Information note 1 Assessing vegetation condition in the English uplands

Introduction

Please note that this Information Note supersedes the method published by English Nature as: Jerram, R. & Drewitt, A. 1998. Assessing vegetation condition in the English uplands. Peterborough: *English Nature Research Reports*, No. 264.

The English uplands support a wealth of wildlife habitats, such as heather moors and blanket bogs with all their associated plants and animals. For future generations to enjoy the wildlife of these areas and to secure their conservation interest, they need to be managed in an environmentally sustainable way. For these reasons English Nature has devised a method for assessing the condition of the vegetation for the four most extensive habitats in the English uplands which is described in this note. Work has recently been completed on some of the more discrete vegetation types in the English uplands including flushes, ledge vegetation and screes, and will be published in due course, as will methodology covering woodlands, grasslands and freshwater habitats in the English uplands.

The method describes how upland heath and mire vegetation in good condition will look, principally in terms of the plant species present and the structure of the vegetation. Areas that fit this description are then considered to be in 'favourable condition'. The aim has been to encompass the range of variation in vegetation composition, structure and management found in different parts of upland England within our definitions of favourable condition, not to impose a homogeneous look to upland habitats. Field methods for making an assessment of vegetation condition at various levels of detail are also described.

The method is intended to be rapid and repeatable and useful for initial assessments of the condition of the vegetation types covered. It was originally developed as a consistent way of assessing the condition of Sites of Special Scientific Interest (SSSIs) and Special Areas of Conservation (SACs) and is used by English Nature for this purpose. However, it is equally applicable to any land and will provide a better understanding of the vegetation condition of these upland habitats in the wider countryside. It is hoped that it will aid general assessments of vegetation condition within agri-environment schemes such as the Countryside Stewardship and Environmentally Sensitive Area schemes. It will also feed into the Biodiversity Action Plan process for the habitats concerned. The method can be used as a crude monitoring tool, as it is capable of detecting gross changes in vegetation, provided it is used in a standardised way for all site visits, but it is not suitable for detailed monitoring.

Assessing favourable condition

The upland vegetation condition assessment method described in this document is used to assess and monitor vegetation interest features[1] on upland SSSIs and the wider countryside. The attributes and targets[2] set here are the national standard and are applicable to all Natural Areas of England. Conservation objectives for individual sites will be set within this standard. English Nature is required to report on the condition of the interest features for which the SSSI was notified. However, English Nature also has responsibilities for these habitats under the Habitats Directive and through the Biodiversity Action Plan process and will also use the techniques described in this note to determine the overall condition of these habitats in the wider countryside.

Common Standards (Joint Nature Conservation Committee 1998) require that site features are assessed against the following categories:

Favourable - maintained
Favourable - recovered
Unfavourable - recovering
Unfavourable - no change
Unfavourable - declining
Partially destroyed
Destroyed

The first two categories equate to favourable vegetation condition as defined in this document, the remaining five categories equate to unfavourable vegetation condition. Whether the unfavourable vegetation is recovering, declining or showing no signs of change will depend on the dynamics of the situation and comparison with its condition on previous assessments.

Principles

Favourable vegetation condition is defined in this note for the four most extensive habitats found in the English uplands:

- Sub-montane dry dwarf-shrub heath
- Wet heath
- Blanket and upland raised mires
- Montane moss and lichen heath

Other upland vegetation types not listed above, such as hay meadows, other enclosed grasslands, limestone grasslands and semi-natural woodlands, are covered by other guidelines.

[1] **Interest features** are those features for which an SSSI, SAC or SPA has been designated. They may include features such as the presence of a particular vegetation type, such as H12 heather-bilberry dry heath, or the presence of particular species or groups of species, for example breeding hen harrier.

[2] An **attribute** is a measurable feature of the vegetation, such as sward height. A **target** is a level of the attribute (eg >3 cm for sward height) which has to be met for the vegetation to be in favourable condition.

These definitions are expressed as a series of attributes with target levels for each habitat. These identify the features which characterise vegetation in favourable condition. They focus on the effects of management on the condition of the vegetation, rather than on whether there is evidence that a particular management practice is, or has been, in operation. All attributes and targets must be met for the vegetation to be judged to be in favourable condition.

Box IN1.1 Definitions of terms of abundance and distribution (see also Figure IN1.5)

Abundance terms (DAFOR)	**Definition**
Dominant	A single species which prevails over other species in terms of the ground cover of a stand of a particular habitat
Abundant	Found regularly throughout a stand of a particular habitat and contributing significa ntly to the ground cover of that stand (>5% cover)
Frequent	Scattered plants or small clumps of plants found regularly throughout a stand (found on at least one in every three footfalls when walking through vegetation) and making a modest contribution to the ground cover of that stand (<5% cover)
Occasional	Scattered plants found on less than one in three footfalls and generally not making a contribution to the ground cover of that stand
Rare	No more than a few individual plants or clumps of a species recorded in a stand
Distribution terms	
Widespread	Widely distributed throughout a stand
Local	Restricted to particular areas or parts of a stand

Definitions of favourable condition

Definitions of favourable condition for each of the four habitat types covered are given below. A number of terms are used throughout to describe specific levels of abundance and distribution. These terms are in common usage in ecology but can be given a variety of meanings. To avoid confusion their usage and meaning in the context of the assessment of upland vegetation condition is defined in Box IN1.1.

Sub-montane dry dwarf-shrub heath

Habitat definition

Dry dwarf-shrub heath is defined as vegetation in which ericoid dwarf-shrubs (heather *Calluna vulgaris*, bell heather *Erica cinerea*, bilberry *Vaccinium myrtillus*, cowberry *Vaccinium vitis-idaea* and crowberry *Empetrum nigrum*) or western gorse *Ulex gallii* form a significant component of the vegetation in relatively dry situations. Species-poor acid grassland is a vegetation type where species such as mat-grass *Nardus stricta*, wavy hair-grass *Deschampsia flexuosa*, bristle bent *Agrostis curtisii*, common bent *Agrostis capillaris* and sheep's fescue *Festuca ovina* are abundant and in which dwarf-shrubs are scarce. These two vegetation types can form an intricate mosaic but species-poor acid grassland is generally derived from dwarf-shrub heath via grazing and/or burning and where dwarf-shrub cover falls below a certain threshold should be regarded as degraded dry heath in this context.

Sub-montane dry heath is sub-divided into two types for the purposes of vegetation condition assessment: 'typical' *Calluna* dry heath and dry heaths with *Ulex gallii.* These are differentiated simply on the presence or absence of *Ulex gallii.*

Table IN1.1 NVC communities covered by upland vegetation condition assessment: Sub-montane dry heath	
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	*Vaccinium myrtillus-Deschampsia flexuosa* heath
H21	*Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium* heath
U2	*Deschampsia flexuosa* grassland
U3	*Agrostis curtisii* grassland
U4	*Festuca ovina-Agrostis capillaris-Galium saxatile* grassland
U5	*Nardus stricta-Galium saxatile* grassland
U20	*Pteridium aquilinum-Galium saxatile* community

Exclusions

Exceptionally, species-rich grasslands can occur on moorlands in England: for example, where base-rich strata lie close to the soil surface or where there is slight base-rich flushing. Where present, the condition of these grasslands should be assessed on a site specific basis as species-rich grassland rather than heath.

Agrostis-Festuca grasslands which retain a relic woodland flora (eg wood anemone *Anemone nemorosa* or bluebell *Hyacinthoides non-scripta*), and hence show clear signs of having been derived from woodland, are also excluded and should be assessed on a site specific basis.

Any vegetation on blanket or raised peat bodies deeper than 0.5 m should be assessed as blanket / raised mire.

Heath over 600 m, particularly on or just below mountain summits, in which pleurocarpous mosses like *Hypnum jutlandicum* and *Pleurozium schreberi* are replaced by species such as woolly hair moss *Racomitrium lanuginosum* and *Polytrichum alpinum,* and montane species such as alpine clubmoss *Diphasiastrum alpinum,* Iceland moss *Cetraria islandica* (a lichen), stiff sedge *Carex bigelowii* or dwarf willow *Salix herbacea* are present, should be assessed as montane heath. Grasslands with abundant *Deschampsia flexuosa, Festuca ovina* or *Agrostis capillaris* on or just below mountain summits over 600 m should also be assessed as montane heath as they are likely to have been derived from montane heath via grazing.

Stands of bracken *Pteridium aquilinum* with a more or less continuous cover of litter (>90% cover) should be mapped as bracken and should not normally be included in the dry heath assessment.

Table IN1.2 Typical *Calluna* sub-montane dry dwarf-shrub heath

Attributes and targets for favourable vegetation condition

(for vegetation to be favourable all targets listed below must be met)

Dwarf-shrub cover

! Dwarf-shrubs are dominant over grass species.
Minimum of 75% cover of dwarf-shrubs, excluding recently burnt stands.

Dwarf-shrub diversity

! At least two dwarf-shrub species should be frequent and widespread in the sward. No one dwarf-shrub species should be dominant to the exclusion of all others. Where there is a dominant species one or more species must also be frequent and widespread. Where three or more species are present, but only one is frequent and widespread, the abundances of the less abundant species may be combined and treated as if they are a single species.

Bryophyte / lichen abundance

! Bryophytes (excluding *Polytrichum* spp and / or *Campylopus* spp) and / or 'bushy' *Cladonia* spp. lichens (eg *C. impexa* and *C. arbuscula*) should be at least frequent and forming patches below or, in more open swards, between the dwarf-shrubs.

Age structure

! Either: all age classes of *Calluna* present with at least 25% of the management unit in the late mature / degenerate age class or 25% or more excluded from the burning rotation
or: the whole management unit is unburnt.
Stands which are never burnt should be present on level or gently sloping ground, not entirely confined to steep slopes.
[Note that in stands which are never or infrequently burnt *Calluna* may regenerate through layering. Where this occurs the pioneer phase may not be present and it may be difficult to distinguish between the building, mature and degenerate phases. Stands where layering of *Calluna* is frequent and widespread should be included in the late mature / degenerate age class.]

Grazing impact

! Grazing impacts should be light
(An absolute maximum of 5% of the grazing unit may show signs of current moderate or heavy grazing).

Indicators of light grazing: *	! Where stands of dwarf-shrubs lie adjacent to stands of preferentially grazed vegetation such as grassland, flushes, or recently burnt heath, any marginal band of distinctly grazed dwarf-shrubs should not exceed 1 m in width.
* Field indicators taken from MacDonald *et al* 1998	! < 33% of long shoots of *Calluna vulgaris* or *Vaccinium myrtillus* showing signs of having been grazed where average shoot growth is >4 cm, or, where average shoot growth is <4 cm then <16% of shoots grazed. [Note that this indicator may only be reliable in late winter and early spring as *Calluna* in particular is mainly grazed in autumn and winter]
	! Only shoot tips (most recent years growth) removed by grazing.
	! Abundant and conspicuous flowering of *Calluna* and / or *Vaccinium myrtillus*.
	! Upright growth of *Calluna vulgaris*. Bush canopy open, not a tightly packed mass of contorted shoots. Very few or no instances of 'drumstick', 'topiary' or 'carpet' growth forms.
	! Little or no signs of grazing of *Empetrum nigrum*, *Vaccinium vitis-idaea* or *Nardus stricta*, if present.
	! No uprooted dwarf-shrub seedlings in areas regenerating after fire.
	! Herbivore dung should be rare and very difficult to find in short vegetation.
	! Negligible bare ground attributable to grazing pressure.

Guidance notes for assessing Calluna sub-montane dry dwarf-shrub heath

Attribute	Notes	
Dwarf-shrub cover	!	It should be assumed that recent controlled burns (areas burnt within the last two years) will regenerate good dwarf-shrub cover unless there is good evidence to the contrary.
	!	The area to assess for dwarf-shrub cover will include species-poor acid grassland, scattered trees or shrubs and open bracken stands, but will exclude other habitat types, such as dense bracken stands, flushes, woodland (including plantations) and stands of the other habitats covered by the assessment system.
	!	The presence of trees and shrubs, both native and non-native, does not in itself render an area of dry heath unfavourable. However, where shading by trees or shrubs reduces dwarf-shrub cover below the target level then it is judged as being in unfavourable vegetation condition. Where non-native trees are seeding in to an area of heath and becoming established this should be highlighted and brought to the attention of the site manager even if dwarf-shrub cover currently meets the target level.
	!	Similarly bracken is a natural component of dry heath, but where the presence of scattered bracken within a stand of heath reduces the cover of dwarf-shrubs below the target level the stand will be in unfavourable condition.
Dwarf-shrub diversity	!	In most dwarf-shrub heaths there is a dominant species; generally this is heather *Calluna*, although occasionally it may be bilberry *Vaccinium myrtillus*.
	!	Stands in favourable condition will also have one or more additional dwarf-shrub species present. To be favourable two or more dwarf-shrubs (including the dominant species) must be frequent and widespread throughout the sward. Where only two species are present this must be strictly interpreted. However, where three or more species are present a slightly less strict interpretation is allowed. In this circumstance one species *must* be frequent and widespread, but the other species may be combined and their abundance assessed as if they were a single species. Where this is done the species that are combined must be truly frequent and widespread.
Frequency of bryophytes and lichens	!	Generally only bryophytes (mosses and liverworts) figure in this assessment, but occasionally bushy lichens can also be a prominent feature of the vegetation.

Attribute	Notes	
Frequency of bryophytes and lichens (continued)	!	Bryophytes which count positively towards the assessment can be described as 'feather mosses' (MacDonald *et al* 1998) or pleurocarpous mosses. These are mosses with much branched shoots, often regularly branched, which form loose, horizontally layered mats (Figure IN1.1b). Typical heathland examples include *Hylocomium splendens, Pleurozium schreberi* and *Hypnum cupressiforme/ jutlandicum*. Liverworts tend to be less conspicuous.
	!	Certain *Polytrichum* and *Campylopus* spp mosses are typical colonisers of bare ground following very hot fires and possibly also frequent fires. They tend to form short mats, generally less than 1.5 cm deep and are small spiky mosses, often with white hairs and an upright growth form. Note that *Polytrichum commune*, a large (3-10 cm+ bright green moss) can be frequent in favourable heath vegetation, particularly in damp humid conditions (Figure IN1.1b).
	!	'Bushy' *Cladonia* lichens have a growth form reminiscent of bushes or trees (arbuscular). Typical species are *Cladonia impexa* (*C. portentosa*) and *C. arbuscula* (Figure IN1.1a).
Age structure	!	The growth phases of *Calluna* (from Gimingham, 1992): **Pioneer phase:** This is the period of establishment, either of seedlings or of sprouts from stem bases surviving after fire. In both cases the young plants are neatly pyramid shaped, but seedlings are scattered whereas stem-base sprouts are clustered. Flowering usually begins in the second growing season after establishment, and from about this time growth is no longer concentrated in a leading shoot but takes place in a number of radiating branches. **Building phase:** Radiating growth gives rise to a dome-shaped bush in isolated individuals, or to a closed canopy in dense stands. This is the most vigorous growth-phase, with abundant production of shoots near the periphery of the branches as well as flowers and seed. Very little light penetrates the canopy. **Mature phase:** In time, extension growth becomes rather less vigorous while the woody parts of the branches continue to increase in girth. The canopy becomes more irregular and inclined to open up. In isolated plants a central gap may form in the canopy. **Degenerate phase:** Gaps in the canopy increase as the older central frame-branches become moribund and die. Branches tend to collapse sideways, increasing the gaps, but any lateral branches which have rooted in the moist humus may remain alive for long periods. These phases merge gradually into one another without sharp transitions. The rate at which the whole process takes place varies considerably according to habitat and geographical location, but to give a general indication the pioneer phase may last until plants are

Attribute	Notes	
Age structure (continued)		from two to six years of age, the building phase up to about 10 to 15 years of age and the mature phase up to 20 to 25 years of age, when the plants pass gradually into the degenerate phase and die back progressively from the central branches outwards.
	!	Stands that are never or infrequently burnt may be found to be layering (vegetative regeneration via the production of adventitious roots from prostrate stems). Examine the underside of a live branch which is lying on the ground and look for roots.
	!	Where layering is occurring the pioneer phase may not be present and it can be difficult to distinguish between the building, mature and degenerate phases.
	!	Stands where layering of *Calluna* is frequent and widespread should be included in the late mature / degenerate age class.
	!	Age structure should be assessed over whole burning management units.
Grazing impacts: General	!	See record card for impact levels for moderate and heavy grazing for each indicator. Examination of these targets will aid an assessment of whether the grazing impact is light or otherwise.
	!	The indicators are just that, they are designed to help a surveyor assess the grazing impact. It is not necessary for all the indicators to be recorded as light to assess the overall grazing level as light. It is permissible for one or more indicators to be recorded as moderate or heavy, but these must not outnumber light indicators recorded.
	!	Grazing impact should be assessed over the whole assessment unit. This will require impacts to be averaged out.
Width of grazing zone	!	Width of heavy grazing zone refers to a zone of obviously heavily grazed dwarf-shrubs which may be present at the interface of stands of dwarf-shrubs and preferentially grazed vegetation, such as limestone grassland, flushes or stands of pioneer / early building phase *Calluna*. Where grazing impact is light there may be no such grazing zone evident. The zone is the result of increasing herbivore density on the preferred vegetation forcing animals to graze the less palatable taller dwarf-shrubs surrounding it.
Percentage long shoots grazed	!	'Long shoots' refers to the current or most recent year's growth (Figure IN1.2).
	!	Strictly speaking this indicator should be used only in early spring (March / April), when an entire season of grazing and growth can be assessed. However, obvious summer grazing of *Calluna* indicates a heavy grazing impact.

Attribute		Notes
Percentage long shoots grazed (continued)	!	The two annual shoot growth lengths relate to the vigour of the bush and refer to long shoots (Figure IN1.2). Vigorously growing bushes will put on an average of >4 cm growth per year, while less vigorous plants will put on an average of <4 cm growth per year. Several factors influence the vigour of dwarf-shrubs: ❑ vigour declines with increased altitude and exposure; ❑ soil dampness / waterlogging reduces vigour; ❑ vigour declines with plant age. Both sets of thresholds may need to be used in a single assessment unit. Vigorously growing plants can tolerate higher grazing levels than less vigorous plants. From record card: ❑ <33% - the sward will not normally be obviously grazed. Grazed shoots will be difficult to find without both intensive and extensive searching; ❑ 33-66% - the sward will be clearly grazed in general appearance, although effects may be patchy; ❑ >66% - grazing of the sward will be very conspicuous and it will be difficult to find ungrazed shoots. Grazing impacts may be harder to assess in stands of low vigour, but any obvious evidence of grazing will tend to indicate heavy grazing here.
Type of shoot material removed	●	As grazing intensity increases the type of shoot material eaten changes. At low grazing levels only the most nutritious shoot tips are removed, but under heavy grazing levels there will be frequent evidence of grazing of woody material older than the most recent year's growth.
Amount of flowering of dwarf-shrubs	●	This indicator can be used in the late summer (late August / September) and autumn, when the previous indicator is less reliable.
	●	Some knowledge of the seasonal grazing pattern is required. If grazing only occurs in winter then new flowering shoots can be produced during the flowering season. However, if there is heavy summer grazing of dwarf-shrubs most flowering shoots will be removed.
	●	Note that the amount of flowering can be affected by weather patterns and may be reduced at high altitude (550 m+).

Attribute	Notes
Frequency of grazing induced *Calluna* growth forms	● Continued moderately heavy and heavy grazing over several years results in changes to the growth form of *Calluna*. The repeated removal of the lead shoot results in side shoots repeatedly becoming the lead shoot, such that the main axis of growth along a branch changes every 1-2 cm, producing bushes with twisted contorted growth forms and tightly packed branches. During the summer this may be obscured by a surface of new growth which is removed over winter. This is particularly the case where grazing of *Calluna* mainly occurs in winter. ● The tightly packed branches of a heavily grazed bush will prevent one from pushing ones fingers into the centre of the bush. ● Lightly grazed bushes will have an open structure with straight, upright shoots. It will be possible to see into the middle of the bush and one will be able to push one's fingers deep into the bush unhindered. ● 'Drumstick', 'topiary' and 'carpet' or 'prostrate' heather describe the appearance of the suppressed growth forms produced by continued heavy grazing. These growth forms give no indication of the relative intensity of the heavy grazing, rather they are indicative of the age of the *Calluna* when heavy grazing started. 'Drumstick' is the result of heavy grazing of late mature / degenerate plants, 'topiary' of building early / mature plants and 'carpet / prostrate' of pioneer *Calluna* (Figure IN1.3). ● Note that this indicator may reflect past grazing impacts rather than the current grazing impact.
Signs of grazing on *Empetrum nigrum, Vaccinium vitis-idaea, Erica tetralix* or *Nardus stricta*	● These four species are unpalatable to livestock and are rarely grazed, except under heavy stocking levels when other, more palatable, species have been grazed down; or at times of high snow cover when other food may be unavailable. Any signs of these species being grazed is evidence of heavy grazing levels in the immediate vicinity.
Uprooting of dwarf-shrub seedlings	● Large numbers of uprooted, but largely uneaten dwarf-shrub seedlings, particularly *Calluna*, in recently burnt patches are a good sign of heavy grazing.
Herbivore dung in short vegetation	● This only relates to the ease of finding dung in short vegetation. It will be hard to find dung in tall vegetation regardless of the grazing impact.
Trampled bare ground	● Look for hoof prints to determine the origin of the bare ground. Note that heavily burnt patches may retain bare ground for several years after being burnt, regardless of the grazing impact.

Figure 1a "Bushy" lichens.

a: *Cladonia arbuscula* and
b: *Cladonia impexa* (*C. portentosa*)

Reproduced from Alvin (1977)

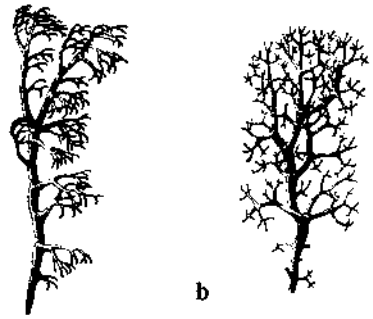


Figure 1b Mosses

a: *Campylopus* sp. (dry and moist);
b: *Polytrichum* sp.;
c: *Polytrichum commune*;
d: a feather moss

Reproduced from Watson (1969)

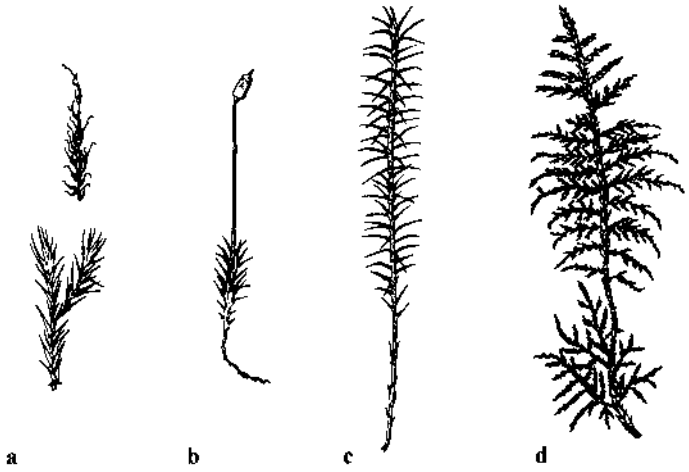


Table IN1.3. *Calluna* Dry heath
Vegetation condition grading system (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1 point**	**2 points**	**6 points**
Dwarf-shrub cover	>75%	26-75%	5-25%	<5%
Dwarf-shrub diversity	2 or more spp widespread & frequent	no more than 1 spp widespread & frequent		
Bryophyte / lichen abundance	frequent patches	occasional	rare	
Age structure	>25% late mature / degenerate or excluded from burning	<25% late mature / degenerate or excluded from burning		
Grazing impact	light	moderate	heavy	

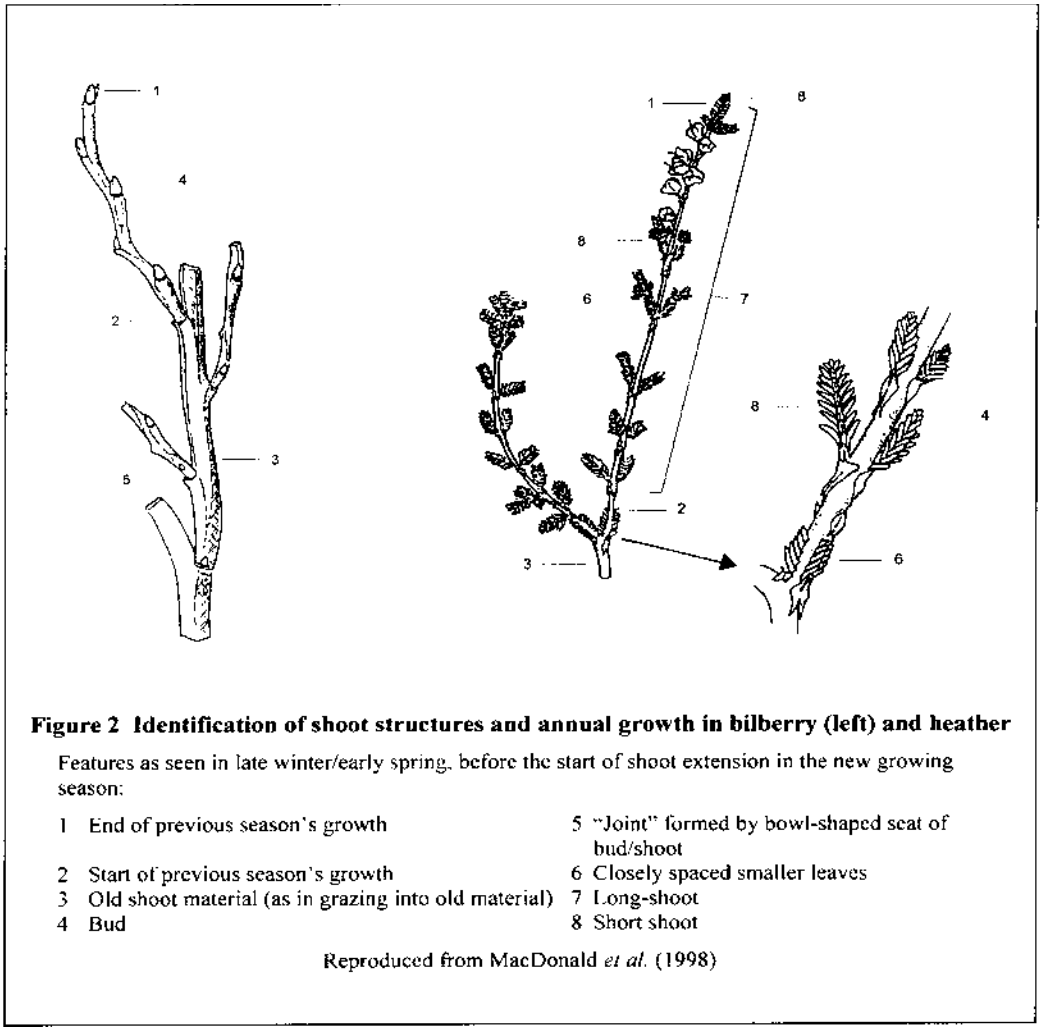


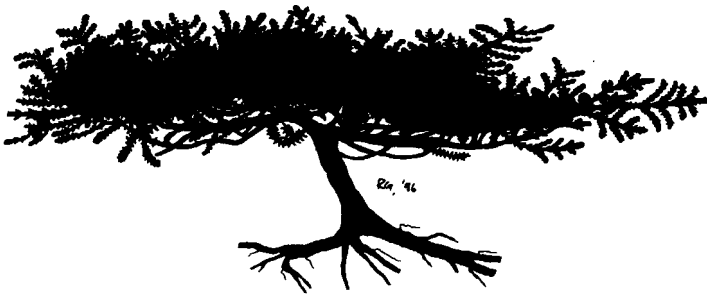
Figure 2 Identification of shoot structures and annual growth in bilberry (left) and heather

Features as seen in late winter/early spring, before the start of shoot extension in the new growing season:

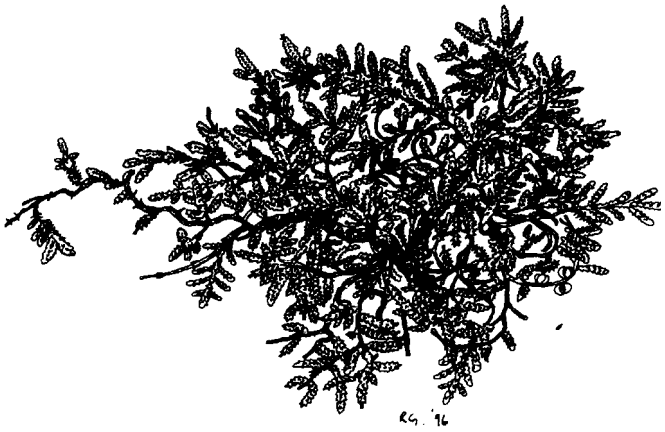
1 End of previous season's growth
2 Start of previous season's growth
3 Old shoot material (as in grazing into old material)
4 Bud
5 "Joint" formed by bowl-shaped seat of bud/shoot
6 Closely spaced smaller leaves
7 Long-shoot
8 Short shoot

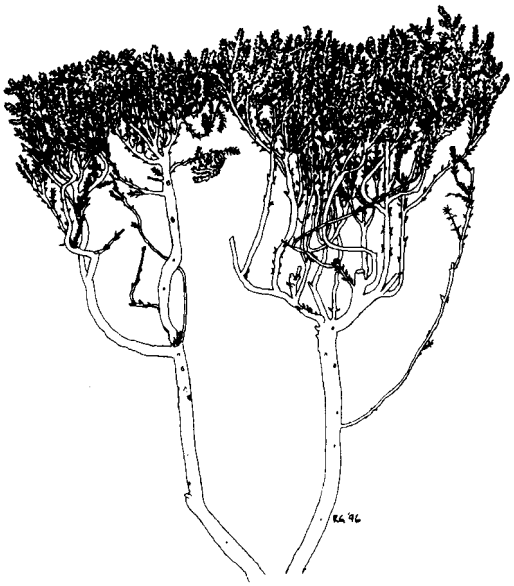
Reproduced from MacDonald *et al.* (1998)

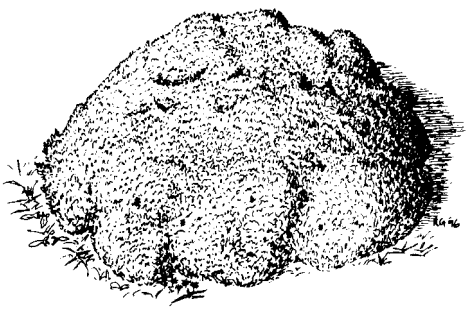
a: Carpet heather seen from the side (includes roots)



b: Carpet heather seen from above







c: Topiary heather, cross-section and bush

d: Drumstick heather

Figure 3 Heather growth forms
Drawings by Robert Goodison ©

Box IN1.2. Grading unfavourable vegetation

Where stands, survey units or entire management units fail to meet one or more of the favourable vegetation condition attributes and targets then the vegetation unit is classed as being in unfavourable vegetation condition. Clearly not all vegetation in unfavourable condition is the same and there will be different degrees of 'unfavourableness'. If we take dry heath as an example, one unfavourable management unit may exhibit signs of moderately heavy grazing over 20% of its area but meet all the other attributes and targets, while another unit may have formerly been dry heath but is now species-poor acid grassland with dwarf-shrubs present. The latter area of degraded dry heath is clearly in far worse condition than the former, which could probably be restored to favourable condition within a few years by fairly modest changes in the grazing regime. However, to restore the acid grassland to heath in favourable condition would take many decades and a considerable amount of management intervention, which even then might not be successful. The ability to distinguish between different degrees of unfavourability will greatly aid land managers and conservation organisations in directing scarce resources at those areas of unfavourable vegetation where the resources are likely to be of most benefit.

A weighted scoring system has been devised to distinguish between different degrees of unfavourable vegetation condition. Points are awarded for each attribute on which the vegetation fails, so that favourable stands score zero points, a stand failing one attribute scores one point, a stand failing two attributes scores two points and so on. Additional weighting is given to those attributes considered to be of particular importance in determining vegetation condition (eg cover of dwarf-shrubs in dry heath, or *Sphagnum* / bryophyte cover in blanket mires). These attributes are sub-divided and additional points are scored for poorer examples of that vegetation condition component.

Scores are graded as follows:

0 points:	favourable
1-5 points:	unfavourable
>5 points:	severely unfavourable

Within the unfavourable grade, the number of points scored can be used to give a further indication of the relative level of the unfavourability of a stand. However, within the severely unfavourable grade there is little value to be gained from comparing scores.

This grading system can be applied to individual stands or parts of stands of a habitat (polygon mapping), sample squares (raster mapping), facets (facet mapping) or whole management units. It must be noted, however, that in the first three situations the age structure attribute can only be assessed over a whole management unit and should not be applied to individual sample squares, stands or facets.

ENGLISH NATURE

Upland Vegetation Condition Assessment **Field record card**

Site Name: | Grid/square reference: | Date:

Management unit: | Surveyor:

***CALLUNA* DRY HEATH** (without *Ulex gallii*) Is this card for a whole management unit, raster square or facet?

ATTRIBUTES AND TARGETS:

	pass (✓)		(circle)
>75% cover of dwarf-shrubs		Cover of dwarf-shrubs:	>75% / 25-75 / 5-25 / <5%
At least 1 dwarf-shrub species other than the dominant species frequent & widespread		Species present & their abundance (DAFOR):	Y / N
Bryophytes &/or bushy *Cladonia* at least frequent & forming carpets		Cover of bryophytes/lichens:	Freq / Occ / Rare
Age Structure			(see Age Structure section below)
Grazing impact (see indicators below)		Impact:	Light / Moderate / Heavy

AGE STRUCTURE:

Calluna regenerating by layering ? Y / N (If yes count layering areas as late mature/degenerate)

	Pioneer & newly burnt	Building & early mature	Late mature & degenerate
% cover of *Calluna* growth phases:			

GRAZING IMPACTS*:

Indicator	**Light**	**Moderate**	**Heavy**
	Impact level (circle indicators & overall impact)		
Width of zone of heavy grazing of dwarf-shrubs on interface with preferentially grazed vegetation	<1 m or absent	1 m-10 m	>10 m
% of long shoots grazed			
(a) if shoot growth >4 cm/yr	<33%	33-66%	>66%
(b) if shoot growth <4 cm/yr	<16%	16-33%	>33%
Shoot material removed	tips only	mainly tips	tips & older woody growth
Amount of flowering of dwarf-shrubs	abundant and conspicuous	obvious but patchy	sparse
Frequency of grazing induced *Calluna* growth forms ('drumstick', 'topiary' or 'carpet')	hard to find	localised	widespread
Signs of grazing of *Empetrum nigrum, Vaccinium vitis-idaea* or *Nardus stricta*, if species present	hard to find		some
Uprooting of dwarf-shrub seedlings in recent burns	hard to find	present but not conspicuous	conspicuous
Herbivore dung in short vegetation	rare and difficult to find	easy to find but not conspicuous	very conspicuous
Trampled bare ground	none, other than sporadic sheep scars or rabbit scrapes in recent burns		widespread

Vegetation condition (✓): Favourable / Unfavourable

Outlook:

[briefly outline your assessment of the short, medium and long-term outlook for the area you have assessed and give reasons]

Land-use & management

Grazers (✓): sheep / cattle / deer / rabbits / grouse / horses / other

Stock feeding points present ? Y / N

Native trees & shrubs: None / Local / Widespread Species:

Non-native trees & shrubs: None / Local / Widespread Species:

Burn patch size	**small (<2 ha)**	**medium (2-5 ha)**	**large (>5 ha)**	**no evidence of being in a burning rotation**
None, Local, Widespread?:	L / W	L / W	L / W	L / W

* Field indicators taken from MacDonald *et al.* (1998) *A Guide to Upland Habitats. Surveying Land Management Impacts*. Vol. 2

Table IN1.4. *Ulex gallii* sub-montane dry dwarf-shrub heath
Attributes and targets for favourable vegetation condition
(for vegetation to be favourable all targets listed below must be met)

Dwarf-shrub cover

! Dwarf-shrubs (*Calluna*, *Erica* spp, *Vaccinium* spp, *Empetrum* and *Ulex gallii*) are dominant over grass species. Minimum of 75% cover of dwarf-shrubs, excluding recently burnt stands.
[Note that when grazing is light *Agrostis curtisii*, where present, can be dominant for the first few years following burning.]

Dwarf-shrub diversity

! At least two dwarf-shrub species should be frequent and widespread in the sward. No one dwarf-shrub species should be dominant to the exclusion of all others. Where there is a dominant species one or more species must also be frequent and widespread. Where three or more species are present, but only one is frequent and widespread, the occurrence of the less abundant species may be combined and treated as if they are a single species.

Cover of *Ulex gallii*

! *Ulex gallii* should not exceed 50% cover, neither over a whole stand of *Ulex gallii* dry heath nor within individual age class stands where burning is practised.

Age structure

! All age classes of dwarf-shrub present with at least 25% of the management unit in the late mature / degenerate age class or 25% or more excluded from the burning rotation.
Stands which are never burnt should be present on level or gently sloping ground, not entirely confined to steep slopes.
[Note that in stands which are never or infrequently burnt *Calluna* may regenerate through layering. Where this occurs the pioneer phase may not be present and it may be difficult to distinguish between the building, mature and degenerate phases. Stands where layering of *Calluna* is frequent and widespread should be included in the late mature / degenerate age class.]

Grazing impact

! Grazing impacts should be light . (An absolute maximum of 5% of the grazing unit may show signs of current moderate or heavy grazing.)

Indicators of light grazing*:	! Where stands of dwarf-shrubs lie adjacent to stands of preferentially grazed vegetation such as grassland, flushes, or recently burnt heath, any marginal band of distinctly grazed dwarf-shrubs should not exceed 1 m in width.
*Field indicators taken from MacDonald *et al* (1998).	! < 33% of long shoots of *Calluna vulgaris* or *Vaccinium myrtillus* showing signs of having been grazed where average shoot growth is >4 cm, or, where average shoot growth is <4 cm then <16% of shoots grazed. [Note that this indicator may only be reliable in late winter and early spring as *Calluna* in particular is mainly grazed in autumn and winter.]
	! Only shoot tips (most recent years growth) removed by grazing.
	! Abundant and conspicuous flowering of *Calluna* and / or *Vaccinium myrtillus*.
	! Upright growth of *Calluna vulgaris*. Bush canopy open, not a tightly packed mass of contorted shoots. Very few or no instances of 'drumstick', 'topiary' or 'carpet' growth forms.
	! Little or no signs of grazing of *Erica tetralix, Empetrum nigrum, Vaccinium vitis-idaea* or *Nardus stricta*, if present.
	! No uprooted dwarf-shrub seedlings in areas regenerating after fire.
	! Herbivore dung should be rare and very difficult to find in short vegetation.
	! Negligible bare ground attributable to grazing pressure.

Guidance notes for assessing *Ulex gallii* dry dwarf-shrub heath

Attribute	Notes	
Dwarf-shrub cover	!	*Ulex gallii* is included as a dwarf-shrub.
	!	*Agrostis curtisii*, where present, can be dominant in the first few years after a burn, but under light grazing such burns will regenerate with good dwarf-shrub cover.
	!	Otherwise as *Calluna* dry heath guidance notes.
Dwarf-shrub diversity	!	In most dwarf-shrub heaths there is a dominant species, in *Ulex gallii* dry heath *Erica cinerea, Calluna* or *Ulex gallii* may become dominant.
	!	Otherwise as *Calluna* dry heath guidance notes.
Cover of *Ulex gallii*	!	When *Ulex gallii* becomes dominant in the sward species diversity tends to decline.
Age structure	!	See *Calluna* dry heath guidance notes.
Grazing impacts	!	See *Calluna* dry heath guidance notes.

Grading unfavourable *Ulex gallii* dry heath

Table IN1.5. *Ulex gallii* dry heath

Vegetation condition grading system (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1 point**	**2 points**	**6 points**
Dwarf-shrub cover	>75%	26-75%	5-25%	<5%
Dwarf-shrub diversity	2 or more spp widespread & frequent	no more than 1 spp widespread & frequent		
Cover of *Ulex gallii*	<50%	>50%		
Age structure	>25% late mature / degenerate or excluded from burning	<25% late mature / degenerate or excluded from burning		
Grazing impact	light	moderate	heavy	

ENGLISH NATURE

Upland vegetation condition assessment **Field record card**

Site Name: | Grid/square reference: | Date:

Management unit: | Surveyor:

***ULEX GALLII* DRY HEATH** Is this card for a whole management unit, raster square or facet ?

ATTRIBUTES AND TARGETS:

	pass (✓)		(circle)
>75% cover of dwarf-shrubs		Cover of dwarf-shrubs:	>75% / 25-75 / 5-25 / <5%
At least 1 dwarf-shrub species other than the dominant species frequent & widespread		Species present & their abundance (DAFOR):	Y / N
Ulex gallii cover <50%		Cover of *U. gallii*:	<50% / >50%
Age structure			(see Age Structure section below)
Grazing impact (see indicators below)		Impact:	Light / Moderate / Heavy

AGE STRUCTURE:

Calluna regenerating by layering ? Y / N (If yes count layering areas as late mature/degenerate)

% cover of *Calluna* growth phases or height classes of other dwarf-shrub spp if *Calluna* absent:

Pioneer & newly burnt (<15 cm)	Building & early mature (15-35 cm)	Late mature & degenerate (>35 cm)

GRAZING IMPACTS*:

Indicator	**Light**	**Moderate**	**Heavy**
	Impact level (circle indicators & overall impact)		
Width of zone of heavy grazing of dwarf-shrubs on interface with preferentially grazed vegetation	<1 m or absent	1 m-10 m	>10 m
% of long shoots grazed			
(a) if shoot growth >4 cm/yr	<33%	33-66%	>66%
(b) if shoot growth <4 cm/yr	<16%	16-33%	>33%
Shoot material removed	tips only	mainly tips	tips & older woody growth
Amount of flowering of dwarf-shrubs	abundant and conspicuous	obvious but patchy	sparse
Frequency of grazing induced *Calluna* growth forms ('drumstick', 'topiary' or 'carpet')	hard to find	localised	widespread
Signs of grazing of *Erica tetralix, Empetrum nigrum, Vaccinium vitis-idaea* or *Nardus stricta*, if present	hard to find		some
Uprooting of dwarf-shrub seedlings in recent burns	hard to find	present but not conspicuous	conspicuous
Herbivore dung in short vegetation	rare & difficult to find	easy to find but not conspicuous	very conspicuous
Trampled bare ground	none, other than sporadic sheep scars or rabbit scrapes in recent burns		widespread

Vegetation condition (✓): Favourable | Unfavourable

Outlook:

[briefly outline your assessment of the short, medium and long-term outlook for the area you have assessed and give reasons]

Land-use & management

Grazers (✓): sheep | cattle | deer | rabbits | grouse | horses | other

Native trees & shrubs: None | Local | Widespread Species:

Non-native trees & shrubs: None | Local | Widespread Species:

Stock feeding points present ? Y / N

Burn patch size	small (<2 ha)	medium (2-5 ha)	large (>5 ha)	no evidence of being in a burning rotation
None, Local, Widespread?:	L / W	L / W	L / W	L / W

* Field indicators taken from MacDonald *et al* (1998) *A Guide to Upland Habitats. Surveying Land Management Impacts.* Vol. 2

Wet heath

Habitat definition

Wet heath is defined by the presence of an ericoid dwarf-shrub cover of more than 25% in wet situations where peat depth does not exceed 0.5 m. However, dwarf-shrubs may be scarce or absent in degraded stands. Cross-leaved heath *Erica tetralix* is generally frequent in wet heath whereas it is usually no more than occasional in dry heath. Bryophytes, including *Sphagnum* spp, are generally abundant, although again they may be absent in degraded stands. Purple moor-grass *Molinia caerulea,* heath rush *Juncus squarrosus* and deer grass *Scirpus cespitosus* may also be frequent or abundant, and where any of these are dominant or abundant in the absence of frequent hare's-tail cotton-grass *Eriophorum vaginatum* on peat less than 0.5 m deep, the vegetation should be assessed as wet heath. Note, however, that herb-rich *Molinia* grasslands should not be categorised as wet heath and are not covered by this scheme.

Table IN1.6. NVC communities covered by upland vegetation condition assessment: Wet heath	
M15	*Scirpus cespitosus-Erica tetralix* wet heath
M16	*Erica tetralix-Sphagnum compactum* wet heath
M25	*Molinia caerulea-Potentilla erecta* mire
U6	*Juncus squarrosus-Festuca ovina* grassland

Exclusions

Any vegetation on blanket or raised mire peat greater than 0.5 m in depth should be assessed using the blanket and raised mire attributes and targets.

Sphagnum moss
Reproduced from Watson (1969)

Favourable wet heath

Table IN1.7 Wet dwarf-shrub heath

Attributes and targets for favourable vegetation condition

(For vegetation to be favourable all targets listed below must be met)

Dwarf-shrub cover

! Sward composed of a variety of higher plants and bryophytes. Dwarf-shrubs should not dominate the sward and there should be a minimum of 25% cover of species other than dwarf-shrubs.

Dwarf-shrub diversity

! At least two dwarf-shrub species should be frequent and widespread in the sward. No one dwarf-shrub species should be dominant to the exclusion of all others. Where there is a dominant species one or more species must also be frequent and widespread. Where three or more species are present, but only one is frequent and widespread, the occurrence of the less abundant species may be combined and treated as if they are a single species.

Bryophyte abundance

! Bryophytes (excluding *Polytrichum* spp and / or *Campylopus* spp) should be at least frequent and forming patches below or, in more open swards, between the dwarf-shrubs.

Age structure

! Either: all age classes of *Calluna* present with at least 33% of the management unit in the late mature / degenerate age class or 33% or more excluded from the burning rotation

or: the whole management unit is unburnt.

Stands which are never burnt should be present on level or gently sloping ground, not entirely confined to steeper slopes.

[Note that in stands which are never or infrequently burnt *Calluna* may regenerate through layering. Where is occurs the pioneer phase may not be present and it may be hard to distinguish between the building, mature and degenerate phases. Stands where layering of *Calluna* is frequent and widespread should be included in the late mature / degenerate age class.]

Graminoid cover

! Purple moor-grass *Molinia caerulea*, deer grass *Scirpus cespitosus*, wavy hair-grass *Deschampsia flexuosa*, heath rush *Juncus squarrosus* or other graminoids should not dominate over other species.
Total cover of graminoids should not exceed 50%.

Grazing impact

! Grazing impacts should be light.

(An absolute maximum of 5% of the grazing unit may show signs of current moderate or heavy grazing.)

Indicators of light grazing: *	! Where stands of dwarf-shrubs lie adjacent to stands of preferentially grazed vegetation such as grassland, flushes, or recently burnt heath, any marginal band of distinctly grazed dwarf-shrubs should not exceed 1 m in width.
* Field indicators taken from MacDonald *et al* (1998)	! < 33% of long shoots of *Calluna vulgaris* or *Vaccinium myrtillus* showing signs of having been grazed where average shoot growth is >4 cm, or, where average shoot growth is <4 cm then <16% of shoots grazed. [Note that this indicator may only be reliable in late winter and early spring as *Calluna* in particular is mainly grazed in autumn and winter.]
	! Only shoot tips (most recent years growth) removed by grazing.
	! Abundant and conspicuous flowering of *Calluna*.
	! Upright growth of *Calluna vulgaris*. Bush canopy open, not a tightly packed mass of contorted shoots. Very few or no instances of 'drumstick', 'topiary' or 'carpet' growth forms.
	! Little or no signs of grazing of *Erica tetralix*, *Empetrum nigrum*, *Vaccinium vitis-idaea* or *Nardus stricta*, if present.
	! No uprooted dwarf-shrub seedlings in areas regenerating after fire.
	! Herbivore dung should be rare and very difficult to find in short vegetation.
	! Negligible bare ground attributable to grazing pressure.

Guidance notes for assessing wet dwarf-shrub heath

Attribute	Notes	
Dwarf-shrub cover	!	See *Calluna* dry heath guidance notes.
Dwarf-shrub diversity	!	In most dwarf-shrub heaths there is a dominant species, in wet heath this is generally heather *Calluna*, although occasionally it may be cross-leaved heath *Erica tetralix*.
	!	Otherwise as *Calluna* dry heath guidance notes.
Frequency of bryophytes	!	Positive bryophytes include *Sphagnum* spp as well as 'feather mosses' (see *Calluna* dry heath guidance notes).
	!	See also *Calluna* dry heath guidance notes.
Age structure	!	See *Calluna* dry heath guidance notes, but note increased cover of late mature / degenerate *Calluna* required for wet heath.
Graminoid cover	!	Graminoids are plants which look like grasses and include true grasses, sedges and rushes.
Grazing impacts	!	See *Calluna* dry heath guidance notes.

Grading unfavourable wet heath

Table IN1.8. Wet heath

Vegetation condition grading system (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1 point**	**2 points**	**4 points**
Dwarf-shrub cover	51-75%	>75% or 26-50%	5-25%	<5%
Dwarf-shrub diversity	2 or more spp widespread & frequent	no more than 1 spp widespread & frequent		
Bryophyte abundance	frequent patches		occasional patches	rare
Age structure	>33% late mature / degenerate or excluded from burning	<33% late mature / degenerate or excluded from burning		
Graminoid cover	<50%	50-75%	>75%	
Grazing impact	light	moderate	heavy	

Site Name: | Grid/square reference: | Date:

Management unit: | Surveyor:

WET HEATH Is this card for a whole management unit, raster square or facet?

ATTRIBUTES AND TARGETS:

	pass (✓)		(circle)			
50-75% cover of dwarf-shrubs		Cover of dwarf-shrubs:	50-75	>75% or 25-75	5-25%	<5%
At least 1 dwarf-shrub species other than the dominant species frequent & widespread		Species present & their abundance (DAFOR):	**Y / N**			
Bryophytes (excluding *Polytrichum* & *Campylopus* spp) at least frequent & forming patches		Bryophytes abundance:	Freq	Occ	Rare	
Age structure			(see Age Structure section below)			
Total cover of graminoids <50%		Cover of graminoids:	<50%	50-75%	>75%	
Grazing impact		Impact:	Light	Moderate	Heavy	

AGE STRUCTURE:

Calluna regenerating by layering? **Y / N** (If yes count layering areas as late mature/degenerate)

	Pioneer & newly burnt	Building & early mature	Late mature & degenerate
% cover of *Calluna* growth phases:			

GRAZING IMPACTS *:

Indicator	**Impact level** (circle indicators & overall impact) **Light**	**Moderate**	**Heavy**
Width of zone of heavy grazing of dwarf-shrubs on interface with preferentially grazed vegetation	<1 m or absent	1 m-10 m	>10 m
% of long shoots grazed			
(a) if shoot growth >4cm/yr	<33%	33-66%	>66%
(b) if shoot growth <4cm/yr	<16%	16-33%	>33%
Shoot material removed	tips only	mainly tips	tips & older woody growth
Amount of flowering of dwarf-shrubs	abundant and conspicuous	obvious but patchy	sparse
Frequency of grazing induced *Calluna* growth forms ('drumstick', 'topiary' or 'carpet')	hard to find	localised	widespread
Grazing of *Erica tetralix, Empetrum nigrum, Vaccinium vitis-idaea* or *Nardus stricta*, if present	hard to find		some
Uprooting of dwarf-shrub seedlings in recent burns	hard to find	present but not conspicuous	conspicuous
Herbivore dung in short vegetation	rare and difficult to find	easy to find but not conspicuous	very conspicuous
Trampled bare ground	none, other than sporadic sheep scars or rabbit scrapes in recent burns		widespread

Vegetation condition (✓) Favourable | Unfavourable

Outlook:

[briefly outline your assessment of the short, medium and long-term outlook for the area you have assessed and give reasons]

Land-use & management

Grazers (✓) sheep | cattle | deer | rabbits | grouse | horses | other

Stock feeding points present ? Y / N

Drainage (✓) None | Inactive (blocked) | Active

Native trees & shrubs: None | Local | Widespread Species:

Non-native trees & shrubs: None | Local | Widespread Species:

Burn patch size	**small (<2 ha)**	**medium (2-5 ha)**	**large (>5 ha)**	**no evidence of being in a burning rotation**
None, Local, Widespread?:	L / W	L / W	L / W	L / W

* Field indicators taken from MacDonald *et al* (1998) *A Guide to Upland Habitats. Surveying Land Management Impacts.* Vol. 2

Blanket and upland raised mire

Habitat definition

Any vegetation on blanket or raised peat bodies deeper than 0.5 m should be assessed using these attributes and targets. This will include not only typical ombrotrophic mire vegetation composed of a mix of hare's-tail cotton-grass *Eriophorum vaginatum,* deer grass *Scirpus cespitosus,* purple moor-grass *Molinia caerulea,* bog mosses *Sphagnum* spp and ericoid dwarf-shrubs (heather *Calluna vulgaris,* cross-leaved heath *Erica tetralix*, bilberry *Vaccinium myrtillus*, cowberry *Vaccinium vitis-idaea* and crowberry *Empetrum nigrum*), but also vegetation superficially resembling dry heath on deep peat and other degraded forms where Sphagna and / or dwarf-shrubs may be absent. In addition to this, any vegetation in which *Eriophorum vaginatum* is more than occasional should be assessed as blanket and raised mire.

The following discussion deals mainly with blanket mires as these are by far the most widespread of the mire types in the uplands. However, much of what is said should also be applicable to upland raised mires.

The majority of English blanket mire is found on the Pennines and belongs to the relatively dry *Calluna vulgaris-Eriophorum vaginatum* type and its degraded derivatives. The wetter *Scirpus cespitosus-Eriophorum vaginatum* type is largely confined to the extreme west, principally the moors of SW England and the western Lake District. As a result, the attributes and targets tend to be biased towards favourable Pennine blanket mires. However, trials have shown that these will also identify the better areas of western blanket mires and should also apply to upland raised mires.

Table IN1.9 NVC communities covered by upland vegetation condition assessment: Blanket and upland raised mire

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 mire
M25	*Molinia caerulea-Potentilla erecta* mire
H9	*Calluna vulgaris-Deschampsia flexuosa* heath
H12	*Calluna vulgaris-Vaccinium myrtillus* heath
H18	*Vaccinium myrtillus-Deschampsia flexuosa* heath
U6	*Juncus squarrosus-Festuca ovina* grassland

Table IN1.10. Blanket and upland raised mires
Attributes and targets for favourable vegetation condition
(for vegetation to be favourable all targets listed below must be met)

Bryophyte abundance	
! Bryophytes should be abundant and must include *Sphagnum* spp. *Sphagnum* spp must be both frequent and widespread in the stand and not restricted to hollows, forming at least occasional lawns or hummocks.	
Dwarf-shrub cover	
! Except in wetter areas where *Sphagnum* spp are abundant and forming lawns, cover of dwarf-shrubs must be greater than 33%.	
Dwarf-shrub diversity	
! At least two dwarf-shrub species should be frequent and widespread in the sward. No one dwarf-shrub species should be dominant to the exclusion of all others. Where there is a dominant species one or more species must also be frequent and widespread. Where three or more species are present, but only one is frequent and widespread, the occurrence of the less abundant species may be combined and treated as if they are a single species.	
Graminoid cover	
! Hare's-tail cotton-grass *Eriophorum vaginatum*, purple moor-grass *Molinia caerulea*, deer grass *Scirpus cespitosus*, wavy hair-grass *Deschampsia flexuosa*, heath rush *Juncus squarrosus* or other graminoids should not dominate over dwarf-shrubs. The cover of graminoids should not exceed 50%, unless *Sphagnum* spp are abundant/co-dominant and forming lawns below the graminoids.	
Extent of bare ground or ground covered by algal mats etc.	
! Little or no bare ground, or bare ground carpeted by *Racomitrium lanuginosum*, *Polytrichum* spp, *Campylopus* spp, crust forming lichens or algal mats (found only after widespread and intensive searching) *.	
Erosion features associated with human impacts	
! No erosion, other than very localised instances, associated with human impacts (eg drainage, fires, peat extraction, livestock grazing, recreational activities or military training).	
Active peat extraction	
! Peat extraction absent (areas of cut peat which have revegetated with good mire vegetation which meets the other attributes for favourable vegetation condition may be acceptable).	
Grazing impact	
! Grazing impacts should be light. (An absolute maximum of 5% of the grazing unit may show signs of current moderate or heavy grazing.)	
Indicators of light grazing: * * Field indicators taken from MacDonald *et al* (1998)	! Widespread and abundant flowering of cotton-grasses *Eriophorum* spp. [Note that this indicator may only be reliable in spring.] ! No evidence of encroachment by graminoid species such as *Juncus squarrosus*, *Deschampsia flexuosa* or *Nardus stricta.* ! Upright growth of *Calluna vulgaris.* Bush canopy open, not a tightly packed mass of contorted shoots. Very few or no instances of 'drumstick, topiary or carpet growth forms. ! No obvious grazing of *Calluna vulgaris* or *Vaccinium myrtillus.* Grazed shoots difficult to find without both intensive and extensive searching. ! Little or no signs of grazing of *Erica tetralix*, *Empetrum nigrum* or *Vaccinium vitis-idaea*, if present. ! Little or no evidence of trampling of *Sphagnum* hummocks or carpets. ! At most only very localised occurrence of trampled bare ground, including animal paths and enhanced hagging.

Guidance notes for assessing blanket and upland raised mires

Attribute	Notes	
Bryophyte abundance	!	In many Pennine blanket mires *Sphagna* do not make up as high a proportion of the bryophyte component as they do in more northern and western mires. In these Pennine mires, other mosses, particularly pleurocarpous or 'feather mosses' (see *Calluna* Dry Heath guidance notes and Figure IN1.1b), can make up a significant proportion of to the bryophyte layer. These mires will be favourable, provided that bryophytes as a group are abundant and that *Sphagnum* spp are at least frequent and widespread throughout the mire vegetation. The presence of Sphagna indicates that these mires are still active in that they are forming peat.
	!	Note that patches of *Polytrichum* spp, *Campylopus* spp (see *Calluna* dry heath guidance notes and Figure IN1.1b) and *Racomitrium lanuginosum* which have colonised bare ground resulting from hot fires do not count towards the bryophyte abundance for this attribute. Note, however, that *Racomitrium* can be present on hummocks within the mire and in this situation it will contribute to bryophyte abundance.
Dwarf-shrub cover	!	In wetter mires dwarf-shrub cover may be reduced owing to the reduced vigour of these species in these conditions. This does not detract from the favourability of a mire, provided that there is high cover of *Sphagnum* mosses. Indeed high *Sphagnum* cover is of greater importance than high dwarf-shrub cover in blanket and raised mires.
Dwarf-shrub diversity	!	See *Calluna* dry heath guidance notes, but note that both *Empetrum nigrum* and *Erica tetralix* can be locally dominant.
Graminoid cover	!	Generally graminoids (plants that are grass-like - see wet heath guidance notes) should not be the dominant component of mire vegetation. However, in very wet mires, where there is a high cover of *Sphagnum* this is allowable as dwarf-shrub vigour will be greatly reduced by waterlogging.
Extent of bare ground	!	This refers to bare ground resulting from fires, rather than erosion, although fire can lead to erosion as well (see below).
	!	While there are examples of blanket mires in favourable condition which are burnt; hot fires can, particularly at high altitude (500 m+), result in loss of mire vegetation and its replacement either by bare ground or ground covered by colonisers of bare peat such as those listed.
Erosion associated with human impacts	!	Erosion is a natural feature of blanket mires, particularly marginal fretting on breaks of slope. However, where natural erosion is exacerbated by human impacts such as heavy livestock grazing impacts; or where erosion is the direct result of human impacts, such as loss of vegetation cover following overly hot fires or use of

Attribute	Notes	
Erosion (continued)		vehicles, the mire will not be in favourable condition, except where such erosion is very localised in nature.
Active peat extraction	!	Current active peat extraction is uncommon on blanket mires and upland raised mires, but examples do exist. All current examples of this practice, together with examples of abandoned peat workings which have not recolonised with mire vegetation that meets the other attributes for favourable vegetation condition will be unfavourable.
Grazing impacts: General	!	See *Calluna* dry heath guidance notes for general comments on grazing indicators.
Flowering of *Eriophorum* spp	!	This indicator is only reliable in spring and early summer, during the cotton-grass *Eriophorum* flowering season. At other times of year flowers may be inconspicuous.
Encroachment by graminoids	!	Species such as *Nardus, Deschampsia flexuosa* or *Juncus squarrosus* tend to have low abundance and cover in mire vegetation in favourable condition. However, they can become more prominent in mire vegetation when it is subject to high grazing impacts over a long period of time.
	!	Widely scattered individual plants of these species may be acceptable, but areas where they are frequent or abundant, except on the very margins of a mire, will be unfavourable.
	!	These species may also become more prominent in mires which are drying out.
Frequency of grazing induced *Calluna* growth forms	!	See *Calluna* dry heath guidance notes.
Conspicuousness of grazing on dwarf-shrubs	!	Where grazing is having a moderate or heavy impact on the vegetation grazed dwarf-shrub shoots will be easy to find. Of particular importance is grazing during the summer or removal of older woody material as opposed to the most recent year's growth (see *Calluna* dry heath guidance notes).
	!	Blanket and raised mires are generally avoided by livestock if more palatable vegetation is available.
Trampling damage to *Sphagnum*	!	Look for hoof prints in areas of *Sphagnum*, broken surfaces on hummocks and lawns and loose, bleached *Sphagnum* plants or parts of plants.
Presence of trampled bare ground	!	Look for hoof prints in bare peat.

Grading unfavourable blanket mire

Table IN1.11. Blanket mire
Vegetation condition grading system (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1 point**	**2 points**	**4 points**
Bryophyte abundance	abundant, including frequent & widespread *Sphagnum* spp	frequent to abundant but *Sphagnum* spp occasional - rare	occasional, *Sphagnum* spp more-or-less absent	rare
Dwarf-shrub cover	>33% except in wetter areas	<33% except in wetter areas	<5%	
Dwarf-shrub diversity	2 or more spp widespread & frequent	no more than 1 spp widespread & frequent		
Graminoid cover	<50%	51-75%	>75%	
Extent of bare ground or ground covered by algal mats etc	none	present	extensive	ubiquitous
Erosion features associated with human impacts	none	present	extensive	ubiquitous
Active peat extraction (excluding areas revegetated with mire spp)	none	present	extensive	ubiquitous
Grazing impact	light	moderate	heavy	

ENGLISH NATURE

Upland vegetation condition assessment **Field record card**

Site Name:		Grid/square reference:		Date:	

Management unit: Surveyor:

BLANKET & UPLAND RAISED MIRE Is this card for a whole management unit, raster square or facet?

ATTRIBUTES AND TARGETS:	**pass** (✓)		(circle)			
Bryophytes abundant, inc. frequent & widespread *Sphagnum*		Bryophyte/ *Sphagnum* cover	Bryos A Sph F & W	Bryos F/A Sph R/O	Bryos O Sph R/abs	Bryos R Sph abs
Dwarf-shrub cover >33% except where *Sphagnum* abundant & forming carpets		Dwarf-shrub cover	>33%	5-33%	<5%	
At least 1 dwarf-shrub species other than the dominant species frequent & widespread		Species present & their abundance (DAFOR):	Y / N			
Total cover of graminoids <50% unless *Sphagnum* abundant/ co-dominant & forming lawns beneath		Cover of graminoids	<50%	>50%	>75%	
Little or no bare ground, or ground covered by *Racomitrium lanuginosum, Polytrichum* spp, *Campylopus* spp, crust forming lichens or algal mats*		Cover of bare ground etc.	none	pres^{nt}	extens.	ubiq.
No erosion assoc. with human impacts (other than very localised impacts)		Extent of bare peat	none	pres^{nt}	extens.	ubiq.
No active peat extraction (Old works reveg. with mire spp are OK)		Extent of peat extraction	none	pres^{nt}	extens.	ubiq.
Grazing impact		Impact:	Light	Moderate	Heavy	

GRAZING IMPACTS*:

Indicator	**Impact level** (circle indicators & overall impact) **Light**	**Moderate**	**Heavy**
Amount of flowering of *Eriophorum* spp	widespread & abundant	patchy or thinly scattered	inconspicuous/absent
Encroachment by *Juncus squarrosus, Deschampsia flexuosa* or *Nardus stricta*	hard to find	localised	widespread
Frequency of grazing induced *Calluna* growth forms ('drumstick', 'topiary' or 'carpet')	hard to find	localised	widespread
Conspicuousness of grazing on *Calluna* & *Vaccinium myrtillus*	hard to find	Grazed shoots easy to find (may be patchy)	
Signs of grazing of *Empetrum nigrum, Vaccinium vitis-idaea* or *Nardus stricta*, where species present	hard to find		some
Trampling damage to *Sphagnum* hummocks or carpets	hard to find	localised	widespread
Presence of trampled bare ground, paths & enhanced hagging	hard to find	localised	conspicuous & extensive

Vegetation condition (✓) Favourable | Unfavourable

Outlook:

[briefly outline your assessment of the short, medium and long-term outlook for the area you have assessed and give reasons]

Land-use & management

Grazers (✓)	sheep	cattle	deer	rabbits	grouse
				horses	other

Stock feeding points present? Y / N

Drainage (✓)	None	Inactive (blocked)	Active

Erosion (✓)	sheep/deer scars	sheet	gully	other

Burning (✓)	Absent	Controlled	Uncontrolled

Native trees & shrubs:	None	Local	Widespread	Species:	

Non-native trees & shrubs:	None	Local	Widespread	Species:	

Age structure:

Calluna regenerating by layering? Y / N (If yes count layering areas as late mature/degenerate)

	Pioneer & newly burnt (<10 cm)	Building & early mature (10-25 cm)	Late mature & degenerate (>25 cm)
% cover of *Calluna* growth phases:			

Burn patch size	**small (<2 ha)**	**medium (2-5 ha)**	**large (>5 ha)**	**no evidence of being in a burning rotation**
None, Local, Widespread?:	L / W	L / W	L / W	L / W

* Field indicators taken from MacDonald *et al* (1998) *A Guide to Upland Habitats. Surveying Land Management Impacts*. Vol. 2

Montane moss and lichen heath

Habitat definition

Montane vegetation occurs above the natural tree line. This limit varies regionally according to climatic conditions but is generally taken to be around 600 m. However, local climatic conditions may lead to considerable variation between individual hills.

There is inevitably a gradation between sub-montane and montane heath. As a general guide, the two habitats can be distinguished floristically by the replacement of pleurocarpous or feather mosses (see *Calluna* dry heath guidance notes), such as *Hypnum jutlandicum* and *Pleurozium schreberi*, by species such as woolly hair moss *Racomitrium lanuginosum* and *Polytrichum alpinum*. Stiff sedge *Carex bigelowii*, *Racomitrium* or "bushy" lichens, notably *Cladonia arbuscula* and *C. impexa* (see *Calluna* dry heath guidance notes), form a significant part of the vegetation in montane heath. Dwarf-shrubs are represented by bilberry *Vaccinium myrtillus*, cowberry *V. vitis-idaea* and crowberry *Empetrum nigrum* but heather *Calluna vulgaris*, cross-leaved heath *Erica tetralix* and bell heather *E. cinerea* tend to be absent (note that the general absence of *Calluna* from this type of vegetation in England is probably grazing induced rather than climatic).

Grassland with wavy hair-grass *Deschampsia flexuosa*, sheep's fescue *Festuca ovina* or common bent *Agrostis capillaris* over the altitudinal limits above should be assessed as montane heath unless there are strong indications that sub-montane attributes should apply.

Montane heath has been identified on Lake District peaks, the North Pennines and Cheviots and may be present elsewhere, particularly in the Yorkshire Dales. Although much of the land above 600 m is likely to be blanket mire over the southern Pennines and Dartmoor, some summits may support grasslands on mineral soils and, where such stands are encountered, they should be assessed as montane heath.

Table IN1.12. NVC communities covered by upland vegetation condition assessment Montane moss and lichen heath	
U10	*Carex bigelowii-Racomitrium lanuginosum* moss-heath
H19	*Vaccinium myrtillus-Cladonia arbuscula* lichen-heath

Exclusions

Areas of peat deeper than 0.5 m above these altitudinal limits should be assessed as blanket mire (see also definition of sub-montane dry dwarf-shrub heath).

Table IN1.13. Montane moss and lichen heaths **Attributes and targets for favourable vegetation condition** (for vegetation to be favourable all targets listed below must be met)	
Cover of *Racomitrium* ! In *Carex bigelowii-Racomitrium lanuginosum* moss-heath the cover of *Racomitrium* should exceed 66% over the whole stand.	
Mean depth of moss / lichen / dwarf-shrub mat ! Mean depth of moss / lichen / dwarf-shrub mat, should exceed 5 cm in *Carex bigelowii-Racomitrium lanuginosum* moss-heath.	
Cover of *Cladonia* spp ! In *Vaccinium myrtillus-Cladonia arbuscula* lichen-heath 'bushy' *Cladonia* lichens (eg *C. impexa, C. arbuscula, C. uncialis* and *C. rangiferina*) should contribute >50% of the vegetation cover over the whole stand.	
Mean depth of moss / lichen / dwarf-shrub mat ! Mean depth of moss / lichen / dwarf-shrub mat, should exceed 7 cm in *Vaccinium myrtillus-Cladonia arbuscula* lichen-heath.	
Grazing impact ! Grazing impacts should be light.	
Indicators of light grazing: * * Field indicators taken from MacDonald *et al* (1998)	! No signs of grazing of any dwarf-shrubs present. ! Very little or no signs of grazing of plant parts, except on leaves of *Carex bigelowii* or fine-leaved grasses such as *Deschampsia flexuosa, Festuca ovina* and *F. vivipara* and then less than 10% of green leaves grazed (grazed leaves hard to find after intensive and extensive searching). ! Very little or no signs of grazing on leaves of broad-leaved grasses such as *Agrostis capillaris, A. vinealis, Anthoxanthum odoratum* or *Poa* spp. ! Fine-leaved grasses such as *Deschampsia flexuosa, Festuca ovina* and *F. vivipara* contribute less than 10% of the vegetation cover in total. ! Negligible collective cover of broad-leaved grasses such as *Agrostis capillaris, A. vinealis, Anthoxanthum odoratum* or *Poa* spp. ! No more than sporadic occurrence of either *Galium saxatile* or *Potentilla erecta.* (Where grazing intensity has been heavy in past but has now been reduced to favourable levels these two species may be present at more than negligible ground cover but other indicators will suggest light grazing.) ! *Juncus squarrosus* absent or very scarce. ! No uprooting of plants. ! Dung of grazing animals sparse or absent - fewer than five groups of sheep pellets per 100 m².

Guidance notes for assessing montane moss and lichen heath

Attribute	Notes
Cover of *Racomitrium* and bushy *Cladonia*	! Either *Racomitrium lanuginosum* or bushy *Cladonia* lichens (see *Calluna* dry heath guidance notes and Figure IN1.1a) must form a major part of the ground cover for the vegetation to be in favourable condition.
Mean depth of moss / lichen / dwarf-shrub mat	! The minimum depths for favourable condition are based on the mean vegetation heights recorded in the NVC data for the two communities (Rodwell 1991 and 1992) and lie in the upper range of vegetation heights recorded in a survey of Lake District montane heath (Jerram 1992). ! Depth should be recorded by measuring the vertical distance a pencil, finger or ruler can be inserted into the vegetation mat until the ground is met. Exclude grass flower spikes from the depth measurement.
Grazing impacts: General	! See *Calluna* dry heath guidance notes for general comments on grazing indicators, but note that only light and heavy impacts are distinguished in montane heath.
Grazing of dwarf-shrubs, if present	! Where heavy grazing occurs evidence of grazing of dwarf-shrubs (see *Calluna* dry heath guidance notes) will be noticeable, but may not necessarily be conspicuous. However, where the grazing impact is light such evidence will be very difficult to find.
Grazing of sedges and fine-leaved grasses	! Where heavy grazing occurs evidence of grazing of species such as *Carex bigelowii, Deschampsia flexuosa* and *Festuca ovina/vivipara* will be easily seen. But where the grazing impact is light there will be little or no signs of grazing of green leaves.
Grazing of broad-leaved grasses, where present	! When present these species will be preferentially grazed as they are more palatable than other species. The principal broad-leaved grasses involved are common bent *Agrostis capillaris,* brown bent *A. vinealis,* sweet vernal-grass *Anthoxanthum odoratum* and meadow grasses *Poa* spp.
Cover of *Galium* and *Potentilla*	! The presence of either of these species indicates that heavy grazing has been present for many years. These species are not a natural component of this vegetation type.
Collective cover of fine-leaved grasses	! High cover (>10%) of these species (see above) indicates that heavy grazing has been present for many years. Although a natural component of the vegetation they generally only occur at low cover under light grazing levels.
Collective cover of broad-leaved grasses	! These species are not a natural component of this vegetation type. The presence of any of these species at abundances of anything other than very occasional indicates that heavy grazing has been present for many years.
Presence of *Juncus squarrosus*	! *Juncus squarrosus* is not normally a component of montane vegetation, but it may become frequent under chronic heavy grazing where there are shallow peat deposits, and it can spread into mineral soils.
Uprooting of plants	! Uprooted plants both of grasses and dwarf-shrubs lying on the ground are a good indicator of current grazing.
Frequency of sheep dung pellet groups	! The threshold density applies to pellet groups not individual pellets. A dung pellet group is an aggregation of more than six individual pellets.

Grading unfavourable montane moss and lichen heath

Table IN1.14 ***Carex bigelowii–Racomitrium lanuginosum*** **montane heath Vegetation condition grading system** (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1point**	**2 points**	**4 points**
Cover of *Racomitrium*	>66%	33-66%	5-33%	<5%
Mean depth of moss / lichen / dwarf-shrub mat	>5 cm	2.5-5 cm	<2.5 cm	
Grazing impact	light		heavy	

Table IN1.15 ***Vaccinium myrtillus-Cladonia arbuscula*** **montane heath Vegetation condition grading system** (see Box IN1.2)

Attribute	Favourable scores	Unfavourable scores		
	0 points	**1 point**	**2 points**	**4 points**
Cover of *Cladonia* spp	>50%	25-50%	5-25%	<5%
Mean depth of moss / lichen / dwarf-shrub mat	>7 cm	2.5-7 cm	<2.5 cm	
Grazing impact	light		heavy	

ENGLISH NATURE

Upland Vegetation Condition Assessment **Field record card**

Site Name: | Grid/square reference: | Date:

Management unit: | Surveyor:

MONTANE MOSS AND LICHEN HEATH Is this card for a whole management unit, raster square or facet?

ATTRIBUTES AND TARGETS:

	pass (✓)		(circle)			
(a) *Carex bigelowii-Racomitrium lanuginosum* moss heath						
Racomitrium lanuginosum cover >66%		Cover *Racomitrium*:	>66%	33-66	5-33	<5%
Mean depth of moss/lichen/dwarf-shrub mat >5 cm		Mat depth:	>5 cm	2.5-5	<2.5 cm	
Grazing impact		Impact:	Light	Heavy		
(b) *Vaccinium myrtillus-Cladonia arbuscula* lichen heath						
Cover of 'bushy' *Cladonia* spp. >50%		Cover of *Cladonia* spp:	>50%	25-50	5-25	<5%
Mean depth of moss/lichen/dwarf-shrub mat >7 cm		Mat depth:	>7cm	2.5-7	<2.5cm	
Grazing impact		Impact:	Light	Heavy		

GRAZING IMPACTS*

Indicator	**Impact level** (circle indicators & overall impact) **Light**	**Heavy**
Grazing of any dwarf-shrubs present	hard to find	noticeable
Grazing of sedge and grass leaves	< 10%	> 10%
Grazing of broad-leaved grass leaves, when species present	infrequent	most
Cover of *Galium saxatile* & *Potentilla erecta*	< 10%	> 10%
Collective cover of fine-leaved grasses	< 10%	> 10%
Collective cover of broad-leaved grasses	hard to find	widespread
Presence of *Juncus squarrosus*	hard to find	widespread
Uprooting of plants	hard to find	noticeable
Frequency of sheep dung pellet groups	<5/100 m²	>5/100 m²

Vegetation condition (✓) | Favourable | Unfavourable |

Outlook:

[briefly outline your assessment of the short, medium and long-term outlook for the area you have assessed and give reasons]

Land-use & management

Grazers (✓) | sheep | cattle | deer | rabbits | grouse | horses | other |

Stock feeding points present?

Erosion (cause ✓) | Absent | Paths | Grazing | other |

Burning (✓) | Absent | Controlled | Uncontrolled |

Burn patch size	small (<2 ha)	medium (2-5 ha)	large (>5 ha)	no evidence of being in a burning rotation
None, Local, Widespread?:	L / W	L / W	L / W	L / W

* Field indicators taken from MacDonald *et al* (1998) *A Guide to Upland Habitats. Surveying Land Management Impacts.* Vol. 2

Field survey techniques

This assessment technique can be applied at several levels of detail. Which method is used will be determined by the amount of detail required and the resources available:

1. The walk-over survey method will provide a general overview of vegetation condition on a site;

2. The raster and facet methods both divide the site up into survey units, across which vegetation condition is averaged out. This avoids the need to record every stand of vegetation and will provide quite detailed information as to how management impacts vary across the site, although some small scale detail may be lost.

1. Field method for a quick walk-over survey

(time required: half a day to one day)

To assess the condition of vegetation for an area of land using these attributes and targets, a minimum of 20% of both the management unit and the habitat within that unit must be covered on foot by doing a 'W-walk' over the site. An assessment of vegetation condition should be made in at least 10 randomly located points along the walk in the main habitat present and at five points in any subsidiary habitats (Figure IN1.4). Where habitats cover similar proportions of the square ten stops should be made in each habitat. It is important that both the core area of the unit / habitat and the margins of the unit / habitat are covered during the assessment walk as impacts are likely to differ across the site. To take this into account, the assessor must cover both 20% of the unit margin and 20% of the core area of the unit.

When a baseline (first) assessment is being made using this method the route walked should be recorded as accurately as possible on a 1:25,000 scale map or larger. Subsequent assessments must follow the same route if the method is to be used as a monitoring tool to indicate broad changes in structure and vegetation composition.

Prior to making an assessment of a habitat, it is necessary to define the extent of the habitat in the unit as shown in Box IN1.3.

2. Methods for more detailed site/management unit surveys

(time required: one to many days - survey rate: 4 km² per day)

Both nature conservation bodies and land managers often wish to assess how the impacts of various land management practices vary across a management unit prior to formulating management prescriptions. On moorland sites in the past, this has frequently involved undertaking a Heather Condition Survey, which maps burning patterns and grazing impacts (Bardgett, Marsden & Howard 1995). The attributes presented here for assessing vegetation condition can be used in a similar manner, particularly if the attributes on which stands, or parts of stands, classified as unfavourable are mapped as well, rather than simply mapping which areas meet the attributes for favourable vegetation condition. Maps of vegetation condition will not only help to target management action but will also aid the zoning of moors where there are potential conflicts between nature conservation objectives. For example, golden plover require short vegetation to breed, but maintaining high proportions of short vegetation can usually involve burning at a frequency that is too high to maintain a botanically diverse sward.

Box IN1.3. Defining the extent of the habitat	
The following definitions of extent are broad so that they will incorporate the marginal areas of the habitats. It is in these marginal areas where change in condition is most likely to occur, so it is essential that these areas are included in any assessment.	
Dry and wet heaths:	For both these habitats the heath to be assessed will include all heath and acid grassland where the abundance of dwarf-shrubs is more than occasional. Areas of acid grassland where dwarf-shrub abundance is more than occasional can be disregarded for the purposes of assessing heath for a walkover assessment but for whole site/unit surveys they should be mapped as the appropriate heath in unfavourable condition.
Blanket and upland raised mires:	The area to be assessed includes the whole of the main peat body plus any satellite areas of deep peat. Any grassland or heath between the main peat body and these satellites should be included in the assessment area.
Montane heath:	The assessment area should include all the heath and grassland above the tree line in the unit.

Modifications to vegetation condition attributes required to facilitate site/management unit surveys

Several of the attributes and targets as defined above require assessments to be made taking into account whole management units. These are inappropriate for surveys designed to map variation in vegetation condition across a management unit and modifications are required:

All habitats:

! Attributes and targets should refer to the stand, square or facet being assessed not the management unit;

! Grazing impacts must be assessed for each stand (or parts of larger stands), square or facet and the allowance for 5% of the assessment area to be either moderately heavily or heavily grazed is dropped.

Dry and wet heaths:

! The percentage cover of each age class in the stand, square or facet should be recorded so that the age class attributes can be assessed for the site as a whole once the survey is completed.

Methodology

Two potential methods for mapping vegetation condition are considered here.

2a. Raster mapping

The area to be surveyed is divided into a series of squares based on the National Grid. 25 ha (5 km²) squares have been used by Scottish Natural Heritage for surveys using their field indicators (MacDonald *et al* 1998) and by English Nature staff testing this English Nature assessment methodology. This allows for increased coverage rates in comparison to recording every stand, while still retaining a sufficient level of detail to pick out local variation of impacts. Imposing a fixed grid for recording acts as a filter and helps to reduce the amount of between observer variability which all field survey is prone to. English Nature staff found that the maximum coverage rate using this method was four square kilometres per day per surveyor.

A 'W-walk' is made through each square and an overall assessment of the vegetation condition (favourable or unfavourable) is made for each habitat within the square. An assessment of vegetation condition should be made in at least ten randomly located points along the walk in the main habitat present in the square and at five points in any subsidiary habitats. Where habitats cover similar proportions of the square ten stops should be made in each habitat (Figure IN1.4). A minimum of 20% of both the square and each habitat present in the square must be walked through, including both core areas and the margins of stands of habitats present. When making the overall assessment, it is important not to give undue weight to small, local patches of an impact. The assessment should be based on the proportion of the habitat over which that condition occurs, not the proportion of the square with the condition. Habitats should be recorded only where they constitute more than 10% of the total area of a sample square. Likewise, where a sample square extends beyond the site boundary, it should be recorded only if more than 10% of the square lies within the site. Again, the attributes on which any unfavourable squares fail are also recorded. Recording can be done simply on to a map, but a considerable amount of additional information on the vegetation in each square can be collected if standardised record cards, such as those included in this information pack, are completed for each habitat present in each square surveyed.

Results can be presented as a habitat map with overlays of vegetation condition for each habitat present. The use of record cards is strongly recommended as it allows comparisons to be made if further surveys are carried out in subsequent years and facilitates input of survey data into a Geographical Information System (GIS) computer mapping / database programme. If data are entered into a GIS then further data analysis can be carried out as it is a relatively simple task to produce maps showing the distribution of particular impacts, light, moderate and heavy grazing for example, or the distribution of other features recorded, such as bryophyte abundance, or the distribution of active drains on a blanket mire.

2b Facet mapping

The Northern Ireland Environment and Heritage Service have used a modified version of the raster technique for a monitoring exercise in a large upland site in 1997. The main modifications to the raster technique are:

The survey area is subdivided into 'facets' (physical units that have been identified from aerial photographs) usually on the basis of physical features such as rivers or breaks in slope which are readily identified in the field. Facet size can vary from 40 to 100 ha.

The variability of the vegetation in a facet is assessed prior to the field visit using aerial photographs. The route the surveyor is to walk through each facet is drawn onto the map or aerial photograph so that it takes the surveyor through the full range of vegetation types and conditions present in the facet.

A minimum of 20% of both the facet and each habitat present in the facet must be walked through including core areas of the facet / habitat and the margins of the facet / habitat.

Periodic stops are made throughout the walk through the facet to assess the attributes on the relevant recording card in a 10 × 10 m quadrat. At least 20 such stops should be made for the dominant habitat in the facet and between five to 10 stops for other habitats present.

The area of each facet must be measured before calculations can be made to assess whether the age structure attributes for dry and wet heaths are met.

The record cards used here to record vegetation condition in each habitat are the same as for the raster sampling technique. However, an additional record card for each habitat is required to record the quadrat data and surveyors also completed a summary card for each facet which recorded estimates of the area of the facet covered by each habitat and general comments on its management and vegetation condition. Again, the information recorded can be entered into a GIS database and presented as a map or series of maps.

The pros and cons of each sampling technique

Both sampling techniques can provide maps showing the range of vegetation condition by habitat across a site. The facet method will provide assessments related to recognisable geographical / vegetation units while the raster method provides an overview of the site as a whole which cannot be directly related to individual stands of vegetation.

The facet method has the higher degree of repeatability for monitoring purposes, as it has the most easily identifiable sample unit boundaries in the field. Determining where the edge of a sample raster grid square can be difficult on featureless terrain. While this may not be particularly important in some instances, where this vegetation condition survey method is used as a regular monitoring technique an error of one or two hundred metres could change the grading of an attribute simply by including or excluding a stand which had been critical to a previous assessment. This problem could be alleviated by the use of a Global Positioning System (GPS) in the field.

In terms of data input to GIS databases, the production of maps and subsequent analysis, the raster method may have the advantage over the facet method because the use of a grid system and uniform sample sizes allows maps to be generated quickly and simply as data can be displayed using symbols generated from a grid reference. The stand and facet sampling methods will require the drawing of polygons on the map, linked to a grid reference to represent the facets in order to produce a meaningful map.

General guidance on field survey and filling out record cards

- The record cards can be used for any of the three survey methods described. Always specify whether the record card is for a management unit, raster unit (0.25 km² grid square) or facet.

- All sections should be completed so that the maximum amount of data is collected from a site visit.

- Borderline situations should always be placed in the lower (less favourable) category; ie the vegetation should be considered to fail to meet an attribute if there is doubt.

- Always fill out the grading box as well as the pass tick box. Circle the appropriate grade level for each attribute.

- For grazing impacts always circle the impact level for each indicator as well as filling in the grading box.

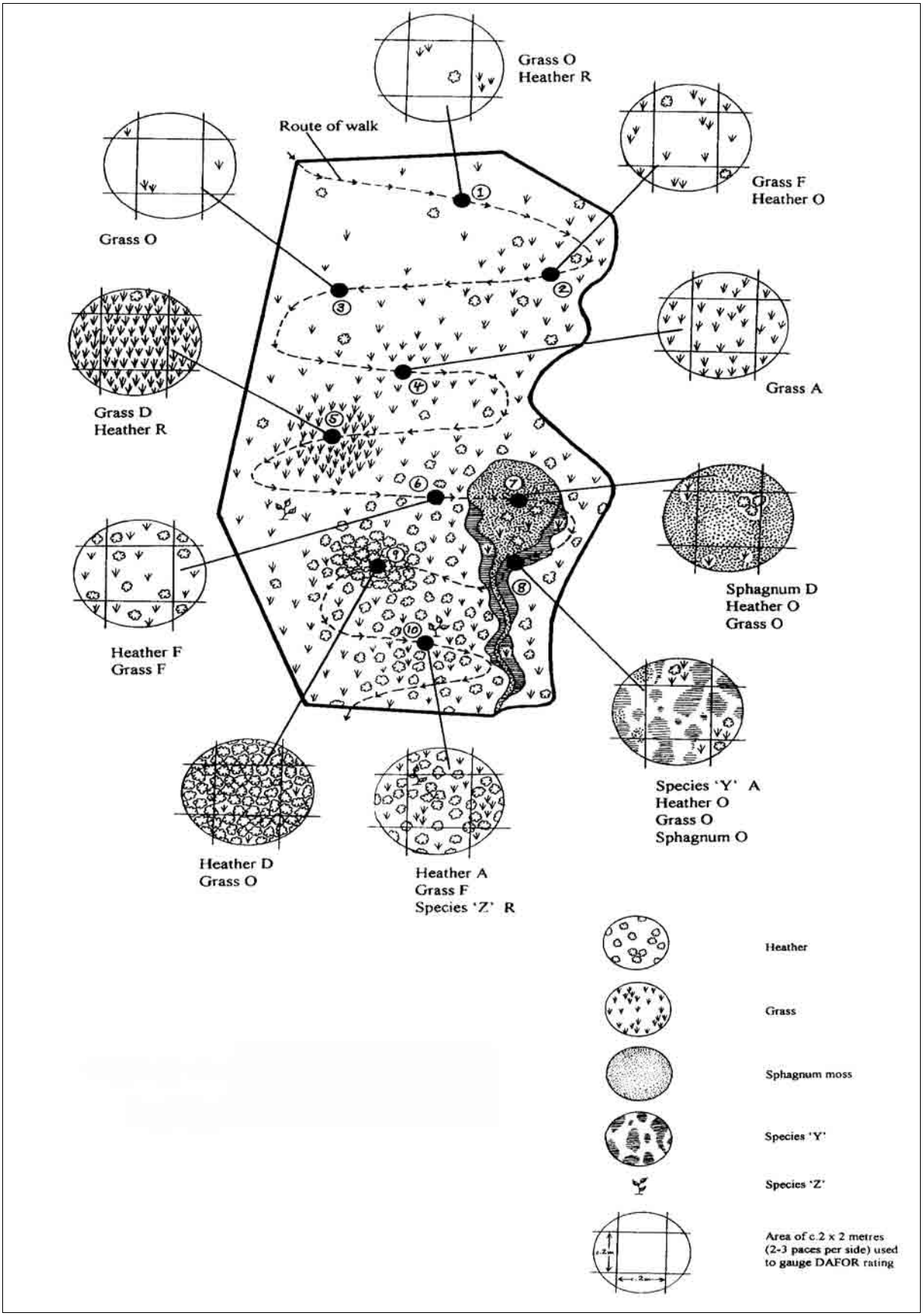


Figure IN1.5 Assessing abundance during a 'W-walk'
Reproduced from Cox, Cooke & Porter (1998)

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Information note 2 Sheep breeds of the English uplands and their characteristics

Introduction

The total sheep flock in England consists of some 19.9 million sheep, of which 7.9 million are breeding ewes (1998 MAFF census). This consists of 73 breeds and 12 recognised crosses. The variety of breeds and crosses can be narrowed down to six main types:

- hardy / hill breeds;
- longwools (for crossing with hill breeds);
- crossbreds;
- lowland meat breeds (terminal sires);
- specialist breeds (eg for milk production and early lambing);
- rare breeds.

The hardy or hill breeds that graze the rough terrain of the UK's uplands account for approximately 50% of the national flock. One of the most important products of the hill farming system is the crossbred ewe, which accounts for a further 40% of the national flock and features highly in the prime lamb producing systems of the more fertile lowland farms. This interaction between upland and lowland practices gives rise to the stratified system on which UK sheep farming is based (see Information Note 3). The uplands role in this system is the breeding of hardy hill ewes with longwool rams to produce crossbred ewes (all males of this resulting generation are reared as slaughter lambs).

Sheep in the uplands

The majority of sheep found in the uplands are from the hill breed, longwool or crossbred categories. Historically, sheep would have stayed relatively local to their breed origins, indicated by their names ie Swaledale, Lleyn, Wensleydale, etc. This is still true to some extent today although examples of the breed will tend to spread throughout the UK as producers seek the particular characteristics exhibited by that breed.

Hill breeds

The main factor differentiating the hill breeds from those found in more lowland areas is the hill breeds ability to thrive in difficult, unfertile terrain, often under prolonged periods of adverse weather and still provide their owners with a live lamb and wool to sell. To do this they have to be hardy, have good mothering instincts and be able to convert rough vegetation and heathland plants into milk to sustain young lambs.

Sheep breeds and nature conservation

The Grazing Animals Project (GAP), involving a partnership of many organisations, will shortly be publishing details of breeds of sheep, cattle, ponies and goats used for nature conservation management.

Badgerface Welsh Mountain

Also known as the Torddu, meaning ›black belly'. Occasionally an individual occurs in which the colour pattern is reversed, which is called the Torwen or ›white belly=. These are varieties of the Welsh Mountain breed and produce good quality purebred and crossbred lambs. Rams are horned and weigh up to 80 kg. Ewes are polled (hornless) and weigh up to 50 kg.

Beulah Speckled Face

Developed over the past century on the hills west of Builth Wells in Mid-Wales. Mature rams and ewes weigh around 86 kg and 52 kg respectively and are larger and less hardy than the Welsh Mountain breed. They also produce a finer fleece than many hill breeds. Beulah ewes are crossed with the Blue-faced Leicester to produce the Welsh Mule.

Blackface

The Blackface evolved to graze the exposed uplands of Scotland and Northern England, particularly the ›black' or heather covered hills. Several distinct types have developed and ewes may be crossed to produce Mules or Greyface lambs. The sheep are hardy and thrifty with a coarse fleece that is much used in the carpet industry. Both sexes are horned and mature rams may weigh as much as 70 kg, the ewes about 55 kg. The ewe population of this breed is one of the largest in the UK.

Brecknock Hill Cheviot

Cheviot sheep were introduced in Breconshire in the mid-nineteenth century. Since then, this hardy breed has adapted to the wet upland and hills of south and west Wales to produce this newer strain of Cheviot. Rams are used to improve the size and quality of native mountain breeds. The rams are usually horned, and may weigh up to 90 kg. Ewes are polled and weigh up to 60 kg.

Cheviot

The breed originated in the Border Hills of southern Scotland but can now be found throughout the world. The rams may be horned or polled and weigh up to 105 kg. The ewes are always polled and weigh up to 60 kg.

Clun Forest

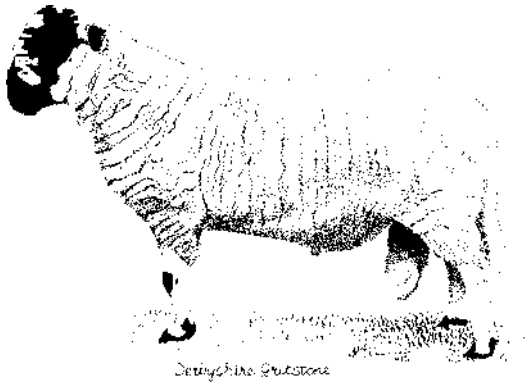
This breed originates in the upland area of southwest Shropshire adjoining the Welsh border. Clun flocks are found at up to 460 m but also thrive in the lowlands of England. Mated with a Border Leicester ram, the Clun ewe produces the English Halfbred. They are a long-lived, productive breed with an average lambing rate of 175%. Rams may weigh up to 90 kg and ewes 65 kg.

Dalesbred

This breed is indigenous to the central area of the Pennine Hills bordering North Yorkshire, Lancashire and Cumbria. In later life the ewes are mated to other breeds to produce Mashams and Mules. The wool is used in tweed and carpet making. Both sexes are horned and the face is black with a white patch on each side of the nostrils. Ewes may weigh up to 60 kg and rams 75 kg.

Derbyshire Gritstone

One of the oldest British hill breeds originating in the Peak District of Derbyshire. They are good rangers and have a weatherproof jacket of wool which is the finest of all grown by Blackface-type sheep. Rams are used to sire polled lambs on other horned hill breeds. Both sexes are polled, the ewes weighing up to 74 kg and the rams 110 kg.

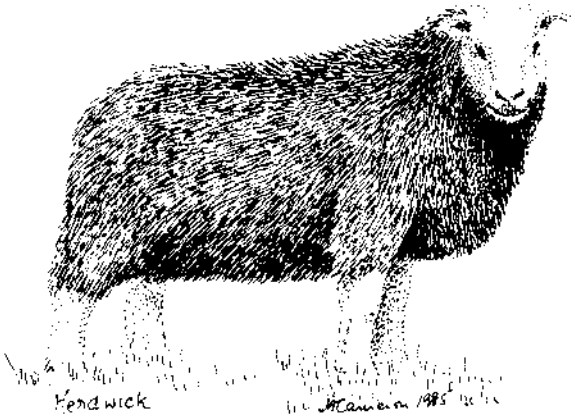


Exmoor Horn

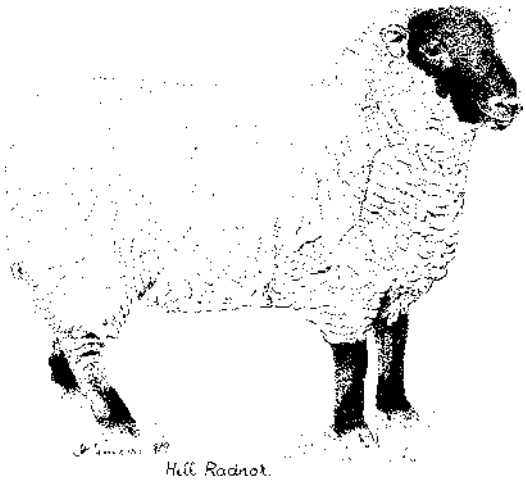
This breed is native to the exposed upland grazings of Exmoor. It produces both a pure and crossbred lamb of high quality. It is also one of the very few hill breeds to produce fine quality wool. Crossing with the Blue-faced Leicester produces the Exmoor Mule. Both sexes are horned; mature rams weigh up to 85 kg and ewes up to 65 kg.

Herdwick

This is Britain's hardiest breed of sheep and is native to the Cumbrian Lake District. The kemp (hair) in the fleece assists in waterproofing. The lambs are born black and the head and legs gradually become white. The fleece lightens to a pale, steel-grey with age. The rams may be horned and weigh around 80 kg. Mature ewes are always polled and weigh about 50 kg.

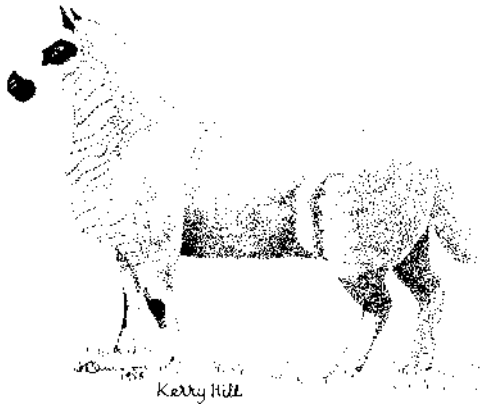


Hill Radnor



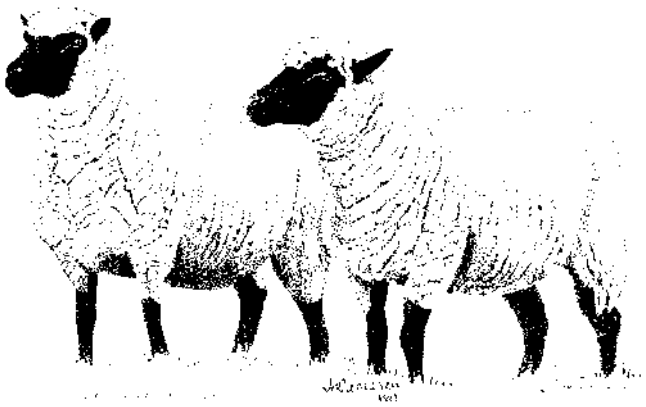
These sheep have a light brown face and legs which are free from wool. The breed was developed in Radnorshire and the central region of the Welsh Marches. It is more docile than some of the other hill breeds and its wool is used to produce speciality fabrics. The ewes are polled and weigh around 50 kg. The rams are horned and weigh about 75 kg.

Kerry Hill



This breed from Powys is named after the village of Kerry near Newtown, where the breed has been recorded since 1809. These hardy sheep are adaptable and much used for cross-breeding. Both the sexes are polled and the rams may weigh around 85 kg, with the ewes around 55 kg.

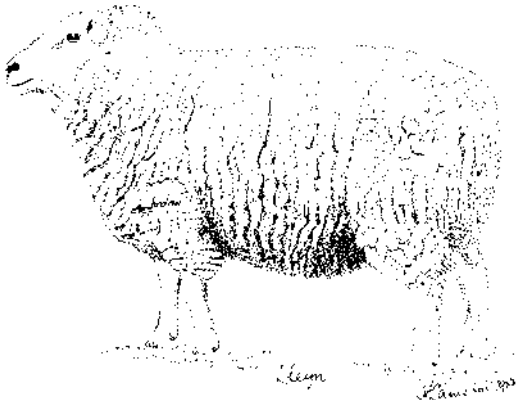
Llanwenog



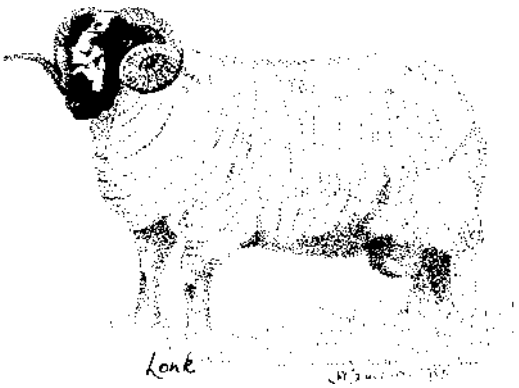
Llanwenogs are a semi-lowland breed with a high lambing percentage. The breed was developed in west Wales at the end of the last century by using Shropshire rams on local sheep and was used as one of the foundation breeds to produce the Cambridge. The head is black with a prominent tuft of wool on the forehead. The wool is considered amongst the finest in the UK. Both sexes are polled, rams weighing around 90 kg and ewes 56 kg.

Lleyn

This breed was developed on the Lleyn Peninsula in North Wales. The ewes are prolific and multiple births are relatively common with lambing percentages regularly above 200%. The sheep and lambs are hardy and well adapted to thrive in the exposed area of the Lleyn Peninsula and in similar conditions. Ewes may be crossed to produce the Welsh Bleu and rams are used to improve the prolifacy and wool quality of other breeds. Both sexes are polled. Mature rams weigh up to 72 kg, ewes to 60 kg.



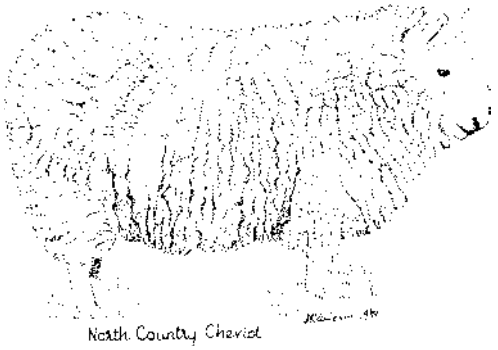
Lonk



This breed, which is one of the largest native hill breeds, originated on the hill ranges of Lancashire and Yorkshire. The sheep are nimble and hardy and can survive in the heather of the exposed Pennines. Lonk rams are used on other hill breeds to produce bigger lambs. Both sexes are horned, with ewes weighing about 50 kg and rams 80 kg.

North Country Cheviot

This is the largest UK upland breed. Developed in the far north of Scotland from the Cheviot, these hardy hill sheep carry a quality fleece and are also ideal for crossing with other breeds. The ewes, crossed with the Border Leicester, produce the famous halfbred. Both sexes are polled. Mature rams weigh up to 100 kg and ewes up to 85 kg.

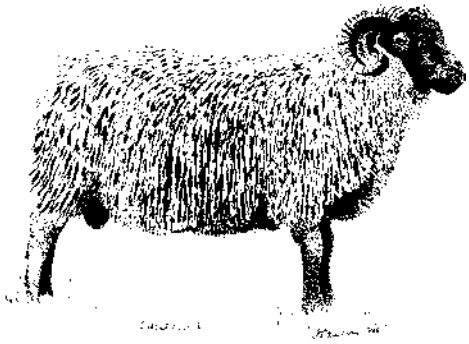


Rough Fell

This is one of the larger bodied mountain breeds. It is particularly hardy and will thrive on the poor grasses and heathers on the moors and fells of Cumbria and the Pennine areas of North Lancashire and Yorkshire. It is exceptionally docile and has a lambing percentage of around 150%. Both sexes are horned. Mature rams weigh around 80 kg and ewes 50 kg.

Shetland

These small sheep formed the basis of the woollen industry of the Shetland Islands. Fleeces occur in a range of colours and the wool is very fine and soft. Ewes are polled and weigh up to 35 kg. Rams are horned and weigh up to 45 kg.



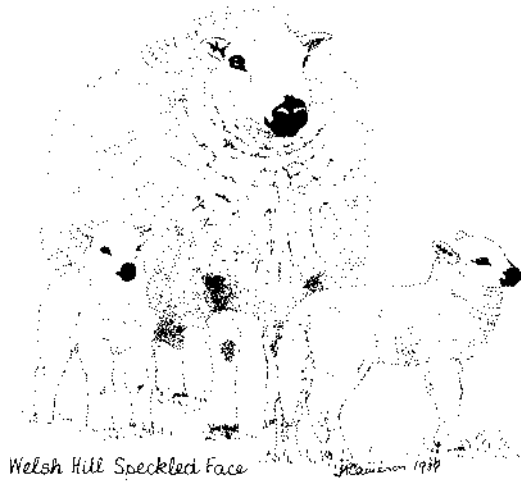
South Wales Mountain

This breed may also be known as the Nelson type of Glamorgan Welsh. The sheep are the largest of the Welsh Mountain breeds and have distinctive tan markings in the face and legs. They are left to range the open hills but have good hefting instincts. The ewes are polled and weigh up to 55 kg. The rams are usually horned and weigh up to 75 kg.

Swaledale

This distinctive breed thrives on the exposed moors of North Yorkshire and other uplands of the north of England. These sheep often produce quality lambs from land unable to support other breeds. The draft ewes are much sought after and when mated with the Teeswater produces the Masham and with the Blue-faced Leicester produces the Mule. Both sexes are horned. Rams may weigh up to 73 kg and ewes 54 kg.

Welsh Hill Speckled Face



This breed originated in the Devils Bridge and Powys Hills area of Mid Wales derived from crossing the Kerry Hill with the Welsh Mountain. The sheep are larger than the traditional Welsh Mountain sheep and the face is distinctly speckled. The Speckled Face has increasingly displaced more traditional hill breeds, especially in North Wales. Crossed with the Blue-faced Leicester, ewes produce the Welsh Mule. Ewes are polled and weigh around 50 kg. The rams may be horned or polled and weigh about 70 kg.

Welsh Mountain

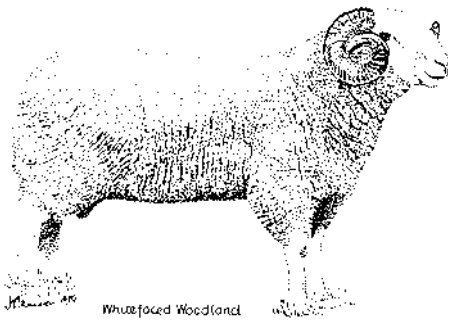
These thrifty and hardy sheep were developed to exploit the available grazing in highland Wales. Welsh Mountain ewes form one of the largest purebred sheep populations in the UK. The rams are horned and may weigh as much as 80 kg. Ewes are polled and weigh about 35 kg, but when moved to lowland grazing may increase in weight by as much as 25%.

Whiteface Dartmoor

These hardy sheep are native to Dartmoor where they graze up to 600 m and the flocks are kept on the Moor from May to December. The sheep used always to be horned, but this feature has tended to disappear, particularly among the ewes. The ewes weigh up to 54 kg and the rams up to 75 kg.

White-faced Woodland

A large hill breed originating in the Pennine Hills of South Yorkshire and Derbyshire. There are two forms: the White-faced Woodland and the Penistone White-faced Woodland. Its remarkably fine wool is likely to be due to the introduction of Merino blood to the breed in the eighteenth century. Rams are frequently used on other hill breeds to improve size and the breed has been spreading to other parts of the UK.



Longwool breeds

The longwool breeds originate from the areas of Britain where the growing conditions of the sloping valley sides are not so harsh as those on the exposed hills. However, the climate is still wet and windy and the sheep are protected by a long warm fleece. As a result of better pasture, they are slightly bigger and will produce more lambs than the breeds on the sparse upland pastures. The ewes have plenty of milk and are able to feed the extra lambs that are born.

Bluefaced Leicester

This breed evolved around Hexham at the beginning of the century. The breed is prolific with lamb crops often exceeding 250%. The rams are crossed with hill ewes to produce the Mule which is valued as the best commercial breeding ewe on the market. The wool of the Bluefaced Leicester is the finest of any native breed. Both sexes are polled. Rams weigh around 115 g and ewes about 80 kg.

Border Leicester

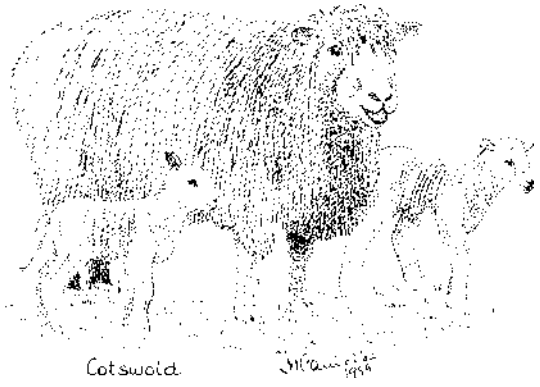
These are direct descendants of Robert Bakewell's Dishley Leicesters which were introduced into Northumberland in 1767. The breed has been recognised as being distinct from Leicesters since the 1850s. Rams crossed with hill breeds produce Halfbreds and the Greyface. The Border Leicester is also used on lowland breeds for early prime lamb production. Both sexes are polled. Mature rams weigh up to 150 kg and ewes to 100 kg.

British Milksheep

This new breed was developed by Lawrence Alderson to produce a crossing ram and a high yield dairy ewe. The ewes are prolific and produce sufficient milk to rear triplets. Both sexes of these white-faced sheep are polled. Mature rams weigh on average 110 kg and ewes around 80 kg.

Cotswold

The native breed of the Cotswolds was improved by crossing with Lincoln and Leicester rams to produce the breed of today. A longwool breed which is now used to produce heavyweight lambs, mature ewes will weigh up to 85 kg and rams may exceed 135 kg. Both sexes are polled.



Dartmoor Greyface

Descended from the original moorland sheep, the Greyface was ›improved' during the last century by crossing with local longwool breeds as well as ›Notts= and Leicester. Dartmoor ewes are generally put to Down or Continental rams to produce early prime lambs. Now a minority breed, it is in danger of extinction. Both sexes are polled. Mature rams weigh up to 102 kg and ewes 68 kg.

Devon and Cornwall Longwool

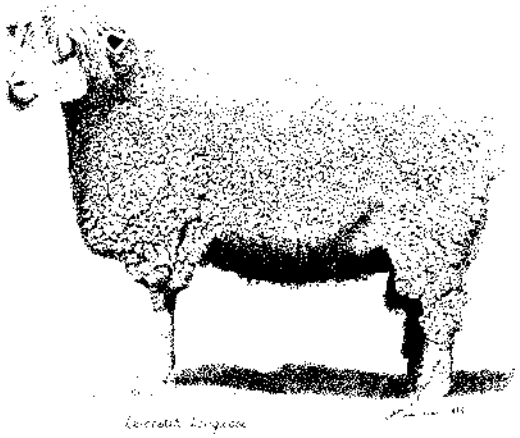
The head and body of this breed are well-covered with long, curly, white wool. The ewes, on grass, will produce 160% lamb crop and the lambs are shorn when 6 months old. Adult fleeces average between 8 and 9 kg but can be up 18 kg. Both sexes are polled. Mature rams weigh 136 kg and ewes 100 kg.

British Friesland

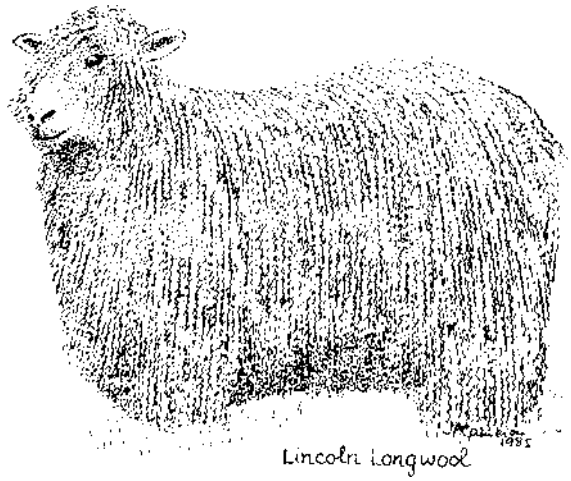
These large-framed sheep originated in Holland and are famous for milk yield and quality, up to 700 litres at 6.5% butterfat. The breed average prolificacy exceeds 240%. Both sexes are polled. Rams weigh an average of 82 kg and ewes 65 kg.

Leicester Longwool

Today's Leicesters are the direct descendants of the Dishley Leicesters developed by Robert Bakewell more than two centuries ago. These large sheep are very hardy and produce a heavy lustrous fleece. Both sexes are polled. The rams weighing an average of 150 kg and the ewes 100 kg.



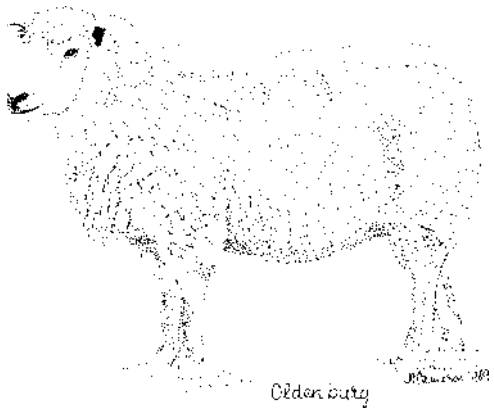
Lincoln Longwool



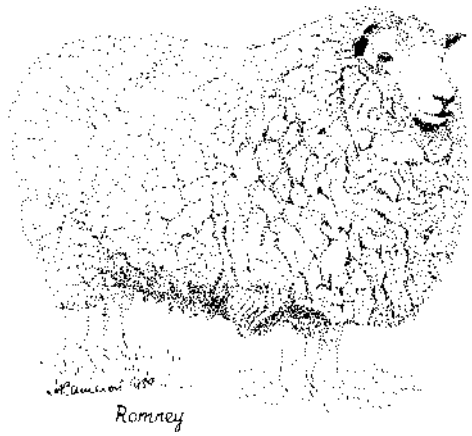
Sheep and wool have been associated with Lincoln City and Shire for very many years. Lincoln sheep were well known by 1750 and it is possible that Robert Bakewell used them in his foundation stock. Both sexes are polled and mature rams weigh around 150 kg and ewes around 85 kg. These sheep have been exported in large numbers to South America, Australia and New Zealand where they have been used to create new wool breeds such as the Corriedale and the Polworth.

British Oldenburg

These docile longwool sheep were first imported to the UK in 1964 from West Germany. The breed was developed on the North Sea Marshes by crossing North German Marsh sheep with local milk sheep and various British longwool sheep, including Cotswolds. The main commercial use of this breed is for crossing with hill breeds such as the Scottish Blackface, the Cheviot and the Swaledale. The resulting half-bred, the Oldenbred, produces prime lamb quickly in both intensive and extensive conditions. Both sexes are polled, ewes weighing around 84 kg and rams 110 kg.



Romney

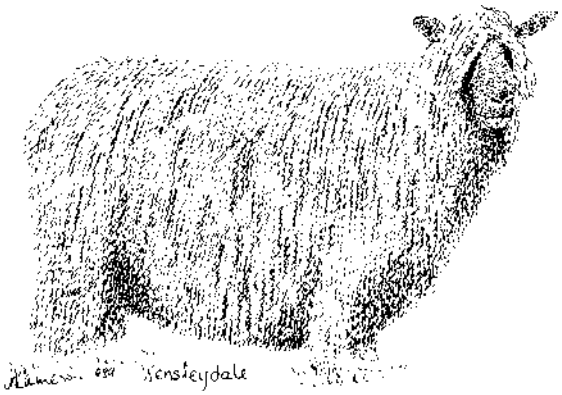


The original Romney Marsh sheep were developed on low lying land along the channel coast of Kent and Sussex. The breed has spread world wide and formed the basis of the sheep industry in New Zealand and other Countries. The Romney ewe is put to the Lleyn ram to produce the Kent Halfbred which is then put to a terminal sire for the prime lamb market. Both sexes are polled and rams weigh up to 100 kg and ewes 72 kg.

Teeswater

These medium size sheep originated in Teesdale. The rams have been used for crossing on Dalesbred, Swaledale, Rough Fell and Scottish Blackface ewes to produce the Masham ewes for commercial lamb production. Both sexes are polled. Rams weigh an average of 100 kg and ewes 80 kg.

Wensleydale



A blue-faced longwool breed producing a fleece with very long staple (up to 30 cm) and weighing up to 5 kg. This breed was developed in North Yorkshire to produce rams for crossing on to hill ewes to produce a breeding ewe (the Masham). The Wensleydale's wool is recognised as the finest lustre longwool. A slow maturing breed, ewes weigh about 113 kg and rams may exceed 136 kg. Both sexes are polled.

Cross breeds (ie mule or halfbred)

These terms are given to recognised first crosses (F1 hybrids) of established breeds as described under the section on stratification in Information Note 3. Usually the term 'mule' is given to a female animal which has been produced by mating a Blue-faced Leicester ram on a hill ewe. The term 'half bred' is given to a similar product which has been produced by using the Border Leicester on a hill ewe. There are also Mashams, Greyfaces and other recognised crosses.

Scottish Greyface

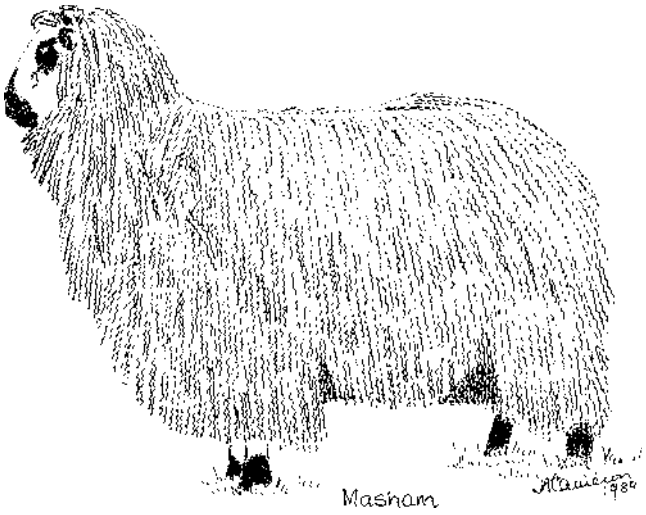
Crossbred ewes are produced by crossing the Border Leicester ram on Blackface ewes.

North of England Mule

Crossbred ewes are produced by crossing the Bluefaced Leicester ram with Swaledale or Blackface ewes.

Masham

Produced by crossing the Teeswater or Wensleydale ram on Dalesbred or Swaledale ewes.



Scottish Half-Bred

Produced by crossing the Border Leicester ram on South or North Country Cheviot ewes.

Welsh Half-Bred

Produced by crossing the Border Leicester ram on Welsh Mountain ewes.

Welsh mule

Welsh mule ewes are produced by crossing Bluefaced Leicester ram on one of three hardy hill breeds - the Welsh Mountain, Welsh Hill Speckled Face or Beulah Speckled Face ewes.

Other cross breeds

Ram	Ewe	Progeny
Border Leicester	Clun Forest	English Halfbred
Blue-faced Leicester	Scottish Blackface	Scottish Mule
Lleyn	Romney	Kent Halfbred
North country Cheviot	Shetland	Shetland-Cheviot
Bleu du Maines	Welsh Mountain Welsh Hill Speckled Face Beulah Speckled Face Lleyn	Welsh Bleu

Hill Farm Allowance Scheme and Specially Qualified Flock

Within Less Favoured Areas, sheep producers can claim the new Hill Farm Allowance (HFA) (which has replaced the Hill Livestock Compensatory Allowance (HLCA)) help maintain extensive livestock systems. Temporary arrangements are in place for 2000-01 and final details of the new scheme were confirmed during 2000. There is an additional sum available to producers who have flocks which meet the ›Specially Qualified Flock‹ requirements. This is limited to flocks of the following breeds:

Balwen
Black Welsh Mountain
Cheviot - All Types
Dalesbred
Derbyshire Gritstone
Exmoor Horn
Gotland
Herdwick
Icelandic
Kerry
Llanidloes
Lonk
Manx Loghtan
Nelson
Radnor
Ronaldsay
Rough Fell
St Kilda (Hebridean)
Scottish Blackface
Shetland
Soay
Speckled Face (Beulah or Welsh Hill)
Swaledale
Torddu
Torwen
Welsh Mountain
Whitefaced Dartmoor
Whitefaced Woodland
Whitefaced Woodland (Penistone)

This information has been derived from *British Sheep* published by the National Sheep Association.

Information note 3

Sheep farming systems of the English uplands

Introduction

Upland sheep farming in England can be classed as two distinct systems; hill / mountain and upland / marginal. Both are extensive systems and differ chiefly in the amount of in-bye land or improved pasture held in the valleys. This determines the numbers and type of stock that the farm can sustain throughout the year. It is difficult to draw distinct boundaries between the two systems as gradation obviously occurs. The sheep flock totals some 19.9 million at peak summer numbers, of which 7.9 million are breeding ewes (1998 MAFF census). Purebred hill ewes account for 50% of the national breeding flock, while crossbred ewes (a product of the hill / upland system) account for a further 40%.

Hill sheep farming

The farm

Traditional hill farming systems occur where little or no fenced or improved in-bye is available around the farm. This is one of the simplest farming systems and is almost entirely based on grass and other native vegetation. True hill farms are confined to northern Scotland, North Wales, the Pennines, the North York Moors, the Lake District and areas of the southwest such as Dartmoor and Exmoor. They possess little or no improved pasture. Often relying totally on sheep, some hill farms may keep a small herd of suckler cows on in-bye land (enclosed pastures).

Climatic conditions are often harsh on the open hillsides with high winds, high rainfall and extreme cold in winter. The available grazing usually consists of agriculturally poor grasslands and areas of dwarf shrubs which can have a low nutritional value. Stocking rates are therefore low and the breeds used must be able to feed on this range of plants and, not only survive, but produce viable offspring in such harsh conditions.

It is often impossible or unfeasible to fence areas of open fell and moorland owing to constraints of land ownership, common land, grazing rights or land use (eg shooting). Stock are often free to roam over wide areas. A hefted flock is therefore necessary to keep stock within a manageable regime. Hefting is where the sheep are acclimatised to, and use a certain area of hillside, knowing the best places to graze and shelter. This hefting instinct aids survival and is passed from ewe to lamb while on the hill. A hefted flock is an important asset to the hill farmer and a flock is usually sold together with the land or grazing rights.

The severe constraint of little in-bye land can be off-set by using buildings to house stock in the winter (although these may have adverse impacts on the landscape) or by the practice of away-wintering ewe lambs. The nutritional value of open fell-side grassland is very poor, especially out of the growing season, with stock relying on taller dwarf shrubs in snowy conditions. Coupled with the severe weather conditions, this is too hard for newly weaned lambs, which are transferred to the in-bye land and either sold as stores or finished for the meat market, depending on how much keep is available. Lack of in-bye, even with housing space, means little conserved fodder (hay or silage) is available and supplementary feed would need to be bought in.

Stock

The mainstay of the hill farming system are the purebred hardy 'hill breeds'. These are often specific to a certain area of the country, as suggested by their names, such as Swaledale, Dalesbred and Welsh Mountain (see Information note 2). These breeds possess hardy characteristics giving them an inherent ability to thrive in the harsh mountain conditions. They are good 'milky' ewes and have strong mothering instincts. They often possess the ability to twin, but this is not usually exploited, owing to the lack of hardiness in the lambs produced. Twins also put a strain on the ewe and when kept on the hill are too small to be commercial in the autumn.

Ewes are put to the ram (tupped) in the late autumn, November / December, and lamb in the late spring from mid-April to May, depending on the breed and location. In harsh conditions, stock may be brought onto in-bye land or to the lower slopes for shelter or possibly supplementary feeding (feed blocks or hay). The sheep will normally be brought down from the hill again only for clipping and dipping in July and the weaning of male lambs in the autumn. To reduce winter grazing some of the ewe lambs (gimmer hoggs) to be used as replacements may be wintered away (tack or agistment) on the more fertile pastures of farms in the lowlands. Winter housing is often cheaper than tacking, if space and capital are available, and housing can be used in addition to tacking. The cost of housing can be partially offset by finishing male (wether) lambs indoors in autumn and then selling them direct to the meat buyer.

Production

Most male lambs (wether hoggs) are sold at the autumn sales to marginal and lowland farms where they will be finished on grass or as store lambs over the winter. Ewes of four to five years old are considered too old for the rough conditions of the hill farm, although they are still healthy. These are sold as draft ewes to the marginal and lowland farms to be bred with 'longwool' rams to produce meatier hardy half-breds or 'mules' (see Information note 2). Some of the ewes may be crossed with lowland meat breeds (eg Texel, Suffolk) to produce fat lambs. Healthy ewe lambs are retained as replacements for the draft ewes, keeping the flock sustainable and maintaining the hefting instinct. Wool production also brings in some income, although the fleece of the hill breeds is not of the best quality.

The low stocking levels, harsh environment and farm size mean that income from traditional hill farming systems is relatively low. To try to preserve hill farming and to stop the movement of people from rural areas, support payments and grant schemes have been made available for farms within the Less Favoured Areas through the Hill Livestock Compensatory Allowance (now replaced by the Hill Farm Allowance Scheme). For hill farming, 45-60% of the gross income per ewe can come from subsidies, the majority of this from the Sheep Annual Premium Scheme (see Chapter 2).

Upland sheep farming

The farm

Usually situated in the valleys of upland areas, these farms will account for the majority of farms in the Less Favoured Areas. As with the hill farm system, the amount and type of stock is often dependent upon the size of in-bye / improved pasture and the availability of buildings. The availability of generally larger areas of in-bye give the farmer a greater flexibility in stocking rates, and dictates the amount of conserved fodder available for over-wintering. The availability of buildings determines the amount of over-wintering store space and accommodation for cattle. As well as in-bye, in-take or allotment which has been land enclosed from the open fell, may be improved, providing land for a more substantial cattle enterprise.

Stock

Marginal farms often keep two flocks of sheep. Hardy hill ewes are run on the open hillside and are made up of hefted flocks of purebred hill breeds, as described above. In addition to these, the older drafted ewes are kept on in-bye land in the valleys, where they are crossed with 'longwool rams' such as Bluefaced Leicester or Border Leicester (see Information note 2). The crossbred progeny of this mating are 'mules' or half-breds. The fast growth rates, prolificacy and larger carcase characteristics of the 'longwool' breeds and the hardiness and good mothering instincts of the hill breeds combine to give a desirable ewe. If good grazing and / or conserved fodder is available in quantity, then the crossbreds may be bred for lowland sheep meat production with large, fast-growing meat breeds of the lowlands and the resulting 'fat lambs' will go to slaughter. A suckler cow or dairy herd will normally be kept as well (see Information note 5).

Production

As with the hill farm, male (wether) lambs will be sold as stores or finished for slaughter. In the marginal system, finishing will usually take place on the farm, which will then benefit from the higher value of finished lambs. 'Mules' or half-bred ewes will normally be sold to lowland farms where they are then crossed with terminal meat sires. If these sires are kept on the marginal farm, the resulting fat lambs will be finished and sold for slaughter. Wool sales will make up a slightly larger proportion of the income than on the hill farms, owing to the higher quality of the wool produced by half-breds, but in percentage terms this is still small. Suckler calves may be sold as store calves or finished on the farm for slaughter if sufficient food is available.

Stratification

All elements of sheep production from the hill farm to the lowlands are linked by the stratification of the sheep industry which is a system unique to the UK. Cross breeding allows for selection of preferable characteristics and enables the optimum use of poor grazing to produce quality meat lambs for both the home and export markets. Figure IN3.1 explains the stratified system.

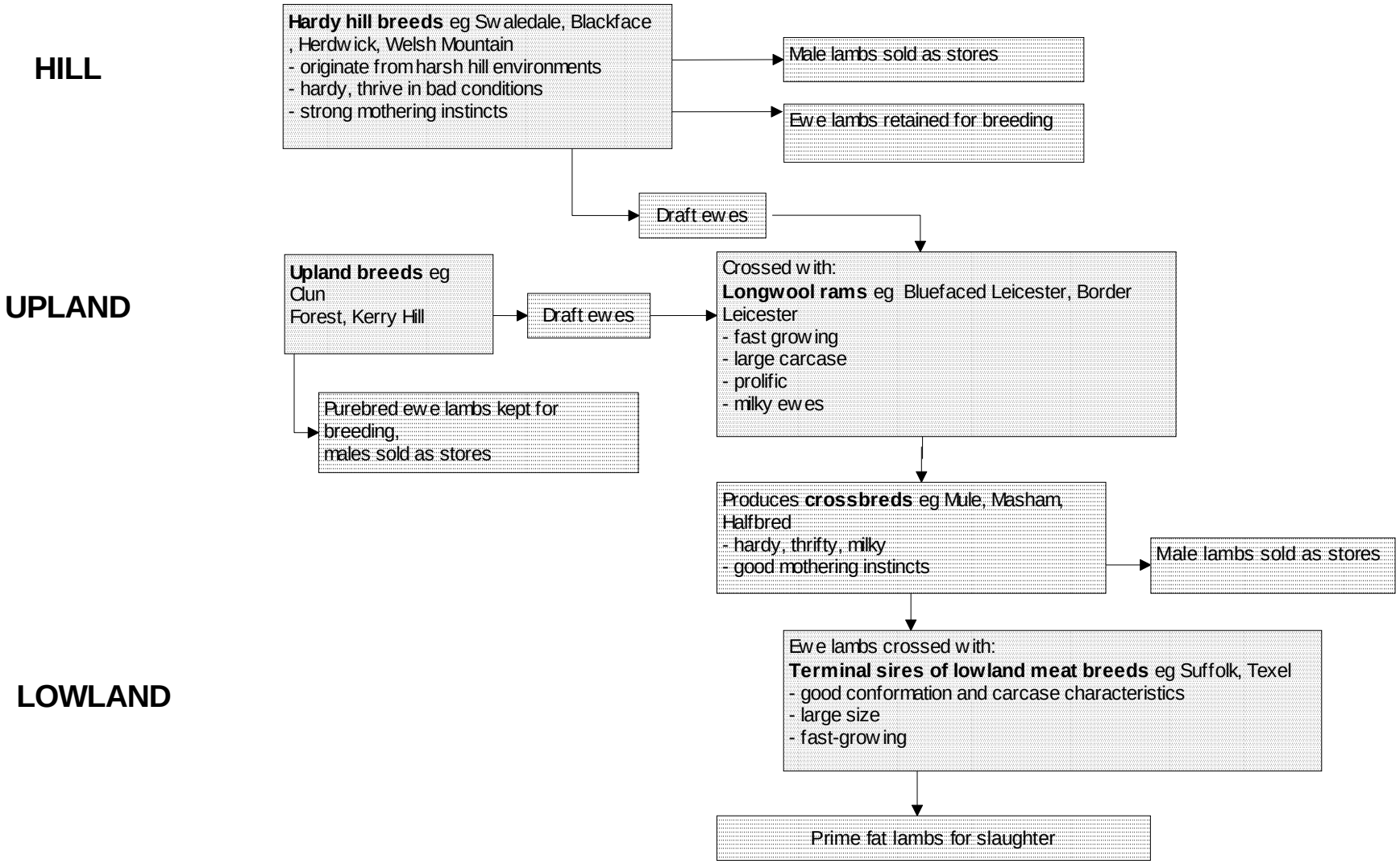


Figure IN3.1 Stratification of the British sheep industry

A typical farming year for hill/upland ewe flocks

Early November:	Draft ewes (4/5-shear and older) mated with Longwool crossing ram on in-bye.
Late November:	Hill ewes gathered onto in-bye for tupping by purebred ram.
1 January:	Ewes may be returned to the hill.
Mid-February:	Ewes (especially drafts) scanned and those carrying twins retained on enclosed low ground with supplementary feed until lambing. Those carrying singles returned to the hill.
February/March:	Blocks and supplementary feed available to hill ewes.
Mid-April/May:	Draft and hill ewes lamb on in-bye. Hoggs return to hill after away-wintering.
Mid-May:	Ewes with single lambs at foot return to hill. Ewes with twins remain on enclosed ground until weaning.
July:	Ewes and followers gathered off hill for clipping and dipping.
Late July:	Lambs weaned off draft ewes. (These 5/6-shear ewes may then be turned out onto the hill until late October).
August/September:	Lambs weaned off hill ewes.
September/October:	Wether lambs/surplus ewe lambs sold as stores or retained on in-bye or inside for finishing.
Mid-October:	4/5-shear hill ewes 'drafted' onto lower ground for cross breeding or sale.
Late October:	Gimmer hoggs (ewe replacements) sent away to lowland pasture over winter.

Note: In a typical hill system, ewes will remain on the hill for approximately 36 weeks on average each year. The main periods off the hill are tupping (4-6 weeks), lambing (4-6 weeks) and clipping/dipping and weaning.

Information note 4 Cattle breeds of the English uplands and their characteristics

Introduction

Upland cattle farming is mostly made up of 'suckler' herds of crossbred cows that are then crossed with beef bulls (terminal sires) to produce calves for finishing in the lowlands (see Information note 5). Hardy hill breeds are used to a lesser extent for the production of suckled calves. Dairy production does take place in the uplands, though in more marginal areas. A description of the main breeds and their positions within this structure are discussed below.

Cattle breeds and nature conservation

The Grazing Animals Project (GAP), involving a partnership of many organisations, will shortly be publishing details of breeds of cattle, sheep, ponies and goats used for nature conservation management.

Dairy cows

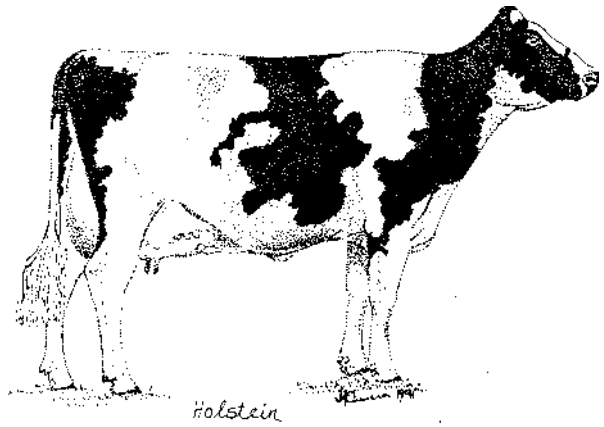
Although there are a number of dairy herds in the uplands, milk production often requires intensive farming methods and is not usually associated with upland areas. Dairy breeds play a large part in the production of calves for suckling within the beef industry. The most widely used breeds are included here.

British Friesian

This used to be the most widespread and popular breed in the UK dairy industry. This was due to the breed's commercial excellence, primarily for high and economic yields of milk, but also the bonus of quickly grown, lean meat production. The Friesian was the biggest producer of home killed beef in Britain, mainly from the male calves produced by the dairy system. This is a dual purpose breed, with good milk production and beef characteristics. As a dairy cow, the Friesian has now been largely surpassed by the Holstein.

In the uplands, the calves from Friesian dams (cows) crossed with beef breed sires, such as the Hereford, Aberdeen Angus and continental breeds, are very popular as suckler cows.

British Holstein



Now the most popular dairy cow, the Holstein is a prolific milk producer. Originally from Friesland Island, as are Friesians, the British Holstein has been bred to be a more effective milk producer and have less of the original beef characteristics of the Dutch strain. As with Friesians, Holstein cows are crossed with beef sires to produce suckler cows.

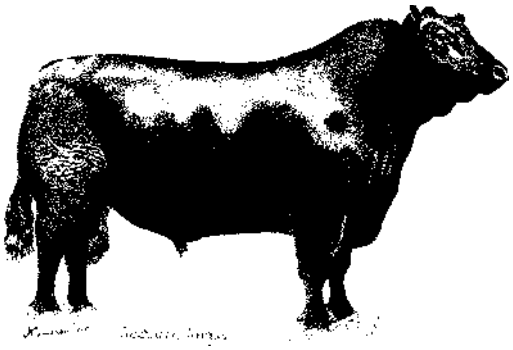
Ayrshire

From its origins in west Scotland in the early seventeenth century, the Ayrshire has spread worldwide as a viable dairy breed that can tolerate extremes of climate. The cows are of medium size and are capable of producing good yields of high butterfat milk (good for cheese making) from poorer pastures than the Friesian or Holstein. Females make top class suckler dams. Ayrshires tend to be a thin-fleshed breed, but crossing with Charolais, Hereford, Friesian or Beef Shorthorn bulls produces beef-type calves.

Beef sires

Purebred beef bulls are important in all aspects of suckled calf production. They are often used to produce the first cross suckler cow, either with a dairy dam or another beef breed. They are then used again to produce the suckled calves as the second cross. Choice of breed depends on many factors, including climate and food availability. The large continental breeds have the advantage of increased weight, and high rate of weight gain, but the disadvantages of higher nutritional requirements, and a higher percentage of difficult births and consequent calf mortality.

Aberdeen Angus



The Aberdeen Angus is renowned throughout the world for the economic production of quality beef. These bulls are largely used as terminal sires for crossing on crossbred cows such as the Blue-Grey (Shorthorn x Galloway) or Hereford x Friesian. Purebred Aberdeen Angus and Aberdeen Angus x Friesian cows are increasingly popular in beef suckler herds. Aberdeen Angus bulls are often used on Holstein or Friesian heifers to give an easy first calving because the calves' heads and shoulders are small. The Aberdeen-Angus breed combines medium size (and therefore ease of calving) with early maturity and high carcase yield despite a slow growth rate.

Beef Shorthorn

The Shorthorn is one of the oldest native British breeds and was established about 200 years ago. The Scotch or Beef Shorthorn has its origins in Aberdeenshire. The Shorthorn cow can be out-wintered in almost any condition and maintained on modest rations. This factor makes the Shorthorn or first-cross cow particularly suited to the uplands. Commercial breeders in these areas use the Shorthorn bull to produce thrifty calves for finishing in upland conditions and also to produce replacement females with good mothering qualities for breeding. The Shorthorn bull, particularly of Cumberland origin, has played an important part in producing first-class commercial suckler cows when put to the pure-bred Ayrshire, Galloway or Highland cow. The Blue Grey is the product of a white Shorthorn bull crossed with a black Galloway cow.

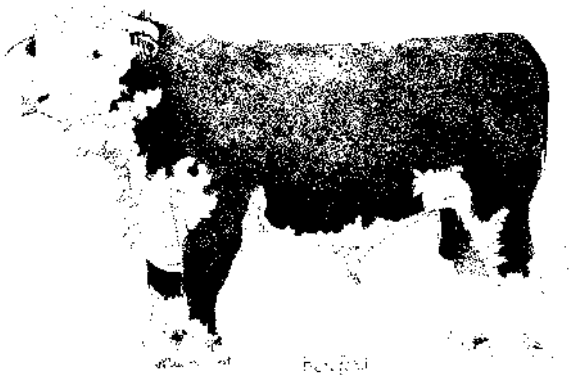
Simmental

This continental beef breed is the most numerically dominant in Europe and originates from the Simmen valley in Switzerland. The Simmental is classed as a big beef breed and can be used both as terminal sire and as a first cross for suckler herd female replacements eg Simmental x Galloway, Simmental x Blue-Grey. Here it imparts size and added milk to the dam, while retaining the important qualities of these indigenous breeds.

Charolais

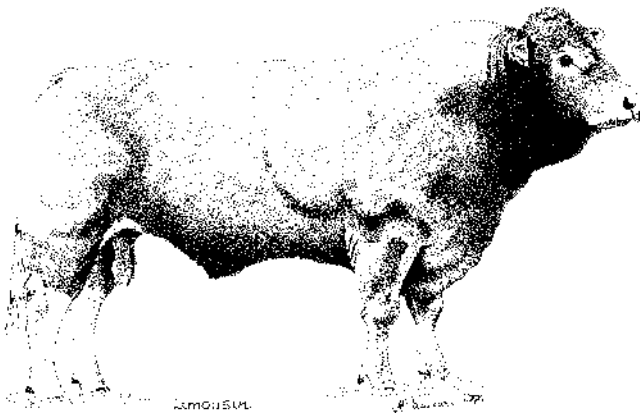
The Charolais was introduced to Britain in the 1960s from France. It is the largest beef breed and is used predominantly as a terminal sire. The exceptional growth rates, food conversion and production of quality lean carcase beef has made the Charolais very popular. However, there is a high incidence of assisted calvings and calf mortality associated with this breed.

Hereford



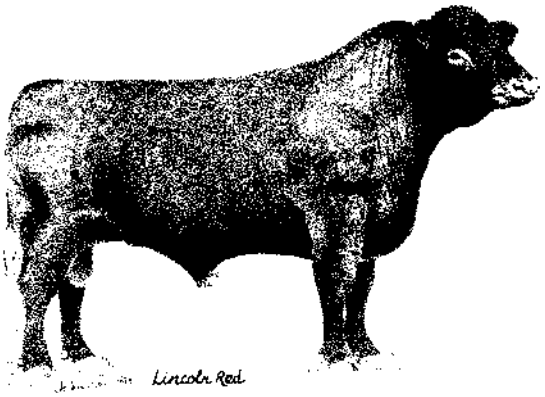
This is the most widespread beef breed in the world. Herefords are extensively used for cross breeding with beef suckler herds. The Hereford has a good reputation for ease of calving. The Hereford x Friesian cross is one of the most popular in Britain and produces hardy calves capable of high growth rates and early maturity.

Limousin



This continental medium / heavy beef breed has its origins on the edge of the Massif Central in France, where 7,000 year old cave paintings depict a very similar beast. Limousin are hardy animals and out-winter well. A Limousin bull on Friesian cows gives male calves that produce a high yield of quality beef for comparatively low food inputs. The heifer calves make first-class hardy suckler cows. A Limousin bull on these suckler cows (to produce three-quarter bred animals), gives most of the commercial advantages in carcase quality and production of the purebred. The Limousin bull on Angus x Friesian, Hereford x Friesian, Blue-Grey or Welsh Black cows will give equal carcase advantage.

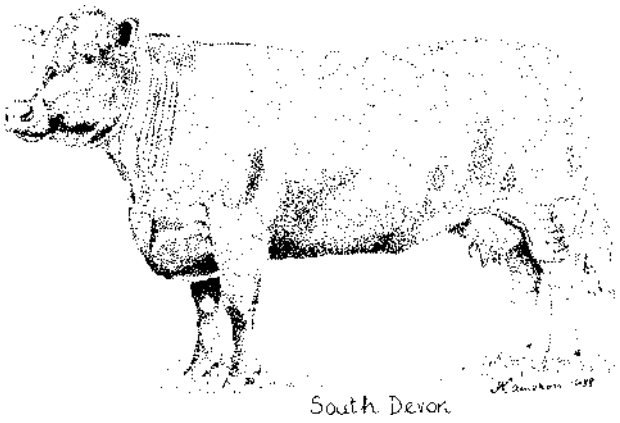
Lincoln Red



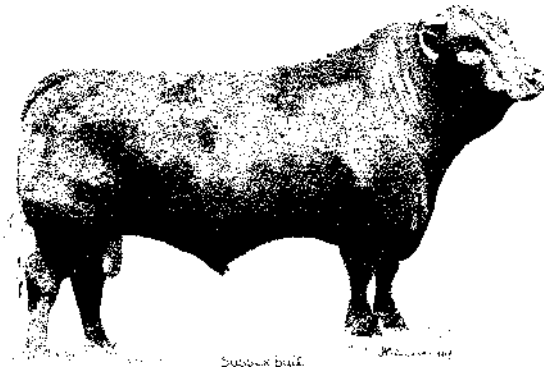
The Lincoln Red may descend from cattle brought to Britain by the Vikings. Used in the past for both meat and milk, today the Lincoln Red is essentially a beef breed. Bulls are sometimes used as terminal sires on crossbred suckler cows. Resulting calves are born easily, mature early and have a rapid growth rate.

South Devon

The earliest mention of this breed goes back 230 years when they were known as the 'Big Red Cattle' which grazed the pastures in 'the South Hams' area of southern Devon. The economic value of this breed is that they are well adapted to the conversion of grass to meat at a fast growth rate. This breed is often used locally as a first and second cross in the production of suckled calves.



Sussex

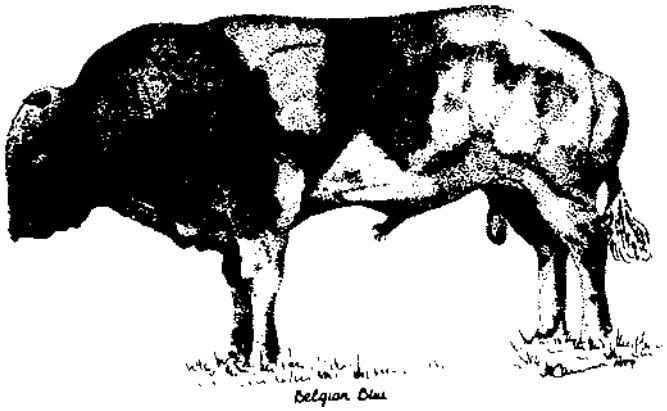


Sussex cattle are generally accepted as being descended from the red cattle that inhabited the dense forests of the Weald land of Sussex and Kent, and were recorded at the time of the Norman conquest. Sussex bulls are widely used as sires in the dairy and suckler herds, producing calves of good growth potential and excellent beef quality. The most popular of these crosses is the Sussex x Friesian.

Blonde D'Aquitaine

A French breed imported in the early 1970s, it is native to southwestern France. It is superficially similar to the Charolais and has many of that breed's characteristics.

Belgian Blue

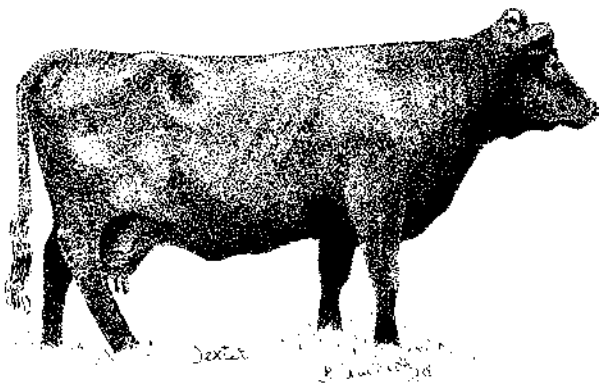


A beef breed which is notable for enormous hind-quarters. The breed has a quiet temperament and has been widely used by dairy farmers to impart fleshing characteristics to milk cows of poor beef conformation, such as Jerseys.

Hardy hill breeds

These are often old breeds which originated in the mountain and hill districts of Britain and Ireland and are often direct decendants of wild cattle once found in these areas. Their hardy constitutions, the greatest attributes of these breeds, mean that they can survive and even thrive in extreme climatic conditions. The ability to turn poor forage into beef, with little need for extra feed or housing is also an advantage. Advances in housing and conserved fodder systems mean that much suckled calf production uses the more profitable dairy x beef cross to the detriment of the hardy hill breeds. Only in the extreme conditions of the hill farm, where these animals thrive, are they still utilised to the full. For conservation purposes, they have the added benefit of being small animals and consequently tend to do less damage through poaching on wet grazings. The use of hill beef breeds to produce crossbred cows is common especially in the marginal upland areas.

Dexter



Dexters originated in the south or southwestern regions of Ireland and they are believed to have descended from the original wild Irish mountain cattle. They are the smallest British cattle breed and were first introduced into England in 1882. Being a mountain breed, they are extremely hardy and can be kept out of doors all the year round, even through the severest winters. Many animals are kept as suckler cows for which they are well suited, although their small size limits the growth potential in their calves.

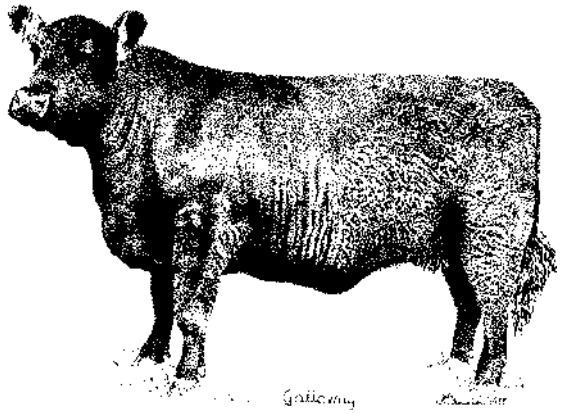
Highland

This breed is a native of Scotland and the Western Isles. The cattle are hardy, largely due to their long shaggy coat. The long hairs of the outer coat shed water, while a short under coat provides insulation. These cattle possess an ability to forage efficiently and can travel far in harsh conditions in search of food. Highland females are in demand as crossing animals due to their good mothering abilities and easy calving. However, they are slow to mature and are often poor milkers.

Belted Galloway

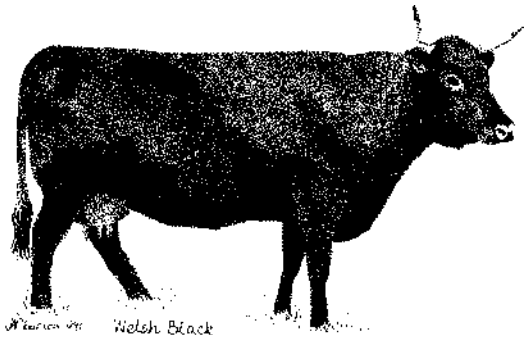
A hardy hill breed with a distinctive white belt. This breed originated in southwest Scotland and is a race of the Galloway.

Galloway



The Galloway is one of the oldest beef breeds in the UK and has been a keystone in prime beef production in Britain for many generations. Owing to its hardy characteristics, the Galloway has been able to thrive in extreme conditions and help to turn acres of mountain moor and poor pasture into economically viable farmland. The Galloway is the foundation breed in the production of the crossbred Blue-Grey (see below) which is so popular as a suckler cow.

Welsh Black



Welsh Blacks have been the native cattle of Wales since pre-Roman times and are referred to in the earliest Welsh literature. The modern breed is a much improved animal which makes a hardy suckler herd producing first class beef. Although traditionally a dual purpose breed, nowadays beef production is regarded as its primary role. This breed is extremely hardy, able to stand the harshest winters with very little shelter. It probably originates from the same foundation stock as the Galloway.

Cross breeds

Suckled calf production relies heavily on crossbred cows, which are then crossed again to produce the suckler calf. Many variations of cow and bull are used, depending on the conditions on the farm (housing, conserved fodder, amount of in-bye, etc), climatic conditions and the preferences of the producer. Other factors that must be taken into account are ease of birth, calf mortality and growth rate of the calf.

Blue-Grey

This progeny of the mating of a Cumberland (sometimes termed Whitebred) Shorthorn sire on a Galloway dam is very popular as a suckler cow. These cows possess sufficient milkiness to produce fast-growing calves, particularly when crossed with large continental beef breeds. The name 'Blue-Grey' sometimes embraces breeds and crosses other than Cumberland Shorthorn x Galloway.

Adapted from *The British cattle book*, published by the National Cattle Association.

Information note 5 — Cattle farming systems of the English uplands

Introduction

Upland cattle farming is usually based on the rearing of beef calves for sale to lowland farms for finishing. This is a low intensity system of one calf per cow where the calf is suckled by its mother until it is weaned at between 6 and 10 months. Finished beef is still produced to a lesser extent, but in the harsh conditions found on hill farms it requires the hardy purebred hill breeds. However, the introduction of the 'Over Thirty Months Scheme' in response to the BSE crisis has put pressure on beef finishing systems based on slow-maturing, mainly upland breeds. Dairy farming also takes place in the more marginal areas. This is a much more intensive system relying heavily on housing and supplementary feed. As with sheep production, the type and number of stock kept is dependent on the amount of in-bye land and the availability of buildings for housing stock over winter.

Suckler cow production

This is the most commonly used cattle farming system in the English uplands and forms the upper tier of the beef stratification system. Calves born and weaned in the uplands can be sold in the autumn sales to lowland farms to be fattened for slaughter. Alternatively, many herds are summer to autumn calvers with calves sold in the spring. Replacement stock for suckler herds may be reared in the lowlands as a by-product of the dairy system.

Hill farms

The size of herd depends on a number of factors. The main constraint on cattle numbers is the ability to grow and store sufficient conserved fodder (hay or silage). This is dependent on the amount of in-bye land available. Suckler cows may be housed over the winter period. The buying-in of large amounts of supplementary feed may not be economically viable. Housing space may also provide a constraint on the numbers kept. Normally, hill calves will be born in the spring and put to grass for the spring and summer. They would be then sold at the autumn sales to provide store calves (finished indoors) for the lowlands.

Marginal upland farms

Here herd sizes may be bigger owing to the availability of more improved grassland and housing space. Most calves will be sold for fattening to lowland farms, as in the hill system. Where feed and housing are available some calves may be kept and finished on the farm, therefore bringing in higher returns. Another option available to the marginal farm is that of double or multiple suckling. Extra calves are bought-in for suckling, thereby increasing productivity, but housing may be necessary and the price of calves can be prohibitive.

The major difference between the hill and marginal systems is the greater choice of options available to those with adequate feed and housing resources. These options are discussed below.

Calving seasons

Suckler cows can be calved at any time of the year. The principal calving times are spring and autumn. When to calve depends upon feed supplies and storage facilities, housing, other farm enterprises and plans for calf sales or finishing.

Autumn calving produces a more mature, heavier calf that is more saleable in the following year's autumn sales. This greater output is balanced by the high input of feed needed to sustain lactation and produce sufficient milk to suckle the calf over the winter. Calves are normally born at grass in September / October and housed in November for the winter. They are then weaned and turned out onto grass in the spring or turned out with their mothers to be weaned later in July / August. In some hill systems, weaned calves are turned out onto in-bye pastures while the cows are run on rough hill grazings for the summer.

Spring calving is a lower cost system, with peak feed demands coinciding with peak grass growth. Over-wintered cows require less food and are fed on hay, silage and small amounts of concentrates. Care must be taken to raise the dietary standards of the cows after winter housing to be sure of conception after calving. The lower input is reflected in the lower value of spring-born calves sold in the autumn, because they are smaller (and younger) than the autumn-born calves. Spring calving cows will normally be calved outside in April / May / June. Though the systems differ in cost terms, there is little difference between the gross margins of autumn and spring calving systems.

Summer and winter calving - to calve every year, a cow must conceive within three months of calving. Low nutrition can lead to failure to conceive and create 'slippage' in the calving time. Summer calving in July / August is similar to the autumn system although less grass will be available as conserved fodder and the good early grazing of spring has been missed. Winter calving must take place indoors. This creates a risk of disease, particularly calf scour, and vaccines may be needed. To avoid slippage and to manage calving times, late calvers or barren cows are often culled and replacements bought in. It is sometimes possible to move an autumn calver into the spring calving herd, though not vice versa.

The suckler cow

Crossbred cows are most often used in the suckler system because hybrid vigour brings the benefits of longevity and reproductive efficiency. Dairy crosses are the most common foundation cows. These are usually Friesian or Friesian Holstein crossed with a beef sire such as Angus, Hereford or South Devon (see Information note 4). More producers are now using to continental crosses with beef breeds such as Charolais, Simmental or Limousin. These crossbred cows are then crossed again with a beef bull (often kept on the farm) to exploit further the advantages of hybrid vigour and improve fleshing characteristics. The introduction of the dairy Holstein into the Friesian breed has had detrimental effects on the quality of suckled calves.

Hill farms sometimes use crossbred cows obtained from hardier breeds, eg the Blue-Grey, which comes from a White Shorthorn sire and a Galloway dam (see Information note 4). These crosses cope better with harsh conditions than crosses derived from dairy breeds.

The sire

The choice of bull is very important, both for productivity and the quality of the calf. A heavy meat breed will be the most productive, producing the heavier and faster growing calves. This is offset by the fact that calves from these bulls are more likely to have difficult births and mortality rates can be higher. Charolais, Simmental and South Devon are examples of heavy beef breeds. Smaller beef breeds such as Aberdeen Angus and Hereford produce smaller and lighter calves. Choice of sire depends on the climatic conditions of the farm with smaller hardier breeds more able to thrive under poor conditions. One strategy is to put a smaller breed of bull on the heifers and a continental sire on the adult cows.

Compatibility

Suckled calf production and upland sheep farming are compatible systems with little conflict between them. Rotational grazing of both sheep and cattle keeps the grazing in good condition, with cattle eating what the sheep will not. In winter hill sheep can graze the open hill sides, and draft ewes can graze the in-bye while cattle are housed. Problems may occur if spring calving coincides with lambing of a large sheep flock. This can be remedied by splitting calving between spring and autumn, or calving only in the autumn if there is capacity to over-winter the whole herd inside.

Income

The suckler cow system produces only one calf per cow with no by-products. This means the calf's survival and wellbeing are of paramount importance to the farmer. Certain subsidies are available to the beef farmer. The Beef Special Premium provides support payments for young male animals, while the Suckler Cow Premium is based on non-milk producing cows of a beef cross. Both of these subsidies are subject to Stocking Density Limits. Extensification premiums are available to producers stocking at less than 1.6 livestock units per hectare or between 1.6 and 2 LU/ha. For farms lying within the Less Favoured Areas, the Hill Livestock Compensatory Allowance (replaced by the Hill Farm Allowance Scheme) is also available now (see Chapter 2). Different amounts are paid depending on whether the land is classified as Disadvantaged or Severely Disadvantaged.

Dairy production

Dairy farming does not play as large a role in upland farming as sheep or suckler cows, but is quite often found in marginal upland areas. The dairy system does not have the same degree of stratification as the beef system, though it does provide the main source of beef calves in England. Replacement dairy stock comes from within the herd. Surplus calves from the dairy farms will be sold on for finishing on grass or intensive cereal systems in the lowlands.

Due to breeding advances, over 90% of dairy herds have been standardised around the Friesian or Holstein breeds. These can be crossed with beef bulls to produce cows of good beef shape and milkiness, making them suitable for use as suckler cows later on. Calves are usually artificially reared, weaned at six weeks and fattened on concentrates. Male calves are fattened for slaughter while females may either be finished for the market or reared as stock cows for future breeding.

A typical farming year for hill/upland suckler cow herds (spring calving)

November / December:	On in-bye, fed outside on hay or silage. Time of housing is weather dependent, eg wet weather = early housing.
December / March:	Inside, fed on hay, silage or straw and perhaps a small amount of concentrates.
March / April / May:	Calving. Usually outside. Turnout depends on season and altitude of the farm.
April / May:	Cows and calves on in-bye. (Possible competition with ewes and lambs, depending on numbers and land available.)
May / June:	Cattle to improved hill. In-bye meadows closed up for hay / silage.
July:	Bull run with cows on in-bye.
August / September:	Cows and calves on in-bye. (Possible competition with weaned lambs, depending on numbers and land available.)
October:	Calves fed some concentrates then sold.
November:	Cows on in-bye, prior to housing. Fed on hay or silage if necessary as quality can be poor and weather can deteriorate.

Modified from Haines, M. 1992. *An introduction to farming systems.* London: Longman.

Introduction

Bracken *Pteridium aquilinum* was originally a woodland fern but locally it has become an invasive weed of marginal land (Pakeman & Marrs 1992; Smith & Taylor 1986). Once established, it is aggressive, supremely competitive, and extremely difficult and expensive to control. There are continuing concerns about the spread of bracken in the UK where bracken cover is thought to have doubled during the twentieth century (Birnie *et al* 1998; Brown 1997; Pakeman *et al* 1996; Rhone-Poulenc 1997; Taylor 1997).

The reasons for and against managing bracken are many and varied. These concern nature conservation, agriculture, forestry, management for grouse, human and animal health, recreation and archaeology. From a wildlife point of view, bracken can be of great value, particularly where it occurs as a mosaic with other vegetation types, and significant areas should be retained in appropriate locations. However, bracken-dominated areas may be less important for wildlife than the communities displaced by invasion (Marrs & Pakeman 1995).

The single most important factor in managing bracken is to adhere to the guidance developed by a number of organisations and described in the following text (Environment Agency 1998; North West Water 1996; Peak District National Park 1997; Rhone-Poulenc 1997; Roberts, MacDonald & Wood-Gee 1996).

Reasons for managing bracken

Nature conservation

- Loss of species and communities of wildlife value, such as heaths, species-rich grasslands and their associated plants and animals.
- Increased grazing pressure on habitats of wildlife value, such as heaths and species-rich grassland.
- Presence of >woodland= fritillary butterflies, most notably two rare and declining species, high brown fritillary *Argynnis adippe* (RDB2 & Schedule 5) and pearl bordered fritillary *Boloria euphrosyne* (Nationally Scarce), but also the commoner dark green fritillary *Argynnis aglaia*, which utilise violets *Viola* spp under appropriately managed bracken (see Butterfly Conservation 1998).
- Reduced diversity of natural vegetation and associated fauna (although bracken may also add diversity).

Agriculture

- Reduced availability of grazing on bracken-infested land.
- Increased numbers of sheep ticks which can cause disease in stock.

- Problems with stock movement and gathering.
- Poisoning and even death of animals owing to powerful poisons in bracken, including some carcinogens (Taylor 1989).

Forestry

- Increased competition with and damage to young trees.

Grouse

- Loss of heather moorland.
- Increased numbers of sheep ticks which create problems for grouse (eg louping ill)

Human health

- Increased numbers of sheep ticks which can lead to Lyme disease in humans (Brown 1993).
- Presence of powerful poisons in bracken, including some carcinogens, leading to fears for human health (Taylor 1989).

Recreation

- Loss of amenity land.
- Problems with access for recreation.

Archaeology

- Damage to archaeological sites and features by the rhizomes.

Reasons against managing bracken

Nature conservation

Plants

- Plants which could be harmed by bracken management, eg rare ferns, may be present in the vicinity of bracken stands, particularly in gills, cloughs, rocky and limestone areas.
- Bracken supports a woodland ground flora in some areas, including violets and bluebells *Hyacinthoides non-scripta*, by acting as a substitute woodland canopy (but see also previous page).
- Bracken protects some plants from grazing, such as chickweed wintergreen *Trientalis europaea* and lesser butterfly-orchid *Platanthera bifolia* (Rhone-Poulenc 1997).

- It enables some plants growing under its shade to survive drought summers better than would the same species growing outside the bracken stand (A. MacDonald, pers comm).

Birds

Bracken provides sheltered roost sites and nesting habitat for birds such as twite *Carduelis flavirostris*, whinchat *Saxicola rubetra*, skylark *Alauda arvensis*, ring ouzel *Turdus torquatus*, merlin *Falco columbarius*, short-eared owl *Asio flammeus*, curlew *Numenius arquata*, stonechat *Saxicola torquata* and meadow pipit *Anthus pratensis*, many of which are birds of conservation concern (RSPB 1996).

- Whinchat, for example, are positively associated with bracken (Allen 1995), and twite are particularly associated with bracken in the South Pennines, where they prefer larger stands (A. Brown, pers comm).

- It provides song posts and perches from which stonechat and whinchat forage, and the litter can provide sheltered roosting sites for red and black grouse in winter.

- It supports small birds, which provide food for raptors such as merlin and hen harrier.

- It provides good habitat for additional birds such as redstart and tree pipit where it occurs with scattered shrubs.

- It provides a diversity of vegetation structure where scattered bracken occurs in a mosaic of other vegetation types, such as with acid grassland, mires, heather moorland, scrub and at woodland margins, and this is important for birds.

Invertebrates

- A high diversity of invertebrate species feed on bracken, particularly flies and sawflies, including some that are specific to it and many generalist fern or broad spectrum plant feeders.

- Bracken provides a significant nectar source early in the year (spring and early summer) when its extra-floral nectaries (low down on the frond, on the stalk at the bases of the pinnae) are producing nectar which is used in particular by ants, small flies and parasitic wasps.

- It provides shelter for one of Britain=s few endemic invertebrates, the weevil *Procas granulicollis* which, although feeding specifically on climbing corydalis *Ceratocapnos claviculata*, normally a woodland plant, seems to do so preferentially when this plant grows among bracken.

- It supports an assemblage of arthropods, many of which are specific or largely dependent on bracken.

Forestry

- A light bracken layer can provide shelter for young trees from wind and frost.

Soil

- Bracken can improve the texture and stability of some soils, especially on sandy slopes.

Landscape

- Bracken provides autumn colour in the landscape.

Managing bracken

Bracken control can be an expensive, difficult and long-term process and it should not be undertaken lightly. It can also lead to considerable problems of erosion. Extensive, blanket control of this species is neither practical nor desirable.

A carefully constructed plan, taking into account all land uses and interests, is required for effective bracken management. The plan must be based on the long-term land management and wildlife objectives for the area concerned. It should identify priority areas for treatment, as well as areas to be left, and take into account all the recommendations contained here. It should include both initial and follow-up treatments . Subsequent follow-up treatment is usually essential, although the form this takes will vary. In some cases this will involve, for example, successive, larger scale aerial or ground-based herbicide applications, while in others annual spot-treatment may be more appropriate.

General recommendations concerning bracken management are contained in Box IN6.1, with further advice on specific methods in the following boxes.

Preventing bracken invasion

As a general rule, prevention is better than cure, so efforts should be focused on preventing bracken invasion of valued habitats, followed by carefully targeted treatment of selected areas where removal of bracken is a priority.

Bracken is an extremely competitive species. Vegetation which is growing vigorously should be able to hold its own against bracken, but where the vegetation is suppressed for some reason then bracken can spread. High grazing pressure, for example, may encourage bracken invasion, and preventing the overgrazing of swards will help prevent the spread of bracken. In some areas, too little grazing (under grazing) or the type of stock used is more of a problem. For example, cattle trampling is more effective in reducing the spread of bracken than sheep trampling.

Bracken often occurs in mixtures with heather on moorlands. When dwarf shrub species are in the building phase of growth they are able to compete successfully with bracken. However, when the competitiveness of dwarf shrubs is reduced, which occurs during the pioneer or degenerate growth phases, or when the land is severely grazed or burnt, bracken may have the advantage (Watt 1955). Here burning can lead to either a reduction or an increase in the cover of bracken, depending on how well the other vegetation regenerates after the fire (A. MacDonald, pers comm). This in turn depends on a number of variables such as the age of the heather before burning, the intensity of the fire and the climate. For example, young heather can regenerate relatively rapidly after a light to moderate fire and so compete

successfully with bracken. Where heaths with bracken are burnt, some follow-up treatment of the bracken may be needed if it is subsequently found to be invading.

Box IN6.1 General recommendations on managing bracken

Only manage bracken where:

- there are definite benefits, for example for agriculture, wildlife, recreation or archaeology;
- there will be no harm to these interests;
- there is a properly resourced, long-term plan in place, including follow-up treatment;
- there is an understorey of heather, bilberry or grass and favoured moorland or grassland vegetation can be restored as a result;

Do NOT manage bracken:

- where the resulting harm to wildlife outweighs the benefits to other land uses;
- on steep slopes, cloughs and gullies where treatment is likely to lead to erosion;
- where other plant communities, such as in limestone pavement and mires, may be adversely affected;
- where other plant species, such as ferns, may be adversely affected;
- on unenclosed land where bracken is in competition merely with mat-grass;
- in areas known to be important for bracken-breeding birds;
- in areas known to be important for bracken-dependent invertebrates;
- along the sides of water courses and water bodies;
- on ancient stands with thick litter and no other vegetation beneath (unless tree planting is planned);
- where there will be significant, adverse impacts on the landscape.

Additional considerations

- Assess all sites before and after treatment so that appropriate further action may be planned.
- Consider the option of planting with native trees and shrubs.
- Consult the Environment Agency. There might be a legal requirement to do so before chemical treatment.
- Consult English Nature if the land to be treated is within or adjacent to a Site of Special Scientific Interest (SSSI). Within 1.5km if aerial application is being proposed.
- Consult the National Park Authority if the land to be treated is within a National Park.
- Consult the National Park archaeologist in National Parks and the County archaeologist elsewhere if the land to be treated involves a site of archaeological interest.
- Consider seeding of resulting bare areas with heather or other appropriate moorland species where necessary.
- Control stocking levels or remove stock following bracken treatment to avoid overgrazing of recolonising plants and seedlings.

Planting native trees in bracken areas

An ecologically sound solution to the problem of unwanted bracken-dominated areas in the uplands is to target them for tree planting. This could be part of the planned long-term expansion of woodland area in England. Much of the bracken land is particularly suitable for the expansion of existing woodlands or the planting of new woods. However, careful survey is needed prior to the approval of particular planting proposals, to ensure that bracken areas of high wildlife value are not lost.

Planting bracken-dominated areas with native trees is an important way of reducing the vigour of bracken stands. It also increases the diversity of the habitat and benefits various animals. Areas with dense litter cover, moorland edges, gills, cloughs and sloping ground which can be fenced from stock are particularly appropriate. It will frequently be more desirable than trying to remove bracken with chemicals, although this may be required in the first instance to allow trees to become established. It has been conducted in various areas, and provides a return to open, patchy native shrub and woodland cover (North York Moors National Park 1991, 1993). Where it is undertaken, only tree and shrub species typical of the area and of local provenance should be used.

Mechanical methods

Mechanical methods of management inflict physical damage on the plant and can be achieved by:

- cutting;
- crushing;
- trampling;
- ploughing;
- rotovating (smaller areas).

The first three methods work on the fronds when they are actively growing and have the effect of starving the surviving rhizomes. Ploughing and rotovating breaks up the rhizomes and exposes them to the action of frost (Gimingham 1992), but in the uplands this is rarely appropriate.

Effective mechanical management of bracken, like chemical methods, involves a long-term approach and is unlikely to eradicate bracken completely. However, mechanical methods are sometimes cheaper and less dependent on weather conditions than chemical treatment. It is most appropriate for small, relatively level areas of bracken or light infestations and is also a useful option in conjunction with other treatments. But mechanical methods are often not feasible in the uplands because of the topography and ground conditions.

Cutting the fronds in late summer (July-August) prevents food reserves being moved to the rhizomes, with the ultimate aim of exhausting the rhizome system (Marrs & Pakeman 1995). Cutting on two occasions during the growing season (mid-late June and mid-August) and for at least three successive years is much more effective than carrying out the process just once (North York Moors National Park 1986, 1993). However, even long-term, annual cutting may not completely destroy the rhizome system (R. Brown, pers comm.).

Crushing by roller or bracken-breaker machines is normally recommended to be undertaken twice a year, particularly during early frond growth when the stems are still brittle (North York Moors National Park 1986, 1993). Its effectiveness reduces as the stems mature. Crushing or >bruising= squashes the bracken stems against the ground as the machine passes over. It does not cut off the stems but leaves them attached to the root to bleed the sap, so denying next year's buds essential food energy. Each bruising operation reduces vigour and shoot numbers by about one third, quickly reducing a dense stand of bracken into more scattered fronds (J. Bacon, pers comm). This process not only reduces bracken regeneration but the machine action also encourages the breakdown of bracken litter. It is not as effective as cutting but is useful as a follow-up treatment on sprayed areas. However, the use of rollers can lead to erosion of peaty soils on sloping ground.

Ploughing and **rotovating** are rarely an option in the uplands because the slope and thin soil usually make these methods impractical. It can also can disrupt the fragile soils, damage other plant communities and lead to erosion. However, it can be effective for managing bracken where practical. A method known as chisel ploughing can be used, which is a deep ploughing technique reaching to a depth of 45 cm. This operation damages the soil profile and should only be used in areas where there is an established monoculture of bracken and no risk of erosion. It imposes maximum stress on the fern by direct mechanical damage and by exposure of the rhizome system to frosts and drought. But bracken re-growth will occur even after a vigorous procedure such as ploughing.

Trampling by stock also inflicts damage on the fronds, particularly in the spring, thus depleting rhizome reserves (North York Moors National Park 1993). Cattle are much more effective than sheep, but care should be taken to avoid the risk of poisoning by providing adequate fodder for the animals. Foddering on dense bracken beds can help to break them up and create a seed bed for grass and heather to re-establish. Feeding sites may need to be moved regularly to avoid poaching. Stock treading also increases the rate of breakdown of dense bracken litter.

Information and recommendations concerning mechanical management of bracken are given in Box IN6.2.

Box IN6.2 Managing bracken with mechanical methods

Do **NOT** use this method on:

- very stony and steep areas which are not suitable for vehicles;
- peat soils;
- areas supporting nesting birds, where mechanical management must be delayed until late August, or other methods used;
- archaeological sites, which can be easily damaged by the movement of vehicles.
  - ❑ Records of known sites are held by Local Authorities and National Parks.
  - ❑ These areas can be marked and dealt with by hand.

Do:

- target management at the invading edge of the bracken (where there is sufficient frond density for treatment to be effective);
- check the area for large stones as these can damage machinery;
- exercise due care for health and safety, eg use a face mask when cutting bracken with spores, cover arms and legs to reduce the likelihood of sheep tick bites.
- repeat the mechanical method for at least three years to give reasonable results.

Box IN6.2 Managing bracken with mechanical methods (cont)

Cutting bracken

- Cut the fronds twice annually, in mid to late June and mid-August, for at least three successive years.
  - ❑ A tractor and rotary swipe can be used, setting the height of the cut to about 10 cm.
  - ❑ Cutting once will produce an even stand with more active buds which will increase the efficiency of chemical treatment carried out the following year.

Crushing bracken

- Crush emerging, brittle bracken fronds at least twice a year, in the first weeks of June and again in the first weeks of August, for at least three successive years.

Ploughing of bracken beds

- Only plough areas with deeper soils (at least 60 cm) and no risk of erosion, on slopes less than 15-20°, and where there is an established monoculture of bracken.
- Precede ploughing by two cuts to weaken the rhizomes.
- Chisel plough to a depth of 45 cm.
- Ideally plough in very hot weather to maximise damage to the plant.

Stock trampling of bracken

- Use cattle trampling in spring as an effective and cheap option, for example for follow-up treatment.
- Provide sufficient fodder to prevent animals eating the bracken.
- Stocking rates of between 0.125 and 0.25 cattle / ha, or between one and 2 sheep / ha if cattle are not available, may be appropriate, depending on the percentage cover of bracken.
- This is only appropriate where there is no risk of overgrazing adjacent heather or other habitats.
- Do not employ this method on archaeological sites as damage may occur.

Dealing with bracken litter

- Where vehicular access is possible, the grazing pressure and the soil are light, and the slope is less than 15°, then raking, chain harrowing or light rotovation of the litter beds can break them up and accelerate the development of new vegetation.
- Treading by stock will also help, provided sufficient fodder is provided to prevent animals eating the bracken. Feed can be positioned on bracken stands.
- Burning of bracken litter should only be undertaken with extreme care, and in accordance with the *Heather and Grass Burning Code* (MAFF 1992). Burning promotes vigorous bracken regrowth and so further treatment will be required.
- Do not undertake any of these activities on steep slopes where erosion may occur, or where populations of high brown or pearl-bordered fritillaries occur.

Preventing bracken invasion

- Do not overgraze areas of heath, grassland or former bracken stands.
- Graze with cattle rather than sheep.
- Manage heather, by appropriate burning or cutting, to keep it in the building phase.

Chemical methods

Effective management of bracken with chemicals is a long-term process because multiple applications and / or some other form of follow-up treatment such as mechanical management is required. Even then bracken may well return and require constant attention.

Asulam (methyl {4-aminobenzenesulphonyl} carbamate), obtained as the product Asulox, is the most widely used herbicide for bracken management (Rhone-Poulenc 1997). At the recommended application rate it is relatively specific to ferns and to a relatively narrow range of higher plants. Docks *Rumex* spp. are highly susceptible and there is some evidence that some bryophytes may also be susceptible. This of course means that all fern and some higher plant and bryophyte species which are sprayed, and not just bracken, may be affected. Asulam can also check the growth of other plant species. Species shown to be susceptible to Asulox to varying degrees include a number of grass species, heather *Calluna vulgaris*, bilberry *Vaccinium myrtillus*, saxifrages *Saxifraga* spp, eyebright *Euphrasia anglica*, common bird=s-foot trefoil *Lotus corniculatus*, certain plantains *Plantago* spp, and tree and shrub species including gorse *Ulex gallii* and *U. europaeus*, willows *Salix* spp and silver birch *Betula pendula* (Rhone-Poulenc 1997). Therefore, when considering the use of chemicals for bracken management, it must be remembered that ferns and other plants of nature conservation value may be present and could be adversely affected (see effects on plants below).

Asulam is translocated into the rhizomes of bracken, where it effects a lethal action on the rhizome buds. The effects of treatment will not be seen until the following season, but there is usually at least a 95% reduction in fronds in the year after spraying, provided the Asulox is properly applied.

The herbicide can be applied to the bracken by a variety of means. These include:

- aerial spraying from a helicopter;
- tractors, quad-bikes or all terrain vehicles (ATVs) with mounted
  - ❑ spray booms;
  - ❑ roller-wiping equipment;
  - ❑ hoses and lances;
  - ❑ spinning-disc applicators;

- portable methods
  - ❑ knapsack sprayers;
  - ❑ Micron Ulva+;
  - ❑ spot-guns.

Helicopter spraying is the most commonly used and cost effective method for large areas. Tractors, quad-bikes and ATVs are used on suitable, even terrain, but areas of land too steep or rocky for vehicle access require portable methods instead. Hoses, lances and spray-guns are often used for follow-up work. Information and advice on chemical treatment of bracken are included below and in Box IN6.3.

Aerial spraying

- May be carried out only by helicopter.
- Applies chemicals in flight lanes 8-12 m wide (such precise targeting is possible when conducted by helicopters fitted exclusively with raindrop nozzles)
- May lead to missed strips.
- May lead to chemical drift. Drift is likely to be more severe if raindrop nozzles are not used, if the wind speed is greater than 10 mph (16 km / h) and if the operator is late in shutting off the chemical at the ends of runs.

Tractors, quad-bikes or all-terrain vehicles (ATVs) with mounted applicators

Conventional spray booms

- Short, stubby booms (2-3 m long) are best suited to use on ATVs and quad-bikes.
- Longer booms (usually up to 12 m for bracken spraying) are used on tractors.
- This method is not cost effective on sparse bracken.
- Volume rates can be reduced by fitting anvil nozzles or Turbo TeeJets to the booms at 1 m spacing;
- These nozzles will also produce coarser sprays which reduce drift.
- It is an advantage to employ reduced volume rates to avoid constant re-filling and to enhance work rates.
- Booms should be set high enough to ensure uniform coverage of the fronds.
- Also causes risk of drift and spraying of herbicide is not recommended if wind speed exceeds 6 mph (9.6 km / h).

Powered roller-wiping equipment

- Can be effective for both primary and secondary treatments but effectiveness decreases as the roughness of the land increases or as frond density decreases.
- Wiping is not suited to the final eradication phase of bracken clearance when small fronds will be encountered.
- Hand-held wiping gear is not generally effective on bracken.

Hoses and lances

- A rack of up to four powered hoses and lances mounted on the rear of an ATV or quad-bike can be used for highly effective follow-up treatment on rougher ground.
- A team of four, walking behind the vehicle, can achieve spot-treatment of bracken regrowth over a width of up to 20 m, thereby achieving high work rates.
- This equipment is not recommended for primary treatment.

Boom-mounted spinning-disc applicators

- Boom-mounted disc units set to give coarse droplets (>250 •m) can be very effective.
- Waterless applications are possible.

Portable methods of application

Knapsack sprayers

- Require an easy access to a water supply.
- Motorised knapsack mistblowers are not suitable for use on bracken.
- Manual, lever-operated knapsack sprayers and compression sprayers are suitable only for the smallest areas, and mostly used for spot-treatments.
- Motorised knapsack sprayers may be used to treat larger areas of shorter bracken when fitted with a short boom up to 3 m long.
- Volume rates can be reduced by fitting flooding nozzles and Turbo TeeJets to the booms at 1 m spacing.
- These nozzles will also produce coarser sprays which reduce drift.
- It is an advantage to employ reduced volume rates to avoid constant re-filling and to enhance work rates.

Micron Ulva+

- Hand-held spinning disc sprayer, operating on torch batteries.
- Can be used for primary treatment or follow-up treatment on dense patches of regrowth and missed strips.
- It is useful to treat tall, dense or inaccessible bracken which cannot be treated by other means.
- Waterless applications are possible.

- This is a skilled operation requiring a specialised spray method, with the operator walking across the wind and applying swaths at 3 m intervals.

- Best results are obtained in a steady, light breeze.

Spot-guns

- These are able to deliver 0.5-1.0 ml per shot and used on foot are a practical means to achieve follow-up treatment of sparse bracken fronds on extended areas of rough ground (sometimes known as the >gardening= stage at the end of a programme eradication scheme).

- Higher capacity, conventional drench guns (minimum output of 5 ml/shot) are not usually suitable for this work.

- A red foodstuffs dye (eg Eurocert Red) may be used to help identify treated fronds.

Further information: Cooke 1986, 1993; North York Moors National Park 1986; Rhone-Poulenc 1997.

Timing of chemical treatments

Timing the application of herbicide is particularly important in bracken eradication. The aim is not to kill the fronds but to use them as a mechanism for translocating the herbicide to the underground rhizome. This is maximised during late summer when there is movement of photosynthetic products from the fronds to the rhizome. The producers of Asulox suggest that at least three pairs of pinnae (bracken >leaves= or fronds) should be fully open before applying the herbicide. This refers to untouched bracken stands, not regrowth and is usually during late July or early August, although it will vary with the location, altitude and the season. In some areas, applications will be effective in September.

Use of additives

Additives (or adjuvants) can enhance the activity of asulam applied to bracken by increasing the rate and quantity of translocation to the rhizome buds, achieving a higher mortality for a given dose. The same effects can also offer a measure of protection against rain washing or poor application (under dosing). However, care is required when additives are used because they can amplify the damaging effects of spraying on other, non-target species and may alter the drift characteristics and the spectrum of activity of asulam. They should also not be used when over-spraying of trees is to be attempted (forestry uses).

Where Asulox is sprayed using water as a carrier, a wetting agent such as Agral is usually employed at 0.1%. For waterless carriers, applied by spinning-disc equipment, Asulox is usually mixed with an emulsifiable oil such as Adder (11:7 ratio). A wetting agent or an emulsifiable oil will also enhance the activity of asulam applied by wiping equipment. Certain forms of wiping gear will require the additional use of a polymer to adjust the viscosity of the mixture.

>Stickers= may help to prevent rain-washing of Asulox after application to bracken but the effect is not proven.

Use of chemicals other than asulam

Other chemicals are available for bracken management but are not specific to bracken. These include glyphosate, which is sold under the product name >Roundup= and other products. The lack of specificity limits the potential location and method of application of such chemicals. For example, they should be applied only with weed wipers or spot treatment, so that the chemical is not applied to plants other than bracken. Non-specific chemicals are best used in areas of dense bracken monoculture because they will kill all non-target plant species. Care should be taken to avoid risks to other non-target organisms, although glyphosate has a fairly low toxicity to animals and is effectively inactive once it reaches the soil. This chemical also has the advantage of producing a general yellowing of vegetation within a few weeks, enabling evenness of application to be judged and any additional treatment to be carried out where necessary.

Follow-up treatment

Most bracken management programmes will involve some degree of follow-up management and this is often more expensive than the primary treatment (Rhone-Poulenc 1997). In the year following the initial herbicide treatment, it is likely that at least a sparse cover of individual fronds will emerge in areas formerly covered by dense stands. If helicopter spraying has been used there may also be strips or areas of bracken which were missed. The type of follow-up treatment used to manage this regrowth will depend on such factors as financial and labour resources, the suitability of the ground for machines and the density of the regrowth.

The response of bracken to chemical treatment is determined by the number of dormant buds and the structure and volume of the rhizome system (Rhone-Poulenc 1997). Generally speaking, the smaller the total rhizome bulk, the simpler the rhizome system, the fewer the total number of buds and the fewer the number of dormant buds, the easier the bracken will be to manage. Complex, layered rhizome beds with large numbers of dormant buds are very likely to require a prolonged programme of aftercare to ensure eradication. An assessment of the rhizome system should ideally be undertaken before a management programme is initiated.

Secondary treatment using herbicides is probably the most straight forward means of follow-up management. Repeated, annual follow-up and spot spraying is highly effective, if expensive and time consuming. Alternatively, cutting or crushing can be conducted as a follow-up (or pre-) treatment for dense stands.

The vegetation that replaces bracken

After it has been removed by spraying, the vegetation that replaces bracken is influenced by (Brown 1986; North York Moors National Park 1991):

- slope;
- aspect;
- altitude;
- soil wetness;
- management practices such as grazing and burning;
- the state of the vegetation beneath the bracken;
- region and locality (ie east coast versus west coast).

In general, where moorland species such as grasses, heather and bilberry are present beneath a stand of bracken, their recovery can be achieved after spraying with Asulox, provided erosion does not result and grazing is sufficiently low or absent. Follow-up spraying is normally required immediately or within two-three years of primary treatment to control the regrowth of fronds. However, recovery of other vegetation may be much slower or may not occur at all if a dense bed of bracken litter prevents seedling germination or establishment. Such litter needs to be broken down by frost, by stock trampling or physically removed. Regeneration of native grasses or heather can be achieved by sowing grass seed or by applying cut heather brash (North York Moors National Park 1986). The stocking density will then need to be greatly reduced, or preferably removed using fencing, to allow seedling establishment.

Applying lime and fertilisers

Applying lime and fertilisers following bracken spraying on areas of grass moorland is sometimes proposed, with the intention of improving the sward and allowing an increase in stocking levels. However, on unimproved land this is not usually compatible with nature conservation objectives, because it prevents successful regeneration of heather and may adversely affect areas such as species-rich mires. On enclosed, improved grassland some follow-up treatment using lime and phosphate may be desirable.

Box IN6.3 Recommendations concerning chemical treatment of bracken

Legislation and safety

- The landowner and operator must ensure that any use of sprays is in accordance with health and safety regulations.
- *Control of Pesticides Regulations* 1986 set out the qualifications required by those involved.
- These also require prior (at least 72 hours) consultation with English Nature before aerial spraying any land within 1,500 m of an SSSI, and with the Environment Agency before spraying any land adjacent to a water course, lake or reservoir.
- *Control of Substances Hazardous to Health Regulations* must be followed by the owner or manager of the land and the persons doing the work, who must be suitably qualified.
- All users of pesticides (including herbicides) are required to take all reasonable precautions to protect the health of human beings, animals and plants, to safeguard the environment and in particular to avoid pollution of water.
- At all times when spraying *The Green Code* (*The code of practice for the safe use of pesticides on farms and holdings*, MAFF 1998) must be complied with.
- The statutory conditions of use on the product label must be adhered to when using any chemicals for bracken management.

Timing of application

- Asulam should be applied when the fronds are fully open and before they have started to die back, for example when at least three pairs of pinnae are fully open (untouched bracken stands, not regrowth). This is usually during late July or early August, although it will vary with the location and the season. In some areas, applications will be effective in September.
- Spraying should not occur until late August where whinchat and twite are present because these species may still be breeding in the bracken.
- A rain-free period of 12 hours must follow application for maximum effect.

Box IN6.3 Recommendations concerning chemical treatment of bracken cont.

Other considerations

- Check the area for the presence of other susceptible plant species of nature conservation interest when using asulam.
  - ❑ No spraying should take place on or close to sites containing susceptible plants of conservation importance.
- Establish buffer zones around all areas to be avoided.
  - ❑ See areas to be avoided above and size of buffer zones below.
- Target management at the invading edge of the bracken.
- Mark out areas clearly, to assist even coverage and ensure buffer zones are adhered to.
- Certain additives may be employed when treating bracken (see *Use of additives* in text).
- Plan secondary treatment.
  - ❑ This is essential, and repeated, annual follow-up and spot spraying is highly effective.
  - ❑ Alternatively, cutting or crushing can be conducted as a follow-up (or pre-) treatment for dense stands.
- Only use chemicals other than asulam where no other vegetation is present, eg areas with deep bracken litter, and then only with weed wipers.
  - ❑ The vicinity must first be checked for the presence of important plant and animal species.
  - ❑ If these are present the area containing the interest should not be treated.
    An appropriate buffer zone must be left around these areas when treating adjacent land (see below).

Aerial spraying of bracken

- Follow all the legal and safety requirements laid out above.
- Conduct aerial spraying in accordance with Civil Aviation Authority licence conditions.
- Publicise aerial spraying operations to avoid hazards to neighbouring properties, livestock and the general public.
- Asulam is the only herbicide cleared for aerial application for bracken management.
- Helicopters should be fitted exclusively with Delavan RD raindrop nozzles to minimise drift.
- No spraying should occur directly on to areas with susceptible, rare plant species beneath the bracken canopy.
- The following no-spray buffer zones must be used:
  - ❑ with helicopters fitted with RD raindrop nozzles:
    - 50 m from water courses (where susceptible, rare plant species are absent);
    - 100 m from areas with susceptible, rare plant species or particularly sensitive habitats, eg limestone pavement;
  - ❑ with helicopters fitted with conventional hydraulic nozzles:
    - 160 m from water courses (where susceptible, rare plant species are absent);
    - 180 m and up to 250 m from areas with susceptible, rare plant species or particularly sensitive habitats, eg limestone pavement.

- Spraying is not permitted when wind speed exceeds 11.5 mph (18.5 km / h).
- Mark out areas to be sprayed and avoided on the ground prior to spraying.
- When spraying outside of an SSSI, spray parallel to the boundary where possible, to reduce the risk of chemical drift from overshooting or wind changes.
- If a buffer zone is not in use, spray when the sensitive site is upwind of the area to be treated.
- Plan secondary treatment, usually by other methods.

Ground spraying of bracken

- Do not spray within the following distances of valuable wildlife features or water courses (Environment Agency 1998; North West Water 1996; Rhone-Poulenc 1997):
  - ❑ wiping systems: 1 m
  - ❑ tractor and knapsack boom systems with conventional, hydraulic nozzles:
    - 10 m for protection of established plants
    - 20 m for protection of seedlings
  - ❑ hand held Micron Ulva drift sprayer: 50 m
- Spraying is inadvisable above wind speeds of 6-9 mph (9.6-14.4 km / h) (Green Code, MAFF 1998)
- Where buffer zones are not in use, spray when the sensitive site is upwind of the area to be treated.
- Only use glyphosate where no other vegetation is present, eg areas with deep bracken litter, and then only on suitable terrain and with a tractor- or ATV-mounted weed wiper.

The effect of bracken management on other plants

Plants of nature conservation value may be present in areas where bracken occurs (Marrs & Pakeman 1995) and bracken management may adversely affect them, particularly when chemicals are involved. Conversely, removing bracken may benefit nature conservation by encouraging the expansion of dwarf shrub heath or species-rich grassland.

Asulam can be toxic to all fern species and can also adversely affect several moorland shrubs, grasses and herbs, causing a temporary check in growth or slight die back (Rhone-Poulenc 1997). This chemical is also sold to control docks *Rumex* spp. in pasture and, therefore, certain members of the Polygonaceae are highly susceptible to it. Lists of species shown to be susceptible to the chemical, as well as those shown to have some resistance to it, are available (Cooke 1986; English Nature 1999; Rhone-Poulenc 1997).

Bracken spraying should not take place on or close to areas containing susceptible plants of nature conversation importance. Where there is concern about the effects of bracken spraying, a suitable buffer zone around the area of interest must be left unsprayed. Spray deposition tends to fall off logarithmically, but it should be remembered that chemical drift can cause adverse effects or death to ferns and other plants beyond the immediate treatment area. Recommended buffer zones are contained in Box IN6.3 above.

Limestone and rocky areas, gills and cloughs are particularly likely to support susceptible plants of nature conservation interest which could be harmed by bracken spraying. Caution should also be exercised when dealing with plant communities which are diverse in both species and groups, because even if plants are not killed, the balance of species across a community could change if one or more species is weakened. In all these situations, appropriate buffer zones are required.

The effect of bracken management on animals

Birds

Any mechanical method must be timed to avoid disturbance to ground-nesting birds, which can be present until late July or early August. Chemical methods involving spraying should not occur until late

August where whinchat and twite are present because these species may still be breeding in the bracken until then. Significant areas of bracken should be retained for breeding birds (Brown & Bainbridge 1995).

Invertebrates

A high diversity of invertebrate species depends on bracken or the habitats associated with it (see *Reasons for retaining bracken*). Managing bracken may lead to the loss of species of nature conversation importance. However, bracken also supports pest species such as sheep tick in high densities (Sheaves & Brown 1995), and removing bracken may be desirable for controlling these invertebrates.

In areas where fritillary butterflies occur, particular conditions and management regimes are required to maintain the populations. This is because the butterflies feed in spring and early summer on violets growing in the warm microclimate provided by the developing bracken canopy. However, as bracken stands become more dense the violets are lost and the value to the butterflies declines. Appropriate bracken management, for example grazing with cattle or ponies to break up the bracken litter, spot-spraying or crushing, is then necessary to retain the required conditions (see Butterfly Conservation 1998; Warren & Oates 1995).

Bracken management should also take into account the weevil *Procas granulicollis* which, although feeding specifically on climbing corydalis *Ceratocapnos claviculata*, normally a woodland plant, seems to do so preferentially when this plant grows among bracken. When not feeding, the weevil spends most of its time sheltering within dead bracken stalks with bracken litter. The distribution of this species is unclear, but it has been found in Cumbria, Northumberland, North Yorks, Wales (Ceredigion) and Scotland.

Amphibians and reptiles

Managing bracken is beneficial for reptiles in some areas. Dense bracken creates problems for these animals because it shades the ground too heavily. Where bracken management is considered in areas with reptiles, the methods used should be sensitive to the needs of these species. Consequently rolling bracken or forage harvesting should be avoided, or at least carried out with caution, in areas that are good for reptiles. Hand spraying using Asulox is recommended.

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Information note 7 Fencing in the uplands

Introduction

Upland fencing is usually aimed at controlling grazing livestock, although it is also used for other purposes such as managing people and access. It is often related to nature conservation objectives, such as protecting vegetation from grazing pressure or restoring eroded areas. It can also assist with stock management over large sites, prevent damage by wild animals such as rabbits or deer, allow vegetation to recover and trees and shrubs to regenerate, and encourage stock to graze relatively unpalatable areas.

In many areas, walls have traditionally been used to control stock numbers and movement, and for biodiversity, building up delapidated walls is preferable to erecting fencing. Where this is not possible, fencing alongside walls is generally preferable to new fences.

Upland areas are highly valued for their open landscape character and recreational use. Both are easily diminished by insensitive fencing and, therefore, new fence lines are unpopular with many organisations. Some National Park Authorities, for example, have policies to resist fencing over open land. Alternatives to new fences should always be explored first, such as reducing stock, shepherding or using individual shelters for protecting trees and shrubs. Where new temporary or permanent stock proofing is still felt to be necessary, it must take into consideration potential visual impacts and effects on recreational access (Andrews & MacDonald 1996).

Many upland areas are registered common land, and the consent of the Secretary of State must be obtained for temporary or permanent fencing. There is a standard procedure to follow and applications must demonstrate the benefits of fencing. The precedent for temporary fencing to restore degraded, damaged or eroded areas has been well established, but the support of common rights holders is essential.

Siting the fence

Terrain

- It is more difficult to erect fencing over sloping and uneven ground, as more materials are needed.
- Animals can often squeeze beneath fences where dips occur, therefore gaps must be blocked with netting or post and rails.
- Sharp rises may make it easier for animals to jump the fence.
- Not siting the fence above, below or on unstable slopes will help to prolong the life of the fence.
- It is wise to try to find the best substrate. Rocky or stony areas for the straining posts should be avoided, if possible.

- If the soil is very soft (ie peaty ground) then mineral soil or rocky ground may be preferable, if available.

- Waterlogged areas may not hold the posts and should be avoided.

Land management factors

- Fencing can hinder as well as help stock movement and should be sited so that is does not unnecessarily impede existing shepherding and gathering practices.

- Where burning is conducted, the impact of fencing on the burning regime will need to be considered.

Appearance

- Where possible, the existing scale and pattern of enclosure should be maintained.

- Siting the fence along the line of existing boundaries, stream lines and breaks of slope helps to minimise the landscape impact.

- Fencing against the sky line should be avoided, if possible.

- Although it may be the most economical option, straight fences should be avoided, especially up steep slopes.

- Oblique angles should be used on steeply sloping ground wherever possible.

- A fence may produce contrasts in vegetation which in the longterm may be more obvious than the fence itself.

Recreation

- Recreational interests should be consulted where enclosures of significant size are considered in popular access areas.

- Rights of way and other similar through-routes must not be blocked and appropriate means of access will be required.

- Explaining the purpose of the enclosure, by descreet interpretative signing or leaflets at appropriate nearby points, will help visitors to understand the situation.

- Fences may displace or concentrate recreational impacts, and this may have adverse environmental or management impacts.

Biotic Factors

- It is best to avoid wild animal and stock tracks. Badgers *Meles meles* may undermine the stock proofness, as may deer in the rutting season. Stock may cause heavy grazing and poaching along fence lines.

- The tops and bases of slopes should be avoided, to limit erosion from animals and humans which may follow the fence line.

- Displaced animals may unacceptably increase the grazing pressure outside the fenced enclosure.

- Stock will still need access to water and adequate shelter in bad weather, whether inside or outside of the fenced area.

- Any fenced enclosure which animals might get into should have a gate. This will also allow vehicular access.

- Birds such as black grouse *Tetrao tetrix* and, to a lesser extent, red grouse *Lagopus lagopus* can collide with fences. Fences should not be sited in particular locations, such as following ridges, and should be positioned so that they are easily flown over without avoiding action being necessary. Attaching markers, such as the traditional twists of heather, or more modern markers such as bright orange plastic strips/nets or metal reflectors, at intervals on the top wire should help. Making the fence more visible by bringing the stock netting up to the height of the top wire (and adding a wire below to compensate) may also reduce fatalities.

- On mires, treated timbers can leach chemical preservatives into the system and cause loss of *Sphagnum*. Treated timbers should not be used in sensitive locations.

Snow

- Drifting snow can break the fence. Site away from hollows and breaks of slope to avoid snow drifts, or seek local advice about where snow accumulates.

- Avoid acute corners in the fence where snow and stock may gather as the stock may be trapped by snow lie.

- Close netting or mesh gathers more snow. Single wire fencing is therefore preferable.

- High tensile wire fencing is better than mild steel because it uses fewer posts, farther apart. High tensile electric fencing may be an alternative.

Choosing the most appropriate type of fence

To choose the most appropriate type of fence, it is necessary to consider the type of stock and vegetation involved, the terrain and ease of access to the area, and the effects of climate (including snow lie, see above). On top of these considerations are the cost of labour and materials, the intended life span of the fence, and the maintenance and appearance of the fence.

Stock proof fencing will vary depending on the type of stock involved and whether they are to be kept in or out. Different types of fence for different kinds of stock are discussed below. The effectiveness of stock fencing is dependent on the contentedness of the stock as much as the competence of the fence. Content animals with sufficient grazing have less inducement to break out. However, in some instances, fencing is aimed at forcing animals to eat coarse vegetation.

Stock are likely to break out of enclosures when:

- insufficient feed or grazing is present;
- the grazing is better on the other side of the fence, and they force their heads through the fence;
- they seek shade in hot conditions;
- certain mountain and rare breeds are kept, which are more likely to jump;
- they are being herded by dogs;
- they are kept on their own and get bored.

The type of vegetation and the terrain to be fenced will also determine the requirements. For example, when fencing trees or shrubs on difficult terrain, it may be more effective and economical to use individual fences or tree protectors.

Concerning access to the area, issues to consider include the following:

- getting tools and materials to and from the site;
- the weight of materials;
- high tensile wire is much lighter than stock netting;
- size of stock netting rolls (some rolls are too big and heavy for people to carry);
- electric fencing is light and cheap but supply of power and maintenance in remote areas may be difficult;
- solar and wind power may be an option.

Types of fencing

Post and wire strained fencing

This is a very common form of fencing consisting of wire stretched between straining posts with intermittent stakes to stiffen the fence and keep the wires apart. It is:

- easy to erect;

- versatile;
- relatively low cost;
- good for covering long distances;
- best suited to smooth terrain;
- less easy and more expensive if the terrain is uneven and/or has many changes in direction.

Types of post and wire fences include:

- wire with stock netting - good, stock proof fence - sheep and cattle;
- three line wires - cattle only - conforms to MAFF specifications;
- five line wires - cattle and sheep;
- seven line wires - cattle and sheep;
- high tensile seven line wires - very strong stock proof fence - conforms to MAFF specifications;
- rabbit fencing - wire and rabbit meshing - cattle, sheep and rabbits (see Information note 8 Rabbit Control);
- deer fencing - 1.85 m fence of line with netting - deer, sheep and goats;
  - wire and netting with rabbit mesh below - deer, sheep, goats and rabbits (see Information note 8 Rabbit Control).

Post and rail fencing

This type of fencing is:

- not usually sheep proof;
- adequate for light use with cattle;
- usually amenity fencing.

Electric fencing

Commonly used as temporary fencing, and useful for managing open habitats and zoning grazing. It is:

- used as a psychological barrier;
- lighter and cheaper than other fencing;
- liable to short out on growing vegetation or snow;
- likely to need frequent supervision and maintenance;
- easily breached by stock if inoperative.

Types of electric fence include:

- cattle fence - temporary single wired fence for cattle control only - can be used to compartmentalise grazing;

- reel system fence
  - similar to cattle fence - capability of more than single wire;
  - single strand - cattle and horses;
  - three strand - cattle, horses, sheep and goats;
- electric netting
  - temporary - different heights for rabbits/sheep/horses;
- scare wire
  - addition of single live wire to existing stock proof fence;
  - prolongs life of fence by lessening damage by animals;
  - located on the interior of the fence for stock and on the exterior for wild animals such as deer or goats;
- permanent five strand
  - sheep/cattle;
  - high tensile version for extreme conditions.

A comprehensive guide to fencing, including siting, choice of fence and construction details is given in Agate (1986).

Examples of upland fencing specifications

Five line strained wire fencing

Strained line wire fencing should be not less than 1.05 m high from ground level to the top wire and can be constructed to the following specifications.

- Preservation Treatment

  All timber should be pressure impregnated with Tanalith C.
  Note: All timber should be dried prior to treatment in order to gain maximum penetration.

- Straining Posts

  Straining posts should be equivalent in strength and durability to:
  - 125 mm top diameter round timber, or
  - 125 □ 125 mm sawn timber,

  and at least 2.17 m long when not set in concrete and at least 1.87 m long when set in concrete. Straining posts should be spaced at centres appropriate for the ground conditions and in any case not exceeding 100 m where mild steel line wire is used or not exceeding 200 m for high tensile line wire.

- Struts

  Struts should be equivalent in strength and durability to:
  - 80 mm top diameter round timber, or
  - 75 □ 75 mm sawn timber,

  and at least 1.9 m long when not set in concrete and at least 1.6 m long when set in concrete.

- Intermediate Posts

  Intermediate posts should be equivalent in strength and durability to:
  - 80 mm top diameter round timber, or
  - 75 □ 75 mm sawn timber,

  and at least 1.72 m long.
  Intermediate posts should be at centres not exceeding 3 m.

- Line Wire

  Wire should be galvanised and equivalent in strength and durability to:
  - 4 mm steel wire, or
  - 2.5 mm mild steel 2 ply twisted barbed wire, or
  - oval section 13 gauge barbed wire.

Woven wire stockproof fencing

Woven wire fencing should be not less than 1.05 m high from ground level to the top wire and can be constructed to the following specifications.

- Preservation Treatment

  All timber should be pressure impregnated with Tanalith C.
  Note: All timber should be dried prior to treatment in order to gain maximum penetration.

- Straining Posts

  Straining posts should be equivalent in strength and durability to:
  - 125 mm top diameter round timber, or
  - 100 □ 100 mm, or equivalent cross section sawn timber,

  and at least 2.15 m long when not set in concrete and at least 1.85 m long when set in concrete.
  Straining posts should be spaced at centres appropriate for the ground conditions and in any case not exceeding 100 m where mild steel line wire is used, or not exceeding 200 m for high tensile line wire.

- Struts

  Struts should be equivalent in strength and durability to:
  - 80 mm top diameter round timber, or
  - 75 □ 75 mm sawn timber,

  and at least 1.9 m long when not set in concrete and at least 1.6 m long when set in concrete.

- Intermediate Posts

  Intermediate posts should be equivalent in strength and durability to:
  - 80 mm top diameter round timber, or
  - 75 □ 75 mm sawn timber,

  and at least 1.8 m long where 1.15 m woven wire is used, otherwise not less than 1.7 m. Intermediate posts should be at centres not exceeding 3 m.

- Woven wire

  Woven wire should be galvanised and should comply with British Standard (BS) 4102. Where the width of the woven wire selected is less than 1.05 m the required fence height should be obtained by fixing plain or barbed wire above or below the woven wire. The use of heavyweight woven wire is recommended in areas subject to atmospheric pollution.

  Woven wire BS reference: C8/115/30
  C6/90/30
  C8/80/15 OR C8/80/30

- Barbed wire

  This should be galvanised barbed wire to BS 12.5 g two strand.

- Plain wire

  This should be galvanised plain wire 10 g (3.15 mm).

- Staples

  These should be galvanised wire staples 40 mm □ 4 mm (8 g).

One strand of plain wire should be fixed 2A (50 mm) above ground level. The bottom of the woven wire should be fixed 2A (50 mm) above the plain wire, ie 4A (100 mm) above ground level. The bottom strand of any wire fence deteriorates most quickly and a single strand below the woven wire can be replaced cheaply and quickly, thereby prolonging the life of the fence.

One strand of barbed wire should be fixed 4A (100 mm) above the top of woven wire. The wire should be properly strained and fastened to the posts with galvanised staples. To allow for future adjustments and to prevent damage to the galvanising, staples should be driven in obliquely but not driven fully home.

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Rabbit grazing

The rabbit *Oryctolagus cuniculus*, which was introduced to Britain in the twelfth century, can be a significant grazer in some areas. Rabbits became a major agricultural pest until myxomatosis almost wiped out the population in 1954. This decline had a dramatic impact on certain grassland types, especially over limestone, where rabbit grazing often maintained the conservation value. However, in many areas rabbits have since returned to, or close to, their pre-myxomatosis levels and can adversly affect valuable wildlife habitats. Plant communities can be prevented from flowering and species may be lost, for example in limestone pavement and grassland areas. The natural regeneration of trees and shrubs can also be prevented by rabbit grazing. They are common on land grazed by domestic stock and therefore their impacts are additional to those of grazing livestock. Their populations tend to fluctuate from year to year and this should be taken into account when considering agricultural stocking rates. The advent of the disease, Viral Haemorrhagic Disease (VHD) may influence rabbit numbers in the future, although to what extent is not fully known.

Rabbit control is an important issue in nature conservation and should be considered in any grazing strategy. The main problem faced by conservationists is that rabbits are difficult to control.

Rabbit control methodology

Non-lethal control methods: barriers

Rabbits may be fenced in or out depending on the prevailing circumstances. Rabbit fencing is based upon the specifications for post and wire fencing given in Information Note 7, with 31 mm, 18 gauge mesh held to line wires above and below by netting rings. Barbed wire may be used as the top strand if stock is also relevant. A further mid-wire is also recommended for additional strength for stock fencing. The bottom 150 mm of the netting may either be turned outwards at an angle of 45E to the vertical and buried in a shallow trench or be laid out at 90E to lay flat on the ground. This should be pegged out with wire loops and turfs may be placed on top. In all cases the netting should face in the direction from which the rabbits are expected to dig. Electric net fencing (Flexinet) can also be effective particularly where there is a temporary need to exclude rabbits.

Individual tree saplings may be protected using tree guards if fencing is inappropriate or unfeasible.

Lethal direct control methods

In certain situations the use of lethal control methods for rabbits may be unavoidable. In situations where rabbits are causing damage to crops, pasture, animal or human foodstuffs there may be a legal responsibility for landowners to eradicate rabbits. Severe degradation of a site=s conservation value may also warrant such action. When considering a methodology, efficacy and humaneness must be taken into consideration. Where rabbit control is required, local landowners and farmers may be a useful source of advice when seeking persons who are able to undertake such control.

The optimum time to commence any form of direct control is when the population is at its lowest, prior to the breeding season. A concerted effort should therefore be made between the months of November and March.

Gassing

Gassing is considered to be the most effective direct control method where burrows are accessible. After a single treatment, rabbit numbers can be reduced by as much as 90%.

This method involves the use of either sodium cyanide powder (marketed by ICI as Cymag) or aluminium phosphide pellets (Talunex). These produce, respectively, hydrogen cyanide gas and hydrogen phosphate gas, are both lethal to rabbits. In both methods the chemicals react with moisture and air to produce the gas. Use of both methods is extremely hazardous and great care must be taken to ensure the safety of humans and wildlife. Aluminium phosphide should only be employed by an operator trained in its use. This method is purportedly safer and quicker than using sodium cyanide.

The powder or pellets is/are introduced at the entrance to a burrow. The other exits to the burrow must be blocked and made sufficiently airtight that there is no risk of a major gas escape. Gas must not be employed where the porosity of the soil or substrata will allow leakage of the gas. This is most apparent in limestone areas where gas could leak into cave and ground water systems.

Shooting

Shooting with a shotgun or .22 rifle is a widely used, though relatively inefficient, method of dealing with surface-living rabbits. Shooting at night with lights (lamping) is considered a more effective method. Both methods are confined to authorised persons, ie owners, occupiers and those possessing the shooting rights.

Possession of firearms, shotguns and ammunition is all governed by legislation which should be consulted (see Parkes 1991).

Snares

Snares should be set on rabbit runs away from cover, preferably on windy, moonlit nights, lacking frost. The 1981 Wildlife and Countryside Act prohibits the use of self-locking snares except under licence and requires that other types should be inspected every 24 hours. Snares should not be sited where livestock or domestic animals have access.

Traps

Spring Traps

Spring traps must be of a type approved by legislation for use on rabbits (see Crofts and Jefferson 1994). They must, according to law, be placed in burrows, at least within the overhang of the hole, to reduce the risk of catching other species. This method of trapping is labour intensive, requires considerable skill and is not widely used.

Drop Traps (Drop Boxes)

This is a much more effective method of trapping with consistent results. Drop traps exploit the behaviour of the rabbits, catching them while they move from rough pasture to more fertile grassland to feed at night. Drop traps consist of a tunnel, below which is a box. The floor of the tunnel acts as a trap door letting the rabbit fall in the box for retrieval later (see Figure IN8.1). The specification of a wooded trap is given below, but metal designs also exist.

It is a legal requirement that the traps are checked daily, but to set the trap at night and check first thing in the morning is probably more acceptable.

Rabbit drop trap specification

- Traps should be placed about 75 m apart.
- Where possible traps should be placed in the paths of identified existing rabbit runs.
- Traps should be dug in at the same time as rabbit mesh is erected, so rabbits will continue to use the same runs.
- Traps should be dug in so that the top is flush with the ground surface.
- Traps need to be locked shut for a period while the rabbits become used to using the tunnels.
- Trap bottoms should be porous to prevent water build up.
- Trap doors should be made loose fitting to allow for swelling of the wood in damp conditions. There can also be a problem with doors freezing shut in winter.
- Correct building specifications are important:
  - ❑ the correct gauge wood must be used to make sure the trap is not too springy or fast acting;
  - ❑ tunnel length must be sufficient for rabbits to be fully inside before the flap falls.
- If wood preserver is used, try to avoid a strong vapoured brand. >Bartoline= shed and fence treatment is ideal, being harmless to plants and animals.

(Adapted from *Focus on rabbits* in the Craven Wildlife Enhancement Scheme newsletter).

Ferreting

This is a useful follow-up method, or for small scale problems. It is advisable to allow at least a week before ferreting in a gassed area. Ferrets are used to bolt rabbits which are either shot as they emerge or caught in nets and killed. It is possible that somebody local will be able to carry out the work, often just for the rabbits caught.

Long Netting

Where rabbits are abundant, large numbers may be taken in long nets. These nets are usually 45 to 135 m long, 1 m wide with a 5 cm mesh. Nets are run out at night, downwind from feeding rabbits, about 13 m from the nearest cover. There is a line along the top of each net which is supported by 1 m sticks at 4 m intervals (smaller hazel pegs are also effective and lighter to transport). The slack of the net is allowed to lie loosely on the ground weighted with a leaded line below. Once the net is erected rabbits can be driven into the net at speed by dogs and beaters, or more quietly at night by herding rabbits toward the net with a slow zig-zag walk. Netting can be used in conjunction with ferreting by setting long nets around and across a warren. Ferrets are then sent down the burrows and the rabbit are caught escaping.

>Trammel= nets work in a similar way to long nets though two nets are involved. A fine mesh front net is pulled by the fleeing rabbit through a hole in the much coarser netting behind. This creates a >purse net= effect making it difficult for the rabbit to escape.

Whichever method is utilised, care must be taken to minimise the impact on the nature conservation resource. The eventual method chosen should account for this, as no method will fit all situations. All methods should be practised in as humane a manner possible and discretion should be paramount where public attention may be drawn to the operation.

Adapted from Crofts and Jefferson (1994).

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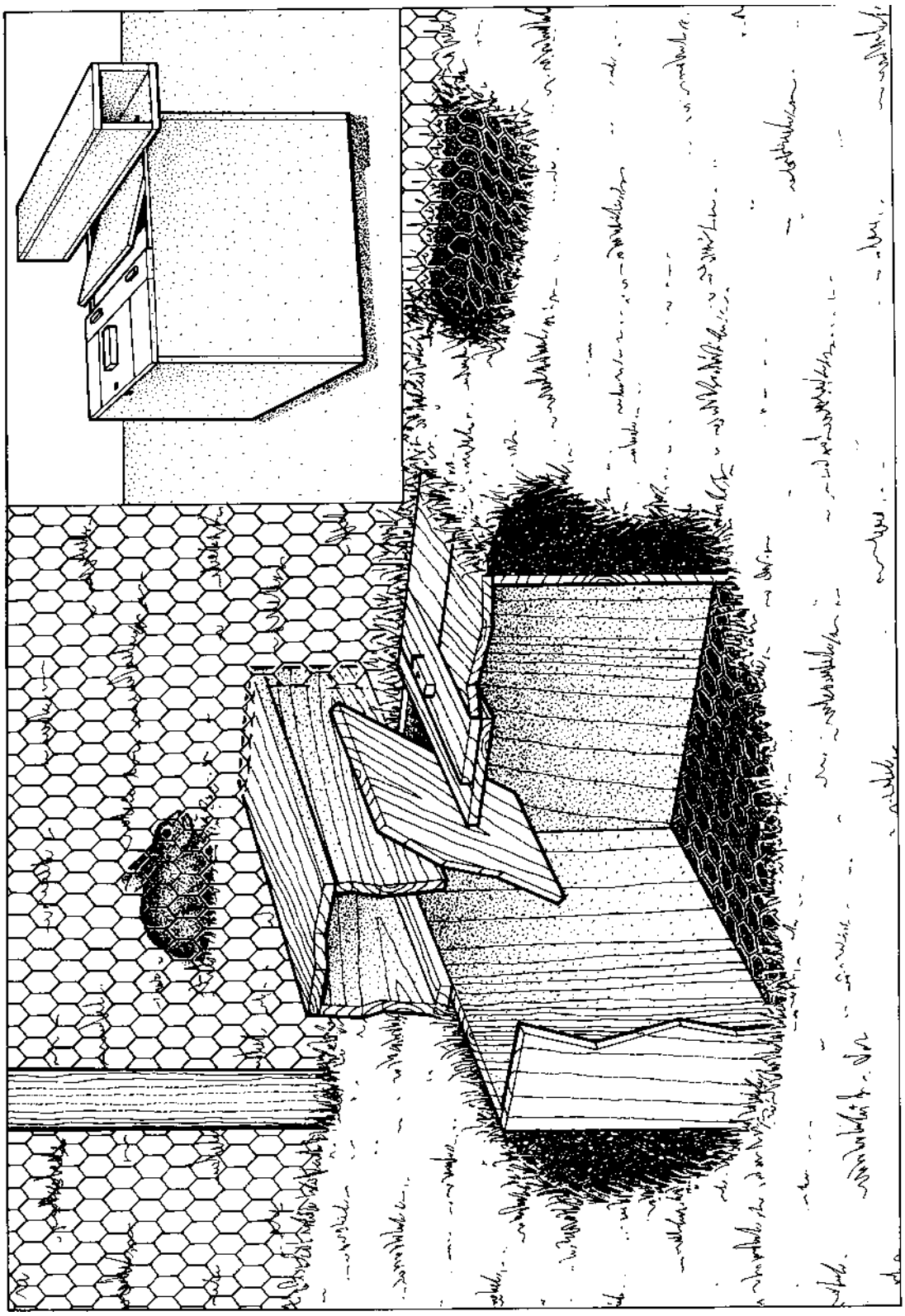

Figure IN8.1. Rabbit drop traps (drop boxes)

Information note 9 Moorland grip blocking

Background

Moorland gripping is the practice of digging ditches with the intention of draining wet areas of heath and blanket bog. Gripping was especially prevalent in the uplands of northern England from the 1960s to the mid-1980s and was often grant-aided. In the Yorkshire Dales about 60% of the peat moorlands in the National Park were subjected to machine gripping. Gripping generally consists of a herring bone pattern of ditches cut into the bog at approximately 20 m intervals.

Apart from the obvious destruction of vegetation caused by gripping, drainage can change the vegetation structure and composition, and the exposed peat surfaces are extremely susceptible to erosion. Subsequent increased runoff can greatly affect flow downstream of the catchment. Increased siltation and a greater likelihood of flash flooding are both associated with an increase in runoff. During dry periods reduced flow can be caused by the bog having reduced capacity to retain water.

Objectives of grip blocking:

- to restore natural drainage patterns;
- to encourage revegetation of the bog surface;
- to reduce erosion;
- to minimise the knock-on effect of hydraulic change downstream.

Achieved by:

- blocking eroding grips (and those feeding into hagged areas);
- blocking 'active' grips that are maintaining themselves;
- blocking grips across level and basin / raised mire areas;
- allowing grips to infill naturally where possible;
- designing works to avoid danger to stock.

Construction

Dams should be constructed using a plug of peat and retaining the surface vegetation where possible. This will allow the vegetation plug to knit together with adjacent vegetation, thus creating a stronger structure. Material should be scooped out of the adjacent ground immediately up slope of the dam, but must not be taken from undisturbed bog. The peat should not be allowed to dry out before it is well compacted into the grip. The breadth of the dam should normally be one to two times the width of the grip (but more where the grip is deep). The dam height should normally be level with, or slightly higher than the surrounding vegetation surface. It is important that water behind the dam should not exceed a depth of 60 cm, as this would create a potential hazard for livestock. In this situation dam height should not exceed 60 cm. Overflow seepage should be directed laterally away from the grip into low points or runnels, where they exist. Dams in wider more eroded grips may be strengthened by the insertion of timber posts or boards, with peat compacted behind. Boards may also be required to stop leakage in the less consolidated peats of raised mires.

Situation

Dams should always be included at the uphill end of a grip system, not just in the highly eroding middle or lower sections. They should be spaced so that the water level reaches the base of the next dam up slope or at 10 -20 m intervals where the ground is level or shallow sloping. On steeper ground this may not be practical, and here high feeder grips should be blocked so as to slow down the water flow. Wherever possible grips should be blocked at the junction with natural drainage runnels. This is preferable to blocking at regular intervals, as it restores natural flow patterns.

Practicalities

Dams should be built in the autumn and should start to revegetate in the spring. Use of excavation machines is likely to be cost effective for any significant number of dams in one area. This should be a low ground pressure, tracked excavator to avoid damage to the vegetation (a Kubota 151 on 60 cm wide tracks has been used in the North Pennines). Access for machines is easier and less damaging at drier times, but the peat may not be wet enough to compact well during these periods. A balance therefore must be sought, to minimise damage while installing effective dams. Hand working is likely to be more appropriate for inserting a small number of dams or for work in steep or eroded situations too dangerous for machines. Care must always be taken to minimise hazards to livestock and wildlife.

Further reading

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BROOKS, S. & STONEMAN, R. 1997. *Conserving bogs: the management handbook.* Edinburgh: The Stationery Office.

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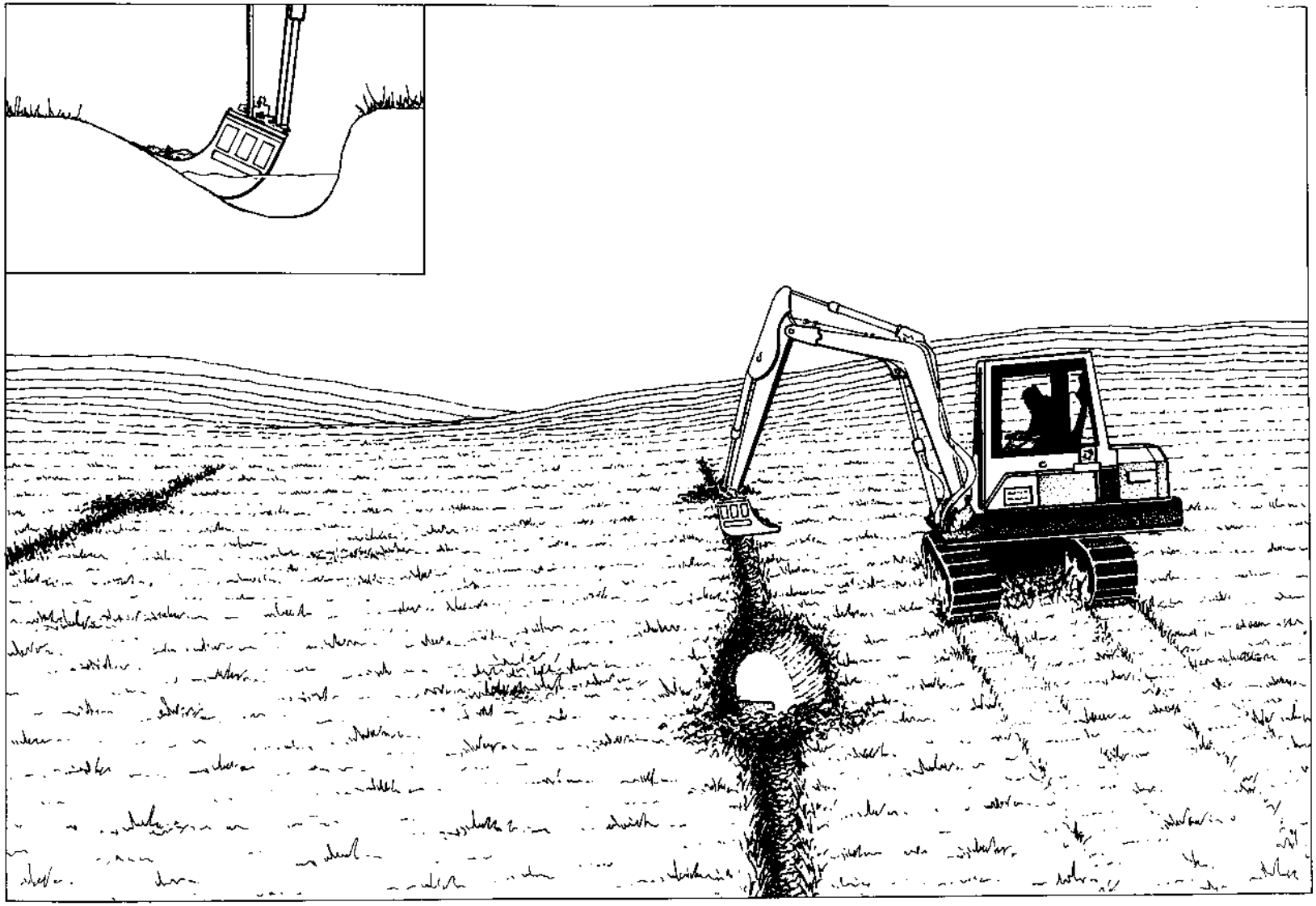

Figure IN 9.1. Moorland grip blocking

Material is scooped out up slope of the proposed obstruction to form the dam itself, but must not be taken from undisturbed bog. As the use of machinery can seriously damage bogs and wet heath, alternative methods should always be considered.

Information note 10 Managing public access and footpaths in the uplands

Introduction

The uplands are popular areas for public access and recreation. They are extremely valuable for providing enjoyment and appreciation of the countryside. In some areas visitor pressure may cause problems for wildlife, landscape interests or land managers, but generally the effects are localised. Public access can take place without causing problems, provided that it is well planned and managed. Where there are localised problems, these can usually be resolved, through the cooperation of interested parties and the type of management being related to the type of access and use, and the area concerned.
Much of upland England is already open to the public to varying degrees and appropriate management here can benefit all concerned. In other areas public access is not permitted, but the extent of the uplands open to the public will increase as a result of the Countryside and Rights of Way Act.

Managing public access is a well documented subject. The detail covered in this Information note merely aims to provide some practical guidance on methods which could be employed.

Why access management is necessary

Management of access may be deemed necessary for varying reasons, for example where:

- areas/species that are susceptible to damage/disturbance need to be protected from public interference;
- public safety may be jeopardised;
- an area of relative seclusion may lose its attraction if over used;
- erosion of a footpath necessitates re-routing of the path to a more sustainable position.

Once the specific motives for management have been identified, then strategies for the implementation of the management can be considered.

Car parking

Practical control of access in many instances begins in the car park. Ease of access to a site is often the most influential factor in determining visitor popularity. In the car orientated environment of today, car parking is a primary consideration for many visitors. The size of a car park dictates the approximate number of visitors during peak periods. This is especially true of nature reserves, view points and other areas of high interest.

Provision of >lay-by= type car parking along a linear feature (eg a lake shore) will spread visitor pressure. The provision of larger car parks at selected sites and the absence of >lay-bys= means intensified visitor pressure in those areas, but also containment to specified sites where remediation of adverse effects may

be more easily implemented. In the same way, development of a new car park at a similar, though less used, site may ease pressure from a >honey pot= location and spread visitor impacts. It must be remembered that if areas are to be formally turned into car parks, planning permission may be needed.

Car parking should ideally be on free-draining soils, to reduce the cost of resurfacing. Care should be taken to minimise the visual impact of the site and screening with trees should be considered. Maximisation of space is important, but this should not be at the expense of visual acceptance. Straight lines of vehicles will look out of place in a rural environment. Small enclosed bays are often more visually acceptable though they are difficult to police and may encourage theft or vandalism (Vickery 1995).

A proportion of spaces should also be specifically allocated for people with special needs such as wheelchair users or visitors with walking difficulties, located near facilities such as toilets and visitor centres and in more scenic parts of the car park. The parking spaces must be wide enough to allow easy movement in and out of the car (minimum width of 3 m, preferably 3.6 m - a standard bay is 2.4 m) and with level access to footpaths (Vickery 1995).

Owing to the significance of the car park as the initial visitor access point, guidance from the car park is an important measure in controlling the movements of visitors from the outset. Strategies for this type of manipulation are discussed below.

Zoning

Zoning is the prioritisation of areas for visitors, either by direct or indirect manipulation. These areas can be represented by parts of a National Park or even county, or small areas of a nature reserve with different access requirements / needs. An example is the designation of quiet areas within the Lake District National Park Authority=s policies. Zoning can involve encouragement of visitors to use a certain area, as much as discouragement. It may be that the only way to divert attention from a site would be to offer an alternative, comparative site elsewhere.

In the Derbyshire Dales National Nature Reserve (NNR) zoning is practised on a sliding scale by the amount of publicity and maintenance given to each Dale. Lathkill Dale is advertised in the local press and visitors are actively encouraged by ease of access and the availability of interpretive material (there are eight leaflets published about this dale). Situated close to Bakewell, this is an ideal place of focus for people when out for a day in the Dales. Cressbrook Dale has a public access path running through it. Paths are maintained and waymarking is provided, making access reasonably easy. Monks Dale is a more isolated valley and attracts fewer visitors. Here the path can be quite difficult to walk on as it passes along the edge of the stream. The path has deliberately not been improved and there is little or no publicity of the Dale because it has been decided that increased recreational use of this dale will not be actively encouraged. The fourth dale in the suite has access by permit only, and completes the range of accessibility from easy to less so (B le Bas, pers comm).

Zoning within smaller areas is also useful. Zoning of access on a reserve can be achieved by active manipulation (eg waymarkers, good paths, interpretive material) and also by inactivity (eg non-removal of scrub / undergrowth, leaving paths to deteriorate).
The zoning of recreational activities and wildlife interests is a well practised formula for inland water bodies. Sizable water bodies can be compartmentalised to allow for recreational activities to be zoned

from >noisy to quiet=, therefore minimalising conflicts between users. Refugia can also be created to maintain a site=s wildlife interest, though wildlife often does not comply with boundaries and time tables. On smaller water bodies zoning may prove more of a problem. Where there is a series of smaller water bodies, for example disused gravel pits, individual water bodies could cater for different activities. However, zoning may be difficult to police and may need wardening.

Interpretation

Interpretive material supplied at a discrete site, such as on a nature reserve, or before a site visit, can be a valuable tool in influencing visitor movements and activities. This can be done in a number of ways, from simply showing the main routes of access at the entrance to a site, to directing people toward areas of special interest. The main uses of interpretation in visitor management are:

- to direct people to areas where the manager would prefer them to go;
- to try to prevent people from visiting areas that are sensitive, or where the manager does not want them to go;
- to provide information on safety and fulfill public liability requirements;
- to increase awareness and a sense of responsibility toward a site or area;
- to enhance the enjoyment of an area.

Interpretive material can come in many different forms. **Information boards** are the most often used and can be very useful in directing the movement of people at a site. As mentioned above, even a simple map showing the main routes around a site is often enough to keep people from wandering. Further explanation of conservation issues and reasons for not straying from waymarked areas are also very effective. Signs and information boards should be made as unobtrusive as possible and usually confined to the site entrance, preferably where visitors leave the car park. Elsewhere signs should be avoided, unless absolutely necessary.

Leaflets detailing general or specific information about a site can be used in a similar manner to information boards. They are especially useful when dealing with visitors with specialist interests. Leaflets about birdwatching, botany and geology can be used to direct visitors to areas chosen by the manager, and to try to deflect interest away from sensitive areas which may suffer from increased visitor pressure. Leaflets of this kind are very helpful in situations where access is limited to permit only. Those applying for permits will probably have some special interest in the site and additional information can be sent with the permit. As well as information detailing where to go, safety information can also be included.

Codes of Conduct are often employed to raise awareness and as a means of access management. These can be conveyed in all forms of interpretive material and can be targeted to certain users and certain recreational activities. Dartmoor National Park Authority, for example, produces Codes of Conduct for many specialist user groups to try to strike a balance between recreational access and wildlife interests.

Nature trails can also be used to concentrate interest, and direct the movement of visitors. At a privately owned reserve such as Upper Teesdale NNR, where access is by footpath only, the provision of nature trails and the explanation that all interest features can be seen from the path helps to ensure trespass is kept to a minimum (C. McCarty, pers comm).

Footpaths

The provision of footpaths is one of the simplest and most effective forms of access management. Many statutory rights of way already exist in the uplands and it is important to remember that there is a legal procedure for altering them. Information on public rights of way is available from County and District councils and National Park Authorities. Societies such as Ramblers Associations will also have information.

In upland areas especially, the majority of visitors will tend to follow recognisable routes. The provision of an easier walking surface than that of the surrounding land (eg a flagged path over wet peat, or a pitched path in a boulder field) will also encourage visitors not to stray. However, the purpose of constructing paths in the uplands is to protect or repair the vegetation - it is not to make access easier, although indirectly this may occur. The problems associated with footpath construction, maintenance and user management are discussed below.

Waymarking

Waymarking is very much a part of footpath management and is a useful technique for preventing accidental digressions from the intended route. Care must be taken not to allow waymarkers to become obtrusive or be placed unnecessarily. Many valley paths across agricultural land are not well defined on the ground. In these instances waymarking allows continued use of a right of way which may otherwise fall into disuse, especially for people without a map.

Waymarks can consist of coloured **dots** or **logos**, displayed on signs, fences, walls and so on, or **arrows** dictating changes in direction. Standard waymark arrows recommended by the Countryside Agency indicate both direction and status of the right of way. A yellow arrow indicates a footpath and a blue arrow a bridlepath. A white arrow indicates a permitted route. Waymarkers should, wherever possible, be placed at or on existing structures, such as stiles or fences and only when absolutely necessary should structures be created for this purpose.

Waymarking in upland areas is often deemed unnecessary by some hill users, who consider a thorough knowledge of navigation techniques a prerequisite to leaving the valley floor. One method of upland waymarking used in the Lake District and other areas, is the **cairn** (pile of stones). Traditionally these marked the tops of passes and high points along routes. Recreational walking has produced a multitude of modern cairns that are often obtrusive and in some cases misleading. Strategically placed cairns can be employed to direct users on to certain path lines and can be a great asset in combatting footpath erosion. Other types of waymarking include the discreet use of boulders, vegetation, and so on. However, in upland areas no waymarking should be the general policy.

Wardening

In certain situations and for certain access management strategies the deployment of wardening staff may be necessary. At Upper Teesdale NNR in the Pennines, wardens are deployed at peak visitor times, in an advisory capacity and to discourage trespass of visitors onto sensitive land. Voluntary wardening staff may be used.

In Dartmoor National Park emphasis is placed upon guided walks for the public led by National Park Wardens. By highlighting and publicising the walks, many visitors get to know certain areas chosen by the Park Authorities. In this way the public=s attention is focused on these areas when independent visits are planned.

Public access management plans and access agreements

This can be a useful way of balancing the requirements of all parties involved. It is a consultative method, whereby all parties with an interest in the access rights of a certain area agree to an Access Management Plan, which then becomes the basis for an Access Agreement. To be successful it has to offer potential benefits to all parties (landowners, farmers, conservationists and those involved in recreation) and recognise that each has a legitimate interest in the area. All parties involved should have an increased awareness of each other=s position and recognise the common goals of maintaining the area=s interest features. Direct involvement of all parties in the plan should reassure each that they can safeguard the qualities that are important to them.

The key to these plans is to include provision for access points, car parks and the other people management mechanisms discussed previously.

Constructing and maintaining footpaths in the uplands

This Information note sets out to cover the basic principles of constructing and maintaining paths in upland settings, including types of path and suggestions for sighting and remediation. Thorough coverage of this subject is given in Davies and Loxham (1996). A comprehensive guide to general footpath issues, construction and maintenance in both the uplands and the lowlands is given in Agate (1996). Visitor pressure has increased substantially since the 1960s and footpath erosion is a problem in all upland areas of England.

Constructing footpaths

Methods for footpath construction can be split into two main categories: paths over rocky substrates, as in the Lake District, and those over deep peat deposits, as in the Dark Peak area of the Peak District and across the Pennines. The two strategies will be dealt with separately.

Paths over rocky substrates

The two main methods of path construction over this kind of substrate are **aggregate paths** and **stone pitching**.

Aggregate paths can appear naturally, when erosion takes the walking surface down to the mineral soil. They can also be constructed by the import of aggregate from other sources. These paths are often self sustaining at lower gradients where water erosion is not serious. Aggregate paths are best used:

- on flat or sloping ground with an angle of less than 15E;
- when linking steeper sections of a route;
- at lower levels (valleys);
- where damage requires hard surfacing.

Where aggregate is imported to a site, it should always be of a compatible colour and geological type (and therefore of the same pH) to that of the surrounding country rock. Where an aggregate path is constructed from scratch then a >cut and fill= method is used. Here the width of path is excavated and an appropriate aggregate is then in-filled.

Stone pitching is the main technique for footpath construction on steep ground in rocky areas. This is an old technique of >laying stones in a random manner, to create a series of small irregular steps which blend naturally into the landscape and do not look like a uniform staircase= (Davies & Loxham 1996). Materials should be gathered en route, and a good route should ensure a healthy supply of suitable stone is available. Nature conservation issues must be taken into consideration when collecting material, as must the aesthetic value of the site, ie leaving visual scars where material is gathered from.

Paths over peat

Path construction on deep peat (over 50 cm) is difficult because of its poor structure and the often waterlogged condition of the soil. This is most apparent in the bog systems which cover large areas of the northern uplands in the Pennines and north Peak District. The wet nature of the peat and the fragility of the overlying bog vegetation make these areas very susceptible to damage from even low numbers of walkers. Once bare areas appear in wet peat due to trampling, the rate of spread can be enormous, with walkers trying to stay on the drier vegetated edges. Wherever possible, new paths should not be constructed over peat.

Due to the high nature conservation value of these areas, great care must be taken not to upset the hydrological systems of the area. This means that drainage to facilitate path construction is out of the question.

Box IN10.1 General guidelines for path repair over peat

Any path repair seeking to prevent further erosion / widening or gully formation should:

! Remedy and / or inhibit further erosion.

! Integrate with and enhance the landscape.

! Be consistent with the ethos of a trail passing through wild country.

! Reduce visually intrusive impacts of earlier management.

! Be durable or offer relatively low level and inexpensive maintenance.

! Float on the peat surface, the principle being that the weight of the path and the people is spread over a wide area so that the repair does not sink.

! Follow desire lines and be smoother to walk on than any alternative beside the path and then separate the boot from the vegetated or bare peat surface.

! Remain above the water table.

! Seek to retain any remnant vegetation and encourage the revegetation of bare peat.

! Try to arrest water flow.

! Be carefully surveyed in the wettest of conditions.

Taken from Davies and Loxham (1996).

The main forms of path construction / repair on deep peat are **floated aggregate paths**, **>causey=** or **>flagged= paths** and a relatively new technique called **soil reorganisation**. As well as these methods, **pitched paths**, **stepping stones** and **boardwalks** are also used.

Floated aggregate paths consist of aggregate filling a shallow trench, lined with a layer of man-made geo-textile or filament matting. Matting is used to combat the sinkage of parts of the path into the peat, spreading the pressure over a wide surface. The aggregate usually consists of a coarse sub-base covered above with smaller stones. Three-metre wide fabric is usually used, though the finished path need not be the full width of the fabric. A camber should always be constructed into the path surface to facilitate drainage. On steeper slopes a semi-pitched path can be constructed over the matting, using the aggregate as filling between the larger >faced= stones.

Advantages of aggregate paths:

- a sound and proven technique;
- they can carry considerable load;

- they are smoother than the surrounding terrain and therefore more attractive to walkers than the vegetation and peat.

Disadvantages of aggregate paths:

- the paths can be uniform and road-like in character if the material and design are not carefully chosen;

- the technique is expensive and labour intensive - further damage and disturbance may be caused by the use of heavy machinery;

- the method introduces man-made materials into blanket peat areas which can become exposed at a later date;

- these paths often require regular maintenance and renewed aggregate as water flow removes material.

The construction of **>causey=** or **>flagged= paths** is a recent revival of a traditional technique used in the Pennines and North Yorkshire. A simple technique, it involves the laying of large flat >flag= type stones over the peat surface, end-to-end. This can be an aesthetically acceptable method where path construction avoids straight lines and exhibits short sight lines. Flags are laid directly onto the peat / vegetation surface except where the ground is extremely wet. In these situations chestnut palings bound with polypropylene chord can be used to disperse the load over a wider area. Aggregate has also been used as an underlayer but should not be required for anything but extremely wet conditions. Flags should be laid so each abuts the next. This helps to stabilise the walking surface and prevent the possibility of flags sinking below the surface.

Ideally flags would be transported to the site by helicopter, minimising handling, facilitating rapid construction and, on large scale projects, being competitive in price to other approaches. The material used for the flags should always be compatible with the surrounding geology of an area. The use of flagging from the floors of old mills is in common practice, though quarried stone is readily available (see Figure 5.2).

Box IN10.2 Advantages and disadvantages of >flagged= paths

Advantages of >causey= or >flagged= paths:

- The path is easily and fairly rapidly laid.
- It is a traditional and durable method.
- The finished surface is smoother and firmer than the surrounding terrain and is used by walkers.
- Requires relatively low maintenance.
- Requires no imported man-made materials.
- Maturation helps the path blend unobtrusively as the colour of the flags darkens and the vegetation covers the edges.
- There is minimum intervention with the disturbance of the hydrology and vegetation during construction.

Disadvantages of >causey= or >flagged= paths:

- They have a very defined, uniform and delineated feel which some people find alien and aesthetically unacceptable in broad and open landscapes.
- Flags are heavy, bulky and pose logistical storage, transport and path-making problems.
- Flags have serious health and safety implications, especially concerning strain-related injuries.
- The long-term success of flags is uncertain.
- Flags are unsuitable for steep slopes in excess of 12-15E.
- It is a regional technique and probably inappropriate outside the Pennine and Yorkshire districts.

Taken from Davies and Loxham (1996)

A relatively new method of footpath maintenance over deep peat is **soil reorganisation** or **HiMac paths**. This technique has been trialled extensively in the Yorkshire Dales National Park especially in the Three Peaks Project. The basis of this method is to excavate the peat along the line of a path (usually with a mechanical excavator, hence the name Hi Mac), down to the mineral soil below. A layer of the mineral soil is then removed, the peat is replaced and the mineral soil laid on top of the replaced peat. Peat can be removed to as deep as the machine used will extend.

This is a comparatively very cheap system of path maintenance and involves no importation of materials. Care must be taken, as with >flagged= paths, to avoid straight lines and keep sight lines along the path to a minimum. The mineral soil surface should be cambered to allow free drainage and avoid erosion from surface water. Shallow ditches at either side of the path help the drainage process. The landscaping of the path, especially the revegetation of the path edges is very important in the appearance and the way walkers use the path. The path should be revegetated to the minimum legal width, to concentrate erosion from walkers and decrease the loss of surrounding vegetation. The positioning of large turves along the edges of the path is the preferable method for encouraging revegetation. Re-seeding and top dressing with fertiliser can also be used.

Another technique used over peat and already mentioned above, is the **pitched path**. When used over peat, a geo-textile base is needed, as with **floated aggregate paths**. These kind of paths are mainly applicable for steep slopes where **aggregate paths** and **flagged** surfaces are not suitable.

Stepping stones are useful for crossing wet areas, often where another form of path maintenance is being used, when wet hollows and flushes cannot be avoided with path alignment. This is another form of **>flagging=** which can also be useful for crossing wet areas in rocky uplands. When this is the case naturally occurring, large, flat (or nearly so), irregularly shaped stones are more desirable than the conformity of rectangular flags. By placing these in a haphazard manner, but close enough to step from one to the next, a natural effect can be obtained.

It is important that the size of the stones used is sufficient to spread out the load of use by walkers without sinking. Not excavating vegetation and placing the stones straight onto existing vegetation will facilitate this.

Owing to their visually intrusive nature **boardwalks** are considered an anathema in virtually all upland situations. The only situation where a **boardwalk** is the viable option would be where the site=s nature conservation interests outweigh the aesthetic value. However, there can be problems with the timber treatment chemicals leaching into the system and harming bryophytes and aquatic systems. The use of **stepping stones**, as described above, should always be the preferred option. The construction of boardwalks is well described by Agate (1996).

Landscaping

Landscaping aims to reduce the visual impact of footpath erosion and lessen the impact of subsequent remedial work. Certain underlying principles can be employed to minimise this impact during maintenance. These include the softening of any edges and boundaries and the avoidance of abrupt changes in texture and colour. All material gathered for use in erosion rehabilitation should blend naturally with their surroundings and disturbance and visual impact to the gathering area should be kept to a minimum. Wherever possible prominent stones, especially edge stones, should be used with their weathered surfaces facing outwards. The use of lines of large boulders to try to keep people on a path should be avoided. Often a few strategically placed boulders is all that is required.

The continued erosion of rehabilitated slopes is a big problem and can undermine much hard work. Exclusion of people and, where necessary, animals from the area may be the only solution. Temporary stock netting is needed for the exclusion of sheep, where signs or barriers may be adequate for people.

For stabilisation of slopes over 15E **revetments** may be used. These can consist of untreated larch poles, kept in place by small stakes, which can be left to rot *in situ* leaving no lasting, incongruous features. Large rocks can also be used in this manner, though care should be taken to leave a natural looking formation. Any boulders or large rocks already present should always be left in place as the best form of natural stabilisation.

For all eroded areas some form of **vegetation reinstatement** must be used. The three main techniques for this are **natural recolonisation**, **seeding** and **transplanting turves/plants**. The practicalities of these techniques and a thorough guide to landscaping in general can be found in Davies and Loxham (1996).

Maintaining footpaths

Guiding principles

A set of principles was formulated by the Lake District Upland Access Management Group, which were adapted from a British Mountaineering Council policy statement on the repair and maintenance of upland paths.

Box IN10.3 Upland path erosion - guiding principles

The repair and maintenance of paths in open country are subject to the following considerations:

- Repairs are necessary to prevent or ameliorate visual intrusion and environmental damage.
- Works should be of a high standard of design and implementation using indigenous materials, sympathetic in colour and texture to the immediate surrounding area. Uniformity of construction should be avoided, eg steps.
- Techniques used should protect existing vegetation and, normally, only locally occurring plant species should be used in restoration. Non-local species will be acceptable only where necessary as a nurse crop and where natural succession will rapidly result in their disappearance.
- The more remote the path, the more stringently the criteria for path repairs should be applied. This will be a matter of judgement, but in general, the more remote or wild the location the less acceptable an obviously engineered path will be.
- Repaired paths should be suitable to the route=s use and constructed on a scale appropriate for the intended use as a footpath, bridleway or byway.
- Before any work is agreed the question should be asked >is there a better solution=?

The use of waymarks, cairns or other intrusive features, other than those traditionally established on summits and path junctions, will be discouraged. A sustained commitment of resources to path management will be sought, so that small scale continuous maintenance can replace infrequent major repairs as the normal method of path management.

Taken from Davies and Loxham (1996)

These principles have been accepted and adopted by the House of Commons Environment Select Committee as the best practice guidelines to establish a nationwide approach for the repair and maintenance of upland footpaths (Davies and Loxham, 1996).

Selecting a route

Box IN10.4 Route selection guidelines

As specialist advice may affect route selection, consult widely. Specialist advice can be obtained from organisations and individuals who are not representatives of statutory bodies.

- Ensure the route has minimal impact on nature conservation, archaeological and landscape features.
- Vary the width of the path, follow natural contours of the land and avoid straight alignments.
- Take advantage of natural topographic features which allow the route to blend in with its surroundings.
- Take account of desire lines (lines of walker=s preferred route) and incorporate them into route design where possible.
- Try to establish a route which follows a clear line for users and discourages the development of short cuts. Choose sustainable alignments. Any diversion from the original route or re-alignment should not cause more problems.
- Avoid direct ascents where possible, as this can lead to drainage problems.
- Avoid water running down the line of the path with potential for erosion. Cross streams and water courses at right angles.
- Design the route to avoid crossing areas of excessive seepage or gullying and where possible, make use of well drained slopes.
- Try to use natural landscape features to contain the path and its users, eg boulder fields, tall vegetation.
- Make sure route alignment and width are compatible with the intended or designated use, eg bridleway.

Taken from Davies and Loxham (1996)

Combatting upland footpath erosion

Preventing erosion

It is much better to prevent the erosion of footpaths than to spend large amounts of time and money on repairing erosion damage. The recognition of early stages in the erosion process mean that preventative measures can be deployed before more severe erosion takes hold. Methods for preventing erosion include:

- reduction of grazing pressure;
- resting a route, ie temporarily changing to an adjacent alignment;
- fertilising and reseeding;
- keeping people on the desired route;

- permanently re-aligning the path to a more sustainable route;
- drainage (see below);
- fencing (usually temporary).

All these techniques can be employed separately, although combinations of preventative measures are often complementary. Fertilising and reseeding an eroded area may need a reduction in grazing pressure or fencing to allow the seeds to grow and surrounding natural vegetation to rejuvenate.

Drainage

Erosion becomes more damaging as a slope steepens, because the erosive power of water increases with increased slope. Soils also tend to be thinner on steeper slopes. The erosive potential of water also increases with decreased vegetation, with robust vegetation being more resilient than sparse cover.

Types of drainage system used in upland path construction include:

- off-path drainage — using natural drainage patterns to divert water from path lines;
- on-path drainage — **water breaks** - barriers or open drains at regular intervals, to divert water to the side of the path;
  rock barriers - help contain aggregate from being carried away therefore reducing scouring and gullying;
  open culverts - often simple open trenches or stone lined features at path edge, or angled across the path;
  closed culverts - small covered box drain angled across the path (for larger volumes of water this may need a rock or >clapper= bridge).

Techniques and strategies for the diversion of water and drainage on and around footpaths is covered in greater detail by Davies and Loxham (1996).

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