone pavement	
IL.2.1	Scree (acid/neutral)	U.21
IL.2.2	Scree (basic)	U.17

References

Armstrong H, 1990 Modelling the effects of vertebrate herbivore populations on Ericaceous moorland vegetation. In: *Modelling heather management* (Ed: Whitby, M & Grant, S). pp 65-67 Department of Agricultural Economics and Food Marketing, University of Newcastle-upon-Tyne

Armstrong H, 1990 Avoiding heather decline: the use of the MLURI grazing model to estimate acceptable stocking rates. In: *Grazing research and nature conservation in the uplands.* (Eds: Thompson, D B A & Kirby, K) pp 32-43 NCC

Baldock D and Beaufoy G, 1992 *Green or mean? an analysis of the agri-environmental package.* IEEP London

Ball, D F, Dales, J, Sheail, J & Heal, O W, 1982 *Vegetation changes in upland landscapes*. Natural Environment Research Council

Bunce, R G H, 1987 The extent and composition of upland areas in Great Britain. In: *Agriculture and conservation in the hills and uplands* (ed: Bell, M and Bunce, R G H). ITE Symposium nr 23

CEC, 1988 *The future of rural society.* COM (88) S01 final, Brussels

CEC, 1991 *The development and future of the CAP.* Com 91 (258), Brussels

CPRE, 1989 *Conserving the countryside: costing it out.* CPRE, London

Edwards 1991 *Fit for the future*: Report of the National Park Review Committee. Countryside Commission

Evans, S & Felton, M 1987 Hill livestock compensatory allowances and upland management. In: *Agriculture and conservation in the hills and uplands,* Bell, M and Bunce, R.G.H (eds). pp.66-72. Natural Environment Research Council

Felton, M & Marsden, J, 1990 *Heather regeneration in England and Wales: A feasibility study for the Department of the Environment by the Nature Conservancy Council.* Nature Conservancy Council, Peterborough

Gimingham, C H, 1985 Age-related interaction between *Calluna vulgaris* and phytophagous insects. *Oikos* 44:12-16

Gimingham, C H, 1985 Muirburn. In: BCPC Monograph nr 30: *Vegetation management in Northern Britain* (ed: Murray, R BO pp 71-75. British Crop Protection Council, Monograph nr 30

Hopkins, J J, 1990 British meadows and pastures, *British Wildlife,* Vol 1:4

Hudson, P J, 1984 Some effects of sheep management on heather moorlands in northern England. In: *Agriculture and the environment*, pp 143-149. (Ed Jenkins, D.) Institute of Terrestrial Ecology Symposium No 13

Bell, M, and Bunce, R G H (eds) 1987 *Agriculture and Conservation in the Hills and Uplands.* ITE Symposium nr 23

Kelly, P G and Perry, K A 1990 *Wildlife habitat in Cumbria.* Nature Conservancy Council, Peterborough

MAFF, 1990 Extensification Scheme literature. MAFF, London

MAFF, 1992 *The North Peak ESA Review: consultation document.* MAFF, London

MAFF/WOAD, 1986 Heather and grass burning code

Marsden, 1990 More sheep and heather in the Lake District - what should be done? In: *Grazing research and nature conservation in the uplands* proceedings of a seminar, 1988 (ed: Thompson, D B A and Kirby, K J). Research and survey nature conservation no 31, NCC, Peterborough

Matheson, S, Pilkinton, E and Thomas, S, 1990. *North York Moors National Park final report of 1987-90 habitat survey.* North York Moors National Park

MacDonald, A, Brown, A and Thompson, D B A, 1989. Heather moorland nature conservation value and biogeographic variation. In: *Heather regeneration in England and Wales* (Ed: Felton, M and Marsden, J H). Annex 3. NCC, Peterborough

MacDonald *et al* 1990 Heather region report in MacDonald, A & Armstrong, H, 1989 *Methods for monitoring heather cover.* Research and survey in nature conservation management of uplands. No.27. NCC, Peterborough

MacDonald, A 1990 *Heather damage: a guide to types of damage and their causes.* NCC, Peterborough

Miles, J 1985 The ecological background to vegetation management. In: *Vegetation management in northern Britain.* (Ed: Murray, R B.) pp.3-20. British Crop Protection Council, Monograph nr 30

Miles, J, 1985 The pedogenic effects of different species and vegetation types and the implications of succession. *Journal of Soil Science* 36:571-584

Mitchell, F J G, 1990 Effects of grazing on upland woods. In: *Grazing research and nature conservation in the uplands*. pp.5-56. (Ed: Thompson, D B A & Kirby, K.) Research and survey in nature conservation nr 31, NCC, Peterborough

Mitchell, F J G & Kirby, K, 1990 The impact of large herbivores on the conservation of semi-natural woods in the British uplands. *Forestry* 63:333-353

Mowforth, M A & Sydes, C, 1989 *Moorland management: a literature review*. Research and survey in nature conservation No.25 NCC

NCC Memorandum to House of Lords Select Committee on the European Communities, Session 1987-88, 18th report: *Review of the sheepmeat regime*, HMSO, London

NCC Memorandum to House of Lords Select Committee on the European Communities, Session 1989-1990, 5th report *Hill livestock compensatory allowances*. HMSO London

NCC, 1990 *Nature conservation and agricultural change*, Focus on Nature Conservation 25. NCC, Peterborough

O'Connor, R J, Shrubb, M (1986) *Farming and birds*. CUP, Cambridge

Potter, C *et al*, 1991 *The diversion of land - conservation in a period of farming contraction*, Routledge

Potter, C, Houghton, T and Robey, M, 1991 Environmental value of farming systems. CEAS Consultants, Wye College (University of London), unpublished report to DoE

Ratcliffe, D A, 1977 *A nature conservation review*. Cambridge University Press

Ratcliffe, D A, 1990 Upland birds and their conservation, *British Wildlife*: Vol 2:1

Ratcliffe, D A & Thompson, D B A, 1988 The British uplands: their ecological character and international significance. In: *Ecological change in the uplands*, Usher, M B and Thompson, D B A (eds). pp.9-36. Oxford: Blackwell

Rawes, M 1983 Changes in two high altitude blanket bogs after cessation of grazing. *Journal of Ecology*, 71, 219-235

Rodwell, J 1992 *British plant communities*. Volume 2: Heaths. Volume 3: Mires. Cambridge University Press

Rowell, T A, 1990 *Management of peatlands for conservation*. British Wildlife Vol 1: 3

Royal Society for the Protection of Birds, 1984 *Hill farming and birds: a survival plan.* RSPB, Sandy

SAC/MLURI, 1988 *Heather moorland - a guide to grazing management*

Sinclair, 1987 *The upland landscape study*, Environment Information Services

Sydes, C and Miller, G R, 1988. Range management and nature conservation in the British uplands. In: *Ecological change in the uplands.* (Ed: Usher, M B and Thompson, D B A), pp 323-337. Blackwell, Oxford

Topham, M R, 1985. *Sheep numbers and heather conservation on common land in the North of England.* Discussion paper, Department of Agricultural Economics, University of Newcastle-upon-Tyne

Thompson, D B A, Gálbraith, H and Horsfield, D, 1987 Ecology and resources of Britain's mountain plateaux: land use conflicts and impacts. In: *Agriculture and conservation in the hills and uplands,* (Eds: Bell, M and Bunce, R G H). ITE Symposium No 23. Institute of Terrestrial Ecology, Grange-over-Sands

Thompson, D B A, Marsden, J H, MacDonald, A and Galbraith, C A (in press) Upland heaths in Great Britain: a review of international importance and objectives for nature conservation. *Biological Conservation*

Thompson, D B A and Kirby, K 1990. *Grazing research and nature conservation in the uplands: proceedings of a seminar, 1988.* Research and survey in nature conservation No. 31. Nature Conservancy Council, Peterborough

Thompson, D B A and Sydes, C, 1992. The British Uplands. In: *Our Natural Heritage.* (Ed: McLean, I F G) NCC, Peterborough

Thompson, D, Whyle, S, Oswald, P, 1988 *NCC research in the uplands: proceedings of a seminar 1986* NCC Research and Survey in Nature Conservation 16, Nature Conservancy Council, Peterborough

Traill, B, 1989 The rural environment - what role for Europe? In: *Land use and the European environment* (Eds: Whitby and Olleranshaw), Belhaven, pp 78-88

Usher, M B and Thompson, D B A BES special publication No.7. Blackwell, Oxford

Woods, A, and Cadbury, C J, 1987 Too many sheep on the hills. *RSPB Conservation review* 1:65-67. RSPB Sandy

Young, N and Williams, N, 1992 *A socio economic evaluation of the one year set-aside scheme in England*. Wye College (University of London)

Glossary

Allotment	Area of enclosed moorland which may have been improved by draining, re-seeding or surface treatments to provide pasture which is generally of poorer quality than the inbye. Put to uses similar to those of the inbye
Cross-bred	Offspring of hill-breed ewe and lowland ram
Draft	Ewe removed from hill/upland flock and transferred to lowland flock (or to inbye or allotment) for crossing with longwool rams to produce cross-bred lambs
Ewe	Female sheep of any age which has been mated
Fell	Area of enclosed, generally unimproved, upland vegetation composed of a mosaic of semi-natural vegetation types, eg, heath, bog and grassland
Foddering	To provide supplementary feed (eg, hay, silage, concentrates) to livestock - usually in winter months
Follower	Home-bred young ewe destined to enter the ewe flock when first mated - usually as a yearling. Generally one follower is kept for every four ewes in order to maintain size of breeding flock
Gimmer	Ewe between first and second shearing
Heaf/heft	An area of, usually, unenclosed land to which a flock of sheep confines itself
Hogg	Lamb that has not yet been sheared
Inbye	Area of enclosed and intensively managed pasture or meadow forming part of the farm unit. It is here that the ewes are usually brought for tupping in November and lambing in April. It may also be used for hay or silage production and over-wintering of stock
Intake	See allotment
Moor	See fell

Rake	The act of shepherding a flock across the moor or pasture to ensure more efficient grazing of available vegetation
Replacement	Ewe lamb retained with breeding flock
Shearling	Sheep that has been shorn once
Stint	A right of pasturage on common land
Stocking rate	Number of ewes or ewe equivalents per hectare for the duration of grazing period
Store	Sheep kept or acquired for fattening prior to slaughter
Tup/tupping	A male sheep/the act of mating ewes with the ram
Wether	Castrated ram
Wintering	Provision of lowland grazing, housing or supplementary feed for hill sheep during the winter
Yearling	Sheep in its second year