Meadows and enclosed pasture 7

Tables

Definition and location of meadows and enclosed pasture

7.1 Definition of meadows and enclosed pasture

This chapter covers the meadows and pastures found within the enclosed land of the English uplands. Pastures are grazed but not cut, while meadows are cut for either hay or silage and may or may not be grazed. While these areas are generally referred to as grasslands, they frequently contain a range of wetland plant communities (mires) which are also covered in this chapter. They may also be described in agricultural terms as in-bye, which is enclosed land in by the farm buildings, or allotment or intake, which is land taken in or enclosed from the hill.

Although grasslands can be composed of a rich mixture of plant species, grasses are typically dominant. Three broad types of dry grassland occur in Britain. These are defined by the type of substrate on which they occur (Crofts & Jefferson 1994, 1999). Neutral grasslands are found mostly within enclosed field systems on moist mineral soils with a pH of between 5 and 6.5. Calcareous grasslands occur on both enclosed and unenclosed land, largely on pervious calcareous bed rocks. The soils here tend to be shallow and typically have a pH range of between 6.5 and 8.5. Acid grasslands normally occur on acid soils, which have a pH below 5. Much grassland has been agriculturally 'improved', by the application of fertilisers or herbicides, drainage or ploughing and reseeding. Where these activities have not taken place they are termed 'semi-natural' or 'unimproved'. The National Vegetation Classification (NVC, Rodwell 1992) describes the grassland communities of England and those which occur in the enclosed uplands are listed in Table 7.12.

The majority of the wet grassland communities found in the enclosed uplands are technically mires, that is they are permanently or periodically waterlogged. Many of these communities, however, resemble grassland in structure and are managed in similar ways to grasslands, though in many cases grasses are replaced as the dominant species by small sedges *Carex* spp. or rushes *Juncus* spp. Depending on the species composition and structure of these communities they are varyingly referred to as wet, flushed or marshy grasslands, fen meadows, mires, flushes or bogs. These communities are listed in Table 7.12 and described in Rodwell (1991 and 1992). For the sake of simplicity these communities are referred to as wet grasslands hereafter.

The emphasis in this chapter is on semi-natural and 'semi-improved' grasslands, as these have a far greater wildlife value than agriculturally 'improved' grasslands. However, where agricultural grasslands are of wildlife interest, this has generally been derived from a long history of management, either as pasture or meadow.

7.2 Location and extent of meadows and enclosed pasture

Enclosed grasslands occur throughout the English uplands, predominantly along valley floors and on the lower valley sides. Some enclosures, however, occur on higher ground and can even extend to the hill tops. In the latter situations, the nature of the enclosed land is often very similar to the open fell or moor.

The extent of the grassland and mire communities found in the enclosed uplands of England varies with the grassland type. Agriculturally improved grasslands are extensive throughout, while unimproved grasslands and their associated mires are often restricted in their distribution. Semi-natural neutral grasslands in particular have become a scarce resource because they usually occur on relatively dry, even terrain which is easily improved (Jefferson *et al* 1994). Calcareous grasslands are more extensive, but again many have received applications of herbicides or fertilisers where full cultivation is not possible (Hillier, Walton & Wells 1990). Acid grasslands are the most extensive of the unimproved types, occurring on the poorest soils. Many acid grassland stands have been derived from dwarf-shrub heath via overgrazing.

At present it is not possible to provide a comprehensive account of the distribution and extent of enclosed dry grassland communities in England. Many of the communities which occur within the upland areas, as defined in this handbook, are more extensive in the lowlands of England. At least two grassland communities, however, MG3 *Anthoxanthum odoratum-Geranium sylvaticum* hay meadows and CG9 *Sesleria caerulea-Galium sterneri* grassland are only found in upland England. Recent estimates indicate that there are less than 1,000 ha of the upland hay meadow (NVC type MG3) in England, located for the most part in upland valleys in the north of England. Upland calcareous grassland has been estimated to cover around 10,000 ha in England, with the largest concentrations occurring in the north Pennines and Cumbria. Further information on the extent and location of lowland grassland types is detailed in Jefferson (1996), Jefferson & Robertson (1996a & b), UK Steering Group (1995) and 7.4.3 below.

Hopkins & Hopkins (1993) reviewed grassland in Britain. Although 50% of swards are over 20 years of age, most have been modified by intensive management. Inorganic fertiliser nitrogen is applied to 80% of these grasslands and only a small proportion are now of high conservation value, over 95% having been lost since 1930.

Wet grasslands occur throughout the enclosed uplands of England, wherever the ground is kept permanently or periodically wet through high annual rainfall, humidity or water table, or by the impervious nature of the underlying rock leading to springs and seepages. Enclosed wet grasslands have been subject to agricultural drainage, as well as other agricultural improvement techniques, and their extent has declined as a result. Again, the extent of these communities in the enclosed uplands of England has not been fully quantified but in Devon and Cornwall only 8% of the purple moor-grass *Molinia caerulea* and rush *Juncus* sp. pastures (known as Culm grassland) present in 1900 remains today (UK Steering Group 1995).

Habitats and species of meadows and enclosed pasture in the uplands

7.3 Why meadows and enclosed pasture are important

Meadows and enclosed pasture in upland England support a rich variety of wild plants and animals, including many rare and scarce species of plants, birds and invertebrates. They contain some semi-natural grassland communities which are now scarce in the UK as well as in Europe (Jefferson & Robertson 1996; Jefferson *et al* 1994; Willems 1990;). These grassland types include neutral grasslands such as northern hay meadows, calcareous grasslands, and certain wet grasslands with purple moor-grass. Certain types of acid grassland of the enclosed uplands are similarly limited in their distribution, occurring only in Britain and Ireland (NCC 1989; Ratcliffe & Thompson 1988). A range of internationally scarce mire communities are also found in the enclosed uplands, including calcareous flushes and alkaline fens. The international significance of the plant communities of meadows and pastures is recognised by their inclusion in the Habitats and Species Directive (see 7.4.3 and Table 7.13) and the UK Biodiversity Action Plan (UK Steering Group 1995).

Semi-natural meadows and pastures may contain a large number of plant species, that is they are species-rich. These include a range of nationally rare and scarce plants which are often restricted to these habitats (Tables 7.9 and 7.10). Semi-natural, as well as agriculturally semi-improved or improved grasslands, can provide feeding, breeding and sheltering habitats for nationally rare and scarce invertebrates, birds, bats and amphibians which are of conservation concern, for example because they are globally threatened or their numbers are declining (Tables 7.13, 7,16, and 7.17). Where such grasslands occur next to moorland they provide particularly valuable feeding areas for birds which nest on the unenclosed land. The international significance of certain plant and animal species of meadows and pastures is recognised by their inclusion in the Habitats and Species Directive (see 7.4) and the UK Biodiversity Action Plan (UK Steering Group 1995).

7.4 Habitats and species of meadows and enclosed pasture, their nature conservation status and distribution

7.4.1 Vascular plants

A wide range of plant species are associated with upland meadows and enclosed pastures, many of which are nationally rare and scarce (Table 7.9). Traditionally managed hay meadows can contain a striking variety and abundance of herbs such as wood crane's bill *Geranium sylvaticum*, great burnet *Sanguisorba officinalis*, pignut *Conopodium majus* and lady's mantles *Alchemilla* spp. Calcareous upland pastures can also be very species-rich, supporting plants such as blue moor-grass *Sesleria caerulea*, common rock rose *Helianthemum nummularia*, wild thyme *Thymus polytrichus*, carline thistle *Carlina vulgaris* and bird's-eye primrose *Primula farinosa*.

More acidic pastures tend to be less diverse in terms of plant species and can be dominated by grasses such as mat-grass *Nardus stricta* with heath bedstraw *Galium saxatile* and tormentil *Potentilla erecta*. Some

acidic pastures are richer, particularly where mires are present or where there is a calcareous influence on the grassland, when common dog-violet *Viola riviniana* and common mouse-ear *Cerastium fontanum* may occur.

Marshy grasslands in the enclosed uplands may be dominated by purple moor-grass and rushes *Juncus* spp., but can also support a variety of other plants, including sedges *Carex* spp., meadowsweet *Filipendula ulmaria*, wild angelica *Angelica sylvestris*, ragged robin *Lychnis flos-cuculi* and marsh hawk's-beard *Crepis paludosa*.

Some of the species associated with enclosed grasslands are included in the UK Biodiversity Action Plan and Species Action Plans have been prepared for them (Table 7.9; UK Biodiversity Group 1998; UK Steering Group 1995).

7.4.2 Bryophytes

Dry grasslands are generally species-poor in relation to bryophytes and there are few specifically associated with meadows and enclosed pastures in upland or lowland Britain. Bryophytes are often very specialised in their niche requirements, and can occupy very restricted small niches. Thus some species may occur in small wetland features, areas of disturbed ground or on stream banks within enclosed grasslands. Some of these are nationally rare and scarce and are shown in Table 7.10.

7.4.3 Plant communities

The plant communities found in the enclosed pastures and meadows of upland England are shown in Tables 7.1 and 7.2 respectively. Table 7.12 shows the nature conservation status and distribution of these communities. Full descriptions and other information on these communities is given in Rodwell (1991 and 1992).

Of particular nature conservation significance are calcareous grasslands (NVC communities: CG2-CG10), examples of purple moor-grass wet grasslands with a calcareous influence (NVC: M24 and M26) and northern hay meadows (NVC: MG3). All these grassland types are of European nature conservation significance and merit the designation of Special Areas of Conservation under the EC Habitats and Species Directive.

The meadows and enclosed pastures of the English uplands are particularly important for several vegetation types which are scarce or absent in lowland England. In particular MG3 *Anthoxanthum odoratum-Geranium sylvaticum* northern hay meadows, with their characteristic sward of bulky tall herbs, are only found in the higher valleys of the Pennines and the Lake District. The MG5 *Cynosurus cristatus-Centaurea nigra* grassland is generally considered to be a lowland hay meadow and pasture grassland, but it also occurs on the upland margins, often as remnants within otherwise agriculturally improved fields. The CG9 *Sesleria caerulea-Galium sterneri* grassland is confined to the Carboniferous limestone of the Pennines, Cumbria and northern Lancashire. Similarly the species-rich M26 *Molinia caerulea-Crepis paludosa* mire community of base-rich and calcareous peats is only found in upland England and is largely restricted to the Pennines and the Lake District.

Enclosed grasslands also provide an important locus for wet grasslands dominated by either rush *Juncus* spp or purple moor-grass *Molinia caerulea* M23 *Juncus effusus/acutiflorus-Galium palustre* rush pasture, M24 *Molinia caerulea-Cirsium dissectum* fen meadow, M25 *Molinia caerulea-Potentilla erecta* mire and M26 *Molinia caerulea-Crepis paludosa* mire). These wet grassland and mire types are found on enclosed land throughout upland England, and in Devon and Cornwall. Wet grasslands are often associated with M16 *Erica tetralix-Sphagnum compactum* wet heath, and a variety of other mire and heath communities, including the uncommon M29 *Hypericum elodes-Potamogeton polygonifolius* and M21 *Narthecium ossifragum-Sphagnum papillosum* mires (Wolton 1994).

Floodplain grasslands are not a major feature of upland England, although they may occasionally be encountered. The principal communities involved are MG8 *Cynosurus cristatus-Caltha palustris* flood pasture (which can occur in association with MG3) and MG13 *Agrostis stolonifera-Alopecurus geniculatus* inundation grassland. MG4 *Alopecurus pratensis-Sanguisorba officinalis* flood meadow and MG11 *Festuca rubra-Agrostis stolonifera-Potentilla anserina* inundation grassland are also found in this habitat but they are almost, if not entirely, confined to lowland England.

Table 7.1 Plant communities associated with management as pasture

MG5	*Cynosurus cristatus-Centaurea nigra* grassland
MG6	*Lolium perenne-Cynosurus cristatus* grassland
MG7	*Lolium perenne* leys
MG8	*Cynosurus cristatus-Caltha palustris* grassland
MG9	*Holcus lanatus-Deschampsia cespitosa* grassland
MG10	*Holcus lanatus-Juncus effusus* rush pasture
MG11	*Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland
MG13	*Agrostis stolonifera-Alopecurus geniculatus* inundation grassland
CG2	*Festuca ovina-Avenula pratensis* grassland
CG3	*Bromopsis erectus* grassland
CG6	*Avenula pubescens* grassland
CG7	*Festuca ovina-Pilosella officinarum-Thymus polytrichus* grassland
CG9	*Sesleria caerulea-Galium sterneri* grassland
CG10	*Festuca ovina-Agrostis capillaris-Thymus polytrichus* grassland
U1	*Festuca ovina-Agrostis capillaris-Rumex acetosella* grassland
U2	*Deschampsia flexuosa* grassland
U3	*Agrostis curtisii* grassland
U4	*Festuca ovina-Agrostis capillaris-Galium saxatile* grassland
U5	*Nardus stricta-Galium saxatile* grassland
M15	*Trichophorum cespitosus-Erica tetralix* wet heath
M16	*Erica tetralix-Sphagnum compactum* wet heath
M22	*Juncus subnodulosus-Cirsium palustre* fen meadow
M23	*Juncus effusus/acutiflorus-Galium palustre* rush pasture
M24	*Molinia caerulea-Cirsium dissectum* fen meadow
M25	*Molinia caerulea-Potentilla erecta* mire
M26	*Molinia caerulea-Crepis paludosa* mire

Table 7.2 Plant communities associated with hay meadow management

Principal hay meadow communities	
MG3	*Anthoxanthum odoratum-Geranium sylvaticum* grassland
MG4	*Alopecurus pratensis-Sanguisorba officinalis* grassland
MG5	*Cynosurus cristatus-Centaurea nigra* grassland
Communities which may occasionally be mown for hay	
MG8	*Cynosurus cristatus-Caltha palustris* grassland
MG13	*Agrostis stolonifera-Alopecurus geniculatus* inundation grassland
M22	*Juncus subnodulosus-Cirsium palustre* fen meadow
M23	*Juncus effusus/acutiflorus-Galium palustre* rush pasture
M24	*Molinia caerulea-Cirsium dissectum* fen meadow
M25	*Molinia caerulea-Potentilla erecta* mire
M26	*Molinia caerulea-Crepis paludosa* mire
M27	*Filipendula ulmaria-Angelica sylvestris* mire

7.4.4 Birds

Enclosed upland pastures and meadows are of outstanding importance for birds. Not only can they support very high densities of breeding waders, such as curlew *Numenius arquata*, redshank *Tringa totanus*, lapwing *Vanellus vanellus* and snipe *Gallinago gallinago*, but they are also used for feeding before, during and after the breeding season by many of the birds which nest on adjacent moors, including merlin *Falco columbarius*.

Upland enclosed pastures are of considerable importance for a number of small passerines, including the skylark *Alauda arvensis*, which has suffered a major decline in its UK population during the last 25 years. Another increasingly rare bird, the black grouse *Tetrao tetrix*, uses upland grassland for feeding and breeding purposes. The corncrake *Crex crex* was once characteristic of meadows throughout Britain, but changes in grassland management, particularly the move from hay to silage with its earlier cutting dates, has caused its widespread loss from the English uplands. These three species - skylark, black grouse and corncrake - are all included in the UK Biodiversity Action Plan and Species Action Plans have been prepared for them (UK Biodiversity Group 1998; UK Steering Group 1995).

Breeding bird species which are positively associated with the uplands (as defined in Stillman & Brown 1998) and also with enclosed grasslands in England are shown in Table 7.14. Additional birds of conservation concern (RSPB 1996), for example skylark and lapwing, occur in these areas but are not positively associated with the uplands. Significant portions of the English populations of these birds nevertheless breed in the uplands and further details of these species can be found in the relevant Species Action Plans which have or will soon be completed as part of the UK Biodiversity Action Plan (UK Biodiversity Group 1998; UK Steering Group 1995).

7.4.5 Invertebrates

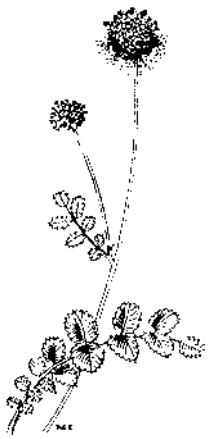
Most types of semi-natural grasslands are of considerable interest for invertebrates, with each grassland type supporting its own suite of species. Upland calcareous grasslands, including some enclosed pastures, are of particular importance for a number of nationally rare, scarce and uncommon butterfly species including the northern brown argus *Aricia artaxerxes* which feeds on common rock-rose, and the small blue *Cupido minimus* which feeds on kidney vetch *Anthyllis vulneraria.* Where there is some scrub or bracken such grassland may be important for the high brown fritillary *Argynnis adippe*, pearl-bordered fritillary *Boloria euphrosyne* and dark green fritillary *Argynnis aglaia*, which feed on violets *Viola* spp., particularly growing under fairly sparse bracken *Pteridium aquilinum*, as well as the Duke of Burgundy *Hemearis lucina*, which feeds on cowslip *Primula veris* and primrose *Primula vulgaris.*

The marsh fritillary *Eurodryas aurinia* and narrow-bordered bee hawk *Hemaris tityus* are species of wet grassland with devil's-bit scabious *Succisa pratensis* in south western and north western England. The heath fritillary *Mellicta athalia* feeds on a number of weedy species, notably ribwort plantain *Plantago lanceolata*, foxglove *Digitalis purpurea* and cow-wheat *Melampyrum pratense*, in sheltered upland grassland in the south west. Some root-feeding invertebrates favour upland grasslands, such as the click beetle *Anostirus castaneus*, which occurs at a single site in scrubby acid grassland in North Yorkshire in addition to the Isle of Wight.

Hay meadows support a very different, and usually depauperate invertebrate fauna compared to pastures. This is because the annual cutting of the sward interrupts the life-cycle of many species so that they are unable to survive under this management regime. However, the root-feeding click beetle, *Selatosomus pectinicornis*, favours old hay meadows, mainly in the north and west. Hay meadows and their surrounding hedgerows also provide an important food source for nectar feeding species during the period before they are cut.

Many of the species mentioned above are included in the UK Biodiversity Action Plan and Species Action Plans have been prepared for them (UK Steering Group 1995; UK Biodiversity Group 1998).

Further information: Barnett & Warren 1995a-e; Bourn & Warren 1998; Drake *et al* 1998; Kirby 1992; Ravenscroft & Warren 1996.



Salad burnet

7.4.6 Mammals

The value of enclosed upland grasslands for mammals depends upon the location, extent and management of the grassland (Table 7.16). In general, cut or heavily grazed grassland is of limited use to native mammals.

Upland meadows and enclosed pastures can support several mammal species, particularly field voles *Microtus agrestis* and shrews *Sorex* spp. where the grassland is structurally diverse. While these species are widespread and generally abundant, small mammals are an important component of the food chain, being important prey items for birds of prey, reptiles and carnivorous mammals. Areas rich with dung from domestic animals support many invertebrates, notably dung beetles and dung flies, which provide food for bats. Bats tend to favour field margins and woodland edges when foraging, and these features also provide food and shelter for other small mammals. Larger mammals such as foxes *Vulpes vulpes*, badgers *Meles meles* and roe deer *Capreolus capreolus* tend to breed in woodland but forage in pastures and meadows.

7.4.7 Amphibians and reptiles

Upland enclosed grassland may be of great importance for reptiles and amphibians and supports several species, including the common lizard *Lacerta vivipara*, common frog *Rana temporaria* and common toad *Bufo bufo* (Table 7.17). It is of value for both groups of animals where it is managed to provide an uneven structure to the vegetation. It is also important where it provides connections between other habitats, such as fragmented woodland or moorland areas, because these animals tend to be relatively poor dispersers. Field margins, such as dry stone walls and boundary banks, often provide habitats of value to reptiles and amphibians.

7.5 Habitat and management requirements of meadow and enclosed pasture species

Typical plant species of these habitats generally require the existing management to be continued, without intensification by reseeding, nutrient inputs or increased grazing pressures.

In general, structurally diverse grasslands are the most valuable, providing both food and cover for a variety of animals. Light grazing is beneficial where it creates a varied structure and prevents scrub encroachment, but heavy grazing (and cutting) results in a short and even sward which is less valuable for wildlife. Light grazing around ponds and other wetland features can favour wildlife by keeping them open, but heavy grazing damages both terrestrial and aquatic vegetation which is required by invertebrates and amphibians.

Where stock are treated with persistent chemicals to remove gut parasites (eg avermectins, see 7.7.5) the dung remains toxic to invertebrates and this in turn removes the food source of many other animals. While some dunging can improve the nutrient status of very nutrient-poor sites, too much can make grasslands and wetlands too nutrient-rich. This may lead, for example, to algal growth and poor water quality in ponds where invertebrates and amphibians breed. However, a very small number of species of specialised scarce invertebrates are associated with high nutrient levels in dung-rich water.

To encourage a diversity of wildlife, management should provide areas of grassland with varied heights and a supply of dung from animals untreated by persistent vermicides. Breeding, feeding and over-wintering areas, such as ponds and other wetlands and woods, should be retained. Manure and compost heaps can also add to biodiversity. Field boundaries such as hedges, dry stone walls and banks should be retained and appropriately managed, both for themselves and to provide connections between other habitats.

Brief habitat and management requirements of key plants, birds, mammals, amphibians and reptiles associated with meadows and enclosed pasture are shown in Tables 7.9, 7.11 and 7.14-7.17. Habitat management for invertebrates of enclosed grasslands is not covered in any further detail because this subject is considered to be adequately addressed in Kirby 1992.

Management of upland meadows and enclosed pasture

7.6 Managing upland meadows and enclosed pasture

This section, together with section 7.7, provides a basic guide to the management of wet and dry grasslands with wildlife interest in the enclosed land below the fell wall. Further information can be found in the *Lowland Grassland Management Handbook* (Crofts & Jefferson 1994, 1999) , *The Wet Grassland Guide: Managing floodplain and coastal wet grasslands for wildlife* (Treweek *et al* 1997) and *European wet grasslands: biodiversity, management and restoration* (Joyce & Wade 1998).

The following sections (7.6.2 to 7.7.7) are particularly relevant for land where some wildlife interest is present, that is semi-natural grasslands, 'wet grasslands' and semi-improved grasslands. Improved grasslands are not considered, although they can be of importance for some breeding and feeding birds. Section 7.6.1 provides a brief introduction to the formulation of an appropriate grassland management regime. The restoration of neglected grasslands and the re-creation of grassland on sites with limited nature conservation interest is considered in section 7.9.

The main agricultural practices which maintain grasslands include grazing, cutting, burning and cultivation; all are discussed in this section of the handbook. Other management practices, including rolling and chain harrowing, and managing pests, weeds, drainage and scrub are covered in the following section (7.7). Changing or stopping management practices can shift grasslands from one type to another. In the absence of some form of management, most types of enclosed grassland would be invaded by woody shrubs and develop into scrub and woodland (Ausden & Treweek 1995; Crofts & Jefferson 1994, 1999).

Most grasslands are used to provide food for livestock. The species composition and vegetation structure (both spatial and temporal) of a grassland is highly dependent on whether it is managed to provide food directly for livestock in the form of grazing, or as conserved fodder in the form of hay and silage. Pastures are grazed but not cut, and meadows are cut for either hay or silage and may or may not be grazed. This fundamental management distinction applies to all grassland types, wet or dry, regardless of substrate. It is uncommon, however, for acid or calcareous grasslands to be managed as meadows, as the most productive land on a farm is usually allocated to hay or silage production; this is invariably the land with deeper, mesotrophic soils and these soils tend to support neutral grasslands. Table 7.3

shows the 'traditional' management treatments associated with the grassland communities found below the fell wall.

If the nature conservation interest of a grassland is to be maintained or enhanced the basic management practice which has given rise to the plant and animal communities of that field must be continued or, where that management practice has lapsed, reinstated. Unless the management practice of a field is known to have changed in the recent past, switching from meadow management to pasture only, or vice versa, will almost certainly result in a major decline in the wildlife interest of that grassland. It may well result in the loss of any rare or scarce species present in that field.

7.6.1 Establishing management objectives and options

When considering the most appropriate management regime for a particular grassland, information needs to be collected on a number of topics to facilitate the decision making process (see Table 7.4).

As a general principle the management regime of a grassland with known wildlife interest should only be altered where there is clear evidence that the interest is in decline. The most likely cause of such a decline is a change in the management at some point in the relatively recent past. Where this is thought to have occurred then the objective should be to return the management regime to one similar to that which supported the nature conservation interest originally present. Depending on the extent of the decline in the wildlife interest, this may, or may not, require some form of restoration management (see Sections 7.7.6 and 7.9) prior to reintroducing the original management regime.

Where a grassland is of limited nature conservation interest (and this situation is not the result of the degradation of a site previously considered to be of interest) then the site manager will have a greater range of management options. The manager will need to decide which options will result in the greatest increase in nature conservation interest on the site.

Buttercup

Table 7.3 'Traditional' management treatments of semi-natural grassland communities
(Adapted from Crofts & Jefferson 1994).

NVC grassland community	Livestock grazing	Mowing & aftermath grazing	Spring grazing, mowing & aftermath grazing	Burning & grazing	Unmanaged/ sporadic management by grazing &/or mowing	Sporadic cultivation/ ploughing/ disturbance	Periodic flooding/ inundation
MG1					✔		
MG2					✔		
MG3			✔				
MG5	✔	✔	✔				
MG8	✔	✔	✔				✔
MG9	✔						
MG10	✔						
MG11	✔	✔					✔
MG13	✔	(✔)					✔
CG2	✔						
CG3	✔				✔		
CG6	✔				✔		
CG7	✔				✔	✔	
CG9	✔						
CG10	✔						
U1	✔					✔	
U2	✔						
U3	✔			✔			
U4	✔						
U5	✔						
M15	✔			✔			
M16	✔			✔			
M22	✔	✔					
M23	✔	✔					
M24	✔	✔					
M25	✔			✔			
M26	✔		✔				
M27					✔		
OV37					✔		

Table 7.4 Information required prior to establishing management objectives and options
(Adapted from Andrews & Rebane 1994)

Information required		Reason for information
Conservation status and interest	Information may already be available - see next column.	Organisations such as county wildlife trusts, English Nature or county / district councils may have already collected information which will assist the decision making process. The majority of unimproved enclosed grasslands will be designated as SSSIs or as Sites of Importance for Nature Conservation (SINCs).
Past management	Grazing regime, mowing practice, surface applications, etc (see current management below) from farm records and other historical information, including aerial photographs and old maps. (The plant species present may give an indication of this where management has lapsed and no other sources of information are available. A number of species are indicative of certain management practices, eg wood crane's-bill *Geranium sylvaticum* is unlikely to be found in permanent pasture.)	Past management practices will have played an important part in the development of a grassland's nature conservation interest. Where the interest is thought to be in decline it is likely that this is due to a change in management practices. Knowledge of how current management differs from previous practices may help formulate an action plan to stem any such decline and may provide a template for the new management regime.
Current management	Grazing regime: including livestock types, stocking rates, timing of grazing, use of supplementary feeding.	It is essential to know what the current grazing regime is. This will form the basis of the future regime, with adjustments, where required, based on the other information collected, particularly indicators of over or under-grazing.
	Mowing practice: including cutting dates and methods and details of grazing.	Again essential information needed if the nature conservation value is to be maintained or enhanced. This should be used in conjunction with the other information collected and adjusted where necessary.
	Use of surface applications such as lime, compound fertilisers and farm yard manure, including application rates.	The application of these surface treatments can have deleterious affects on the species composition of grasslands. The nature conservation interest of many grasslands has declined due to changes (almost invariably increases) in the use of surface treatments, particularly compound fertilisers. Some 'traditional' hay meadow regimes do, however, include use of farm yard manure or lime.
	Other management practices such as chain harrowing, rolling, burning etc.	Such practices can be harmful to the nature conservation interest of sites, or may be the key to any unusual features present.
	Weed control measures.	Weed control measures can be harmful to the nature conservation interest of grasslands.

Information required		Reason for information
Stock boundaries	The condition of fences, hedges, walls and ditches needs to be known.	Boundaries need to be stock proof where grazing is to be a feature of the management regime.
Hydrology	Map those areas which flood (and record the season when flooded), or are flushed, and the presence of mires, ponds, water courses and the location of drains / dikes.	The hydrology of the site may have important implications for site management, including type of stock used and use of machinery.
Grassland structure and composition	Species composition, including species abundance.	Species composition will tend to indicate past management.
	Map the location and extent of tall coarse grassland, tussocks and areas with a deep litter layer.	These features can be indicative of under-grazing.
	Map the location and extent of bare ground, gappy swards, very closely grazed swards and the presence of 'injurious weeds'.	These features can be indicative of overgrazing.
	Map the location of trees, scrub and bracken.	Invasion by these features may indicate a lapse in management practices, though this could be historical rather than current. On larger sites these can enhance the nature conservation interest, but on smaller sites where the interest is primarily grassland then they may be deleterious to the nature conservation interest.
	Map the location of rare or scarce species present, including plants, breeding birds and butterflies.	The specific habitat requirements of any uncommon species present may need to be accommodated in the management regime.
Other features	Record features such as anthills, earth banks and ridge and furrow systems.	Anthills are indicative of old pasture and will be destroyed by the rolling and harrowing. Other features may be of historical / archeological interest.

7.6.2 Managing pastures

The majority of enclosed grassland in the uplands is managed as pasture, as are most, if not all, of the wet grasslands and mire communities that are found here. Pastures are managed principally by grazing and are normally not cut. Exceptions include, for example, methods of controlling rushes by topping.

Stock type

The type of stock used to graze a grassland is a significant determinant of the vegetation structure and species composition of a grassland sward. The three main livestock animals used in England, sheep, cattle and horses, all have different grazing attributes, and these are summarised in Table 7.5. In general, sheep are the most widely used stock, largely due to their cheapness and relative ease of handling. In a number of situations, however, cattle are preferable for conservation management, particularly where the ground is marshy or a tussocky sward structure is required. Ponies are relatively uncommon in the uplands, but they can be invaluable for nature conservation management where other stock are

unavailable. Goats are not generally favoured by land managers, but in specific circumstances they can be useful, particularly for restoration management (section 7.9).

Table 7.5 Grazing attributes of sheep, cattle, horses and goats

Livestock type	Positive attributes	Negative attributes
Sheep	Readily available and cheap, relatively easy to handle.	Most breeds will not eat long or coarse grass and unsuitable for scrub control or restoration grazing.
	Produce uniform, tightly grazed sward, especially at high stocking densities.	Produce uniform, tightly grazed sward, especially at high stocking densities - poor for invertebrates.
	Light so do not cause trampling damage.	Unsuitable for particularly wet situations as susceptible to disease.
Cattle	Create a less uniform sward than sheep at lower stocking densities - greater structural diversity for invertebrates and tussocks are a requirement for many waders to breed.	Expensive to buy and valuable - farmers maybe less willing to graze cattle on semi-natural grassland due to its low productivity.
	Will maintain a short sward at higher stocking densities.	Harder to transport and handle than sheep. More likely to be treated with avermectins than sheep or goats.
	Trample and eat coarse grasses and will browse scrub - can be used for restoration grazing.	Require large amounts of water.
	Low level trampling damage and light poaching can be beneficial in providing niches for both invertebrates and short-lived plants, especially in upland calcareous or dry acid grassland.	Can cause trampling damage at higher stocking rates, particularly in winter, leading to weed infestations and erosion.
Ponies	Produce patchily grazed sward which can support diverse invertebrate communities.	Graze more palatable species, selectively - can result in overgrazed areas and uneaten coarse stands if stocking rate is too high.
	Native breeds of ponies are relatively cheap, require minimal handling and will eat coarse grasses and scrub-making them useful for restoration grazing.	Tend to have specific latrine areas which they do not graze - also result in localised nutrient enrichment and can lead to stands of nutrient demanding weeds. More likely to be treated with avermectins than sheep or goats.
	Low level trampling damage can be beneficial in providing niches for both invertebrates and short-lived plants.	Can cause trampling damage at higher stocking rates, particularly in winter, leading to weed infestations and erosion.
Goats	Preferential browsers so useful for dealing with scrub (but not birch or conifers).	Will tend to browse rather than graze so may be of limited use where grazing is the main requirement.
	Will eat and hence help to control rushes, tufted hair-grass and mat-grass at high stocking densities.	Handling and containment can be problematic and all goats require shelter.

The grazing attributes of livestock also vary between breeds. As a general rule upland and older breeds are most suitable for nature conservation and sustainable grazing. These tend to have originated in the north and west of Britain. These hardy breeds are able to utilise vegetation of low nutritional quality, require less husbandry and are more 'hard mouthed' than more modern or lowland breeds. 'Hard mouthed' breeds are less selective grazers than 'soft mouthed' breeds and will also browse scrub. Information Notes 3 and 5 provide more information on sheep and cattle breeds, as do Crofts & Jefferson (1994, 1999).

The grazing habits of stock also vary with age. With cattle, store animals, fattening beef animals and sucklers are the most suitable for environmentally sustainable management. With sheep, ewe or wether lambs (store lambs), barren or dry ewes and mature wethers are most likely to be suitable. It is important to note, however, that young and old stock are more 'soft mouthed' than 'middle aged' animals and so may not be suitable where coarse vegetation is to be grazed.

Stocking levels

The establishment of an appropriate stocking regime is vital if the wildlife value of a grassland is to be maintained or enhanced. Both too much and too little grazing can lead to a decline in the biodiversity of a sward. A wide variety of factors play a part in determining what the appropriate level will be and it is not possible to provide a precise guide here. The following general principles, however, should enable a land manager to draw up an appropriate regime to achieve both biodiversity and sustainable agriculture objectives once local factors have been taken into consideration. Where breeding waders are present the factors discussed in Section 7.8.1 should also be taken into account.

An example of management for wildlife on limestone grassland is given in Box 7.1.

Table 7.6 A guide to stocking rates for lowland grassland (animals per hectare)

No of grazing weeks per year	Calcareous grassland		Neutral grassland		Acidic grassland		Wet/marshy grassland	
	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle
2	60	15	100	25	50	12	50	12
4	30	8	50	12.5	25	6	25	6
6	20	5	33	8	16	4	16	4
8	15	4	25	6	12	3	12	3
10	12	3	20	5	10	2.5	10	2.5
12	10	2.5	17	4	8	2	8	2
14	8.5	2	14	3.5	7	1.5	7	2
16	7.5	2	12.5	3	6	1.5	6	1.5
20	6	1.5	10	2.5	5	1	5	1
24	5	1	8	2	4	1	4	1
36	3.5	1	5.5	1.5	3	0.5	3	0.5
52	2.5	0.5	4	1	2	0.4	2	0.4
Annual stocking rate LU / ha / yr	0.25	0.25	0.5	0.5	0.2	0.2	0.2	0.2

Source: Nature Conservancy Council 1986b and Crofts & Jefferson 1999

The best guides to establishing an appropriate grazing regime are the vegetation composition, structure and sward height (Andrews & Rebane 1994). Management objectives will vary, but in general a sward height of 5-10 cm at the end of any particular grazing period should be the aim (unless tall grass is required for other conservation reasons; Crofts & Jefferson 1994, 1999). Reliable historical records of stocking levels can provide a useful starting point, but, where these are not available, the figures in Table 7.6 may provide a useful guide in more lowland situations. Table 7.7 gives examples of the stocking regimes required by various environmental land management schemes. They are, however, only a guide but may also help to provide a starting point.

Whatever the basis for the stocking rate used, regular assessment of the sward should be undertaken and the stocking rate adjusted as appropriate. Note, however, that stock may not be able to keep up with sward growth during the peak growing season, but they will generally be able to 'catch up' as productivity declines, to produce the desired sward height by the beginning of the next growing season.

Table 7.7 Examples of stocking rates for different vegetation types as specified by various environmental land management schemes

Scheme	Vegetation type	Stocking rate
Tir Gofal (Welsh Office *et al* 1999)	Whole farm.	Overall stocking rates should not exceed 2.4 LU / ha. Should not exceed levels carried in 1998.
	High mountain heath-moss and lichen heath + low-mat dwarf shrubs.	Not more than 0.05 LU / ha / yr. Remove all animals between October and March.
	Upland heath - >25% cover heathers, bilberry and other dwarf shrubs with variable amounts of coarse grasses.	Not more than 0.225 LU / ha / yr (dry heath) OR 0.1 LU / ha / yr (wet heath). At least 25% of stock removed between October and March.
	Unimproved acid grassland - dominated by sheep's fescue, bents, wavy hair-grass and mat-grass or heath rush.	Not more than 0.4 LU / ha / yr (can be increased up to 0.75 LU / ha / yr where dominated by bents and fescues).
	Unimproved neutral grassland - includes flower-rich and pastures below mountain wall.	Not more than 0.75 LU / ha / yr.
	Unimproved limestone grassland.	Not more than 0.4 LU / ha / yr. On limestone pavements not more than 0.15 LU / ha / yr.
	Semi-improved grasslands / hay meadows.	Not more than 1 LU / ha / yr (neutral) or 0.75 / LU / ha / yr (acid or limestone).
	Marshy grassland.	Not more than 0.4 LU / ha / yr.
	Acid peatlands - blanket bog / lowland raised bog.	Not more than 0.05 LU / ha / yr. Avoid grazing between October and March.

Scheme	Vegetation type	Stocking rate
Countryside Stewardship Scheme (MAFF 1999)	Hay meadows.	Cut sward should be lightly grazed to achieve an average sward height of 20-50 mm through the winter period.
	Grazed pastures (lowland pasture & upland in-bye pasture).	April-December: at least 10 weeks light grazing, aiming to produce a sward height of 20-50 mm at end of grazing period (no stocking figures given). March-August: light grazing 'for a number of months' at 0.6 LU / ha may be required.
	Upland rough grazing pastures.	As for pastures but stocking should not exceed 0.25LU / ha.
	Culm grassland.	As for pastures except that grazing should be at a low level over a period of time and aim for a sward that is less than 15 cm for at least part of grazing season. Autumn or winter grazing is acceptable where there is no risk of poaching.
	Chalk and limestone grassland.	Graze lightly with sheep and / or cattle for at least 10 weeks in each year. Aim to produce an average sward height of 75 mm by end of summer. Stocking should not normally exceed 0.75 LU / ha.
	Upland limestone grasslands.	As for chalk & limestone but "rest the pasture" by limiting sheep grazing to 0.1 LU / ha and remove all cattle for a period of at least eight weeks between May and August.
	Regenerating suppressed heather moor: Heather comprises less than 25% of sward - aim to achieve 40-50% heather cover in years 1-5.	First year lightly graze summer grass growth between June and July, and between April and July in subsequent years. Stocking should not exceed 1 sheep / ha and livestock should be excluded at all other times. After achieving 40-50% heather cover, light winter grazing may be reintroduced with the aim of achieving 50-70% heather cover by year 10. Summer sheep grazing can be increased progressively to a maximum of 1.5 sheep / ha between lambing and tupping. Winter grazing not to exceed 0.75 sheep / ha between tupping and lambing.

Scheme	Vegetation type	Stocking rate
	Enhancing heather moorland: Heather comprises 25-50% of the sward.	Summer and winter stocking levels are set in accordance with the type and condition of vegetation on the moor subject to general maxima: ! maximum summer stocking (lambing to tupping) 1.5 sheep / ha; ! maximum winter stocking (tupping to lambing) 0.75 sheep / ha; ! where appropriate, light summer cattle grazing; ! no cattle on moor (1 October-31 March).
	Management of heather moorland habitat.	Heather in good condition. Additional stock reductions may be agreed to speed up regeneration or to accommodate rare or unusual species.
Clun Environmentally Sensitive Area (ESA) (MAFF 1998a)	Wet areas. [Applicable to wet pasture.]	Exclude stock between 1 April and 30 June. Graze so as not to cause poaching, over grazing or under-grazing at other times.
Dartmoor ESA (MAFF 1998b)	Dry grass moorland (Tier 1 - maintenance). [Applicable to acid grassland.]	Do not exceed 0.36 LU / ha (excluding ponies) between 16 April and 31 October. Do not exceed 0.235 LU / ha (excluding ponies) between 1 November and 15 April. Do not exceed 0.04 LU / ha for ponies.
	Moorland (Tier 1 - maintenance). [Applicable to other moorland including heath and blanket bog.]	Do not exceed 0.225 LU / ha (excluding ponies) between 16 April and 31 October. Do not exceed 0.17 LU / ha (excluding ponies) between 1 November and 15 April. Do not exceed 0.04 LU / ha for ponies.
	Heather moorland (Tier 2). [Applicable to acid grassland, heath and blanket bog. Designed to increase the area and improve the condition of heather moorland.]	Do not exceed 0.17 LU / ha (excluding ponies) between 16 April and 31 August. Do not exceed 0.08 LU / ha (excluding ponies) between 1 September and 15 April. Do not exceed 0.04 LU / ha for ponies.
Exmoor ESA (MAFF 1998c)	Heather moorland and coastal heath (Tier 1 - maintenance). [Applicable to dry heath.]	Do not exceed 0.225 LU / ha throughout the year. Between 1 November and 15 April: ! remove all cattle; ! graze with sheep at no more than 1 ewe / ha; ! pony grazing only with written approval.

Scheme	Vegetation type	Stocking rate
	Heather moorland and coastal heath (Tier 2). [Applicable to dry heath. Designed to increase the area and improve the condition of heather moorland.]	Do not exceed 0.1 LU / ha between 16 April and 31 October. Remove all livestock other than pure-bred Exmoor ponies between 1 November and 15 April.
Lake District ESA (MAFF 1998d)	Fell without heather. [Applicable to areas of acid grassland].	Do not exceed 0.3 LU / ha.
	Intermediate heather fell. [Applicable to areas with a mosaic of dry heath and acid grassland. Designed to increase the extent of heath and improve its quality.]	Do not exceed 0.15 LU / ha. Between 1 December and 28 February remove: ! all cattle; ! all replacement hoggs; ! 25% of remaining livestock units (ie 25% of overwintering ewes).
	Heather fell (Tier 1 - maintenance). [Applicable to areas of dry heath.]	Do not exceed 0.225 LU / ha throughout the year. Between 1 October and 28 February remove: ! all cattle; ! all replacement hoggs; ! 25% of remaining livestock units (ie 25% of overwintering ewes).
	Heather fell (Tier 2). [Applicable to areas of dry heath. Designed to increase the extent of heath and improve its quality.]	Do not exceed 0.1 LU / ha throughout the year. Between 1 October and 28 February remove: ! all cattle; ! all replacement hoggs; ! 25% of remaining livestock units (ie 25% of overwintering ewes).
Shropshire Hills ESA (MAFF 1998e)	Moorland (Tier 1 - maintenance). [Applicable to heather and other semi-natural upland vegetation.]	Do not exceed 0.225 LU / ha. Between 1 November and 28 February remove: ! all cattle; ! 25% of remaining livestock units (ie 25% of overwintering ewes).
	Heather moorland (Tier 2). [Applicable to heather and other semi-natural upland vegetation. Designed to increase the area and improve the condition of heather moorland.]	Do not exceed 0.1 LU / ha between 1 March and 31 October. Remove all livestock between 1 November and 28 February.

Scheme	Vegetation type	Stocking rate
South West Peak ESA (MAFF 1998f)	Extensive pastures.	Limit stock numbers between 1 April and 30 June to no more than 0.6 LU / ha. Graze so as not to cause poaching, overgrazing or under-grazing at other times.
	Wet areas. [Applicable to wet pasture.]	Exclude stock between 1 April and 30 June. Graze so as not to cause poaching, overgrazing or under-grazing at other times.
	Moorland (Tier 1 - maintenance). [Applicable to dry heath, acid grassland and blanket bog.]	Do not exceed 0.225 LU / ha throughout the year. Between 1 November and 28 February remove: ! all cattle & horses; ! all sheep replacements; ! 25% of remaining livestock units (ie 25% of overwintering ewes).
	Moorland (Tier 2). [Designed to enhance the wildlife value of moorland.]	Do not exceed 0.1 LU / ha between 1 March and 30 September. Remove all livestock between 1 October and 28 February.
ESAs general (MAFF 1998 a, b, c, d, e & f)	Low-input permanent grassland, unimproved pasture, enclosed rough land / grazing, intake and in-bye (except where other regimes are specified above).	Do not graze so as to cause poaching, overgrazing or under-grazing. Additional grazing supplements (eg for off-wintering) are normally available.

Table 7.8 The effects of grazing at different times of year

(Adapted from Crofts & Jefferson 1994)

Timing	Advantages	Disadvantages
Spring (April/May)	Useful where the dominant species is particularly unpalatable, eg mat-grass, rushes, tor-grass etc. Checks growth of scrub seedlings and in some cases can be used to check growth of ragwort. Can be beneficial for invertebrates in creating bare ground.	Continual spring grazing on sites with early flowering plants such as early purple orchid *Orchis mascula* and green-winged orchid *O. morio* can cause local extinctions. Continual heavy grazing at this time can prevent development of structural diversity in the sward and considerably reduce the diversity of invertebrates present. Trampling of eggs and chicks can be a problem where waders breed.
Summer (May-September)	Can help control tall herb species such as meadowsweet *Filipendula ulmaria.* Less nutrient build up from animal dung due to greater micro-bacterial processes.	At high stocking rates grazing removes flowers, reducing nectar sources for invertebrates and lessens aesthetic appeal for visitors. Also reduces structural variability of sward, which is important for tussock-dwelling invertebrates, web-spinning spiders, and flower- and seed-feeding species. Heavy grazing pressure can prevent flowers from setting seed. Although perennials will be able to persist in a vegetative form, continual summer grazing will affect the abundance of annual species.
Autumn (September/October)	Least damaging time for sensitive invertebrates. Has little effect on most species which finish flowering and set seed before this time. May help seeds to establish through trampling.	Removes flowers of late flowering species such as devil's-bit scabious *Succisa pratensis.* This can have a knock-on effect for the marsh fritillary butterfly *Euphydryas aurinia* which depends on this species for food. Also reduces/eliminates seed heads, which are important for species such as picture-winged flies, which use seed heads of composites (as does winter grazing).
Winter (October-April)	Most grassland herbs are not directly affected by winter grazing as they are generally dormant (depending on weather to some extent). May encourage tillering of some grass species. Less damaging to invertebrates which are usually over-wintering in the base of tussocks. Moderate trampling breaks up the litter layer exposing ground for colonising by annuals the next spring.	Heavy trampling can lead to poaching and infestation by weed species. Does not remove as many nutrients by grazing. More nutrients from dung absorbed by soil as lower levels of micro-bacterial activity. Stock may lose condition. Hard winter grazing which removes all plant litter and tussock structure can destroy the habitat of many over-wintering invertebrates.

Duration and timing of grazing

As Table 7.7 suggests, it is not simply the number of stock that is important; the length of time and season they graze a field is important as well. The same grazing level (but not necessarily outcome) can be achieved both by grazing throughout the year and by grazing with a larger number of animals for only part of the year. Short periods of intense grazing can be useful in problem situations, but the rapid defoliation which results can be catastrophic for many invertebrates, so careful consideration is required before such action is implemented. In many situations the duration of grazing is dictated by when stock are available, and this is particularly so when the land manager is relying on a third party to supply the stock.

The timing of the grazing period can greatly affect the nature conservation interest of a grassland sward. It is not just the vegetation that is affected; bird and invertebrate populations that utilise the grassland will also be affected by the time of year at which grazing occurs. Table 7.8 summarises the effects of grazing at different times of year.

The duration and timing of grazing are also affected by the way stock utilise the ground. They do not always graze an area evenly, because some vegetation is more palatable than others and some areas are closer to the farm, water or feeding points, or are more sheltered. Shepherding will also affect the distribution and hence the impact of the stock across the land (see Chapter 6).

Surface treatments

Unimproved pasture

Application of artificial and organic fertilisers 'straight' N (nitrogen) and compound NPK (nitrogen, phosphorous and potassium), hoof and horn meal, dried blood and liquid seaweed rapidly reduces the species richness and diversity of semi-natural swards, even at low application rates such as 25 kg / ha / year of inorganic N. The use of such fertilisers is generally unacceptable on any type of semi-natural unimproved grassland if the nature conservation interest is to be maintained (Crofts & Jefferson 1994, 1999). Likewise, slurry and sewage sludge provide an immediate source of N, P and K and their application seriously damages the nature conservation interest of semi-natural grasslands. Therefore, they should not be applied.

Well rotted farm yard manure should not be applied to semi-natural grassland managed solely as pasture.

Lime should not be applied to semi-natural acidic grasslands (NVC communities U1 to U5) or calcium deficient neutral grassland (NVC MG5c *Danthonia decumbens* sub-community). Application of lime to other neutral and calcareous grasslands is acceptable where this is a proven long-established practice. It should not, however, be used where there is an intimate mosaic of calcareous and acidic grasslands or heath communities. Lime should be applied no more frequently than once every five to 10 years and at no more than three tonnes per hectare of calcium oxide (CaO) equivalent in any one dressing (Crofts & Jefferson 1994, 1999).

'Semi-improved' pasture

There are extensive areas of 'semi-improved' pasture in the enclosed uplands. Much of this land will have received low levels of nutrient input for many decades and some will be formerly improved pasture which is reverting to unimproved grassland because the nutrient inputs have stopped and the drainage changed. While this grassland is of lower nature conservation interest than unimproved pasture it can still be of considerable importance, particularly in areas where there is little or no unimproved grassland. Without surface treatments these grasslands may, in the medium to long term, revert to unimproved grassland.

Two management options are available for this type of pasture:

1. Initiate the reversion of the sward to unimproved semi-natural grassland by ceasing all applications of fertilisers, farm yard manure, slurry or lime.

2. Maintain the sward in its semi-improved state by continuing light applications of fertilisers and / or lime at low levels. Application rates should not, in general, exceed 50-100 kg / ha of artificial fertilisers or 12-20 tonnes / ha of well rotted farm yard manure per year. Lime should be applied no more frequently than once every five to 10 years and at no more than three tonnes per hectare of calcium oxide (CaO) equivalent in any one dressing.

Which option is taken will depend on the management objectives for (and particular nature conservation interest) of the pasture in question.

Allotments

Many allotments which lie adjacent to unenclosed moorland support identical vegetation to that of the unenclosed moorland. Where this is so they should be managed in a similar manner to the moorland. The management of dry heath, blanket mire, bracken and unenclosed grasslands is covered in Chapter 6, but see also Table 7.7.

Where allotments have been agriculturally improved or have a low wildlife value, they can benefit nature conservation by being used in a two pasture system (Mowforth & Sydes 1989). This involves using them for grazing only when herbage quality is most important to the stock. For sheep this is in the autumn prior to tupping and in the spring immediately before lambing and during lactation. In this way, lamb production can be maintained while effects on adjacent moorland are reduced. It enables the fell vegetation to achieve a higher nature conservation quality than would otherwise be agriculturally feasible.

Box 7.1 Example of limestone grassland management for wildlife

English Nature Craven Limestone Grassland Wildlife Enhancement Scheme (WES)

The Craven limestone grassland WES operates within the Craven District of North Yorkshire and applies to a series of Sites of Special Scientific Interest (SSSI) in the Yorkshire Dales. These SSSIs contain species-rich limestone grassland and the scheme aims to maintain and enhance the wildlife interest of the land.

The scheme allows for a variety of management regimes to increase the nature conservation condition of limestone grassland. The standard prescription (Tier 1) is as follows (Mercer & Evans 1997):

- Graze stock at no more than 1 ewe / ha (or equivalent) for any continuous period of eight weeks between 1 May and 31 August.
- At any other time graze stock at no more than 2 ewes / ha (or equivalent). Grazing rates may be higher when gathering stock on up to five separate days per year.
- Ideally, in summer cattle should be grazed, rather than sheep.
- Livestock equivalents are calculated on the basis of 5 ewes = 1 adult cow / bull / bullock.
- Milking dairy cows may not be grazed.
- Lambs (up to 1 October) and calves at foot are included in stocking rates for adult stock.
- Any control of thistles should be by mechanical means or chemical spot treatment.
- Any winter stock feeding must be carried out in specified areas without causing poaching and any waste must be cleaned away.
- No application of farmyard manure, slurry, artificial fertiliser or lime.
- All wet areas must be retained.
- Rabbits must be controlled.

Two examples of the effects of this regime are summarised below (Mercer & Evans 1997).

A different set of prescriptions apply to areas of limestone pavement and woodland.

Malham-Arncliffe SSSI (The Gill)

The effect of five years under this management regime following 10 years of heavy stocking (5-6ewes / ha, with stock removed in late summer) on two key limestone grassland plant species has been beneficial. Results from the Malham-Arncliffe (The Gill) monitoring programme show the following:

	1991 (start of management agreement)	1996
Mountain avens *Dryas octopetala*	9 (no flowers)	21 (4 flowers)
Rock rose *Helianthemum nummularium*	129	147

Lords Wood Pasture SSSI

The reintroduction of light autumn grazing in accordance with Tier 1 stocking rates following a period where grazing was absent, resulted in new site records for northern brown argus *Aricia artaxeres* and small skipper *Thymelius flavus* butterflies. Autumn grazing removed the coarse vegetation that had built up when there was no grazing, resulting in abundant flowering of species such as rock rose *Helianthemum nummularium*, ladies bedstraw *Galium verum* and bird's-foot trefoil *Lotus corniculatus* in the slightly calcareous grassland.

7.6.3 Managing meadows

A meadow is any grassland mown to produce a conserved forage crop. Two basic systems of meadow management are practised in the UK today: hay production and silage production. The principal difference between the two systems is that hay is allowed to dry in the field after it is cut, so that its moisture content is reduced to around 20-25%. This usually takes about three rain-free days, after which the hay is stored as unwrapped bales. In silage production, the cut grass is kept in a relatively moist state (moisture content is reduced from 80% in the uncut grass to 70-75%) and stored in anaerobic conditions, either in clamps or in big bales wrapped in polythene.

Hay making tends to be practised in less intensive farming systems. Fertiliser inputs tend to be lower and reseeding with high yield grasses is less common. In some cases swards may have been in existence for centuries. In hay making systems only one crop is harvested in the year, usually in July, which is generally after ground-nesting birds have left the nest.

Silage production is a more capital intensive system than hay making, so it tends to be used on larger, more intensive farms. Because of the high initial capital investment (for equipment and machinery) there is a requirement to maximise returns and consequently silage systems tend to use high inputs of fertilisers to maximise production. This allows several grass crops to be harvested each year, starting in late April / mid-May, although in some cases only one cut is taken per season (big-bale silage). An early cutting date has a detrimental effect on ground-nesting birds, for example corncrake, which will still be on the nest at this time. To maximise yields, most fields in silage production are sown with high yielding varieties of perennial rye-grass *Lolium perenne*.

Fields managed for silage tend to be of limited nature conservation interest, owing to the species-poor swards and the early cutting date, although they may support ground-nesting and wintering birds and provide feeding grounds for breeding waders. Big-bale silage fields may contain more wildlife value because they are cut only once and can be composed of less agriculturally improved swards. Hay meadows where 'traditional' low input management has continued to the present day can be of considerable importance for biodiversity.

This section is largely concerned with those hay meadows where the continuance of 'traditional' management practices has resulted in species-rich swards. The main meadow management system encountered in the uplands is the northern hay meadow type, which has produced a characteristic plant community (NVC community MG3). However, other systems and communities may also be encountered (see Table 7.2). In Britain calcareous and acidic grasslands are rarely managed for hay production.

Cutting/mowing

Mowing differs from grazing in its effect on the sward in several ways. It is non-selective, results in a sudden removal of biomass, does not produce patchiness in the vegetation and does not create open ground and gaps in the sward. Bare patches are important for invertebrates and the establishment of new plants. As a result cutting can produce a very different species composition compared with that produced through grazing.

Hay meadows are frequently of limited value for invertebrates except as a nectar source, and so are not generally the primary objective of hay meadow management for conservation. This is because cutting alone is poor for invertebrates; it results in a sudden defoliation and low structural diversity. It can be used for invertebrate conservation, however, preferably on a rotational basis, where grazing is not possible (see 7.8.2).

Timing of cutting

The timing of the cut is greatly influenced by environmental factors such as climate, altitude and aspect. Summer weather can be very unsettled in the uplands and a certain amount of flexibility is required. Generally speaking northern (Pennine and Lake District) hay meadows are normally cut in mid- to late-July, while farther south cutting may take place between mid-June to early July. As the species-richness of meadows has been created and maintained by traditional meadow management, continuing traditional cutting times is recommended to maintain this interest. Cutting should not take place during the bird breeding season, which is defined as 15 March to 15 July, to prevent eggs and young being destroyed. Where reliable historical information is not available, the dates above can be used as a guide. Repeated early cutting has been shown to reduce species-richness (Smith 1994), and for nature conservation purposes an occasional late cut (in August or September, once every five years) is thought to be beneficial for late flowering species (Andrews & Rebane 1994; Crofts & Jefferson 1994, 1999).

Methods

Hay is usually cut using drum or disc mowers driven by the power take-off (PTO) on the back of the tractor. Cutting should be straight forward, though several factors should be taken into account:

- Avoid low cutting heights as this can scalp the ground, producing areas suitable for weed invasion.
- Mowing from the centre of the field outwards or from side to side will allow breeding birds and mammals to escape.
- The use of machinery in damp conditions can result in rutting which can produce bare ground suitable for weed invasion.
- On ridge and furrow fields modern cutters tend to scalp ridges and leave tall vegetation in furrows. Finger bar cutters are more suitable in these circumstances.

Removing the hay crop is the key to retaining the wildlife interest of the meadow. Firstly, it removes nutrients from the system; secondly, the mechanical action of collecting the grass creates small areas of bare ground which allows annual species to re-establish in the sward. Bales should be removed from the field within three to four weeks.

While failing to mow, bale and remove a crop for a single year is unlikely to have any long-term consequences for the botanical richness of a field, it can make management more difficult in the following year. When harvesting is not completed it is advisable to graze the sward with either sheep or cattle then

top it with a flail mower or chain harrow it in the autumn. Alternatively, a forage harvester can be used to remove the crop for disposal off the field.

Grazing in meadows

Grazing in some form is an integral part of most, if not all, meadow management systems. There are two main meadow grazing regimes in the UK. Northern hay meadows (MG3) are traditionally grazed in spring (April and May) and stock removed, or 'shut up', in late May prior to cutting in July. The late summer and autumn growth (aftermath) is grazed from late summer (August) onwards. From then on grazing usually occurs, at least sporadically, through the winter, depending on stock movements on the farm. Although on many farms sheep are grazed on the unenclosed moor from late December / January through to the beginning of April. More lowland and southern meadows are not usually grazed in spring, but late summer / autumn aftermath grazing almost always occurs.

Grazing, particularly aftermath grazing, is essential for the maintenance of the botanical diversity of hay meadows. Kirkham, Mounford & Wilkins (1996) and Smith (1997) have both shown that cessation of aftermath grazing results in decreases in species-richness and changes in species composition in meadow swards.

At the end of the autumn / winter grazing period the sward height should not generally exceed 10 cm, depending on the nature conservation objectives. Where wintering wildfowl or spring-nesting waders are present then the sward height should be around 3 cm (Crofts & Jefferson 1994, 1999).

Changes in long-established traditional meadow management regimes, including the grazing regime, should not be made where that regime is already fulfilling the objectives. Where available, reliable historical information should be used as a guide for establishing grazing regimes in hay meadows. Where such information is not available the timings given above, together with the advice on stock type and stocking levels given in Section 7.6.2 should be used as a guide, with adjustments made for local conditions as necessary.

Both cattle and sheep are suitable for grazing meadows. Horses can also be used; however, special care must be taken to prevent overgrazing. Poaching and the creation of bare ground in general is undesirable as it allows weeds to become established in the sward.

Surface treatments in meadows

As for pastures the application of artificial and organic fertilisers ('straight' N and compound NPK, hoof and horn meal, dried blood, liquid seaweed) rapidly reduces the species richness and diversity of hay meadow swards. The use of such fertilisers is generally unacceptable on any type of semi-natural unimproved grassland. Likewise slurry and sewage sludge provide an immediate source of N, P and K and their application seriously damages the nature conservation interest of semi-natural grasslands. Therefore they should not be applied.

Well rotted farm yard manure (manure that has been stored for at least four months) should only be applied to hay meadows on neutral soils where there is a proven history of use and no evidence of loss of nature conservation interest of the sward. On meadows supporting breeding waders and wildfowl

farm yard manure should only be spread outside the breeding season, which is defined as 15 March to 15 July. Application rates should not normally exceed 20 tonnes / ha every three to five years and should only be applied in a single dressing (Crofts & Jefferson 1994, 1999). Further research is required on the effects of different application rates of farm yard manure and it may be that higher rates are acceptable, but at present a precautionary approach is advised.

Lime should not be applied to calcium deficient meadows (NVC MG5c *Danthonia decumbens* sub-community). Application of lime to other hay meadows is acceptable where this is a proven long-established practice. Lime should be applied no more frequently than once every five to 10 years and at no more than three tonnes per hectare of calcium oxide (CaO) equivalent in any one dressing (Crofts & Jefferson 1994, 1999).

Cow parsley

Frequent or abundant cow parsley *Anthriscus sylvestris* in hay meadows normally indicates inappropriate management for biodivesity. It increases in abundance when aftermath grazing lapses and / or where inputs of nitrogen, particularly inorganic forms, are inappropriately high. Its control may be necessary where it is out-competing other desired vegetation.

To control or prevent its spread (R Jefferson, pers comm):

- maintain or re-establish aftermath grazing, but avoid poaching, which creates niches for new plants;
- prevent inputs of artificial fertilisers or other nutrients (except farm yard manure where there is clear evidence of long-term historical use, see above);
- cut three or more times each year, where this species is dominant and cutting is not detrimental to other interests (eg outside the bird breeding season).

7.6.4 Flushed grassland and mires

Flushed (as opposed to floodplain) wet grasslands dominated by rushes *Juncus* spp and / or purple moor-grass are widespread in upland England below the fell wall. A number of reotrophic (ground water fed) mire communities in the form of flushes and valley mires can be found in association both with these wet grasslands and the drier pastures dealt with above. Flushes may also be found in meadows. Flushed grasslands and mires are very valuable for plants and animals, especially where there is a calcareous influence. They can contain rich invertebrate faunas, with crane flies, soldier flies, ground beetles and spiders. Where such grasslands support marsh violets *Viola palustris*, they can be the habitat of the small pearl-bordered fritillary.

To a large extent all these habitats can be managed in a similar manner and are treated together here. They are generally managed as pasture although some examples are managed as meadows (Table 7.2). Where the latter is the case section 7.6.3 should be referred to. Where managed as pasture, this type of vegetation should be lightly summer grazed, preferably with cattle, but hardy breeds of pony may also be acceptable. Sheep are not generally suited to wet conditions as they are prone to a number of diseases

in these conditions, although many flushed grasslands are sheep grazed as they occur in mosaics with drier plant communities.

Suggested grazing times and stocking rates are as follows:

Grazing period:	late May to late September / mid-October. However, where breeding waders are present the stocking levels should be reduced to avoid losses of eggs or chicks through trampling.	
Stocking rate:	*Molinia* grassland and valley mires:	1 cow / ha (0.65 LU / ha)
	Rush pasture and fen meadow:	1-2 cows / ha (0.65-1.3 LU / ha)

These stocking rates are only approximate guides and sward height, structure and poaching should be assessed on a regular basis. As a general rule, the grazing regime should be adjusted so that the sward height over the majority of the area is less than 15 cm high for at least part of the year, excluding rush and *Molinia* tussocks. Where *Molinia* is present it can dominant the sward and in time create a very tussocky structure. The aim is usually to prevent the tussocks developing by grazing so as to achieve a smooth, even sward (see also Chapter 6 on *Molinia*). It should be noted, however, that many breeding waders prefer a tussocky sward so a uniform sward height is undesirable in areas important for birds (Ausden & Treweek 1995). An example of appropriate management prescriptions for species-rich *Molinia* grassland is given in Box 7.2.

Where these wet features are found within areas of drier grasslands, the most appropriate management regime will depend on the wildlife interest of the habitats present, as well as their extent. Flush and valley mire communities require no more than light grazing to prevent succession to woodland. This is especially true of the wetter communities, such as those dominated by bottle sedge *Carex rostrata*. Some flush communities, particularly M10 *Carex dioica-Pinguicula vulgaris* flushes, may require trampling, such as that associated with light grazing, to maintain species richness. However, repeated heavy trampling will lead to a loss of nature conservation interest in the long term.

Box 7.2 English Nature Culm Grassland Wildlife Enhancement Scheme

Culm grassland is a mosaic of wet acidic grassland, wet heath, fen and mire communities. It is largely confined to south west England, southern Wales and south west Scotland. Although English examples are largely found in lowland England this habitat does extend into upland areas in the Dartmoor Natural Area. Also the management recommendations given for this habitat in Wolton (1994) are considered to be relevant to other wet grasslands found in the uplands.

The ideal management of Culm grassland

Grazing

Sites should be grazed by cattle at times between late May and late September. Stocking levels should be adjusted so as to ensure that the sward over the majority of any field is less than 15 cm high for at least part of the year, excepting areas dominated by tussocks of rush or *Molinia.* However, the ground surface should never be heavily poached and no attempt should be made to graze the whole of a field closely.

Flexibility in the grazing regime is essential, to allow for vagaries of weather and stock availability and differences between sites in plant community composition. If cattle are not available, ponies or even hill sheep are permissible in the short term.

Stocking levels

Guidance stocking levels are: for *Molinia*-dominated fields, over a 20-week period, one suckler cow per 0.8 ha or two 12-24 month stock cattle per hectare. These figures may be increased by up to 50% for rush-dominated fields. Rather than shut stock into Culm Grassland fields it may often be more practical, particularly on small sites, to run the land in with adjoining improved pasture.

Topping and burning

Often adequate grazing cannot be achieved because the land is not stock-proof or without risking heavy poaching, particularly in wet summers. Under these circumstances autumn cutting or winter burning will be necessary. Rush-dominated fields should be topped after the beginning of August at a minimum height of 15 cm. Either a flail mower should be used or cut material removed from site. *Molinia*-dominated fields should if necessary be burnt, preferably during January to February, once every other winter. No more than half of a site, and preferably of each field, should be burnt in any one year and fires should be quick and cool, just taking off the leaf litter. No attempt should be made to burn boggy or peaty areas, or right up to the field edges.

Tree and shrub management

Areas of trees and shrubs should be managed so that they are in an optimal, stable balance with the open sward. The greater part of each field should be kept open, but with scattered bushes or clumps of bushes throughout, larger ones at about 40 m intervals and smaller ones more frequently. Willow *Salix* spp should be especially favoured (and not oak *Quercus* spp). Thick, overgrown hedges that grade down from mature trees through scrub and tall grassland to a short sward are to be encouraged.

Scrub clearance

Where it is necessary to clear trees and shrubs from abandoned sites to reach the optimal balance given above, this should be done between September and March, preferably using hand-held tools. The use of vehicles should be avoided if possible. Cut material should be stacked near field edges or in adjacent woodland, or burnt off site. Following scrub clearance from neglected sites it may be necessary to:

a. Burn off any accumulations of leaf litter during the winter. No more than one third of any field should be so burnt in any one year.
b. Fence the land and ensure drinking water is available.
c. Treat regrowth from cut stumps with herbicide should grazing, burning, topping or swiping levels

7.6.5 Floodplain grasslands

Floodplain grasslands are uncommon in upland England, though they may occasionally be encountered. The management of these grasslands is covered in detail in *The Wet Grassland Guide: Managing floodplain and coastal wet grasslands for wildlife* (Treweek *et al* 1997) and land managers are advised to consult this document where major management decisions are concerned. Box 7.3, however, gives a brief summary of the management of floodplain grasslands.

Box 7.3 A summary of the management of floodplain grasslands for nature conservation (adapted from Andrews & Rebane 1994)

- Do not change the hydrological regimes of grasslands subject to winter flooding or with high spring and early summer water tables.
- Continue traditional mowing and grazing management.
- Do not improve the sward agriculturally.
- On peat maintain a high water table in spring and early summer by managing adjacent ditch water levels.
- On clay or silt soils use surface flooding to maintain wet conditions suitable for breeding waders.
- Where land drainage has lowered the water table, reinstate former conditions by 'reverse drainage' or surface re-wetting. (Re-wetting by surface flooding is inappropriate where the sward is plant-rich.)

7.7 Further management techniques for upland meadows and enclosed pasture

7.7.1 Drainage

Where long-standing drainage systems are present in fields with significant nature conservation interest, particularly in meadows, they should be retained. Maintenance works should not damage the sward. Semi-natural grasslands that are traditionally drained include some upland hay meadows (MG3 and fen meadow communities; Crofts & Jefferson 1994, 1999).

Drainage systems should not, however, be extended during maintenance into areas of mire or other wet areas which have not been previously drained. Where drainage systems have been recently installed in mires or other wet grasslands of nature conservation interest they should be blocked as otherwise the interest of the habitat is likely to be lost.

7.7.2 Stock feeding

Stock feeding in areas of wildlife interest can lead to nutrient enrichment and poaching of the ground, resulting in the loss of characteristic plants and animals. However, stock feeding during severe weather is a standard agricultural practice. The following practices are recommended:

- Seek to avoid stock feeding wherever possible but if unavoidable keep it to a minimum.
- Where stock feeding is unavoidable, do not undertake it on areas of wildlife value.
- The exception is in hay meadows, where hay made from the specific meadow should be used rather than imported hay or silage. The hay should also be spread widely and thinly over the field rather than placed in one area.
- Feed in small quantities at widely scattered sites, avoiding using the same sites and making sure that all the food is eaten (this is more appropriate for sheep).
- Or, rotate the feeding sites to avoid excessive pressure on any one area.
- Alternatively, locate a permanent feeder in a place with the least or no wildlife value and treat this as a sacrificial 'write-off' area.

7.7.3 Rolling and chain harrowing

Rolling is usually undertaken in spring and involves rollers towed by a tractor for levelling grassland, pressing in stones, encouraging the tillering of grasses and flattening mole hills. The aim is to prepare the ground for hay or silage harvesting later in the season. Rollers consist of two or three smooth-surfaced, hollow, rotating cylinders to which ballast can be added for weight (Crofts & Jefferson 1994, 1999). A chain harrow consists of a large number of small spikes carried on a flexible chain frame usually trailed by a tractor. They are used on grassland to break up matted swards, to spread dung after grazing and to spread molehills.

Rolling and chain harrowing are generally compatible with maintaining wildlife interests when conducted in spring, but the timing and wetness of the site are important. Advisable restrictions are shown in Box 7.4 (Crofts & Jefferson 1994, 1999).

Great burnet

Box 7.4 Recommendations concerning rolling and chain harrowing of enclosed grasslands

! Where grassland is important for ground-nesting birds, neither rolling nor harrowing should take place between 15 March and 15 July because these activities crush eggs and chicks.

! Where grassland supports early flowering species which may be vulnerable to damage by rolling, it should take place about six to eight weeks before flowering (ie not after 15 March).

! Sites with ant hills should not be rolled or harrowed.

! Wet sites should not be rolled because compaction and rutting by wheels may cause damage. Harrowing may be a more acceptable alternative or all terrain vehicles (ATVs) towing the equipment may avoid damage.

7.7.4 Managing problem species

Bracken

Bracken is commonly viewed as an invasive plant of grassland that reduces the area of grass available for stock grazing and, where severe, reduces the overall wildlife interest. However, it also provides essential habitat for the whinchat *Saxicola rubetra* and a variety of invertebrates, such as the high brown fritillary butterfly. The problems this species causes for farmers and the potential value of bracken to wildlife are covered in detail in Information Note 6, along with guidelines on its management.

Rushes

There are several types of rush *Juncus* spp. found in the enclosed grasslands of the uplands but the two most commonly occurring species are soft rush *Juncus effusus* and compact rush *Juncus conglomeratus*. Both are associated with damp fields. Rush infestation can be caused by a number of factors, including under-soil drainage systems falling into disrepair and poaching. Severe trampling can also lead to rushes becoming dominant in wet grasslands and they can remain dominant in a sward for long periods. They produce very large amounts of seed, which can persist in a dormant state in the soil until activated by further soil disturbance.

While rushes can invade pastures they are also an integral component of many semi-natural vegetation types of high nature conservation interest, including acid and mesotrophic flushes, rush pastures and fen meadows. Rush tussocks provide nest sites and cover for snipe, redshank and curlew and their chicks. Stands of rushes support various invertebrate species, which in turn are a food source for young birds, including black grouse.

Despite these positive attributes there are occasions where rushes may need to be controlled (Crofts & Jefferson 1994, 1999):

- where rush infestations reduce the species and structural diversity of swards of wildlife interest;
- in semi-natural swards where rushes are not generally a major component and they reduce the amount of grazing available;
- where the spread of rushes reduces the extent of short turf between tussocks which is required by breeding waders.

The most widely used and generally recommended method of controlling rushes is topping (cutting at a height of around 15 cm) in early August (after the bird breeding season). This will usually reduce the vigour of rushes to a level where they are controlled by normal grazing if carried out two years in succession. Herbicides can be used, if target methods such as spot-spraying or weed wiping are employed. However, whenever possible, herbicide use should be avoided in sensitive areas and near water courses. Good practice codes for herbicide use should always be followed (MAFF & HSC 1990; MAFF 1998g & h).

Docks, thistles and ragwort

Curled dock *Rumex crispus* and broad-leaved dock *R. conglomeratus*, spear thistle *Cirsium vulgare* and creeping thistle *C. arvense* and common ragwort *Senecio jacobaea* can become injurious agricultural 'weeds' when they become extensive in grassland swards. They can be controlled by topping prior to flowering (but not ragwort), spot control with herbicide, weed wiping on larger areas and hand control techniques such as pulling or cutting (not ragwort) at ground level prior to flowering. Cut or pulled plants should be removed from the site, particularly ragwort as it remains toxic and palatable to stock after wilting. As with rushes, the use of herbicides should be avoided, whenever possible, where nature conservation is the primary objective. Where injurious weeds pose a serious threat to agriculture or agricultural production, MAFF may require control action to be taken. It may be an offence under the Weeds Act 1959 to fail to control injurious weeds when under notice by MAFF to do so. Further information on weed control methods is contained in Crofts & Jefferson (1994, 1999).

Rabbits

Rabbits *Oryctolagus cuniculus* are the most significant non-domestic grazers and continuous heavy rabbit grazing can be damaging to the nature conservation interest of semi-natural grasslands, particularly those on shallow soils. Rabbit grazing has, however, maintained grassland on sites that would otherwise have developed into coarse grassland or scrub and also provide important niches for invertebrates. Where rabbit grazing is a problem, see Information Note 8 on methods of rabbit control.

7.7.5 Use of avermectin anthelmintics

Avermectins are a group of chemicals, several of which are used as veterinary medicines to control internal and external parasites in livestock. They are used in a range of animals, including cattle, sheep, horses and pigs. They are administered to stock by injection, oral drench or pour-on, or as a slow-release bolus. These chemicals are excreted in the dung of treated stock and remain active against invertebrates

that colonise dung. They can have a significant effect on the invertebrate fauna of grassland, particularly dung flies and dung beetles. Invertebrates form an important food source for other animals, particularly bats and birds, and rare invertebrates associated with dung in grassland may be adversely affected.

The length of time the dung remains toxic varies according to the application method. This ranges from one to two weeks following the use of an oral drench in sheep, to several weeks following a single injection in sheep and cattle, and five to six months for the Ivermectin bolus in cattle.

The use of avermectins, particularly the original active form, Ivermectin, is not generally recommended on pastures and meadows with wildlife interest, especially where rare or scarce invertebrates, including aquatic species, might be affected. Crofts & Jefferson (1999) give alternatives for the treatment of internal and external parasites. See also Cooke 1997 on avermectin use in livestock.

7.7.6 Burning

Burning is not a management technique which is widely used in the enclosed grasslands of upland England. In general it is not recommended as a management practice for meadows and pastures with wildlife interest.

Grassland burning has traditionally been used in upland areas to burn off dead and unpalatable grasses, especially purple moor-grass, to provide a flush of young, palatable grass for grazing (Ausden & Treweek 1995). It favours plant species which are able to withstand the effects of the burn, for example, those with growing points protected at or below the surface of the ground, such as purple moor-grass and mat-grass. These species can become dominant with repeated burning, to the exclusion of other valued plant species and their associated animals.

Crofts & Jefferson (1994, 1999) discuss burning in greater detail, including situations where it can be a useful tool. Wolton (1994) discusses burning on Culm grasslands of Devon and Cornwall. See also Chapter 6 Moorland.

7.7.7 Managing scrub

Scrub usually develops where management such as grazing, burning or mowing is reduced or ceases altogether. It develops most easily in the more open conditions of shallow soils, such as on limestone and on rocky ground, and is slow to invade grasslands on deep, fertile soils because of the dense cover of grasses or herbs (Hopkins 1996).

In enclosed grasslands scrub is often viewed as an undesirable development. This is particularly true where it is invading an area of existing high nature conservation interest, such as species-rich hay meadows or limestone grassland. However, scrub can have considerable nature conservation value in its own right and the positive aspects of scrub are now being given greater emphasis (Hopkins 1996, Mortimer *et al* 2000).

Nature conservation interest of scrub

Scrub, scattered trees and open woodland is of great value to birds. Light scrub cover provides nest sites, song posts, foraging areas and sheltered roosts for birds such as black grouse, whinchat, stonechat *S. torquata*, tree pipit *Antacus trivialis* and ring ouzel *Turdus torquatus*. Scrub is also very important for invertebrates, providing food and shelter and a range of vegetation structures which lead to a diverse invertebrate fauna. Many species occur at the margin of scrub and grassland, eg the northern brown argus butterfly and the Duke of Burgundy butterfly. Additionally, a number of uncommon plant species are characteristic of scrub margins, including globe flower *Trollius europaeus* and dark-red helleborine *Epipactis atrorubens* (Crofts & Jefferson 1994, 1999). Scattered trees such as rowan *Sorbus aucuparia*, and shrubs like hawthorn *Crataegus monogyna*, gorse *Ulex europaeus* and juniper *Juniperus communis*, are particularly beneficial on steep banks where bird and invertebrate interest might otherwise be limited.

Juniper scrub is a nationally rare habitat type and all examples should be maintained and, where appropriate, extended.

Where scrub grades into upland native woodland it provides a diversity of habitats beneficial to animals and plants alike. Upland woodland itself supports its own particular flora and fauna, covered in greater detail in Chapter 8. For further details of the ecology and conservation of scrub in general see Chapter 8, Hopkins (1996) and Mortimer *et al* (2000)

Managing scrub in enclosed pastures

Scrub should be retained and developed amongst enclosed upland farmland, to encourage breeding bird and invertebrate populations, provided its development does not threaten another habitat of wildlife value.

Scrub-grassland interfaces can be managed and maintained by rotational cutting on a five to 10 year cycle. Areas of scrub should be cut back to create scalloped edges to increase the length of interface. Where grazing levels are adequate, this can generally be done without using herbicide stump treatments to prevent re-growth. However, where grazing is absent or inadequate and species capable of rapid underground vegetative spread are present, eg blackthorn *Prunus spinosa*, then some herbicide control may be required to prevent such species dominating. Where scrub regeneration is desirable, but poor, it can be encouraged by scarification of the soil. Grazing may also be beneficial in these circumstances.

Grazing can be used to create a range of growth stages, using temporary fencing to exclude and include areas of scrub from grazing. If grazing is reintroduced to sites where it has been relaxed or abandoned, care must be taken to ensure that any intensive restoration grazing does not result in major damage to the floristic and entomological interest of the scrub boundary.

Open scrub is generally of greater wildlife value than dense scrub. Where closed canopies have developed, the grassland that would result from scrub clearance is likely to be of less wildlife interest than the woodland that would develop. Ward (1990) suggests that where scrub has developed a closed canopy with little or no field layer it can be managed on a 30-year rotation, clear-felling sections and allowing them to develop back into scrub. Ward (1990) found that scrub stands originating from dense scrub with bare ground produced a more species-rich community than stands originating from scrub clearance in earlier successional stages where tall grassland was present.

Reversing scrub invasion

Scrub can be removed either by hand- or machine-cutting or by grazing with goats. Cutting is the technique most commonly used. Sheep are generally unsuitable for grazing sites with scrub as they are prone to becoming entangled in branches. Cattle or horses of hardy breeds may be used to reduce minor encroachment by scrub if stocked at high densities in spring, but are unlikely to be capable of eradicating scrub from a site.

The clearance of closed canopy scrub does not normally result in its replacement by species-rich grassland because soil conditions alter under scrub and nutrient enrichment occurs. When such scrub is cleared there is often a rapid growth of nutrient-loving plants which smother slower growing grassland species. Grazing and cutting may reduce the vigour of the undesirable species but this may take a considerable time as the build-up of nutrients in the soil, especially phosphorus, is an extremely slow and difficult process to reverse. The best option, therefore, is to act before the canopy becomes dense, when some of the original grassland vegetation remains beneath the shrubs and the accumulation of leaf litter and other organic material has not significantly changed the soil nutrient status.

Where eradicating or reducing scrub will be of benefit, for example where there is scrub invasion of species-rich swards, then clearance should be carried out in winter, either by hand (mattocks, chain saws and axes) or using machinery (tractor-mounted flails, sickle-bar mowers, forage harvesters and excavators with root forks). The most appropriate method will depend on the resources available, the size of the area to be cleared, the terrain, stem size, scrub species and the nature conservation interest of the sward. Heavy machinery is generally unsuitable for species-rich or wet grassland, because it disturbs the ground, and for steep and rocky terrain. Stumps should be treated with suitable herbicides to prevent regrowth. Any regrowth present the following summer should be retreated with herbicide. Herbicides should not be applied by spraying where the ground flora is of nature conservation interest.

Grazing, other than by goats, is not normally an effective method of reducing or eradicating scrub. Goats, however, are preferential browsers and have been used to eradicate large areas of scrub (Crofts & Jefferson 1994, 1999).

Managing juniper scrub

Juniper does not reproduce vegetatively and a closed grass sward prevents its establishment from seeding. Because of this, reduction or removal of grazing alone is unlikely to be successful in promoting significant regeneration of juniper beyond an initial spurt. Bare ground is required if significant regeneration is to occur. This can be created by scarification or burning, although the latter should only be used where there is no danger of damaging existing juniper bushes. Juniper tends to establish best on the edges of existing stands rather than within them due to the shading effect of mature bushes.

Further information: Barrett 1997.

7.7.8 Archaeological and historical interests and management in enclosed grasslands

Archaeological sites and features are often preserved in unimproved grassland. Those which survive today are only a small proportion of the original number. These fragile and fragmentary remains are easily destroyed by changes in land use and management. Once gone, this unique record of the evolution of the countryside and how people once lived is lost for ever.

Management which is sympathetic to wildlife, as outlined in this chapter, is usually beneficial to archaeological interests. However, many aspects of farm work inadvertently result in damage. The implications for archaeology should be carefully considered before starting any work near archaeological sites and features.

Further information: Chapter 3 Decision making; Wood-Gee 1996.

7.8 Specific management for fauna

On many enclosed unimproved semi-natural grassland sites management is likely to be aimed principally at the vegetation. However, many of these sites may also have considerable entomological and / or ornithological interest, as may semi-improved grasslands. Additionally, improved pastures can be important in providing rich feeding for lapwing, golden plover *Pluvialis apricaria*, curlew and ring ouzel when they are not incubating eggs or tending chicks. Birds may fly several kilometres from the moors to feed in such areas. The following sections provide a brief overview of how management practices can be modified to enhance the value of grasslands for these groups.

7.8.1 Managing for birds

Unimproved permanent pastures and traditionally managed hay meadows are generally of greater benefit to birds than improved grasslands. Agricultural improvement, including drainage, applying inorganic fertilisers and reseeding, has been shown to result in the virtual disappearance of snipe and marked reductions in the density of, and proportion of fields used by redshank, curlew and lapwing (Baines 1988). In contrast, oystercatchers were found to nest on improved grasslands. Thus, the species composition on unimproved grasslands changes following improvement and within large areas containing many fields, the overall density of waders declines as the percentage of improved fields increases.

Sward structure

There is a pronounced dichotomy in the habitat preferences of bird species breeding in grassland. Species such as lapwing and wheatear *Oenanthe oenanthe* favour short, closely cropped swards (<2 cm), while species such as redshank, snipe, meadow pipit *Anthus pratensis*, skylark, whinchat and curlew prefer more lightly grazed, tussocky vegetation. Lightly grazed swards also support large vole populations which are preyed upon by raptors and owls.

! Short swards can be produced by sheep grazing, cattle, if stocked at moderately high densities, or rabbits.

- More tussocky swards with a high degree of structural diversity, particularly for breeding waders, are best produced by cattle, or sheep and cattle, at low stocking densities.

Additionally, the tall swards of hay meadows can support breeding birds, including corncrake.

Stocking levels/timing

Stocking levels also play a vital role in determining the breeding success of waders owing to stock trampling eggs and young. Grazing during the breeding season (15 March-15 July) reduce breeding success and this effect is increased with increased stocking density. Green (1986) has shown that at a stocking density of 1 cow / ha 18% of lapwing nests, 34% of snipe nests and 43% of redshank nests are trampled. At 2 cows / ha this increases to 33%, 57% and 67% respectively. With sheep grazing similar patterns are found, though at higher stocking densities.

If compatible with other nature conservation objectives, grazing during the wader breeding season should be avoided where breeding waders are present. Where grazing is required during this period then stocking densities below 0.5 cattle, or 1 sheep, per hectare should be used, to keep trampling levels below 25% for the above species.

Timing of cutting and other mechanical management practices

Cutting of meadows, rolling, chain harrowing and similar practices should only be carried out outside the breeding season (as above).

Water levels

Wetland features such as flushes, pools, damp grassland and patches of rushes are essential habitat requirements for breeding waders, as they provide both sources of food and nest sites. Poorly drained land, especially where *Sphagnum* and / or rushes have developed, supports a rich invertebrate fauna and is a major feeding ground for chicks of grouse and waders. These birds may travel considerable distances from their nest sites to reach such areas. Birds such as snipe also rely on wet grasslands for breeding and feeding, and require the upper soil to be moist to allow them to probe for food (Ausden & Treweek 1995). The pricipal requirement is water levels high enough during summer to keep the surface moist. Natural water levels should be maintained and such features as pools and flushes retained. No new drainage should be undertaken in such areas and existing drains should be blocked, using techniques which minimise hazards to livestock and create small wetland features.

More complex control of water levels is not a feature of management in upland England. Land managers requiring information on managing water levels in floodplain grasslands should refer to Treweek *et al* (1997) or Crofts & Jefferson (1994, 1999).

Figure 7.1 shows a range of stylised, ideal, enclosed grasslands for birds.

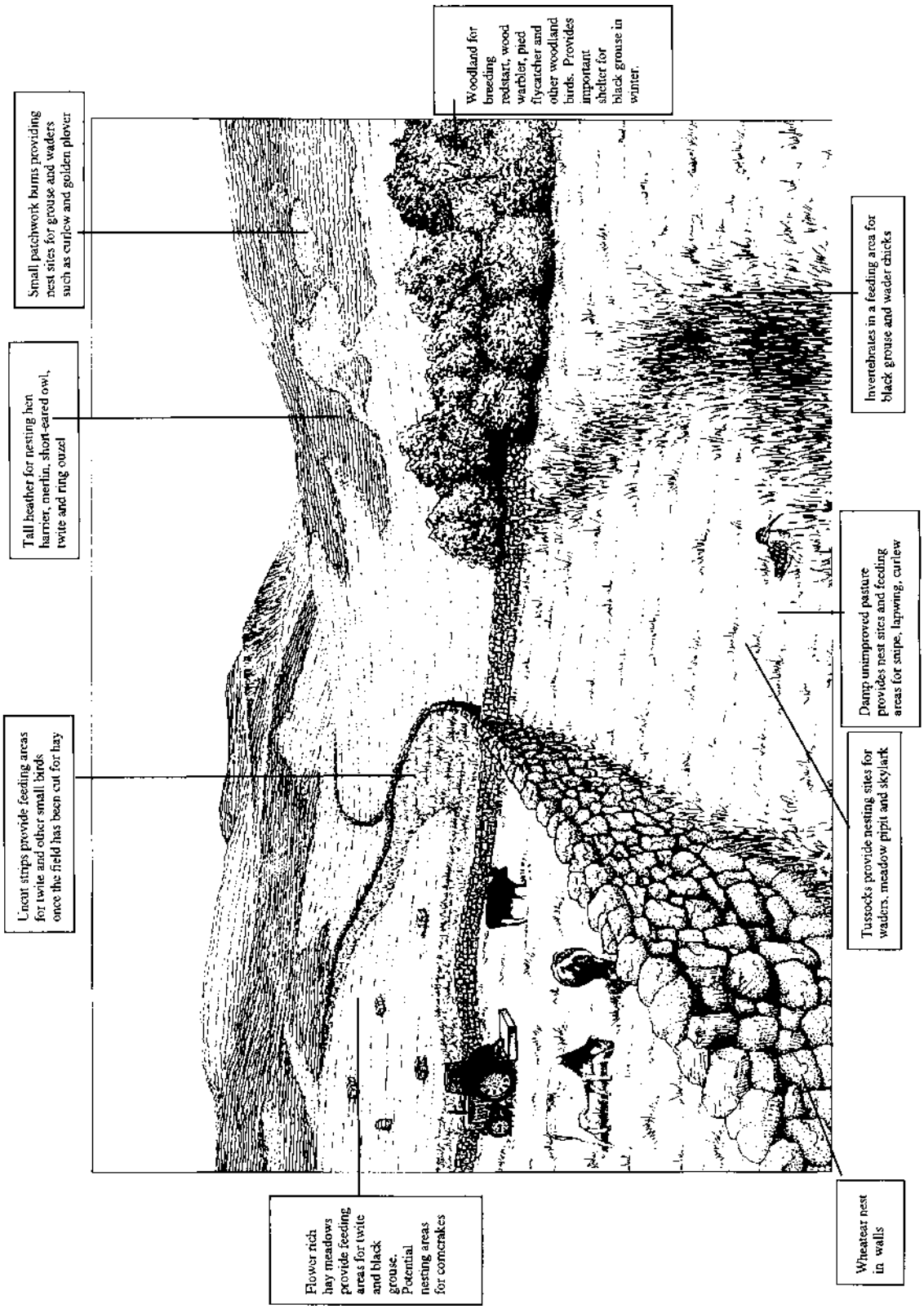


Figure 7.1. Stylised, ideal enclosed grassland and adjacent habitats for birds in the English uplands

7.8.2 Managing for invertebrates

The following are some general principles which should enhance general invertebrate diversity (Kirby 1992). Where specific rare or scarce species are known to be present specialist advice should be sought from appropriate sources.

- Continuity of management through time, ie consistency, is highly important in maintaining invertebrate diversity.
- Invertebrate diversity is heavily dependent on the structural diversity of the vegetation. Ideally the sward should contain areas of both short turf and stands of taller grass and tussocks.
- Short turf is especially valuable on south-facing slopes.
- Areas of bare ground are important for many invertebrate species, although too much can cause problems such as weed invasion.
- Grazing is the best management option for maintaining invertebrate diversity (but hay meadow management should not be compromised or changed to pasture).
- Cattle are better than sheep as they can produce a more structurally diverse sward. They also produce more bare ground, although heavy poaching is detrimental to wildlife interests.
- Winter grazing should allow at least some tussocks to remain.
- Where grazing is carried out throughout the year it should be at a low stocking density.
- Overgrazing, ie reducing the physical structure of the vegetation to a uniformly short sward, reduces invertebrate diversity because some areas of taller vegetation can be important for invertebrates.
- Cutting alone is poor for invertebrates (although hay meadow management should not be compromised or changed to pasture). It results in a sudden defoliation and low structural diversity. It can, however, be used, preferably on a rotational basis, where grazing is not possible.
- Scrub-grassland interfaces should be maximised: scalloped edges and long narrow bands of scrub are better than dense blocks. Rotational cutting can be used to maintain the structural diversity of scrub.
- Burning is not generally recommended as a management technique unless there has been a long history of such management.

7.9 Techniques to restore species-rich meadows and enclosed pasture

In the absence of management grassland will tend to become dominated by coarse grasses, tall herbs and scrub. This generally results in a reduction of botanical interest, although it should be noted that rank grassland does provide habitat for invertebrates, small mammals and reptiles.

Under-grazing can also lead to grasslands becoming rank. Stock are able to selectively graze the more palatable species present and avoid coarser grasses, herbs and shrubs when sward production is greater than that which the stock present are capable of utilising.

Prior to implementing any form of restoration management it is important to assess the current nature conservation value of the site; research its ecological and management history; assess the type of grassland the land could support and whether it is feasible to recreate it via management; and decide whether the management anticipated would improve or reduce the current wildlife value of the site.

There will be instances where restoration to grassland will achieve little for nature conservation, such as when a dense canopy of scrub has developed and there is little ground flora. In this situation it is likely to be difficult to restore species-rich grassland owing to the increased nutrient status of the soil following the build-up of leaf litter. Where this is the case other management objectives may need to be considered, such as rotational cutting to maintain scrub or management to promote the development of woodland (see Section 7.7.7 and Chapter 8). In some cases it may be possible to remove the nutrient-rich surface layer through scraping. In any grassland, testing the seed bank can reveal whether the desired plant species are still present and viable.

Some area may be much easier to restore than others. For example, semi-improved grasslands containing remnants of species-rich communities or a variety of plant species reminiscent of more valued grassland types, are likely to be easier to restore than grass leys (see Crofts & Jefferson 1999).

Before implementing any restoration management clear management objectives should be drawn up, against which the effects of the implemented management can be assessed.

Environmental land management schemes, such as the Countryside Stewardship and Environmentally Sensitive Area schemes, include provision for the restoration, and in some cases the re-creation, of species-rich grasslands.

7.9.1 Restoration management

Cattle, particularly the hardier breeds, or hardy breeds of pony (or goats) are capable of tackling coarse, rank grassland. Sheep tend to be less suited to restoration grazing as they tend to prefer short swards and fine grasses. They are, however, useful on steep slopes where heavier stock are likely to cause significant trampling damage, or where the sward has been pre-treated by prior grazing with cattle or mowing to remove the coarser herbage (Crofts & Jefferson 1994, 1999).

Although timing of grazing is not critical, where particularly unpalatable species, such as purple moor-grass, mat-grass or, occasionally in the uplands, tor-grass *Brachypodium pinnatum* are present, it is best

to graze in spring when fresh growth is being produced. Spring grazing will also help to control scrub where this is desirable. Note, however, that this option may not be ideal where certain ground-nesting birds are present.

Grazing at high stocking densities for short periods or at lower densities for a longer time can reclaim rank grassland. High stocking rates may be necessary in some instances to force animals to eat relatively unpalatable vegetation. However, care is needed when reintroducing high grazing pressures because it can have a damaging effect on invertebrate populations. For example, reductions in marsh fritillary numbers in specific locations was attributed to the introduction of high stocking rates to control scrub and coarse grassland (Warren & Bourn 1997). The increased stocking rate reduced the sward height to below that required by this butterfly. Often invertebrates associated with taller swards require the grassland to be grazed at particular stocking levels or certain times of year. Therefore, where rare or scarce invertebrates associated with taller swards are present it may be prudent to exclude some areas from grazing, at least temporarily during the restoration process, possibly on a rotational basis, to allow populations to be maintained (Kirby 1992)

Mowing can be used to aid restoration management, particularly to remove taller vegetation if sheep are to be used. It is not, however, as effective a restoration method as grazing as it does not break up the litter layer unless it is followed by chain harrowing.

Burning, followed by grazing, can also be used to clear coarse vegetation. Burning should only be carried out in January, February and early March as this reduces the adverse effects of fire on flora and fauna. Burning codes and regulations must be followed at all times (see Chapter 6 Moorland). Prior to using burning as a restoration tool, consideration should be given to the potential adverse effects it can have on invertebrates over-wintering in the litter layer.

If grazing is not an option for restoration management owing to lack of availability of livestock then serious consideration should be given as to whether restoration is appropriate in the first place as grazing will be required to maintain any restored sward.

7.9.2 Grassland re-creation

Those seeking to establish grassland swards of nature conservation interest on land with little or no nature conservation interest, such as arable fields, industrial sites or quarry / mining spoil, should consult *The lowland grassland handbook* (Crofts & Jefferson 1999), *Reclamation of Damaged Land for Nature Conservation* (Department of the Environment 1996b), *The establishment and management of wildflower meadows* (Wells, Cox & Frost 1989) and *Habitat restoration project: factsheets and bibliographies* (Dryden, Horton & Hall 1997).

Table 7.9 Nationally rare and scarce vascular plants associated with meadows and enclosed pastures in England

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Alchemilla acutiloba an alchemilla	LR-nt	Hay meadows or roadside verges. The species will not survive in intensively managed grass fields especially those cut early for silage.	! Traditional hay meadow management without reseeding or heavy use of fertilisers. ! Populations in roadside verges may benefit from occasional cutting of the vegetation, but not before ripe seed has been set.	North Pennines
Alchemilla glaucescens an alchemilla	LR-nt	Limestone grassland maintained by sheep-grazing.	! Protect sites from the application of fertilisers or pesticides. ! Maintain moderate levels of sheep grazing.	Cumbria Fells & Dales Forest of Bowland Pennine Dales Fringe Yorkshire Dales
Alchemilla glomerulans an alchemilla	LR-ns	Ungrazed or lightly grazed habitats on base-poor rocks. In Teesdale, also in species-rich hay meadows and roadsides. See Table 10.1.	! Prevent heavy grazing.	Border Uplands North Pennines Yorkshire Dales
Alchemilla gracilis an alchemilla	VU	More or less closed grassland over Carboniferous limestone. A few plants are also known from rough pasture, a hay meadow and a grassy roadside verge. It is thought to rely on grassland remaining unimproved and, at some sites, on continued grazing.	! Traditional methods of managing hay meadows and pasture, with no reseeding or heavy use of fertilisers. ! Grazed sites should continue to be grazed. ! Consideration should be given to cutting of roadside verges, following the setting of seed.	Border Uplands
Alchemilla minima an alchemilla	VU, EE	Very short, moist, calcareous, *Festuca ovina* grassland or amongst limestone boulders and debris. It is well adapted to sheep grazing. Its requirements are poorly understood. See Table 6.1.	! Maintain moderate grazing. ! Protect sites from habitat destruction and the application of fertilisers or pesticides. ! See Species Action Plan (UK Biodiversity Group 1998).	North Pennines Yorkshire Dales
Alchemilla monticola an alchemilla	LR-nt	Traditionally managed hay meadows or roadside verges. It depends on the continuation of traditional farming. Populations on road verges may be threatened by mowing where this is done too early in the year, before the setting of seed.	! Traditional hay meadow management without reseeding or heavy use of fertilisers. ! Populations in roadside verges may benefit from occasional cutting of the vegetation, but not before ripe seed has been set.	North Pennines Pennine Dales Fringe

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Alchemilla subcrenata an alchemilla	EN	Species-rich hay meadows or pastures. It requires traditional methods of hay cropping and is damaged by early cutting before seed has been set.	! Traditional management of hay meadows and pastures, without reseeding or heavy use of fertilisers, or early cutting. ! Populations in roadside verges may benefit from occasional cutting of the vegetation, but not before ripe seed has been set.	North Pennines
Arabis glabra tower mustard	VU	Light sandy soils over limestone, on disturbed, free-draining ground. It does not survive long where a dense cover of grasses develops or under trees.	! Protect sites from destruction and habitat degradation. ! See Species Action Plan (UK Biodiversity Group 1998).	Pennine Dales Fringe White Peak
Bartsia alpina Alpine bartsia	LR-nt	A perennial hemiparasite of moist, basic soils in upland meadows and pastures. Also on the drier hummocks within base-rich flushes and on species-rich flushed banks. Light grazing and trampling by cattle and / or sheep is necessary in the sites with hummocky flush-pasture; prevention of sheep-grazing in summer allows the plants to flower. Heavy poaching by cattle is detrimental. Some colonies by paths have been damaged by trampling.	! Protect sites from drainage. ! Where relevant, prevent trampling of populations. ! If possible, exclude sheep in summer and control grazing in the rest of the year to moderate levels, high enough to keep the vegetation low and open, while allowing the plants to grow and flower.	Cumbria Fells & Dales North Pennines Yorkshire Dales
Carex ericetorum rare spring-sedge	LR-ns	Short grassland on limestone.	! Protect sites from destruction.	Cumbria Fells & Dales North Pennines
Carex ornithopoda bird's-foot sedge	LR-nt	Open, calcareous grassland on Carboniferous limestone, often on thin, parched soils, which require light grazing to maintain the open character of the vegetation. Also close to exposed rocks on south-facing slopes, in full sun, and in shattered limestone pavement.	! Maintain light or moderate levels of grazing.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Chamaemelum nobile chamomile	LR-ns	Herb-rich, closely grazed or mown, moderately acidic grassland which has not been heavily sprayed or fertilised, often wet in winter. It cannot compete with the tall herbs or scrub which develop when grazing stops. It has also been lost when sites are drained.	! Maintain grazing by ponies and cattle in sites which are currently grazed. ! Prevent the use of fertilisers and pesticides. ! Prevent roadside sites being unnecessarily fenced.	Bodmin Moor Dartmoor Exmoor and the Quantocks
Crepis mollis northern hawk's-beard	LR-ns	Herb-rich grassland or wood pasture on shallow, slightly flushed, base-rich soils, often on north-facing slopes.	! Not currently understood.	Border Uplands Cumbria Fells & Dales North Pennines Yorkshire Dales
Crepis praemorsa leafless hawk's-beard	EN	Grazed calcareous pasture.	! Not currently understood.	Cumbria Fells and Dales
Dactylorhiza traunsteineri narrow-leaved marsh-orchid	LR-ns	Wet, base-rich habitats, especially fens or flushes. A reduction of grazing places the species at a competitive disadvantage.	! Maintain moderate levels of grazing where possible. ! Protect sites from drainage or other activities which lower levels of ground or surface waters, including the planting of conifers nearby.	Forest of Bowland North York Moors and Hills Yorkshire Dales
Dianthus armeria Deptford pink	VU Sched 8 priority	Dry pastures, field margins and hedgerows on light, sandy, often rather basic soil, preferring short grassland with some open ground maintained by grazing or some other form of disturbance. It dies out when shaded by coarse grasses or scrub.	! Where possible, sites should be grazed. ! Some populations may benefit from disturbance of the soil to expose buried seed. ! See Species Action Plan (UK Biodiversity Group 1998).	Exmoor and the Quantocks

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Dianthus deltoides maiden pink	LR-ns	In sandy grassland or heath, on sunny slopes on soils with some base-content, often where the sward is broken by bare soil or rocks. Although susceptible to heavy grazing, at many sites it requires some grazing to maintain an open sward. See Table 10.1.	! Control levels of grazing and other disturbance to moderate levels.	Border Uplands Clun & North West Herefordshire Hills Dark Peak North Pennines North York Moors and Hills White Peak Shropshire Hills
Equisetum variegatum variegated horsetail	LR-ns	A wide variety of open habitats including river gravels, upland flushes and calcareous springs, usually on fairly basic, moist sandy or gravelly substrates, with a pH of 6.5-7.3 or higher, where competition from other plants is reduced by winter-flooding or the mobility of the substrate.	! Maintain the site's hydrology, including water quality and patterns of water levels and flow.	Border Uplands Cumbria Fells & Dales Exmoor and the Quantocks North Pennines Yorkshire Dales
Eryngium campestre field eryngo	Sched. 8 of WCA VU	Neutral or calcareous semi-natural grassland on light soils. Open ground is necessary for germination and establishment of seedlings, and light disturbance of the soil is beneficial.	! Artificial fertilisers should not be used. ! Where possible sites should be grazed by cattle or sheep; mowing with occasional disturbance of the soil is an acceptable alternative. ! Rough grassland and scrub should be controlled.	Exmoor and the Quantocks
Euphrasia rostkoviana subsp. *montana* a euphrasia	LR-ns	Upland hay meadows, mainly in relatively dry sites but also in wet meadows and upland fens. It appears to be adapted to mature much of its seed before the hay is cut. It rarely if ever colonises improved grasslands.	! Traditional management of hay meadows, without reseeding or artificial fertilisers.	Border Uplands Cumbria Fells & Dales Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Euphrasia rostkoviana subsp. *rostkoviana* a euphrasia	LR-ns	Fertile soils in damp, herb-rich hay meadows, riverside grassland, lightly grazed pasture or grassy roadsides. It is a hemiparasitic annual which requires a cold period before germination. In hay meadows, much of the seed is thought to be produced after the first cutting of hay.	! Traditional management of hay meadows and pastures, without reseeding or artificial fertilisers.	Black Mountains and Golden Valley Cumbria Fells & Dales Forest of Bowland Shropshire Hills
Fumaria purpurea purple ramping-fumitory	LR-ns Priority	Hedge-banks, earthy walls or cliffs, cultivated fields or waste ground. It is usually most abundant where there is disturbance or where habitats are opened up by summer drought.	! Not currently understood. ! See Species Action Plan (UK Biodiversity Group 1998).	Shropshire Hills
Galeopsis angustifolia red hemp-nettle	LR-ns Priority	Usually on well drained, warm soils, often where competition is not great, especially arable fields on calcareous soils. It is most frequent in spring-sown crops and competes poorly with dense, heavily fertilised crops. Early ploughing of stubble may also reduce populations.	! Important populations should be managed by traditional arable methods, with modest use of fertilisers. ! See Species Action Plan (UK Biodiversity Group 1998).	Cumbria Fells & Dales Oswestry Uplands Pennine Dales Fringe White Peak
Juncus filiformis thread rush	LR-ns	Periodically flooded wet marshy pasture or open communities on lake-shore sand and gravel. Some lake sites have been damaged by misguided 'erosion protection'.	! Protect sites from changes in the water regime which would prevent the fluctuation of levels. ! Maintain the marshy or open, disturbed character of lake shores.	Cumbria Fells & Dales Forest of Bowland North Pennines Pennine Dales Fringe Yorkshire Dales
Linum perenne perennial flax	LR-ns, sub-species E	Base-rich grassland over limestone. In open, sunny, well drained situations on road verges, dry banks, lightly grazed grassland and similar habitats. It is slow-growing and a poor competitor which is readily shaded out by scrub and tall plants; it reproduces solely by seed. Heavy grazing and repeated close mowing will also eliminate the species.	! Mowing late in the year to 10-15 cm height, or light grazing by cattle or sheep all year or, preferably, during the winter only leaving a reasonably long sward. ! It can persist for a number of years without management or, at least for a few years, moderate grazing throughout the year.[1]	Cumbria Fells & Dales Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Lotus angustissimus slender bird's-foot trefoil	LR-ns	Short open-textured grassland swards over thin drought-prone soils, amongst scrub, around rocky outcrops and on grassy banks, most typically near the sea. Patches of bare soil are essential for germination of seed and cutting of scrub, trampling, fire and especially drought may all be useful in creating bare patches.	! Where the vegetation has become dense or closed, some disturbance should be carried out to provide patches of open ground.	Dartmoor Exmoor and the Quantocks
Lysimachia thyrsiflora tufted loose strife	LR-ns	Fens and swamps, usually among open, tall vegetation.	! All sites should be protected from drainage and lowering of ground waters.	North York Moors and Hills
Mentha pulegium penny royal	Sched. 8 of WCA VU	Short, seasonally inundated grassland over clay and silt, subjected to intense all year round grazing, trampling, dunging or disturbance by livestock or vehicles, causing poaching or ruts. It relies on the traditional management of commons and village greens.	! Traditional pastoral management, with, for example, grazing by cattle or horses. ! Resist proposals to 'tidy up' sites for this species. ! Maintain the seasonal pattern of water levels. ! See Species Action Plan (UK Biodiversity Group 1998).	Exmoor and the Quantocks
Meum athamanticum spignel	LR-ns	Dry neutral or acidic grassland in unimproved pastures, hay meadows and roadside banks, typically over slightly acid soils. It is unpopular with farmers as it can taint cow's milk.	! Where possible, continue with traditional grassland husbandry, without pesticides, reseeding or artificial fertilisers.	Border Uplands Cumbria Fells & Dales Pennine Dales Fringe
Myosotis stolonifera pale forget-me-not	LR-ns	Wet, somewhat base-poor, springs and seepage areas, soakways and flushes on hillsides and in valleys by pools, in ditches and in backwaters of streams.	! Protect major sites from destruction and drainage.	Border Uplands Cumbria Fells & Dales Dark Peak Forest of Bowland North York Moors and Hills Southern Pennines Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Oenanthe silaifolia narrow-leaved water dropwort	LR-ns	Unimproved, damp meadows, primarily hay meadows on riverside alluvium, which receive calcareous flood water in winter. The plants have tubers and are long-lived; most are mown each year before seed is set. Even quite modest agricultural intensification will eliminate the species.	! Continue traditional grassland management, with no ploughing, reseeding or use of artificial fertilisers or pesticides.	White Peak
Orchis ustulata burnt orchid	LR-ns	Short, well drained, open limestone grassland mainly in the lowlands. It is not a strong competitor and may be shaded out if the vegetation is left ungrazed; heavy grazing is also considered to be detrimental. Ploughing and the application of inorganic fertilisers appear to be fatal.[2] There are two varieties of this species: var. *ustulata* mainly flowers in May, var. *aestivalis* in July.	! Grazing should be light and preferably by sheep or sheep and cattle. ! Pasture can be grazed from early spring until April and again from July (from late August for var. *aestivalis*). ! Hay meadows can be traditionally managed, with no grazing between May and the end of July, followed by light grazing through the winter.[1] ! Prevent ploughing or the use of inorganic fertilisers.	North York Moors and Hills Pennine Dales Fringe White Peak Yorkshire Dales
Persicaria mitis tasteless water-pepper	LR-ns	Wet mud or peat banks left exposed in late summer as the water level drops. By ditches, in wet hollows, by cattle-trampled patches in pastures, by ponds, near former middens and in abandoned peat-cuttings.	! Protect major sites from drying out, filling in of ponds and fencing of ditches.	Border Uplands Shropshire Hills Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Pilularia globulifera pillwort	LR-ns	Bare wet substrates at the edges of slightly acid to neutral water bodies. Unable to compete with larger plants such as reeds or other fen species nor survive under the shade of overhanging trees, it relies on fluctuations in the water level to control the spread of larger plants. In some sites the species relies on disturbance by cattle or horses to uncover bare substrate which it can colonise; at such sites it seems to disappear if grazing ceases.[3]	! In sites where the species relies on a fluctuating water level, the pattern of fluctuating levels should be maintained. ! In sites where the species relies on disturbance, then the site should be kept accessible to large livestock. In small sites, care should be taken that poaching is not accompanied by excessive manuring. In the absence of grazing animals, mechanical or manual means could be used to control the spread of swamp and fen and provide bare substrate for pillwort. ! All sites should be protected from drainage or habitat destruction. ! Protect the sites from water pollution, especially by agricultural fertilisers. ! See Species Action Plan (UK Biodiversity Group 1998).	Black Mountains and Golden Valley Cumbria Fells & Dales Dartmoor Pennine Dales Fringe
Primula farinosa bird's-eye primrose	LR-ns	Calcareous flushes, marshes and mires, most typically amongst grasses and sedges on low hummocks of calcareous gravelly clay around eroded springs and stream banks. Also on steeply sloping banks of streams and rivers and in closely grazed moist pasture. It is vulnerable to agricultural intensification, including draining, manuring, use of inorganic fertilisers, reseeding and heavy grazing. Some grazing can be beneficial in creating open ground and restricting competition from taller plants.	! Control grazing to moderate levels wherever possible. ! Protect sites from agricultural intensification.	Cumbria Fells & Dales Forest of Bowland North Pennines North York Moors and Hills Pennine Dales Fringe White Peak Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Scandix pecten-veneris shepherd's-needle	LR-ns Priority	Arable fields on soils which are dry in summer, often heavy, calcareous clays. It has declined sharply with the use of modern herbicides.	! Where possible, herbicide use should be controlled to low levels where this species grows. Reduced use can be carefully targeted to small areas such as field margins or even smaller areas. ! See Species Action Plan (UK Biodiversity Group 1998).	Dartmoor Exmoor and the Quantocks Forest of Bowland
Senecio cambrensis Welsh groundsel	LR-nt E	An ephemeral species of disturbed sites such as roadsides and waste ground on dry soils.	! The habitats of this species are not really suitable for conservation management, but populations should occasionally be monitored. ! Seed from a range of populations should be maintained in seed banks in case of widespread losses.	Oswestry Uplands
Silene gallica small-flowered catch fly	LR-ns Priority	Cultivated or disturbed ground, most frequently on sandy soils. The autumn germinating seedlings are killed at temperatures below minus10^{o}C. The species is eradicated by the routine use of herbicides and inorganic fertilisers.	! Remaining sites should be protected from intensive use of herbicides and fertilisers. ! See Species Action Plan (UK Biodiversity Group 1998).	Exmoor and the Quantocks
Verbascum lychnitis white mullein	LR-ns	Waste places, disturbed ground, open grassy places on roadsides and banks, usually on calcareous soils. Seed retain their viability for many years when buried in soil, for example in woodland, and large colonies can emerge following disturbance.	! Periodic disturbance of sites with current or recent populations.	Exmoor and the Quantocks
Verbascum virgatum twiggy mullein	LR-ns	Dry banks, old walls, waste places or pastures. It cannot survive much competition and often disappears when lack of management allows coarse grassland and scrub to grow up.	! Control the growth of scrub and tall vegetation by grazing or cutting as appropriate.	Exmoor and the Quantocks

Key to Table 7.9

Status

Annex IIb	- listed on Annex IIb of the EC Habitats and Species Directive
Sched. 8 of WCA	- listed on schedule 8 of the Wildlife & Countryside Act.

Red list categories

CR	- critically endangered
EN	- endangered
VU	- vulnerable
DD	- data deficient
LR -nt	- Lower risk-near threatened
LR-ns	- Lower risk-nationally scarce.
E	- endemic to Great Britain
EE	- endemic to England.

Biodiversity Action Plan (BAP)

Priority	- Priority species from UK Steering Group 1995 and UK Biodiversity Group 1998.
SCC	- Species of conservation concern from UK Steering Group 1995 and UK Biodiversity Group 1998.

Sources

Most information from Hodgetts, Palmer & Wigginton 1996; Porley & McDonnell 1997; Stewart, Pearman & Preston 1994; Wigginton 1999.

1. Rich 1997. 2. Foley 1987. 3. R Cooke, pers comm.

Table 7.10 Nationally rare and scarce bryophytes associated with upland meadows and enclosed pastures in England

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Anthoceros agrestis	LR-ns	A summer annual on neutral or slightly alkaline, water-retentive disturbed clay and loam, especially in arable fields	Bodmin Moor
Hamatocaulis vernicosus slender green feather-moss	Annex IIb DD	Base-rich flushes. See Table 6.2.	Cumbria Fells & Dales Shropshire Hills
Moerckia hibernica	LR-ns	Base-rich flushes, fens, quarries, on ditch banks and on silty or marshy ground.	Cumbria Fells & Dales Yorkshire Dales
Oncophorus virens	LR-ns	In damp calcareous turf, especially in flushes and close to streams.	Cumbria Fells & Dales North Pennines
Philonotis caespitosa	LR-ns	On moist or wet non-calcareous soil and rocks, where flushed or flooded by slightly basic mineral-rich water.	Bodmin Moor Border Uplands Cumbria Fells & Dales Dark Peak Exmoor and the Quantocks Forest of Bowland Pennine Dales Fringe Southern Pennines Yorkshire Dales
Pohlia lescuriana	LR-ns	Preferring moisture-retentive soils, usually clay, although not those that are strongly basic. On banks of streams and ditches, at the margins of ponds and reservoirs, on bare soil in old fields, in ruts, on moist compacted soil by paths and on open clay soil in woodland rides.	Dark Peak Dartmoor Forest of Bowland Shropshire Hills Southern Pennines
Rhytidium rugosum	LR-ns	Open grassland on well-drained soils. See Table 6.2.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales
Sphagnum affine	LR-ns	In a variety of weakly minerotrophic mires.	Cumbria Fells & Dales
Sphagnum angustifolium	LR-ns	On flushed ground beside streams, on banks, in marshes and in open woodland, confined to minerotrophic sites.	Border Uplands

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Sphagnum flexuosum	LR-ns	In weakly minerotrophic marshes, in wet open woodland and on flushed rock-ledges.	Cumbria Fells & Dales This species is thought to be under-recorded.
Tomentypnum nitens	LR-ns	Wet fields and flushes with gently flowing water of pH 5.8 or more, often on gentle slopes.	Border Uplands Cumbria Fells & Dales North Pennines South West Peak Yorkshire Dales
Tortula subulata var. *subinermis*	LR-ns	On soil and about tree-bases by streams and rivers.	Forest of Bowland White Peak
Weissia microstoma var. *brachycarpa*	LR-ns	On wet non-calcareous clay, loam or marl. It is known from fields, woodland rides and glades, ditch-banks, pits and reservoir margins.	Dark Peak Forest of Bowland
Weissia rostellata	LR-nt Priority	An ephemeral species colonising moist bare ground. See Table 6.2.	Border Uplands Forest of Bowland Southern Pennines

Key to Table 7.10

Status

Annex IIb	- listed on Annex IIb of the EC Habitats and Species Directive
Sched. 8 of WCA	- listed on schedule 8 of the Wildlife & Countryside Act.

Red list categories

CR	- critically endangered
EN	- endangered
VU	- vulnerable
DD	- data deficient
LR -nt	- Lower risk-near threatened
LR-ns	- Lower risk-nationally scarce
E	- endemic to Great Britain
EE	- endemic to England.

Biodiversity Action Plan (BAP)

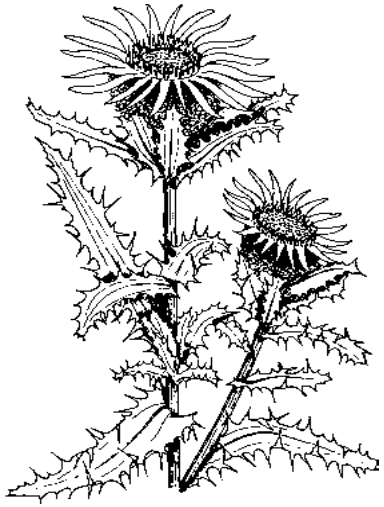
Priority	- Priority species from UK Steering Group 1995 and UK Biodiversity Group 1998.
SCC	- Species of conservation concern from UK Steering Group 1995 and UK Biodiversity Group 1998.

Sources

Most information from Hill, Evans & Bell 1992; Hill, Preston & Smith 1992 & 1994; Hodgetts, Palmer & Wigginton 1996 and Porley & McDonnell 1997.

Table 7.11 Habitat and management requirements of nationally rare and scarce bryophytes associated with meadows and enclosed pastures in England

Plants	Habitat requirements	Management requirements
Plants of arable fields, bare soil and mud.	Some of these species take about 18 months to complete their life-cycle and are damaged by autumn ploughing (N. Hodgetts pers comm).	! Some disturbance is required to provide patches of bare mud. ! Ploughing should wherever possible be in spring.
Plants of fens and flushes	Adequate levels of unpolluted water. Some species benefit from disturbance to open the vegetation.	! Protect sites from artificial reduction of levels or flows of ground or surface water. ! Where possible prevent contamination of ground and surface waters by agricultural and other chemicals.



Carline thistle

Table 7.12 Semi-natural plant communities associated with enclosed grassland in the uplands of England

NVC code	NVC name	Inclusion in Annex 1 of the Habitats Directive[1]	Significance in England[2]	Upland Natural Areas of England where community occurs[3]
Grassland				
Neutral (mesotrophic) grasslands				
MG1	*Arrhenatherum elatius* grassland.	--	Not specified	30
MG2	*Arrhenatherum elatius-Filipendula ulmaria* tall herb grassland.	--	Not specified	4, 8 / 15, 30
MG3	*Anthoxanthum odoratum-Geranium sylvaticum* northern hay meadow.	Mountain hay meadows (British types with *Geranium sylvaticum*)	Not specified	2, 4, 8 / 15, 10, 14
MG5	*Cynosurus cristatus-Centaurea nigra* lowland hay meadow and pasture.	--	Not specified	4, 8 / 15, 10, 12, 14, 17, 25, 29, 30, 41, 42, 58, 60, 87, 92, 94
MG8	*Cynosurus cristatus-Caltha palustris* flood pasture.	--	Not specified	4, 8 / 15, 10, 14, 29, 41
MG10	*Holcus lanatus-Juncus effusus* rush-pasture.	--	Not specified	2, 8 / 15
MG11	*Festuca rubra-Agrostis stolonifera - Potentilla anserina* inundation grassland.	--	Not specified	87
MG13	*Agrostis stolonifera-Alopecurus geniculatus* inundation grassland, silver meadows.	--	Not specified	87

NVC code	NVC name	Inclusion in Annex 1 of the Habitats Directive[1]	Significance in England[2]	Upland Natural Areas of England where community occurs[3]
Calcareous grassland				
CG2	*Festuca ovina-Avenula pratensis* grassland. (See also Ch 6 Moorland).	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	Not specified	2, 8 / 15, 10, 12, 17, 30, 41
CG3	*Bromopsis erectus* grassland.	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	Not specified	42
CG6	*Helictotrichon pubescens* grassland.	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	Not specified	2
CG7	*Festuca ovina-Pilosella officinarum-Thymus polytrichus* grassland.	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	Not specified	2, 30, 41
CG9	*Sesleria caerulea-Galium sterneri* grassland. (See also Ch 6 Moorland.)	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	I	2, 4, 8 / 15, 10, 12 14
CG10	*Festuca ovina-Agrostis capillaris-Thymus praecox* grassland. (See also Ch 6 Moorland.)	Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and sub-mountain areas in continental Europe)*	UK	2, 4, 8 / 15, 10, 12, 30, 42, 60
CG11	See Ch 5 Montane areas.			

NVC code	NVC name	Inclusion in Annex 1 of the Habitats Directive[1]	Significance in England[2]	Upland Natural Areas of England where community occurs[3]
Acid grassland				
U1 - U6	See Ch 6 Moorland.			
U7, U10, U13	See Ch 5 Montane areas.			
U15, U16, U17, U19, U21	See Ch 10 Crags, scree & limestone pavement.			
U20	See Ch 6 Moorland.			
Open vegetation				
OV37	See Ch 6 Moorland.			
OV38-OV40	See Ch 10 Crags, scree & limestone pavement.			
Mires				
Bog pools				
M1-M3	See Ch 6 Moorland.			
Small sedge bryophyte fens				
M4	*Carex rostrata-Sphagnum recurvum* mire.	Transition mires and quaking bogs	L	2, 4, 8/15, 10, 12, 25, 29, 58, 87, 92, 94
M5	*Carex rostrata-Sphagnum squarrosum* mire.	Transition mires and quaking bogs	L	10
M6	*Carex echinata-Sphagnum auriculatum/recurvum* mire.	--	I	2, 4, 8/15, 10, 12, 14, 17, 25, 29, 42, 58, 60, 87, 92, 94
M7, M8	See Ch 5 Montane areas.			
M9	*Carex rostrata-Calliergon cuspidatum* mire.	Transition mires and quaking bogs Alkaline fens	L	2, 4, 8/15, 10, 29, 41, 87
M10	*Carex dioica-Pinguicula vulgaris* mire.	Alpine pioneer formations of *Caricion bicoloris-atrofuscae** Alkaline fens	UK	2, 4, 8/15, 10, 12, 14, 17, 25, 29, 42, 60, 87
M11	*Carex demissa-Saxifraga aizoides* mire.	Alpine pioneer formations of *Caricion bicoloris-atrofuscae**	UK	4, 10, 42

NVC code	NVC name	Inclusion in Annex 1 of the Habitats Directive[1]	Significance in England[2]	Upland Natural Areas of England where community occurs[3]
M13	*Schoenus nigricans-Juncus subnodulosus* mire.	Alkaline fens	Not specified	17
Wet heath & blanket mire				
M15-M20	See CH 6 Moorland.			
Valley mire				
M21	*Narthecium ossifragum-Sphagnum papillosum* valley mire.	--	L	10, 17, 25, 29, 58, 92, 94
***Molinia* and *Juncus* fens**				
M22	*Juncus subnodulosus-Cirsium palustris* fen-meadow.	--	Not specified	17, 41
M23	*Juncus effusus/acutiflorus-Galium palustre* rush-meadow.	--	I	2, 4, 8/15, 10, 12, 14, 17, 25, 29, 41, 42, 58, 87, 92, 94
M24	*Molinia caerulea-Cirsium dissectum* fen-meadow.	*Molinia* meadows on chalk and clay (Eu-*Molinia*)	Not specified	29, 87, 92
M25	*Molinia caerulea-Potentilla erecta* mire.	--	I	2, 4, 8/15, 10, 12, 14, 17, 25, 29, 42, 58, 87, 92, 94
M26	*Molinia caerulea-Crepis paludosa* mire.	*Molinia* meadows on chalk and clay (Eu-*Molinia*)	I	4, 8/15, 10, 29, 58
Tall-herb fen				
M27	*Filipendula ulmaria-Angelica sylvestris* mire.	--	Not specified	8/15, 10, 17, 29, 41
Springs				
M29	*Hypericum elodes-Potamogeton polygonifolius* soakway.	--	I	10, 42, 87, 92
M31-M32	See Ch 5 Montane areas.			
M35	*Ranunculus omiophyllus-Montia fontana* rill.	--	L	4, 10, 25, 42, 87

NVC code	NVC name	Inclusion in Annex 1 of the Habitats Directive[1]	Significance in England[2]	Upland Natural Areas of England where community occurs[3]
M36	Lowland springs and stream banks of shaded situations.	--	L	42
M37	*Cratoneuron commutatum-Festuca rubra* spring.	Petrifying springs with tufa formation (*Cratoneurion*)*	L	4, 8 / 15, 10, 25
M38	*Cratoneuron commutatum-Carex nigra* spring.	Petrifying springs with tufa formation (*Cratoneurion*)*	L	4

Key to Table 7.12

1. Taken from Brown *et al* 1997
   * Priority habitat.
2. Taken from Drewitt & Manley 1997 and Jefferson 1996.
   - I Internationally scarce with UK representation.
   - UK Well developed in UK but represented elsewhere.
   - L Well developed in Europe.

3. The following 18 Natural Areas are classed as upland by English Nature:

No	Natural Area name
2	Border Uplands
4	North Pennines
8	Yorkshire Dales
10	Cumbria Fells & Dales
12	Forest of Bowland
14	Southern Pennines
15	Pennine Dales Fringe
17	North York Moors and Hills
25	Dark Peak
29	South West Peak
30	White Peak
41	Oswestry Uplands
42	Shropshire Hills
58	Clun & North West Herefordshire Hills
60	Black Mountains and Golden Valley
87	Exmoor and the Quantocks
92	Dartmoor
94	Bodmin Moor.

Table 7.13 Breeding birds associated with upland enclosed grasslands in England

Bird species[1]	Birds of conservation concern in the UK[2]	Listed on Schedule 1 of the 1981 Wildlife & Countryside Act	Listed on Annex 1 of the EC Birds Directive	No of British 10-km squares with breeding records 1988-90	% of breeding records in upland ITE squares[3]	Main upland habitat associations	Principal upland Natural Areas supporting the species *= major/important areas[4]
Red kite *Milvus milvus*	Red list	!	!	45	71.1	Woodland	Extinct in English uplands
Buzzard *Buteo buteo*	-	-	-	1,174	47.6	Woodland and enclosed land	2, 4*, 8, 10*, 41*, 42*, 58*, 60*, 87*, 92*, 94*
Merlin *Falco columbarius*	Red list	!	!	386	87.3	Moorland and enclosed land	2, 4*, 8*, 10*, 12*, 14*, 15, 17*, 25*, 29, 42, 58, 87
Black grouse *Tetrao tetrix*	Red list Priority BAP species	-	-	278	86	Moorland and enclosed land	2, 4*, 8, 29, extinct elsewhere
Corncrake *Crex crex*	Red list Priority BAP species	!	!	105	51.4	Enclosed land	Extinct in English uplands
Oystercatcher *Haematopus ostralegus*	Amber list	-	-	1,365	44	Enclosed land and fresh waters	2*, 4*, 8*, 10, 12*, 14*, 15
Golden plover *Pluvialis apricaria*	Amber list	-	!	630	84.1	Moorland and enclosed land	2*, 4*, 8*, 10, 12*, 14*, 15, 17*, 25*, 29, 92
Snipe *Gallinago gallinago*	Amber list	-	-	1,307	49.8	Enclosed land and moorland	All upland NAs but 87, but note in particular 2*, 4*, 8*, 12*, 14*, 15*, 25*, 29*
Curlew *Numenius arquata*	Amber list	-	-	1,354	48.1	Moorland and enclosed land	2*, 4*, 8*, 10, 12*, 14*, 15*, 17*, 25*, 29*, 30, 41, 42, 58, 60, 87, 92, 94
Redshank *Tringa totanus*	Amber list	-	-	1,046	36.8	Enclosed land and moorland	2*, 4*, 8*, 12*, 14*, 15, 25
Short-eared owl *Asio flammeus*	Amber list	-	!	381	70.9	Moorland	2*, 4*, 8*, 12*, 14*, 15, 17*, 25*, 29

Bird species[1]	Birds of conservation concern in the UK[2]	Listed on Schedule 1 of the 1981 Wildlife & Countryside Act	Listed on Annex 1 of the EC Birds Directive	No of British 10-km squares with breeding records 1988-90	% of breeding records in upland ITE squares[3]	Main upland habitat associations	Principal upland Natural Areas supporting the species *= major/important areas[4]
Meadow pipit *Anthus pratensis*	-	-	-	2,257	38.1	Moorland and enclosed land	All areas
Pied wagtail *Motacilla alba*	-	-	-	2,466	32.5	Ubiquitous	All areas
Whinchat *Saxicola rubetra*	-	-	-	1,062	59.9	Moorland and scrub	2*, 4*, 8*, 10*, 12*, 14*, 15*, 17*, 25, 29*, 30, 41, 42, 60, 87*, 92*, 94*
Stonechat *Saxicola torquata*	Amber list	-	-	847	47.7	Moorland and scrub	10*, 42, 58, 87*, 92*, 94
Wheatear *Oenanthe oenanthe*	-	-	-	1,339	60.6	Montane areas, moorland and enclosed land	2*, 4*, 8*, 10*, 12, 14, 15, 17, 25, 29, 30*, 41, 42, 58, 60, 87, 92*, 94
Twite *Carduelis flavirostris*	Red list	-	-	420	70.2	Moorland and enclosed land	4, 8, 14*, 25*, 29*

Key to Table 7.13

1. Upland breeding bird species as identified in Stillman & Brown 1998.
2. Birds of conservation concern from RSPB 1996.
   BAP relates to the UK Biodiversity Action Plan and those species which are considered to be priority species (UK Steering Group 1995; UK Biodiversity Group 1998).
3. From Bunce & Barr 1988, using the 13 ITE land classes which were regarded as upland (information not available on an English basis).
4. The following 18 Natural Areas are classed as upland by English Nature:

No	Natural Area name
2	Border Uplands
4	North Pennines
8	Yorkshire Dales
10	Cumbria Fells & Dales
12	Forest of Bowland
14	Southern Pennines
15	Pennine Dales Fringe
17	North York Moors and Hills
25	Dark Peak
29	South West Peak
30	White Peak
41	Oswestry Uplands
42	Shropshire Hills
58	Clun & North West Herefordshire Hills
60	Black Mountains and Golden Valley
87	Exmoor and the Quantocks
92	Dartmoor
94	Bodmin Moor

Table 7.14 Habitat requirements of birds associated with upland enclosed grasslands in England

Bird species	Habitat requirements
Red kite *Milvus milvus*	! Strong association with native woodland. ! Nest placed high in native woodland tree. ! Adults forage widely for carrion across roadsides and hillsides and for earthworms in improved and semi-improved pastures and tilled land. ! Food brought to dependent young in nest by adults. ! Present throughout year but extinct in English uplands.
Buzzard *Buteo buteo*	! Strong association with woodland and enclosed grassland at the moorland fringe. ! Nest placed in isolated or woodland trees or occasionally on rock ledges, usually within woodland. ! Adults feed over all types of open country - moors, acid grasslands, tilled land and pastures and meadows, taking earthworms from pastures and tilled land and small mammals, road kills and other carrion from hill and roadsides. ! Adults bring food to dependent young in nest. ! Present throughout the year.
Merlin *Falco columbarius*	! Strong association with heather moorlands. ! Nest placed on ground in tall heather, or occasionally in bracken, on moderate to steep slopes. ! Also nests occasionally in trees on moorland and at the edge of plantations. ! Adults forage for a wide diversity of small bird prey (especially meadow pipit) over both moorland and enclosed grassland. ! Food brought to nest for dependent young by adults. ! Some birds present throughout the year, but many more present in breeding season, April-July.
Black grouse *Tetrao tetrix*	! Nests on ground in tall heather moorland or in rushy pastures. ! Adults associate strongly with mixed moorland areas, with heather moors, *Vaccinium* heaths, *Eriophorum* bog and scrub and light woodland. ! Chicks forage in wet flushes for invertebrates, particularly moth and sawfly larvae. ! In winter, birds forage on heather moorland and amongst birch, rowan, hawthorn, alder and willow scrub. ! Present in uplands throughout the year.
Corncrake *Crex crex*	! Strong association with traditionally managed hay meadows, particularly those with damp patches where sward height is tall enough to conceal birds on return in mid-April. ! Nest placed on ground in meadow grasses. ! Adults and young forage for invertebrates in hay fields - cutting dates must be sufficiently late to avoid destroying nests, eggs and young and cut should be from inside out to allow escape of remaining birds. ! Extinct in English uplands, otherwise present mid-April to end August.
Oystercatcher *Haematopus ostralegus*	! Strong association with riparian grasslands. ! Nest placed on sparsely vegetated ground in riparian gravels or other bare patches in improved / semi-improved fields and riparian grasslands, usually near lake or river. ! Adults forage for earthworms and other invertebrates in improved, worm-rich pastures and riparian grasslands. ! Chicks feed in damp flushes, pools and stream sides, and in semi-improved pastures. ! Present late February to end June.

Bird species	Habitat requirements
Golden plover *Pluvialis apricaria*	! Strong association with flat or gently sloping ground, on unenclosed blanket bog and heather moors managed for grouse or sheep for nesting and enclosed pastures for feeding. ! Nests on ground in short vegetation, created by burning, grazing or stunting on bogs or on ridge summits. ! Chicks feed on grass patches on heather moor or in wet flushes - chicks may be led over a kilometre to feed in invertebrate rich areas by their parents. ! When not incubating and before and following the breeding season, adults forage in enclosed, earthworm-rich, improved and semi-improved grassland up to at least 7 km from nests. ! Presence in uplands very weather dependent: in mild years or areas, birds may be present throughout the year, but more usually present between late February and end June.
Snipe *Gallinago gallinago*	! Strong association with damp to wet unenclosed and enclosed land. ! Nest placed on ground concealed in tussock in tall vegetation especially rushes in enclosed fields, wet moorland, grassland and wet flushes. ! Adults forage for invertebrates in soft soil where water table near (<20 cm) surface, in damp rushy flushes, pools, stream sides on moors and on enclosed land. ! Chicks forage for invertebrates in damp, rushy flushes, pools on moor or in enclosed fields. ! Present mainly late February to end June.
Curlew *Numenius arquata*	Broad habitat association with flat or gently sloping ground, on low to moderate altitude moorlands and enclosed grasslands. ! Nest in a wide range of sites, on the ground in both enclosed fields and on moorland, in tall and short vegetation. For example, in *Eriophorum* and large grass tussocks, in tall rushes and amongst the dead stems of sharp-flowered rush, in short or prostrate heather, in fresh burnt patches, and amongst bracken litter. ! On heavily grazed moors with short grassland, nesting birds undertake much feeding on these moors. Occasionally breeding adults will also feed in enclosed fields some distance (3-4 km) from nest sites, rather than using fields immediately adjacent to the moor. Prior to laying and during incubating, adults feed on improved and semi-improved pastures rich in invertebrates because they are feeding mainly on earthworms and leatherjackets. After hatching, adults feed in the same areas as the chicks. ! Chicks feed particularly in areas of wet rushy grassland and flushes, and moorland nesting birds will often take chicks into neighbouring enclosed fields. Also feed on the ground beneath tall heather, on short burnt heather, ! Present late February to end June.
Redshank *Tringa totanus*	! Associated with riparian grasslands, unimproved and semi-improved pastures and, much less frequently, with damp moorland. ! Nest is placed on ground in tussock in unimproved and semi-improved fields and allotments, in wet hollows or riparian grasslands. ! Adults and chicks forage for invertebrates in wet riparian grasslands, stream sides and lake sides, enclosed improved land and wet, rushy patches in fields. ! Present mid-April to end June.

Bird species	Habitat requirements
Short-eared owl *Asio flammeus*	! Strong association with unenclosed moorland, particularly on moderate to steep slopes towards moorland edge, and with young forestry. ! Nests on ground within patches of tall heather, amongst bracken litter or in tall grassland, usually with good visibility. ! Adults forage over all open moorland and enclosed unimproved grasslands for small mammals. ! Food brought to nest by adults. ! Small numbers present throughout year but most present during breeding season April to August.
Meadow pipit *Anthus pratensis*	! Found in association with nearly all types of upland habitat . ! Nest placed on ground in tussock or depression in heath, grass or bracken. ! Birds forage for invertebrates in short or moderately tall vegetation. Densities appear to be greatest on heather moors with a higher grass component. ! Food brought by adults to dependent young in nest. ! Present mainly March to late July. Not usually present outside breeding season.
Pied wagtail *Motacilla alba*	! Avoidance of open moorland but strong association with enclosed grasslands, farm buildings and stream sides in valleys. ! Nest placed in hole in wall, outhouse, under stones, in open grassy places, screes. ! Adults forage for invertebrate food in improved fields, farmyards, stream sides, lake shores and roadsides. ! Food brought by adults to dependent young in nest. ! Present throughout the year.
Whinchat *Saxicola rubetra*	! Strong association with tall vegetation, notably scrub, bracken and very tall grass and heather. ! Adults sally for invertebrates from tall vegetation, fence posts and fencing wire or feed off ground on grassy patches amongst heather adjacent to bracken or on improved / semi-improved pastures. ! Adults bring food to dependent young in nest. ! Birds present end April to July.
Stonechat *Saxicola torquata*	! Strong association with scrub, tall heather or bracken. ! Nest placed low in bracken, gorse and other tall, thick scrub, trees or heather. ! Adults feed on open grassy areas, within otherwise shrub-dominated habitat or amongst patches of bracken, so long as perches are available on tall vegetation. ! Adults bring food to dependent young in nest. ! Found throughout year on scrub areas on enclosed farmland and on open moorland.
Wheatear *Oenanthe oenanthe*	! Nest in hole in ground or wall, in bracken clump, beneath stones, on enclosed farmland, moorland or scree. ! Adults forage for invertebrates over bare ground or short swards on heather moors, stream sides, lake shores and enclosed farmland. ! Adults bring food to dependent young in nest. ! Birds usually present during extended breeding season, March to September.

Bird species	Habitat requirements
Twite *Carduelis flavirostris*	! Strong association with tall vegetation at moorland edge, often in close proximity to water and to flower-rich meadows. ! Nest placed on ground or low down in tall heather, bracken litter or, more rarely, in grass, *Eriophorum* or small crevice, always on unenclosed land. ! Adults forage for flower seeds collected in burnt *Molinia* patches and from farmyards and haystacks in April and early May, from flower-rich meadows and pastures in May and June and from roadside verges and any remaining uncut meadows thereafter. Birds will forage up to at least 2 km from moorland nest site. ! Food brought to dependent young in nest by adults. ! Birds usually present during extended breeding season, April to September.

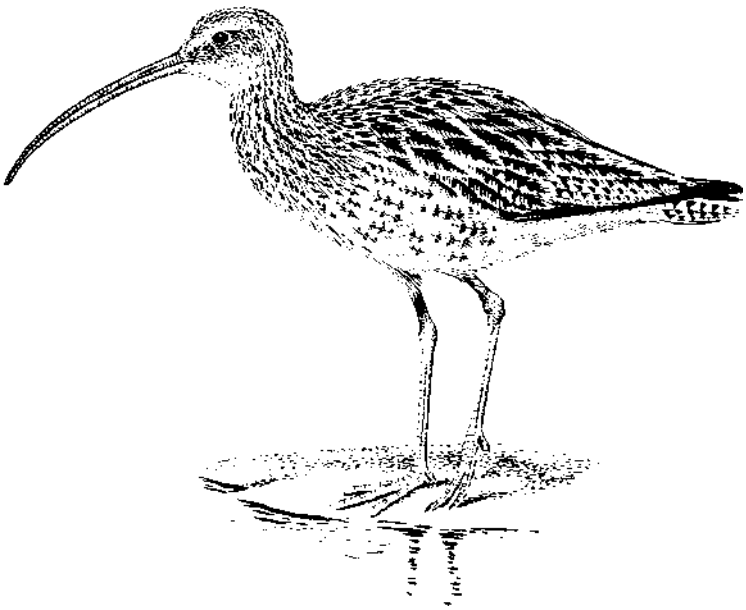


Table 7.15 Management guidelines for birds associated with upland enclosed grasslands in England

Management of enclosed grassland for birds
! Maintain natural drainage and wetland features such as pools and flushes. ! Create small wet areas by blocking existing drains and grips. ! Do not reseed or plough permanent pastures. ! Do not apply inorganic or organic fertiliser, slurry or lime to upland farmland unless this has been a traditional practice. ! If rolling is necessary, roll immediately after drilling and before nesting season in April. ! Graze over an extended period using a low density of stock. Cattle or horses will produce a tussocky sward favoured by breeding waders. ! Turn stock out onto fields used by nesting waders after second week in June. ! Cut hay meadows after mid-July to avoid harming nesting birds. ! Leave an uncut strip at the edge of the meadow and allow wild flowers to colonise lanes and roadsides. ! Control dense stands of rushes using a combination of cutting and grazing to achieve a scattered cover of 10-20% of the field.
Management of scrub in enclosed grassland for birds
! On steep slopes retain scrub such as gorse and juniper and scattered trees such as hawthorn and rowan. ! On gentler slopes graze or cut scrub in rotation. Provide a range of habitats by clearing about 10% of scrub each year when it is about 10 years old.
Woodland and scrub creation in enclosed grassland for birds
! Fence off areas where there is some scrub to allow natural regeneration. ! Scarify the ground where old stands of scrub have been removed and regeneration is poor. ! Plant native tree species on areas of low wildlife interest.

Table 7.16 Mammals associated with upland meadows and enclosed pastures in England

Scientific name	Common name	Nature conservation status	Typical habitat	Distribution by upland Natural Area[1]
Cervidae eg *Capreolus capreolus*, *Cervus elaphus*	Deer, eg roe deer, red deer	Common and widespread; increasing. Important effects on vegetation structure.	Woodlands with open rides; open moorland, grassland adjacent to woodlands	All have one or more species
Vespertilionidae	Bats	Widespread; some species common. All bats are fully protected by Schedule 5 of the Wildlife and Countryside Act 1981, and some are Priority Biodiversity Action Plan species (UK Biodiversity Group 1998; UK Steering Group 1995).	Open pasture adjacent to woodlands, woodland rides	All, but more abundant in lowland river valleys
Microtus agrestis	Field vole	Widespread and common; important component in food chain.	Rough grass pasture, grass moorland, open woodland and rides and young 'pre-thicket' plantations	All
Sorex spp	Shrews	Widespread; most species common.	Grass pasture, grass and heather moorland, open woodland and rides	All

Source
Mitchell-Jones & Gent 1997.

[1] The following 18 Natural Areas are classed as upland by English Nature:

No	Natural Area name
2	Border Uplands
4	North Pennines
8	Yorkshire Dales
10	Cumbria Fells & Dales
12	Forest of Bowland
14	Southern Pennines
15	Pennine Dales Fringe
17	North York Moors and Hills
25	Dark Peak
29	South West Peak
30	White Peak
41	Oswestry Uplands
42	Shropshire Hills
58	Clun & North West Herefordshire Hills
60	Black Mountains and Golden Valley
87	Exmoor and the Quantocks
92	Dartmoor
94	Bodmin Moor.

Table 7.17 Amphibians and reptiles associated with upland meadows and enclosed pastures in England

Scientific name	English name	Nature conservation status	Typical habitat	Distribution by upland Natural Area[1]
Rana temporaria	Common frog	Widespread, locally common.	Uneven structured vegetation, eg grassland, woodland margins, near or connected to ponds (can be small, must have shallow areas) or other water bodies with roughly neutral pH.	All
Bufo bufo	Common toad	Widespread, locally common, but probably declining.	Uneven structured vegetation, eg grassland, woodland margins, near or connected to ponds or other water bodies with roughly neutral pH. Ponds may be deeper and presence of fish less a problem than for other amphibians. Will travel long distances to breeding ponds.	All
Triturus vulgaris *T. helveticus*	Smooth newt Palmate newt	Widespread, locally common. Palmate generally more associated with upland or more acid waters while smooth newt common, more abundant in lowland habitats.	Structurally varied habitats, eg grasslands, woodland edges, quarries, with nearby or integral ponds. Ponds can be small to fairly large.	All
T. cristatus	Great crested newt	Widespread, declining but may be locally abundant and more often found in lowland habitats. Fully protected by Schedule 5 of the Wildlife and Countryside Act 1981, and a Priority Biodiversity Action Plan species (UK Steering Group 1995).	As for other newt species (see above). Great crested newts tend to use larger ponds or rely more on clusters of nearby ponds than other newt species.	All
Lacerta vivipara *Anguis fragilis*	common lizard slow-worm	Widespread, can be locally common, but nationally probably declining. Partially protected by Schedule 5 of the Wildlife and Countryside Act 1981.	Structurally varied, open habitats; often providing basking areas. Banks, woodland margins, open moorland, tussocky grasslands and bogs. Areas should not be too wet. Limited dispersion potential means adults fairly sedentary and reflects importance of connected habitats for long term survival of populations. Slow-worms tend to be found more in grassland habitats, especially where slugs and snails are present (major food item).	All

Scientific name	English name	Nature conservation status	Typical habitat	Distribution by upland Natural Area[1]
Vipera berus	adder	Widespread, locally common, but declining. Partially protected by Schedule 5 of the Wildlife and Countryside Act 1981.	Structurally varied habitats, such as moors, woodland edges, ungrazed (or low intensity grazed) grassland. Especially in areas with low levels of disturbance, and in areas with several habitat types (eg. woodland and moorland) in close proximity.	All
Natrix natrix	grass snake	Widespread, locally common, but more associated with lowland habitats. Partially protected by Schedule 5 of the Wildlife and Countryside Act 1981.	Structurally varied habitats. Very mobile species; often associated with water (amphibians and fish are major prey items) and needs rotting vegetation for egg laying. Therefore more often associated with farmed areas than other snake species.	Most Natural Areas though records sparse in northern England

Source

Mitchell-Jones & Gent 1999

[1]The following 18 Natural Areas are classed as upland by English Nature:

No	Natural Area name
2	Border Uplands
4	North Pennines
8	Yorkshire Dales
10	Cumbria Fells & Dales
12	Forest of Bowland
14	Southern Pennines
15	Pennine Dales Fringe
17	North York Moors and Hills
25	Dark Peak
29	South West Peak
30	White Peak
41	Oswestry Uplands
42	Shropshire Hills
58	Clun & North West Herefordshire Hills
60	Black Mountains and Golden Valley
87	Exmoor and the Quantocks
92	Dartmoor
94	Bodmin Moor.