2 *Introduction to lowland semi-natural grasslands*

2.1 Definitions

Semi-natural grasslands are defined here as plant communities where a high proportion of the vegetation consists of a mixture of native grasses and dicotyledonous herbs where woody shrubs are largely absent and where vegetation height is normally less than one metre.

The species composition of these grasslands has not been substantially modified by intensive cultivation or the regular use of inorganic fertilizers and herbicides. They are managed systems which are used to provide winter feed (hay) or grazing for domestic livestock. Lowland grasslands are generally enclosed meadow or pasture land occurring at altitudes of *c* 350 metres or less in the UK. The types of lowland grassland are described in more detail in section 2.3.

2.2 History and development

Lowland semi-natural grasslands are mostly the result of human activity. They have developed through forest clearance and wetland drainage, probably since Mesolithic times, in order to provide fodder for domestic livestock. Grazing, cutting and, to a lesser extent, burning have been important factors in both the creation and the maintenance of these grasslands. Plant species now occurring in semi-natural grasslands are likely to have originated from the woodland ground flora, from open habitats such as cliffs and sand-dunes which were maintained by natural catastrophes, grazing by native mammals, instability and exposure and from the drier edges of fens, swamps and marshes.

2.3 Lowland grassland types and their management

Five main categories of lowland semi-natural grassland occur in Britain. These are detailed below:

2.3.1 Neutral or mesotrophic grasslands

These are mostly found within enclosed field systems on moist mineral soils with a pH between 5 and 6.5. They do not normally occur on soils which combine extremes of acidity or alkalinity with extremes of wetness and dryness. They tend therefore to be absent from excessively free-draining soils of high pH and low pH and from water-logged soils of high or low pH. Suitable soil conditions occur widely over level and slightly undulating ground throughout the British lowlands. However, largely as a result of 20th century agricultural improvement, unimproved semi-natural neutral grasslands are now very scarce and few individual sites exceed 20 hectares in extent. Neutral grasslands are normally used for hay production and/or grazing.

2.3.2 Calcareous or calcicolous grasslands

These include both enclosed and unenclosed grasslands occurring largely on pervious calcareous bed rocks. Soils are usually shallow, typically with a pH range between 6.5 and 8.5. Calcareous grassland in the lowlands is now primarily restricted to steep slopes on limestones (including chalk) associated with dry valleys or dales and scarp slopes where agricultural improvement has been impractical. Calcareous grasslands are mostly used for grazing of sheep and cattle.

2.3.3 Acidic or calcifugous grasslands

Acidic grasslands normally occur on acid rocks such as sandstones, acid igneous rocks and on superficial deposits, such as sands and gravels, over which soils with a pH below 5 have developed. They are often associated with lowland dwarf shrub heath communities and in some circumstances may be derived from such communities as a result of heavy grazing and burning.

2.3.4 Fen meadows and rush pastures

These marshy grasslands occur on peat and mineral soils derived from a variety of substrates and occur on level ground or gentle slopes. The soils range from acid (pH 4) to moderately base-rich (pH 7.5). The water table is normally close to the surface for much of the year.

Typically, these grasslands are used for summer cattle grazing but occasionally may be 'shut-up' for 'bog' hay.

2.3.5 Calaminarian grassland

In some parts of the northern Pennines and the Mendips, dry calcareous or siliceous soils, enriched with heavy metals such as lead and zinc, give rise to heavy metal vegetation, often termed Calaminarian grassland (Ellenberg 1988). These are often associated with areas of former mining activity. This type of grassland also occurs in near natural situations on serpentine soils in northern Scotland. These communities can range from sparsely vegetated to short, closed swards. Typically, they support species which have particular tolerance to soils with high metal concentrations. These include alpine penny-cress *Thlaspi caerulescens* and spring sandwort *Minuartia verna*.

2.3.6 National Vegetation Classification (NVC)

The National Vegetation Classification (NVC), (Rodwell 1991a, 1991b, 1992, 1995, in press) provides a systematic classification of British vegetation including grasslands. It does not, however, cover Ireland. The earlier classifications of British vegetation developed by Tansley (1939) and Ratcliffe (1977) are not systematic and have been superseded by the NVC. The definition of lowland semi-natural grassland used here embraces 29 communities and 78 sub-communities. Table 2.1 lists these communities, together with brief notes on their distribution and extent. Grassland types with high botanical/nature conservation value are listed in part A of Table 2.1. Types which have been the subject of agricultural improvement or are the result of recolonisation of nutrient-rich substrates and are of lesser nature conservation value are listed in part B. It should be stressed that the latter can sometimes be of value for other taxa, especially birds or invertebrates. Further information can be found in Rodwell (1991, 1992).

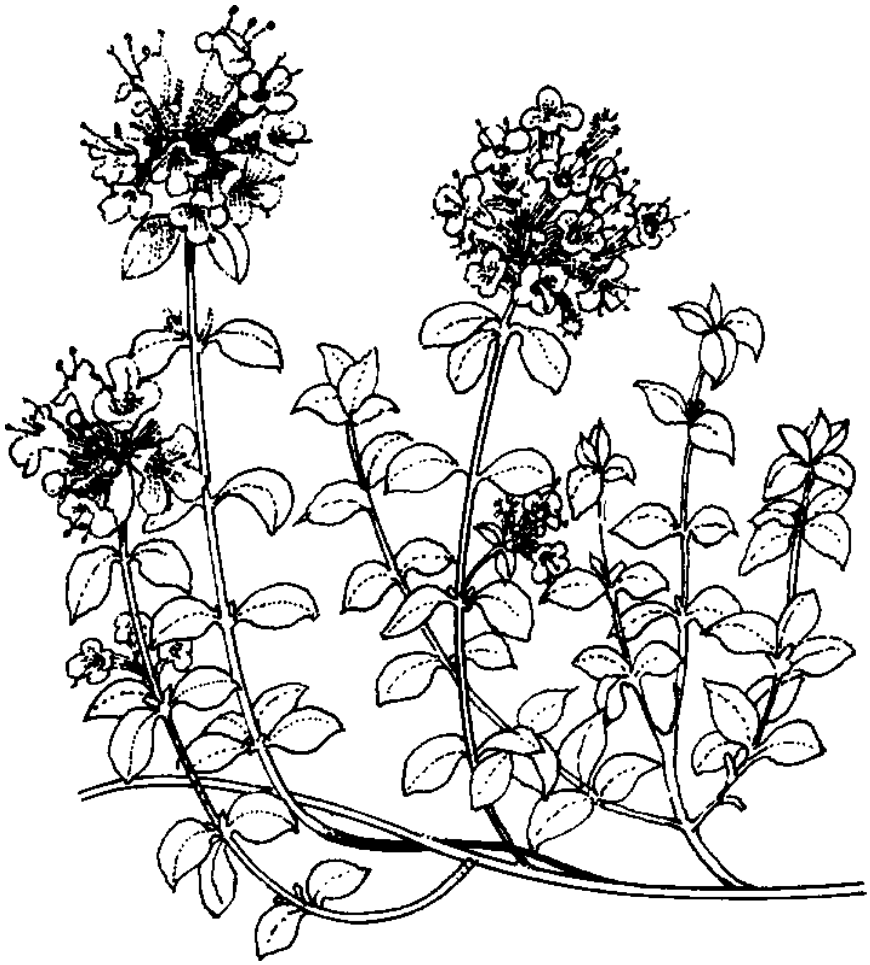


Table 2.1. National Vegetation Classification* - lowland grassland communities and their distribution in Britain (modified from NCC (1989). See species glossary for English names of plant species cited.

A. Grasslands of high botanical nature conservation value

1. Neutral grasslands

MG1 *Arrhenatherum elatius:* dry tall-herb grassland.
Some stands of the *Pastinaca, Centaurea nigra* (especially the *Pimpinella saxifraga* variant) and *Filipendula* sub-communities may be semi-natural and have high botanical nature conservation value. The *Pastinaca* sub-community occurs on calcareous soils in south and east England while the *Centaurea* and *Filipendula* sub-communities are widely distributed on suitable soils in lowland Britain. The *Pimpinella* variant only occurs on limestone in the Mendips and the Pennines.

MG2 *Filipendula ulmaria - Arrhenatherum elatius*: northern tall herb grassland.
A sub-montane community restricted to the Carboniferous limestone in northern England especially in Pennine areas of Derbyshire and North Yorkshire.

MG3 *Anthoxanthum odoratum - Geranium sylvaticum*: northern hay meadow.
Valley grasslands and river-banks of northern England and Scotland often used as hay meadows. Major concentrations in the Pennine and Cumbrian Dales.

MG4 *Alopecurus pratensis - Sanguisorba officinalis*: flood meadow.
Seasonally-flooded land in lowland river flood plains. Widely scattered but with concentrations in the Thames, Yorkshire Ouse, Seven, Trent, Great Ouse and Nene catchments.

MG5 *Cynosurus cristatus - Centaurea nigra*: lowland hay meadow and pasture.
Widely scattered throughout the British lowlands. The community covers a wide range of soil types and the sub-communities reflect this. The *Galium verum* sub-community shows affinities with some calcareous grasslands and the *Danthonia* sub-community with acid grasslands. Major concentration in Worcestershire.

MG8 *Cynosurus cristatus - Caltha palustris*: flood pasture.
Widespread but rather local distribution throughout England; scarce in Wales and Scotland. Characteristic of land with a seasonally high water table.

MG11 *Festuca rubra - Agrostis stolonifera - Potentilla anserina*: inundation grassland.
Scattered localities in lowland England characteristic of areas frequently inundated with fresh or brackish water. Also present in Scotland, particularly in the Western Isles. Only one sub-community (*Lolium perenne* sub-community) is found inland and it has often been agriculturally improved.

MG13 *Agrostis stolonifera - Alopecurus geniculatus*: inundation grassland, silver meadows.
Scattered localities in lowland areas throughout Great Britain usually in river flood plains. In eastern England it forms mosaics with swamp communities in extensive stands on washlands, but elsewhere it is fragmentary alongside watercourses and on the edges of ponds. This community has special value in providing feeding areas for wildfowl.

* Does not include Northern Ireland
NB: Nomenclature of vascular plants for the NVC follows (Clapham, Tutin & Moore (1987))

2. Calcareous grassland

CG1 *Festuca ovina - Carlina vulgaris*: warm southern temperate limestone grassland.
Distribution limited to scattered sites on harder limestones principally around and near to southern and western coasts of England and Wales.

CG2 *Festuca ovina - Avenula pratensis*: species-rich chalk grassland.
Species-rich grassland widely distributed principally over southern lowland calcareous formations, with regional differences showing up as sub-communities.

CG3 *Bromus erectus* grassland
Distribution follows that of the species and so this community is especially frequent over the Chalk, Jurassic Limestone (Oolite) and Magnesian Limestone (Permian).

CG4 *Brachypodium pinnatum* grassland
Frequent on the Cretaceous chalk and Jurassic limestone in England.

CG5 *Bromus erectus - Brachypodium pinnatum* grassland.
Distribution is centred on the Jurassic limestone in central and eastern England.
Major concentration in the Cotswolds (Gloucs).

CG6 *Avenula pubescens* grassland.
Occurs in scattered localities over a variety of lowland limestone areas but is nowhere extensive, being a product of little or no grazing of grasslands over moist, mesotrophic calcareous soils on flat or gently-sloping sites. Most of these areas have been converted to arable.

CG7 *Festuca ovina - Hieracium pilosella - Thymus praecox/pulegioides* grassland.
Occurs in scattered localities in Wiltshire, the Yorkshire Wolds, the Carboniferous limestone of Derbyshire and the Mendips, with its greatest concentration and extent in Breckland.

CG8 *Sesleria caerulea- Scabiosa columbaria*: Magnesian limestone grassland.
Distribution is confined to magnesian (Permian) limestone in County Durham.

CG9 *Sesleria caerulea - Galium sterneri*: Carboniferous limestone grassland.
Distribution is confined to the Carboniferous Limestone of northern England, with the sub-communities marking regional differences. The *Helianthemum canum - Asperula cynanchica,* and typical sub-communities occur in lowland situations.

CG10 *Festuca ovina - Agrostis capillaris - Thymus praecox* grassland.
Scattered localities throughout the British uplands and occasionally the lowlands on calcareous soils. Principally an upland (sub-montane) community but in north-west Scotland it descends almost to sea level.

3. Acid grasslands

U1 *Festuca ovina - Agrostis capillaris - Rumex acetosella*.
These very diverse and open swards occur widely on light soils in the drier areas of lowland Britain.

U2 *Deschampsia flexuosa*.
These swards are of local distribution on wetter but free-draining, base-poor soils in lowland Britain often associated with heathland.

U3 *Agrostis curtisii*.
A community based on the abundance of *Agrostis curtisii* and therefore confined to central, southern and south-west England and south Wales. Frequently occurs in a mosaic with H3/H4 heathland.

U4 *Festuca ovina - Agrostis capillaris - Galium saxatile*.
Principally a community of upland (sub-montane) areas of north and western Britain associated with a range of acidic soils on lime-poor substrates. Examples do occur in lowland situations (<300m).

4. Fen meadows/rush pastures

M22 *Juncus subnodulosus - Cirsium palustre* fen meadow.
Occurs on wet, base-rich peats and mineral soils in southern lowland Britain with a notable concentration in East Anglia and Anglesey.

M23 *Juncus effusus/acutiflorus - Galium palustre* rush-pasture.
Widespread but local on wet, moderately acid to neutral peaty and mineral soils in the cool and wet lowlands and upland fringes of northern and western Britain.

M24 *Molinia caerulea - Cirsium dissectum* fen meadow.
A widespread but local community characteristic of moist neutral to mildly acidic soils in the lowlands of southern Britain. Particular concentrations occur in north Devon, Wales and East Anglia.

M25 *Molinia caerulea - Potentilla erecta* mire.
This community occurs on moist but well-aerated acid to neutral peats and mineral soils in the western lowlands of Britain. It is particularly frequent in south-west England, Wales and southern Scotland.

M26 *Molinia caerulea - Crepis paludosa* mire (*Festuca rubra* sub-community).
A very rare sub-community occurring on moist, moderately base-rich peats and peaty mineral soils mainly in the sub-montane northern Pennines. It often occurs on slopes in enclosed meadows and pastures in association with the MG3 *Anthoxanthum odoratum - Geranium sylvaticum* northern hay meadow.

M27 *Filipendula ulmaria - Angelica sylvestris* mire.
This community occurs on moist moderately nutrient-rich neutral soils throughout the lowlands of Britain. It usually thrives in ungrazed situations often fringing watercourses.

5. Calaminarian grassland

OV37 *Festuca ovina - Minuartia verna*.
Occurs largely on free-draining calcareous soils and river shingles enriched with heavy metals such as lead and zinc. In England it is most commonly associated with former metal mining areas in the Pennines, especially in Derbyshire and North Yorkshire. In Scotland it occurs on serpentine soils.

B. Grassland communities of lower botanical nature conservation value

MG1a, b, *Arrhenatherum elatius*: Rank grassland.
An unmanaged coarse grassland occurring on neutral soils throughout the British lowlands on road verges and railway embankments and in neglected agricultural and industrial habitats.

MG6 *Lolium perenne - Cynosurus cristatus*: improved permanent grassland.
The major permanent pasture type in lowland Britain, often brought about by the action of fertilisers, herbicides and drainage on many other MG types or by agricultural rundown of MG7. May also be used for silage or hay-making.

MG7 *Lolium perenne*: reseeded grassland.
The major and ubiquitous sown grassland type in Britain.

MG9 *Holcus lanatus - Deschampsia cespitosa*: damp pasture.
This is highly characteristic of permanently moist soils throughout the British lowlands. Often results from invasion of *Deschampsia caespitosa* into MG6 and 7 where drainage has deteriorated.

MG10 *Holcus lanatus - Juncus effusus*: rush pasture.
This is ubiquitous throughout the British lowlands, commonly developing by invasion of *Juncus* into MG6 and MG7 where drainage becomes impeded.

Species glossary for Table 2.1

Scientific name	English name	Scientific name	English name
Agrostis capillaris	Common bent	*Filipendula ulmaria*	Meadowsweet
A. curtisii	Bristle bent	*Galium saxatile*	Heath bedstraw
A. stolonifera	Creeping bent	*G. palustre*	Lesser marsh bedstraw
Alopecurus geniculatus	Marsh foxtail	*G. sterneri*	Limestone bedstraw
A. pratensis	Meadow foxtail	*G. verum*	Lady's bedstraw
Angelica sylvestris	Wild angelica	*Geranium sylvaticum*	Wood crane's-bill
Anthoxanthum odoratum	Sweet vernal-grass	*Helianthemum canum*	Hoary rock-rose
Arrhenatherum elatius	False oat-grass	*H. nummularium*	Common rock-rose
Asperula cynanchica	Squinancywort	*Hieracium pilosella*	Mouse-ear-hawkweed
Avenula pratensis	Meadow oat-grass	*Holcus lanatus*	Yorkshire-fog
A. pubescens	Downy oat-grass	*Juncus acutiflorus*	Sharp-flowered rush
Brachypodium pinnatum	Tor-grass	*J. effusus*	Soft-rush
Bromus erectus	Upright brome	*J. subnodulosus*	Blunt-flowered rush
Caltha palustris	Marsh-marigold	*Lolium perenne*	Perennial rye-grass
Carlina vulgaris	Carline thistle	*Minuartia verna*	Spring sandwort
Centaurea nigra	Common knapweed	*Molinia caerulea*	Purple moor-grass
Cirsium dissectum	Meadow thistle	*Pastinaca sativa*	Wild parsnip
C. palustre	Marsh thistle	*Pimpinella saxifraga*	Burnet-saxifrage
Cynosurus cristatus	Crested dog's-tail	*Potentilla anserina*	Silverweed
Crepis paludosa	Marsh hawk's-beard	*P. erecta*	Common tormentil
Danthonia decumbens	Heath-grass	*Rumex acetosella*	Sheep's sorrel
Deschampsia cespitosa	Tufted hair-grass	*Sanguisorba officinalis*	Great burnet
D. flexuosa	Wavy hair-grass	*Scabiosa columbaria*	Small scabious
Festuca ovina	Sheep's-fescue	*Sesleria caerulea*	Blue moor-grass
F. rubra	Red fescue	*Thymus praecox*	Wild thyme
		T. pulegioides	Larger wild thyme

2.3.7 Management

Most types of lowland grassland, in the absence of management by cutting, grazing or burning, would undergo vegetation change resulting in the development of scrub and woodland (see Chapter 2, sub-section 2.7.1. and section 2.8).

Table 2.2 lists the lowland semi-natural grassland types identified by the NVC and indicates the broad historical management treatments which have been instrumental to their maintenance. Table 2.3. provides summary management requirements for the different communities.

It should be emphasised that most types of grassland are successional and cessation of management or changes in the intensity or frequency of management can result in shifts from one grassland type to another or from grassland to scrub. This is illustrated by Figure 2.1 which shows the dynamics of lowland neutral grassland in relation to treatment.

Further details on grassland management techniques are provided in Chapters 5, 6 and 8.

Table 2.2. Traditional management treatments of semi-natural lowland grassland communities

NVC Grassland Community	1	2	3	4	5	6
MG1 c, d, e					T	
MG2					T	
MG3			T			
MG4		T				
MG5	T	T	T			
MG8	T	T	T			
MG11	T	T				
MG13	T	T				
CG1	T				T	
CG2	T					
CG3	T				T	
CG4	T				T	
CG5	T			T	T	
CG6	T				T	
CG7	T				T	T
CG8	T					
CG9	T					
CG10	T					
U1	T					T
U2	T					
U3	T			T		
U4	T			T		
M22	T	T				
M23	T	T				
M24	T	T		T		
M25	T			T		
M26	T		T			
M27					T	
OV37					T	

1. Livestock grazing
2. Mowing and aftermath grazing
3. Spring grazing, mowing and aftermath grazing
4. Burning and grazing
5. Unmanaged/sporadic management by grazing and/or mowing
6. Sporadic cultivation/ploughing/disturbance

Table 2.3. Summary management requirements for lowland semi-natural grassland communities

NVC Grassland Community	**Summary management requirements** (N.B. These are generalised and more specific prescriptions may be required to fulfil particular nature conservation objectives especially for key species). The management guidelines assume that the damaging practices outlined in Chapter 8 are not applied. Sward height ranges for communities managed as pastures are **very provisional** and encompass limits of acceptable change for maintenance of favourable condition. Sward heights should ideally fall within these limits at anytime during the year although the actual height at any particular time will depend on the grazing regime deployed.
MG1 c,d,e	Management requirements not fully understood but is likely to involve either low intensity episodic grazing by sheep or cattle or annual mowing.
MG2	Management requirements not fully understood but is likely to involve low intensity episodic grazing by sheep or cattle.
MG3	Annual late hay cut (July) combined with spring and autumn grazing (normally sheep or cattle). Periodic dressings of well-rotted farmyard manure and occasional applications of lime were part of traditional management (see Chapter 8).
MG4	Annual late hay cut (July) combined with late summer/ autumn grazing (normally sheep, cattle and horses). Traditional maintenance of existing ditches and other channels. Nutrient input normally through deposition of silt from flooding but periodic dressings of well-rotted farmyard manure and occasional applications of lime may have been part of the management in some areas. High autumn/winter water tables reducing in early spring.
MG5	1) **Meadows**: Annual hay cut and late summer/autumn grazing by sheep, cattle and horses. Periodic dressings of well-rotted farmyard manure and occasional applications of lime were part of traditional management. 2) **Pastures**: Low intensity livestock grazing (sheep, cattle and horses. Optimum sward height range for maintenance of favourable condition: 5-10 cms.
MG8	Most often managed as pasture (cattle and horses) but some stands are managed as meadow with a late hay cut (July) followed by late summer/autumn grazing. Upland stands in the north Pennines are managed in a similar manner to MG3 meadows. Characteristic of periodically inundated land in river valleys, around springs and flushes and in high altitude dales in northern England. Target sward height for pastures likely to be similar to MG5. Formerly some areas were managed as water meadow.
MG11	Low intensity livestock grazing during the period May to October (sheep, cattle and horses). High soil moisture levels in autumn, winter and early Spring including frequent inundation with fresh or brackish water is likely to be a factor influencing species composition. Optimum sward height range for maintenance of favourable condition: 5-10 cms
MG13	Low intensity livestock grazing during the period May to October (sheep, cattle and horses). Some stands, particularly where part of a mosaic with other communities such as MG4, may be maintained by hay cutting and aftermath grazing. High soil moisture levels in autumn, winter and early Spring including frequent inundation with fresh or brackish water is likely to be a factor influencing species composition. Optimum sward height range for maintenance of favourable condition: 5-10 cms.
CG1	Livestock grazing particularly sheep and rabbit grazing. On very steep, shallow, unstable soils or on exposed coastal cliffs this community may be self-sustaining in the absence of grazing. A short-turf community usually with much natural bare soil and rock. Optimum sward height range for maintenance of favourable condition: 2-10 cm with 10 % or more bare ground/rock
CG2	A short-turf community maintained by grazing (sheep, cattle, horses and rabbits). Optimum sward height range for maintenance of favourable condition: 2-10 cms with up to 10% bare ground.
CG3	A short to medium sward height community maintained by livestock grazing (sheep, cattle and horses) and rabbits. Optimum sward height range for maintenance of favourable condition for maintenance of species-richness: 2-15 cms.
CG4	A short to medium sward height community maintained by livestock grazing (sheep, cattle and horses) and rabbits. Optimum sward height range for maintenance of favourable condition: 2-15 cms.
CG5	A short to medium sward height community maintained by livestock grazing (sheep, cattle and horses) and rabbits. Optimum sward height range for maintenance of favourable condition: 2-15 cms.
CG6	A short to medium sward height community maintained by livestock grazing (sheep, cattle and horses) and rabbits. The distinctive *Potentilla-Tragopogon* sub-community however, appears to be associated with little or no grazing and may remain stable in this state for long periods. Optimum sward height range for maintenance of favourable condition (*Dactylis-Briza* sub-community): 2-15 cms.

CG7	A short, open or closed community maintained by livestock grazing, rabbits and sometimes other forms of soil disturbance (e.g. shallow rotavation). Optimum sward height range for maintenance of favourable condition: 1-5 cms with 5% or more bare ground/rock.
CG8	A short to medium sward height community maintained by livestock grazing (sheep, cattle and horses) and rabbits. Optimum sward height range for maintenance of favourable condition: 2-15 cms.
CG9	Generally closed or open sward community maintained by livestock grazing, normally sheep or cattle. Optimum sward height range for maintenance of favourable condition: 2-15 cms.
CG10	A generally closed sward maintained by livestock grazing (sheep or cattle). Optimum sward height range for maintenance of favourable condition: 2-10 cms.
U1	A short-turf community maintained by grazing (sheep, cattle, horses and rabbits) or soil disturbance (e.g.shallow rotavation). Optimum sward height range for maintenance of favourable condition: 1-5 cms with 15 % or more bare ground.
U2	A short to medium height community maintained by grazing (sheep, cattle, horses and rabbits). Optimum sward height range for maintenance of favourable condition: 5-10 cm.
U3	A short-turf community maintained by moderate to heavy grazing (sheep, cattle, horses and rabbits), burning or soil disturbance. Optimum sward height range for maintenance of favourable condition: 1-5 cms with 15% or more bare ground.
U4	A short to medium height community maintained by grazing (sheep, cattle, horses and rabbits). Optimum sward height range for maintenance of favourable condition: 5-10 cms.
M22	Usually grazed by cattle during the period April to November. Typically stocking rates between 0.2 and 0.5 LU/ha/year are likely to maintain the nature conservation value. A few sites are managed as hay meadow with a July hay cut followed by aftermath grazing. Optimum sward height range for maintenance of favourable condition: 5 - 40 cm. Soils have a high water table during much of the year but surface flooding is rare.
M23	Usually grazed by cattle or sheep during the period April to November. Typically stocking rates between 0.2 and 0.5 LU/ha/year are likely to maintain the nature conservation value. A few sites are managed as hay meadow with a July hay cut followed by aftermath grazing. Optimum sward height range for maintenance of favourable condition: 5 - 40 cm. Soils have a high water table during much of the year but surface flooding is rare.
M24	Usually grazed by cattle during the period April to November. Typically stocking rates between 0.2 and 0.5 LU/ha/year are likely to maintain the nature conservation value. A few sites are managed as hay meadow with a July hay cut followed by aftermath grazing. Periodic winter burning has also been practised in some areas although the whole site should not normally be burned in one year (Wolton 1991). Optimum sward height range for maintenance of favourable condition: 5 - 40 cm. Soils have a high water table during much of the year but surface flooding is rare.
M25	Usually grazed by cattle during the period April to November. Typically stocking rates between 0.2 and 0.5 LU/ha/year are likely to maintain the nature conservation value. Periodic winter burning has also been practised in some areas although the whole site should not normally be burned in one year. Optimum sward height range for maintenance of favourable condition: 5 - 40 cm. Soils have a high water table during much of the year but surface flooding is rare
M26b	This community can be found on flushed slopes where the water table is close to the surface for much of the year within upland enclosed grasslands managed as either meadow or pasture. Meadow management should follow the guidelines as for MG3 with which it is often found. In cattle or sheep grazed pastures optimum sward height range for maintenance of favourable condition: 5-15 cm
M27	A tall, rank community generally dominated by tall herbs found on soils which are moist for much of the year. Management requirements are not fully understood but are likely to involve very low intensity episodic grazing by sheep or cattle or occasional mowing.
OV37	An open, short-turf community associated with soils with high heavy metal concentrations. The mineralogy of the soil parent material strongly influences the composition of the vegetation. Long-term management requirements are not fully understood although vegetation change in the absence of any management is likely to be very slow due to the extreme nature of the environment. However, livestock grazing is likely to be beneficial particularly for stands on less immature soils with a greater vegetation biomass with more palatable herbage (e.g. the OV37b *Achillea millefolium-Euphrasia officinalis* agg. sub-community)

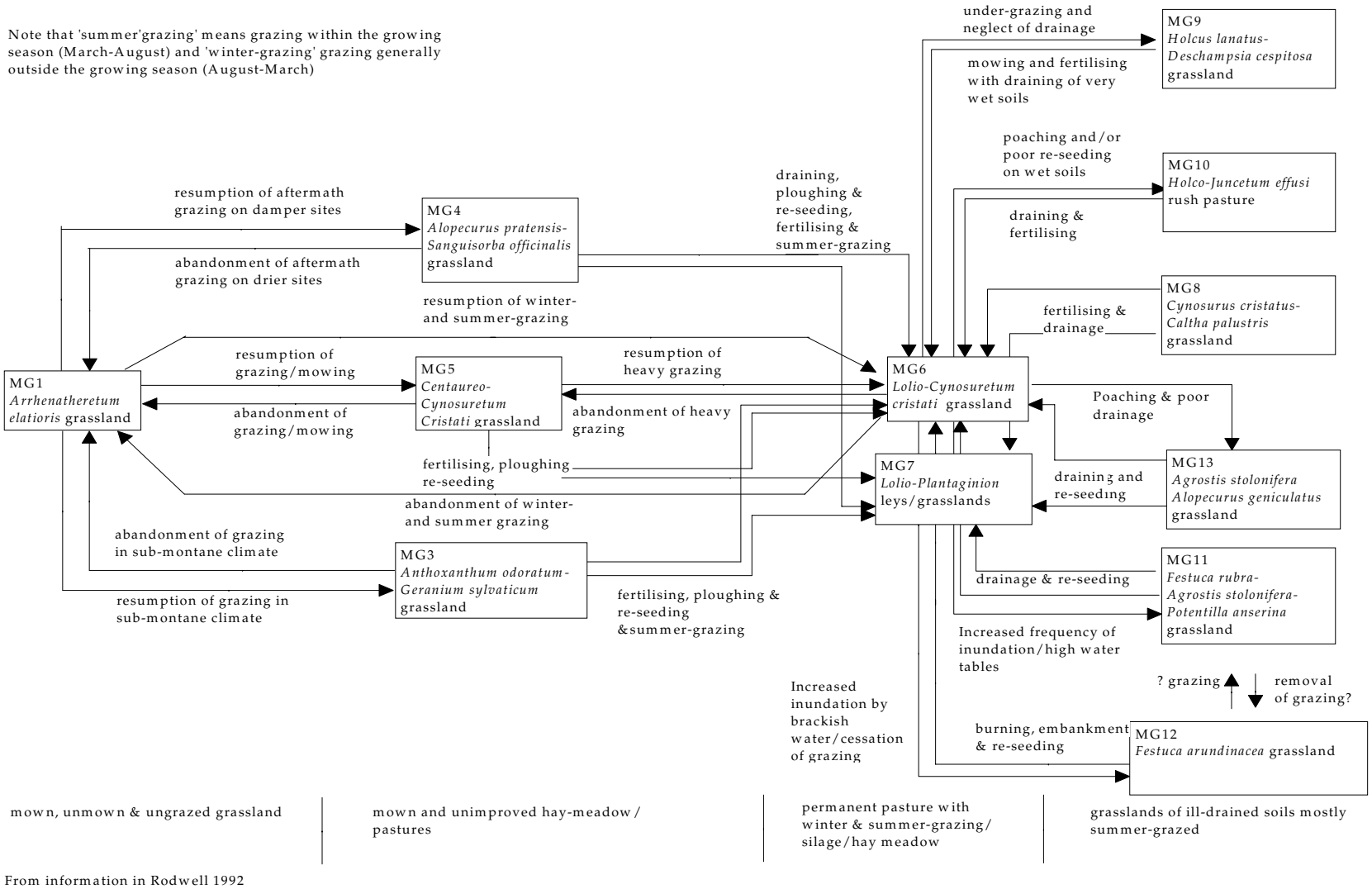


Figure 2.1 Some possible successional relationships between some mesotrophic grasslands mediated by treatments

2.4 Nature conservation value

2.4.1 Grassland communities and plant species

Lowland semi-natural grasslands have long been recognised as a resource of high nature conservation value. They are often of great antiquity and may have been managed continuously by grazing and/or cutting for hundreds or even thousands of years. They contain a high proportion of plant species native to the UK. Many of the grassland types occurring on neutral and base-rich soils support a large number of plant species (ie they are species-rich). Some calcareous grasslands can have up to 50 plant species per square metre.

Lowland semi-natural grasslands also provide a habitat for a number of nationally rare or scarce vascular plant species. Table 2.4 lists those (excluding dandelions *Taraxacum* spp.) which have a high affinity for lowland semi-natural grasslands. Table 2.4 shows that a high proportion of rare and scarce vascular plant species are confined to calcareous grasslands. Many of these are species with a southern continental distribution in Europe and hence their distribution in the UK tends to be largely south of a line from the Humber to the Seven.

The lower plant interest of lowland grassland is not as well known but some types of grassland have been recognised as important for their lower plants. Palmer (1994) in the UK Plant Conservation Strategy document lists bryophyte and lichen-rich heath (this includes the grass heaths of Breckland covering NVC types CG7 and U1) and metallophyte lichen communities (eg on old mine waste). Chapter 13, Section 13.5 lists rare bryophytes and lichens occurring in lowland semi-natural grasslands and indicates that calcareous and parched acid grasslands are particularly important for bryophyte and lichen assemblages. Gilbert (1993) describes the importance of a range of chalk grassland sites for lichens and Rose *et al* (1991) lists some important bryophytes in chalk grassland sites in Sussex.

The importance of semi-natural grasslands for fungal assemblages has until recently been largely overlooked by conservationists in the UK.

There is a growing realisation that some types of semi-natural grassland, notably neutral and acid grasslands, are important for their fungi in particular waxcap fungi (*Hygrocybe* species) (Marren 1998, Rotheroe 1997, Sanderson 1998). Further investigation of the fungal interest of semi-natural grasslands would be desirable.

2.4.2 The birds of wet grassland

Grazing marshes and seasonally inundated flood plain grasslands, sometimes termed lowland wet grasslands, are particularly important as habitats for a range of breeding and wintering wildfowl and waders. Such areas can include a wide range of grassland, swamp and mire types, in both inland and coastal situations (for example grazing marsh) including semi-improved grasslands. The unimproved and semi-improved grassland communities which may occur within lowland wet grassland are NVC communities MG4, MG6, MG7, MG8, MG9, MG10, MG11, MG13, M22, M23, M24, M25 and M27 (see Table

2.1). To these, Jefferson & Grice (1998) in their definition of lowland wet grassland have also added three swamp communities (S5, S22 and S28) and excluded M27.

The most important factors determining the suitability of sites as breeding or wintering localities for birds are: i) water table height; ii) substrate type; iii) soil moisture levels; iv) duration and extent of inundation at specific times of the year; v) maintenance of low intensity agricultural management; vi) vegetation structure; and vii) lack of human disturbance.

Grassland structure is generally much more important for birds than the botanical composition of the sward. However, it is known that geese and swans tend to favour nutritious grasses in winter and there may be situations where this influences site selection by these species.

For further information on the subject of lowland wet grasslands and birds see Chapter 13, Section 13.1 and Treweek, *et al* (1997).

Characteristic breeding species of lowland inland flood meadows include a variety of wildfowl and wader species, including snipe *Gallinago gallinago*, lapwing *Vanellus vanellus*, redshank *Tringa totanus*, teal *Anas crecca* and shoveler *Anas clypeata* and passerines such as grasshopper warbler *Locustella naevia*, sedge warbler *Acrocephalus schoenobaenus* and yellow wagtail *Motacilla flava*.

In winter, flooded grasslands can attract large numbers of waders and wildfowl, including species such as wigeon *Anas penelope*, teal, mallard *Anas platyrhynchos*, golden plover *Pluvialis apricaria* and lapwing. The breeding and wintering species of conservation concern closely associated with lowland wet grassland are listed in Table 2.5.

Table 2.4. Nationally rare and nationally scarce vascular plant species occurring in lowland semi-natural grasslands in Great Britain

Scientific name	English name	NVC community	Status (see key)
Aceras anthropophorum	Man orchid	CG2, CG3, CG4, CG5	NS
Allium schoenoprasum	Chives	U1, CG1, CG7, MG?	NS
Althaea hirsuta	Rough marsh-mallow	CG7, MG?	RDB, S8, LL
Alyssum alyssoides	Small alison	CG7, U1	RDB, S8, P
Ajuga chamaepitys	Ground-pine	CG2	NS, S8, LL
Alchemilla acutiloba	Lady's-mantle	MG3	RDB
A. monticola	Lady's-mantle	MG3	RDB
A. subcrenata	Lady's-mantle	MG3	RDB
Apera interrupta	Dense silky-bent	U1	NS
Apium repens	Creeping marshwort	MG4, MG13	RDB, A11, S8, P
Arabis scabra	Bristol rock-cress	CG1	RDB, S8, LL
Armeria maritima subsp. elongata	Tall thrift	MG?	RDB
Artemisia campestris	Field wormwood	CG7	RDB, S8, LL

Scientific name	English name	NVC community	Status (see key)
Aster linosyris	Goldilocks aster	CG1, CG9	RDB, LL
Bartsia alpina	Alpine bartsia	CG9, MG8? M26?	RDB
Bunium bulbocastanum	Great pignut	CG2, CG3	RDB
Bupleurum baldense	Small hare's-ear	CG1	RDB, S8, LL
Carex ericetorum	Rare spring-sedge	CG2, CG5, CG7, CG9	NS
C. humilis	Dwarf sedge	CG1, CG2, CG3	NS, LL
C. montana	Soft-leaved sedge	CG2, M24	NS
C. muricata subsp. muricata	Prickly sedge	CG	RDB, P
C. ornithopoda	Bird's-foot sedge	CG2, CG9	RDB
C. filiformis	Downy-fruited sedge	MG4, MG5?	RDB
Cerastium pumilum	Dwarf mouse-ear	CG1, CG2, CG7, MG5	NS
Chamaemelum nobile	Chamomile	MG, U1	NS, LL
Cirsium tuberosum	Tuberous thistle	MG5, CG2, CG3	RDB, LL
Clinopodium calamintha	Lesser calamint	CG?	NS
Corynephorus canescens	Grey hair-grass	U1	RDB
Cotoneaster cambricus	Wild cotoneaster	CG1	RDB, S8, P, E3
Crassula tillaea	Mossy stonecrop	U1	NS
Crepis mollis	Northern hawk's-beard	MG?	NS
Cypripedium calceolus	Lady's-slipper	CG9	RDB, S8, A11, P
Dianthus armeria	Deptford pink	U1	NS, S8, P
D. deltoides	Maiden pink	U1	NS
Draba aizoides	Yellow whitlowgrass	CG1	RDB, LL
Epipactis atrorubens	Dark-red helleborine	CG3, CG6, CG8, CG9	NS
Erica vagans	Cornish heath	M25	RDB
Euphorbia portlandica	Portland spurge	CG1	NS
Euphrasia pseudokerneri	Eyebright	CG2	NS, E1? (France?)
E. rostkoviana subsp. montana	Eyebright	MG?	NS
E. roskoviana subsp. rostkoviana	Eyebright	MG?	NS
E. vigursii	Eyebright	U3	RDB, P
Festuca longifolia	Blue fescue	U1?	RDB, LL
Fritillaria meleagris	Fritillary	MG4, MG5	NS
Galium pumilum	Slender bedstraw	CG2, CG3, CG5	NS
Gastridium ventricosum	Nit-grass	CG1, CG2?, CG7, MG5	RDB
Gentiana pneumonanthe	Marsh gentian	M23	NS
Gentianella anglica	Early gentian	CG1, CG2, CG3, CG7	NS, S8, All, E2, P
G. ciliata	Fringed gentian	CG2	RDB, S8, LL
G. germanica	Chiltern gentian	CG2	NS
Helianthemum appeninum	White rock-rose	CG1	RDB, LL

Scientific name	English name	NVC community	Status (see key)
H. canum	Hoary rock-rose	CG1, CG2, CG9	RDB
Herminium monorchis	Musk orchid	CG2, CG3, CG4, CG5	NS
Herniaria glabra	Smooth rupturewort	U1	RDB, LL
Himantoglossum hircinum	Lizard orchid	CG3, CG4, CG5, CG7	RDB, S8, LL
Hornungia petraea	Hutchinsia	CG7	NS
Hypericum undulatum	Wavy St John's wort	M24	NS
Hypochaeris glabra	Smooth cat's ear	U1	NS, LL
H. maculata	Spotted cat's-ear	CG1, CG2, CG3, CG9	RDB, LL
Iberis amara	Wild candytuft	CG2, CG3	NS
Koeleria vallesiana	Somerset hair-grass	CG1	RDB
Lathyrus palustris	Marsh pea	M22, M23	NS
Linum perenne subsp. anglicum	Perennial flax	CG2, CG3, CG4, CG6, CG8	NS, E2
Lobelia urens	Heath lobelia	M25	RDB, LL
Lotus angustissimus	Slender bird's-foot-trefoil	U1	RDB, LL
Lotus subbiflorus	Hairy bird's-foot-trefoil	U1	NS
Lychnis viscaria	Sticky catchfly	U1	RDB, LL
Marrubium vulgare	White horehound	CG	NS
Medicago minima	Bur medick	U1	NS
Medicago sativa subsp. falcata	Sickle medick	CG7, U1	NS
Meum athamanticum	Spignel	MG3	NS
Minuartia hybrida	Fine-leaved sandwort	CG7	NS
Minuartia verna	Spring sandwort	CG9, OV37	NS
Muscari atlanticum	Grape-hyacinth	U1	RDB
Oenanthe silaifolia	Narrow-leaved water-dropwort	MG4	NS
Orchis fuciflora	Late spider-orchid	CG2, CG3, CG4	RDB, S8, LL
O. militaris	Military orchid	CG2, CG3, CG7	RDB, S8, LL
O. simia	Monkey orchid	CG2	RDB, S8, LL
O. sphegodes	Early spider-orchid	CG1, CG2, CG3, CG4, CG5	RDB, S8, LL
O. ustulata	Burnt orchid	CG2, CG3, MG5	NS, LL
Orobanche artemisiae-campestris	Oxtongue broomrape	CG2	NS, S8, LL
O. caryophyllacea	Bedstraw broomrape	CG?	RDB, S8, LL
O. reticulata	Thistle broomrape	CG?	RDB, S8, LL
Peucedanum palustre	Milk-parsley	M22, M24	NS
Phleum phleoides	Purple-stem cat's-tail	CG7	RDB, LL
Phyteuma orbiculare	Round-headed rampion	CG2, CG3, CG4, CG5	NS
Polemonium caeruleum	Jacob's-ladder	MG1, MG2	RDB, LL
Polygala amarella	Dwarf milkwort	CG2, CG9	RDB

Scientific name	English name	NVC community	Status (see key)
Potentilla neumanniana	Spring cinquefoil	CG1, CG7, CG9	NS
P. rupestris	Rock cinquefoil	CG2, U1	RDB, S8
Primula farinosa	Bird's-eye primrose	CG8, CG9, M26	NS
Pulsatilla vulgaris	Pasqueflower	CG2, CG3, CG5	NS, LL
Rhinanthus angustifolius	Greater yellow-rattle	MG5, CG3	RDB, S8, LL
Salvia pratensis	Meadow clary	CG2, CG3	RDB, S8, LL
Scilla autumnalis	Autumn squill	CG1	NS
Scleranthus perennis	Perennial knawel	U1	RDB, S8, P
Scorzonera humilis	Viper's-grass	M23, M24, M25	RDB, S8, LL
Sedum forsterianum	Rock stonecrop	CG1	NS
Selinum carvifolia	Cambridge milk-parsley	M24	RDB, S8, LL
Seseli libanotis	Moon carrot	CG2, CG3	RDB
Sesleria albicans	Blue moor-grass	MG2, CG8, CG9	NS
Silene conica	Sand catchfly	CG7, U1	RDB
S. nutans	Nottingham catchfly	MG1, CG2	NS
S. otites	Spanish catchfly	CG7, U1	RDB, LL
Tephroseris integrifolius	Field fleawort	CG2, CG3, CG7	NS
Teucrium botrys	Cut-leaved germander	CG2, CG7	RDB, S8, LL
Thesium humifusum	Bastard-toadflax	CG2, CG3, CG5	NS
Thlaspi caerulescens	Alpine penny-cress	OV37	NS
T. perfoliatum	Perfoliate penny-cress	CG7?	RDB, S8, P
Thymus serpyllum	Breckland thyme	CG7, U1	RDB, LL
Trifolium glomeratum	Clustered clover	U1	NS
Trifolium ochroleucon	Sulphur clover	MG5	NS
T. suffocatum	Suffocated clover	U1	NS
Trinia glauca	Honewort	CG1	RDB, LL
Veronica spicata subsp. hybrida	Spiked speedwell	CG1, CG2, CG9	NS, S8, LL
V. spicata subsp. spicata	Spiked speedwell	CG7, U1	RDB, S8, LL
V. verna	Spring speedwell	CG7, U1	RDB
Viola lactea	Pale dog-violet	U1, U3	NS
Vulpia ciliata subsp. ambigua	Bearded fescue	U1, CG7	NS
Vulpia unilateralis	Mat-grass fescue	CG7	NS

KEY

S8 - Listed on Schedule 8 of the 1981 Wildlife and Countryside Act
RDB - Listed in Red Data Book (Perring & Farrell 1983). (Nationally rare)
NS - Nationally scarce (occur in 16-100 10 km squares)
A11 - Listed on Annex II of the EC Habitat and Species Directive (Council of the European Communities 1992)
E1 - Endemic to British Isles
E2 - Endemic to Great Britain
E3 - Endemic to Wales
P - Priority species (formerly short and middle list species) See the UK Steering Group 1995
LL - Long list of Globally Threatened/Declining Species

Table excludes introduced and doubtfully native species.

Table 2.5 Red and Amber listed birds of conservation concern in the UK (1) dependent on lowland wet grassland

Scientific name	English name	Breeding	Wintering/Passage	List (R = Red A = Amber)	Schedule 1. Wildlife & Countryside Act	Annex 1 EC Bird Directive	List of Globally threatened/declining species
*Cygnus columbianus**	Bewick's swan		T	A	T	T	TLL
C. cygnus	Whooper swan		T	A	T	T	TLL
*Anser fabalis**	Bean goose		T	A			TLL
A. anser	Greylag goose		T	A			TLL
Anas penelope	Wigeon		T	A			TLL
A. strepera	Gadwall		T	A			TLL
A. crecca	Teal		T	A			TLL
*A. acuta**	Pintail	T	T	A			TLL
*A. querquedula**	Garganey	T		A	T		TLL
*A. clypeata**	Shoveler	T	T	A			TLL
Aythya ferina	Pochard	T	T	A			TLL
Coturnix coturnix	Quail	T		R	T		TLL
Crex crex	Corncrake	T		R	T	T	TLL
*Porzana porzana**	Spotted crake	T		A	T		TLL
Pluvialis apricaria	Golden plover		T	A		T	TLL
Vanellus vanellus	Lapwing	T	T	A			TLL
Tringa totanus	Redshank	T		A			TLL
Gallinago gallinago	Snipe	T		A			TLL
*Philomachus pugnax**	Ruff	T		A	T	T	TLL

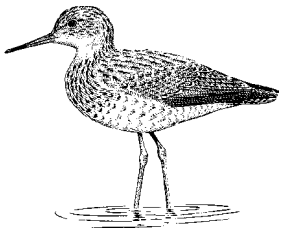
Scientific name	English name	Breeding	Wintering/Passage	List (R = Red A = Amber)	Schedule 1. Wildlife & Countryside Act	Annex 1 EC Bird Directive	List of Globally threatened/declining species
Limosa limosa	Black-tailed godwit	T		R	T		TLL
Numenius arquata	Curlew	T	T	A			TLL
*N. phaeopus**	Whimbrel		T	A	T		TLL
Tyto alba	Barn owl	T		A	T		TLL
Asio flammeus	Short-eared owl	T		A			TLL

(1) For definition see Anon (1996).

LL = Long list (see The UK Steering Group 1995)

P = Priority species
(formerly short and middle list species)

* Over 40% of UK population uses wet grassland during the relevant time period (from Treweek, José & Benstead 1997)



2.4.3 The birds of lowland dry grasslands

Lowland dry grassland is defined broadly as NVC communities CG1-CG10 (calcareous grassland), MG5b (neutral grassland over limestone) and U1-U3 (dry acid grassland). Lowland dry grasslands generally support very few breeding bird species, although, skylark *Alauda arvensis* and meadow pipit *Anthus pratensis* are often present (see Chapter 13, Section 13.2). Where scrub is present on calcareous grasslands, a greater range of breeding bird species generally occur. These tend to be widespread and abundant passerines, such as willow warbler *Phylloscopus trochilus*, yellowhammer *Emberiza citrinella*, dunnock *Prunella modularis* and blackbird *Turdus merula* (Fuller 1982) (see Chapter 12, Section 12.2).

However, a small group of less frequent breeding and wintering species are associated with lowland dry grassland and these are considered to be of conservation concern (see Table 2.6). For further information on dry grassland birds see Chapter 13, section 13.2 and Dolman (1992) and Porter, *et al* (1991).

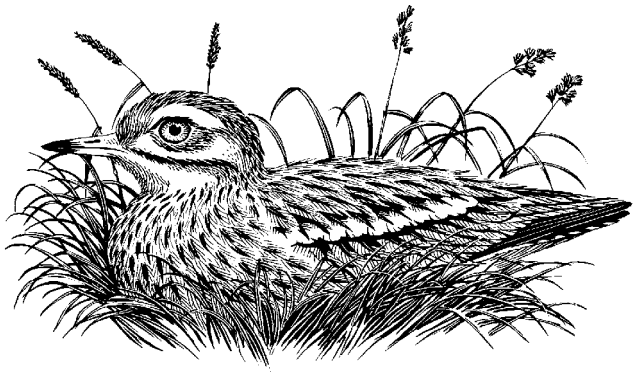


Table 2.6 Red and Amber listed birds of conservation concern in the UK (1) associated with lowland dry grassland

Scientific name	English name	Breeding	Wintering/Passage	List (R = Red A = Amber)	Schedule 1 Wildlife & Countryside Act 1981	Annex 1 EC Bird Directive	List of globally threatened/declining species
Circus cyaneus	Hen harrier		T	R	T	T	TLL
Falco columbarius	Merlin		T	R	T	T	TLL
Perdix perdix	Grey partridge	T	T	R			TP
Coturnix coturnix	Quail	T		R	T		TLL
Burhinus oedicnemus	Stone curlew	T		R	T	T	TP
Vanellus vanellus	Lapwing	T		A			TLL
Asio flammeus	Short-eared owl	T	T	A		T	TLL
Lullula arborea	Woodlark	T	T	R	T	T	TP
Alauda arvensis	Skylark	T	T	R			TP

(1) For definition, see Anon (1996)

Other Red and Amber list birds which can also occur on lowland dry grassland include barn owl (A), green woodpecker (A) corn bunting (R), curlew (A), nightjar (R), montagu's harrier (A) and ring ouzel (A)

P = Priority species (formerly Short and Middle list species; LL = Long list (see The UK Steering Group 1995).

2.4.4 Other lowland grasslands

Upland valley hay meadows (MG3, MG5) can be important for breeding waders such as redshank *Tringa totanus* and curlew *Numenius arquata* (see Chapter 6) and yellow wagtail *Motacilla flava* and for part of the year may provide an important food source for breeding twite *Carduelis flavirostris* (McGhie *et al* 1994).

Dry neutral grasslands in the lowlands (MG5) including semi-improved types (MG6, MG7) can be of importance as habitats for wintering waders such as lapwing *Vanellus vanellus* and golden plover *Pluvialis apricaria*, gulls *Larus* spp, corvids *Corvus* spp and fieldfare *Turdus pilaris* and redwing *T. iliacus*.

Neutral tall herb/rank grasslands (MG1, MG2), Calaminarian grassland (OV37) and moist acid grassland in the lowlands (U4) are, in isolation, of little significance for birds although where they form part of larger habitat mosaics they may be utilised for feeding.

2.4.5 Invertebrates

Many types of semi-natural grasslands are of considerable interest for invertebrates. Different types of grassland vary considerably in the richness of the invertebrate fauna they support and in the number of rare, scarce and declining species they contain.

As a broad generalisation, the invertebrate species richness and nature conservation interest of calcareous grassland is greater than that of either neutral or acid grassland. It is unclear what factors contribute to these differences but variations in plant-species richness is likely to be one factor. For further information on the grassland invertebrate fauna see Duffey *et al* (1974), Ratcliffe (1977), Butt (1986) and Kirby (1992, 1994) and Chapter 13, section 13.3).

There are a number of rare and scarce invertebrate species associated with lowland grasslands. Kirby (1994) gives a total of 153 for numbers of *Red Data Book* invertebrate species found in grassland habitats and 350 notable species (ie occurring in fewer than 100 10km squares). Further information on the rare and scarce invertebrate species associated with lowland semi-natural grassland can be found in Shirt (1987), and Kirby (1994) for insects and Bratton (1991) for other invertebrates. Tables 2.7 and 2.8 list the rare and scarce butterflies and grasshoppers and crickets respectively associated with lowland semi-natural grasslands.

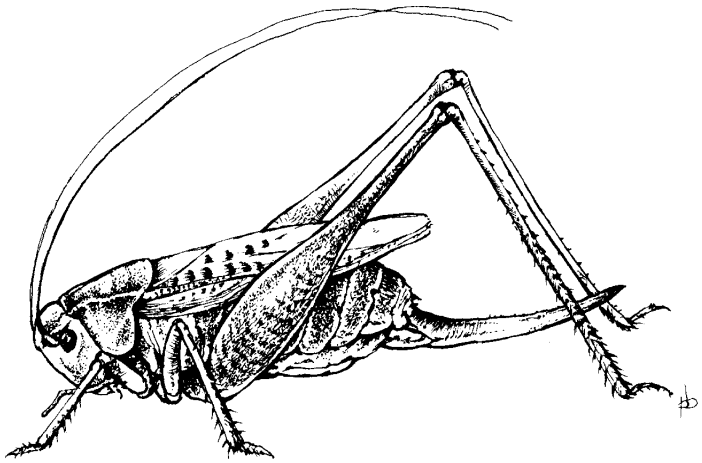


Table 2.7 Rare and scarce butterflies associated with lowland semi-natural grassland

Scientific name	English name	Red Data Book Category (see key)	Red list (R = Red A = Amber After Warren *et al* 1997	Wildlife & Countryside Act 1981: Schedule 5	Nationally rare (1-15 10 x 10 km squares)	Nationally scarce (16-100 10 x 10 km squares)	List of globally threatened/ declining species	Grassland type
Aricia artaxerxes	Northern brown argus	-	R	T Section 9 (5) only	-	T	TLL	Calcareous
Cupido minimus	Small blue	-	A	T "	-	T	TLL	Calcareous
Euphydryas aurinia	Marsh fritillary	-	R	T	-	T	TP	Calcareous, Fen meadow, Rush pasture
Hamearis lucina	Duke of Burgundy fritillary	-	-	T "	-	T	TLL	Scrub margins on calcareous grassland
Hesperia comma	Silver-spotted skipper	3	R	T "	-	T	TP	Calcareous
Lysandra bellargus	Adonis blue	-	A	T "	-	T	TP	Calcareous
L. coridon	Chalkhill blue	-	-	T "	-	T	TLL	Calcareous
Maculinea arion *	Large blue	1	R	T	T	-	TP	Calcareous
Plebejus argus	Silver-studded blue	-	A	T Section 9 (5) only	-	T	TP	Calcareous, acid
Thymelicus acteon	Lulworth skipper	-	A	T "		T	TLL	Calcareous, neutral
Boloria euphrosyne	Pearl-bordered fritillary	-	R	T "	-	T	TP	Bracken slopes and rough grassland

Key: * Became extinct 1979; Swedish sub-species subsequently re-introduced

P = Priority species (formerly Short and Middle list species) - see The UK Steering Group 1995

RDB categories

1. Endangered
2. Vulnerable
3. Rare
4. Out of danger

Table 2.8 Rare and scarce Orthoptera (grasshoppers & crickets) associated with lowland semi-natural grassland

Scientific name	English name	Red Data Book category (see key)	Wildlife & Countryside Act 1981: schedule 5	Nationally rare (1-15 10km squares)	Nationally scarce (16-100 10km squares)	List of globally threatened/ declining species
Decticus verrucivorus	Wart-biter	2	T	T	-	TP
Metrioptera roeselii	Roesel's bush-cricket	-	-	-	T	-
Omocestus rufipes	Woodland grasshopper	-	-	-	T	-
Gomphocerippus rufus	Rufous grasshopper	-	-	-	T	TLL
Gryllotalpa gryllotalpa	Mole cricket	1	T	T	-	TP
Gryllus campestris	Field cricket	1	T	T	-	TP
Conocephalus discolor	Long-winged cone-head	-	-	-	T	-
Chorthippus vagans	Heath grasshopper	3	-	T	-	TLL

Key : RDB categories

1. Endangered
2. Vulnerable
3. Rare
4. Out of danger

P = Priority species (formerly Short and Middle list species); LL = Long list (see The UK Steering Group 1995).

2.4.6 Mammals

The majority of native species of mammals are primarily adapted to woodland. Only a few have very specialised habitat requirements and many are very versatile and use a variety of habitats within their range.

Table 2.9 lists the mammal species which are often associated with semi-natural lowland grasslands but which are not necessarily confined to this habitat. For further details of the biology of these species see Corbet & Harris (1991).

While bats have been omitted from Table 2.9, some species search for prey over semi-natural grasslands and these grasslands may be important components of suitable habitat mosaics.

None of the species listed in Table 2.9 are scarce in a UK context and the majority are common and widespread. However, evidence suggests that the brown hare *Lepus europaeus* may be declining and for this reason it is on the Biodiversity Action Plan short list of globally threatened/declining species and an action plan has been produced (The UK Steering Group 1995).

2.4.7 Reptiles

Four species of reptile are sometimes found in grassland habitats in Britain. These are adder *Vipera berus*, grass snake *Natrix natrix*, slow worm *Anguis fragilis* and common lizard *Lacerta vivapara,* the latter of which also occurs in Ireland. These are generally "woodland edge" species and where they occur in managed grassland it is normally in association with tall herb vegetation, scrub or woodland. The adder uses a variety of habitats including calcareous grassland in southern England. While remaining relatively widespread in Britain, it is thought to be declining as a result of habitat loss.

The grass snake occurs in a variety of habitats including semi-natural grasslands but is normally found close to water. While still relatively widespread in England and Wales, numbers appear to be declining. Slow worm and common lizard are widespread in Britain and both feed on invertebrates. (Adder, grass snake, common lizard and slow worm are listed on Schedule 5 of the Wildlife & Countryside Act 1981 which now protects them from killing, taking, injuring and sale under Section 9).

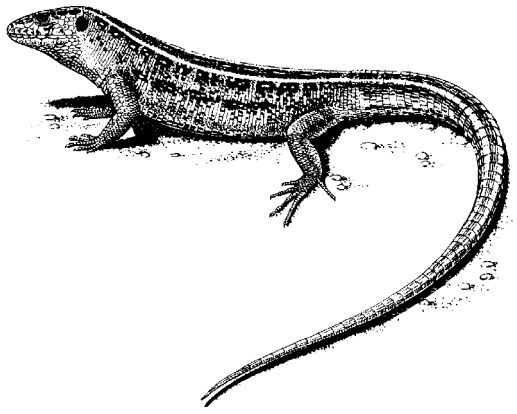


Table 2.9 Grassland mammals

Scientific name	English name	Relevant legislation* (Protection only)
Talpa europaea	Mole	Protected from certain methods of killing or taking. Section 11 (Schedule 6) of 1981 Wildlife & Countryside Act.
Erinaceus europaeus	Hedgehog	Protected from certain methods of killing or taking. Section 11 (Schedule 6) of 1981 Wildlife & Countryside Act.
Sorex araneus	Common shrew	Protected from certain methods of killing or taking. Section 11 (Schedule 6) of 1981 Wildlife & Countryside Act.
S. minutus	Pygmy shrew	Protected from certain methods of killing or taking. Section 11 (Schedule 6) of 1981 Wildlife & Countryside Act.
Oryctolagus cuniculus	Rabbit	
Lepus europaeus	Brown hare	Protected from sale at certain times of the year
Clethrionomys glareolus	Bank vole	
Microtus agrestis	Field vole	
Apodemus sylvaticus	Woodmouse	
Micromys minutus	Harvest mouse	
Vulpes vulpes	Fox	
Mustela erminea	Stoat	
M. nivalis	Weasel	
Meles meles	Badger	Protection of Badgers Act 1992. Wildlife & Countryside Act & 1985 Amendment.

* All wild mammals are protected from certain cruel acts by the Wild Mammals (Protection) Act 1996.

2.5 International importance

2.5.1 Grassland communities

Semi-natural grasslands of all types were probably widespread in Europe at the turn of the century (van Dijk 1991). However, much of this resource has been lost in the last 50 years and all types of semi-natural lowland grassland are now scarce within Europe (Willems 1990).

Some UK grassland types do not occur elsewhere in north-west Europe.

The lowland grassland types listed on Annex 1 of the EC Habitats and Species Directive (Council of the European Communities 1992) are as follows:

a. **Priority habitats**

   i. *Festuco-Brometalia* (includes NVC types CG1-CG9). Semi-natural dry grasslands with important orchid populations.

b. **Habitat types of EU interest**

   i. *Festuco-Brometalia* (CG1-CG9).

   ii. Mesophile grasslands. Lowland hay meadows. MG4 *Alopecurus pratensis-Sanguisorba officinalis* flood meadows.

   iii. Mountain hay meadows (British types with *Geranium sylvaticum*) MG3 *Geranium sylvaticum-Anthoxanthum odoratum* grassland.

   iv. Calaminarian grasslands. OV37 *Festuca ovina-Minuartia verna* grasslands on substrates containing a high concentration of heavy metals.

   v. *Molinia* meadows on chalk and clay (Eu-Molinion) M24 *Molinia caerulea-Cirsium dissectum* fen meadow and M26 *Molinia caerulea-Crepis paludosa* mire.

   A selection of sites conforming to the types listed above will be designated as Special Areas of Conservation or SACs under the Directive. These sites will form part of a European network considered to be of international significance for nature conservation. Choice of SACs will be completed over the next few years. For further information on the selection of UK sites see Brown *et al* (1997).

2.5.2 Birds

Thirty lowland UK sites containing significant areas of lowland grassland have been designated as Wetlands of International Importance under the Ramsar Convention especially as waterfowl habitat and/or as Special Protection Areas (SPAs) under the EC Directive on the Conservation of Wild Birds (Council of the European Communities 1979).

A high proportion (26 sites) of these internationally important sites contain wet grassland, which reflects the importance of this habitat for bird conservation. Some of these sites (for example the Nene Washes and the Somerset Levels) have a high proportion of improved/semi-improved grassland. The qualification of these sites is principally based on their concentrations of wintering and breeding waders and wildfowl.

Of the dry grasslands, there are two large areas of calcareous grassland in Wiltshire, namely Salisbury Plain and Porton Down; which have been designated as SPA on the basis of their populations of breeding stone curlew. This is an Annex 1 species which is considered to be vulnerable in Europe. The remaining four sites are mosaics of lowland heath, acid and calcareous grassland which support important bird species associated with heath and dry grassland habitats. Further information on the selection criteria for UK SPA and Ramsar sites is given in Stroud *et al* (1990) & Way *et al* (1993).

2.6 Semi-natural grasslands: past, present and future

2.6.1 Losses, threats and extent of the resource

The plant and animal communities of lowland semi-natural grasslands can be damaged or destroyed very easily.

Firstly, grasslands are dependent on continuity of management to maintain their nature conservation value. Cessation of grazing and/or cutting ultimately results in successional change towards scrub and secondary woodland with a consequent loss of floristic interest associated with grasslands. Secondly, grasslands have been a particular focus for agricultural intensification over the last 50 years. Many grasslands have been converted to arable or improved agriculturally by ploughing and reseeding with high productivity rye-grasses, under-drainage and the use of herbicides and artificial fertilisers. Fuller (1987) concluded that in 1984, unimproved grassland occupied 3 per cent of the area it occupied in 1930 in England and Wales. The rate and extent of loss of lowland grassland has varied according to the grassland type. Neutral grasslands (for example NVC community MG5) have sustained the greatest losses as they usually occur on relatively dry, even terrain and are easily improved (Jefferson *et al* 1994). Data gleaned from recent surveys of neutral grasslands in England indicate high annual loss rates (range 2-10 per cent per annum) of this type of grassland where they were not protected by some form of conservation designation (Jefferson & Robertson (1996).

Other causes of deterioration or loss of grasslands include residential/industrial/road development, afforestation and lack of management leading to scrub encroachment.

Accurate estimates of the extent of the grassland resource are not currently available. However, it is likely that the area of lowland calcareous grassland in the UK is unlikely to exceed 41,000 hectares (NVC communities CG1-CG10). Semi-natural neutral grassland of high botanical nature conservation interest (NVC communities MG2-MG5, MG8, MG11 and MG13) is a much scarcer resource. Table 2.10 provides a rough estimate of the extent of the UK neutral grassland resource by NVC community.

The lowland acid grassland resource is less well known but is not likely to exceed 27,000 hectares in the UK.

Dargie (1993) estimated that lowland wet grassland totalled 219,410 ha in England although much of this is improved or semi-improved grassland which has potential for restoration to wet grassland. There is very roughly 20,000 ha of grazing marsh and floodplain grassland in Wales (D P Stevens, pers. comm. 1997).

Table 2.10 Estimates of the extent in hectares of the neutral grassland resource in GB (1)

NVC COMMUNITY TYPE	ESTIMATE IN HA
Semi-natural stands of MG1c, d, e	**Unknown***
MG2	< 100
MG3	< 1000
MG4	< 1500
MG5	< 7000
MG8 and related vegetation	< 800
MG11	< 1000
MG13	< 2000
All communities (MG)	< 14000 ?

(1) Includes those communities considered to be of high botanical interest (see Table 2.1).

* not enough information on which to make a reasonable estimate due to lack of survey information and determination to sub-community level.

2.6.2 Protection and enhancement

Since 1949, some semi-natural grasslands have been conserved by the acquisition of sites by conservation organisations and by the use of statutory designation. Table 2.11 attempts to summarise the variety of mechanisms currently available for the protection and enhancement of semi-natural grasslands of nature conservation value in the UK. A high proportion of remaining lowland semi-natural grassland occurs in England.

Available data indicates that 47 per cent of all biological SSSIs in England contain semi-natural lowland grassland as a significant component (Jefferson & Grice 1998) while 45 National Nature Reserves were declared primarily because of their lowland grassland interest. There are also many other grassland nature reserves owned or leased by local Wildlife Trusts, Local Authorities, RSPB, National Trust and other wildlife conservation organisations.

In Wales, nearly 4,000 ha of semi-natural lowland grassland is included within the SSSI series (Blackstock *et al* 1996).

Table 2.11 Protection and enhancement mechanisms for lowland grassland in the UK

Mechanism	Enabling legislation (where appropriate)	Principal organisation(s) involved
Site of Special Scientific Interest (SSSI)	S.28 1981 Wildlife & Countryside Act & 1985 Amendment	Nature Conservancy Council for England (English Nature-EN) Scottish Natural Heritage (SNH) Countryside Council for Wales (CCW)
Wildlife Enhancement Scheme (WES)	S28 1981 Wildlife & Countryside Act & 1985 Amendment	EN
Areas of Special Scientific Interest (ASSI)	Part IV 1985 Nature Conservation and Amenity Lands (Northern Ireland) Order (1989 Amendment)	Department of the Environment for Northern Ireland (DOENI)
National Nature Reserve (NNR)	S.19 1949 National Parks & Access to the Countryside Act S.35 1981 Wildlife & Countryside Act	EN, SNH, CCW
Natural Heritage Area	S.6 Natural Heritage (Scotland) Act 1991	SNH, Scottish Office.
Local Nature Reserve	S.21 1949 National Parks & Access to the Countryside Act	Local Planning Authorities, EN, SNH, CCW
Management Agreement (S.39)	S.39 1981 Wildlife & Countryside Act	Rural Local Planning Authorities including National Park Authorities
Area of Special Protection (Statutory Bird Sanctuary)	S.3 1981 Wildlife & Countryside Act (replaces Bird Sanctuary designated under 1954 Protection of Birds Act)	Department of the Environment, Transport and Regions(DETR)
Wetland of International Importance (Ramsar site)	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitats (Iran) 1971	DETR, Welsh Office, Scottish Office, EN, CCW, SNH, JNCC
Special Protection Area (SPA)	Article 4 of the EC Directive on the Conservation of Wild Birds (EEC/79/409)	DETR, Welsh Office, Scottish Office, EN, CCW, SNH, JNCC
Special Area for Conservation (SAC)	Article 7 of the EC Habitats & Species Directive	DETR, Welsh Office, Scottish Office, EN, CCW, SNH, JNCC
Environmentally Sensitive Areas (ESA)	S.18 1986 Agriculture Act	MAFF, WOAD, SOAEFD, DOANI, EN, SNH, CCW, DOENI, Countryside Commission
Countryside Stewardship	NA	MAFF, EN
Tir Cymen*	NA	CCW
NGO Nature Reserve	NA	The Wildlife Trusts, Royal Society for the Protection of Birds (RSPB), National Trust etc
Scottish Countryside Premium Scheme	NA	SOAEFD, SNH

* To be superseded by the All Wales Agri-Environment Scheme (AWAES/Tir Gofal)

Incentive payments to landowners to undertake positive conservation management are now available in certain parts of the UK. These include Environmentally Sensitive Areas (ESAs) operated by MAFF, WOAD DANI and SOAEFD, the Countryside Stewardship Scheme run by MAFF in England, Tir Cymen run by the Countryside Council for Wales and the Countryside Premium Scheme (CPS) run by SOAEFD (see Chapter 16).

A number of ESAs include important concentrations of lowland semi-natural grassland; these are listed in Table 2.12. The ESA provides a voluntary mechanism for incentive payments to encourage sympathetic grassland management. Similarly, the Countryside Stewardship Scheme is targeted at 12 landscape types of which several, in particular chalk and limestone grassland, waterside landscapes, old meadows and pastures, coast and historic landscapes can include lowland semi-natural grassland. This is a voluntary scheme where payments are made in return for agreed management aimed at conserving and enhancing the targeted landscape/habitat. Tir Cymen, the equivalent scheme in Wales, includes all types of unimproved grassland. The CPS includes various grassland options and covers all species-rich grassland on in-bye land. For further information on incentive schemes see Chapter 16.

Table 2.12 Environmentally Sensitive Areas with a significant lowland grassland interest

ESA name	Grassland type
+* Breckland	Acid and calcareous grasslands including lichen grass-heath
+ The Broads	Wet grasslands
North Peak	Primarily upland, very limited area of enclosed grassland, mostly improved
* Pennine Dales	Northern neutral hay meadows
Clun	Mix of upland and lowland including some neutral grassland
+* Somerset Levels and Moors	Wet grasslands including fen meadows
* South Downs	Calcareous grasslands
Suffolk River Valleys	Mix of wet grassland, neutral meadows and reed bed
Test Valley	River and wet grassland
West Penwith	Mix of heath, coastal and enclosed grassland, mostly improved
+ Avon Valley	River and wet grassland including water meadows
Exmoor	Primarily upland, some unimproved enclosed grassland
* The Lake District	Upland and dales with northern neutral meadows, wet grassland and calcareous grassland
+ North Kent Marshes	Coastal grazing marsh
* South Wessex Downs	Calcareous grassland
South West Peak	Mainly upland, a little unimproved enclosed grassland
The Blackdown Hills	Mix of woodland, grassland, heath and mire including unimproved wet acid grassland/fen meadow
* The Cotswold Hills	Calcareous grassland
Dartmoor	Principally upland but enclosed grassland includes wet acid grassland/fen meadow
+ The Essex Coast	Coastal grazing marsh
* The Shropshire Hills	Upland and woodland and some enclosed grassland, some unimproved neutral/acid grassland
* The Upper Thames Tributaries	Rivers and wet grassland including flood meadows on neutral substrates
*+Machair of the Uists, Benbecula Barra & Vatersay	Machair grassland with associated wetlands
West Fermanagh and Erne Lakeland	Neutral meadows and pastures, fen meadows/rush pastures
Lleyn	Fen meadows, rush pastures, neutral and acidic grasslands
Preseli	Fen meadows, rush pastures, neutral and acidic grasslands
Cambrian Mountains	Neutral and acid grasslands, fen meadows/rush pastures
Radnor	Neutral and acid grasslands, fen meadows/rush pastures
Anglesey (Ynys Môn)	Fen meadows/rush pastures/neutral and calcareous grasslands/grazing marsh
Clwydian Range	Calcareous, neutral and acid grasslands
*Stewartry	Wet grasslands
+Argyll Islands	Machair, coastal and other herb-rich grasslands, including traditional hay meadows
Shetland Islands	Mosaic of rushy pastures, improved pastures, hay meadows and silage fields.

* Significant for lowland grassland of botanical interest

+ Significant for species especially birds and/or ditch fauna and flora

2.6.3 UK Biodiversity Action Plan

The UK Biodiversity Action Plan stems from the signing of the Biodiversity Convention in Rio in 1992 by the UK Government. The UK Steering Group (1995) lists key habitats and species which merit costed action plans and are thus priorities for conservation action. Key habitats are defined as:

- those for which the UK has an international obligation;
- habitats at risk, eg with a high rate of decline, or which are rare;
- areas important for key species;
- areas, particularly marine areas, which may be critical; for organisms inhabiting wider ecosystems.

Grassland key habitats or those where grassland is an important element of the habitat are:

- Lowland hay meadows
- Upland hay meadows
- Lowland dry acid grassland
- *Purple moor grass and rush pastures
- Lowland calcareous grassland
- *Coastal and floodplain grazing marsh
- Lowland wood pastures and parklands

(* These habitats have costed action plans described in Volume 2 of the report. The remaining grassland action plans were published in English Nature (1998a).

The habitat action plans, when completed, will be implemented over the next few years.

2.7 Grassland community ecology

In this section, ecological principles which are relevant to the management of grasslands are briefly examined. This is not intended to be an exhaustive treatment of grassland ecology and further information on this subject can be found in Hillier, Walton and Wells (1990), Duffey *et al* (1974), Grime (1979); Smith (1980), and in a range of other publications.

2.7.1 Ecological succession

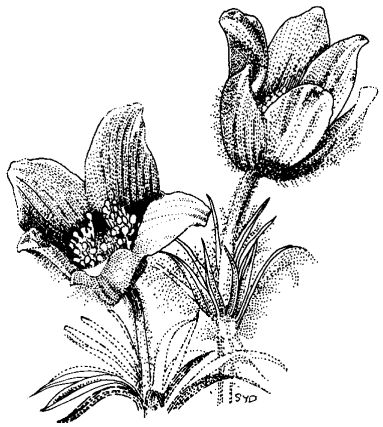
Most lowland grasslands, in the absence of grazing or cutting management, will undergo changes in their plant and animal composition over time. This process is known as succession. In general terms, change is ultimately towards scrub and woodland communities often with an intermediate tall grassland stage with a decline in species-richness and an increase in soil nutrients as the succession progresses. The speed of vegetation change is variable and depends on a variety of factors including proximity of a source pool of potential colonising species, soil nutrient status and vegetation structure. For example, there is evidence that an intermediate stage of tall, unmanaged grassland with a thick litter layer can actually inhibit scrub colonisation, at least in the short-term. Pathways of change can also vary and there are some instances on the chalk where the succession progresses from the relatively open, sparsely vegetated community to scrub without an intervening closed grassland stage.

2.7.2 Factors controlling plant species-richness in grassland communities

Different types of lowland semi-natural grassland vary in numbers of plant species which they support per unit area (species-richness). Species richness is often used by conservationists as a criterion for assessing the nature conservation value of grasslands. The processes controlling grassland species-richness include evolution, colonisation, competition, reproduction and establishment.

Grime (1973) put forward a model describing some of the major factors which influence species-richness in herbaceous vegetation. This is illustrated at Figure 2.2.

Species density/richness is low in very highly stressed or harsh environments, for example highly disturbed or very arid areas and also paradoxically in very fertile situations, for example areas with deep, well-drained soils with a high nutrient availability. Most species-rich communities, including many types of calcareous and neutral grassland occur in areas of intermediate fertility where competitive species are unable to thrive. Management (a type of stress) such as cutting and grazing, plays a part in maintaining species-richness by preventing a build-up of soil nutrients and in limiting the ability of competitive species to achieve dominance. Conversely, application of fertiliser to species-rich grassland, for example, has the opposite effect, decreasing species-richness, enhancing the ability of competitive species to thrive and increasing the standing crop.



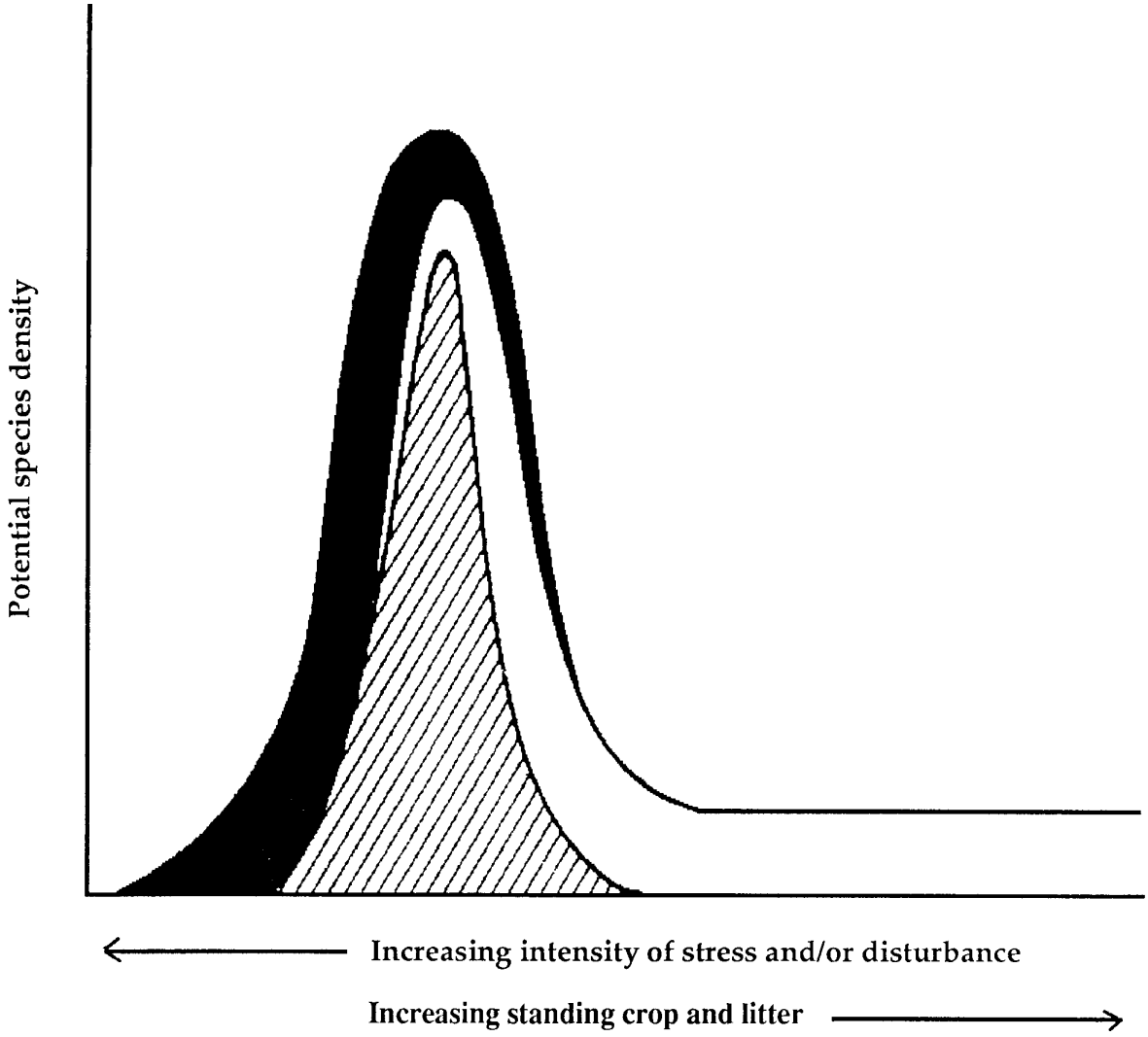


Figure 2.2 Model describing the impact of a gradient of increasing stress and/or disturbance upon the potential species density in herbaceous vegetation, □ potential dominants; species or ecotypes, highly adapted to the prevailing form(s) of stress disturbance; + species which are neither potential dominants, nor highly adapted to stress or distrurbance. (Reprinted with permission from Nature Volume 242. copyright 1973 Macmillan Magazine Ltd.)

Grubb (1977) also emphasised the importance of gap creation in grasslands as a means of allowing the establishment of the new generations of grassland species from seed, particularly short-lived annual species. This may be particularly important for the long-term maintenance of the nature conservation interest of many grasslands. Such gaps can be created by livestock trampling and rabbit activity and by environmental stress such as persistent drought. However, while gap creation may be important in some situations, it is worth emphasising that a high proportion of grassland species are long-lived perennials where vegetative reproduction may also be an important mechanism of regeneration.

2.7.3 Life history strategies

Grime (1974, 1977) put forward a model describing some of the major factors which influence the species composition of herbaceous vegetation. This is the C-S-R model illustrated in Figure 2.3.

The model suggests that it is useful to classify the external factors which affect vegetation into two broad categories. The first, **stress**, consists of factors which restrict the photosynthetic production, such as shortages of light, water and mineral nutrients. The second, **disturbance**, is associated with the partial or total removal of the vegetation. This could arise from grazing, mowing, wind damage, drought, soil erosion and fire. When the four permutations of high and low stress with high and low disturbance are examined it is evident that only three of the environments (see below) are viable as plant habitats.

Grime (1974, 1977) suggests that these three environments are associated with the evolution of three primary strategies in plants. These are **competitors** associated with conditions of low stress/low disturbance, **stress-tolerators** associated with high stress/low disturbance and **ruderals** characteristic of low stress/high disturbance environments. These three strategies can be displayed in a triangular diagram where the apices represent the three extremes of specialisation (Figure 2.3). The three strategies represent extremes and there are clearly intermediate conditions.

The C-S-R model proposes that the vegetation which develops in a particular place and at a particular time is the result of an equilibrium which is established between the intensities of stress, disturbance and competition.

Grime *et al* (1988) suggests that it is possible to predict both the stability of a community and its resilience to disturbance by identifying the established strategies of the individual species which comprise the vegetation. Resilience to disturbance is low in communities dominated by stress tolerators (for example, calcareous grassland) and high in those dominated by ruderal species (for example, waste ground).

Semi-natural grasslands contain a high proportion of species which are stress tolerators because the environments where such communities occur are normally stressed by factors such as low nutrient availability but have relatively low levels of disturbance.

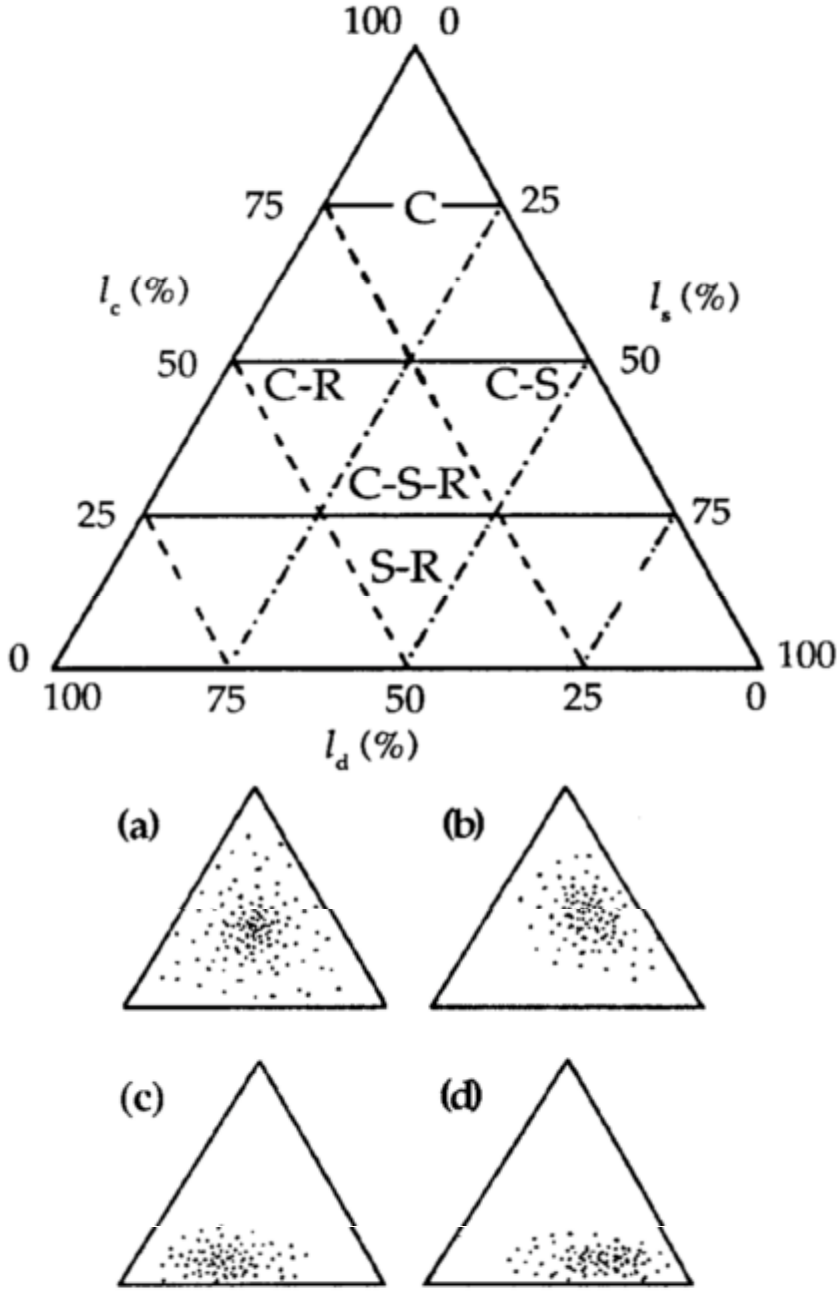


Figure 2.3 A model describing the various equilibria between competition, stress and disturbance in vegetation and the location of primary and secondary strategies. C, competitor; S, stress tolerator; R, ruderal; C-R, competitive-ruderal; S-R, stress tolerant ruderal; C-S, stress-tolerant competitor; C-S-R, 'C-S-R strategist'. I_c,relative importance of competition (- -); I_s, relative importance of stress (- · -); I_d, relative importance of disturbance (---). The strategic range of four life forms is also shown: (a) herbs, (b) trees and shrubs, (c) bryophytes and (d) lichens. Reproduced from Grime *et al* 1988 with permission of Chapman & Hall, London.

An assessment of the proportion of stress tolerators to other types (competitors, ruderals) in semi-natural grasslands over time may be a useful way of detecting adverse changes. Alternatively, the selection of a range of stress tolerators as indicator species and subsequent monitoring of their abundance through time could also be used in a similar manner (see Chapter 15).

2.7.4 Vegetation structure in grasslands

The structure of grassland vegetation is an important influence on the distribution and composition of plants and animals (Hopkins 1991).

Different plant and animal species characteristic of semi-natural grasslands require specific structural types of vegetation. Certain Lycaenid ("blue") butterflies in Britain, for example adonis blue *Lysandra bellargus*, require short grass swards containing the larval food plant while other plant and animal species require tall swards (for example marbled white butterfly *Melanargia galathea*).

Some species may also require different grassland structures at different periods of their life cycle (for example wart-biter *Decticus verrucivorus* (a bush cricket)) or may depend on a mosaic of structures (for example woodlark *Lullula arborea*).

Vegetation structure has both vertical and horizontal components, and can also vary in time and space. Parameters which strongly influence structure include microclimate, soil structure, soil chemistry, intensity, timing and scale of management (cutting, grazing and burning), animal herbivory, competition between species and the intrinsic architectural properties of the component species.

From a nature conservation viewpoint, the desirable sward structure or mosaic of structures for a particular grassland site will depend on the particular nature conservation objectives. For a useful review of sward structure see Hopkins (1991).

2.8 Grassland scrub

2.8.1 Introduction

Scrub is widespread in the UK lowlands and it develops spontaneously through the invasion of grassland and other open habitats by shrubs, woody climbers and trees. It often represents a stage in the succession to woodland but in some situations, where physical conditions inhibit tree growth, it can form a climax community.

The presence of colonising scrub on grassland is strongly related to the reduction or cessation of some form of management, usually grazing, mowing or burning.

2.8.2 Species composition of scrub and types of scrub

The types of woody species able to colonise grassland depends on factors such as the proximity of potential scrub colonists, the structure and management of the grassland and the nature of the geology, soils and microclimate. A list of the principal woody species colonising lowland grassland is provided in Table 2.13.

Scrub vegetation has been classified by Rodwell (1991a) and Table 2.14 lists the seven types which can develop from grassland following cessation of management. These types represent vegetation where shrubs are the dominant plant types as opposed to situations where shrub and tree species are widely scattered throughout an open habitat such as grassland.

2.8.3 Nature conservation value

In terms of a botanical conservation, many scrub types (for example species-poor hawthorn scrub) are considered to have low intrinsic value as they are commonplace, have low species-richness, are often of recent origin and are easily recreated. Additionally, scrub has often been seen as a threat to the integrity of more valuable vegetation types including semi-natural grassland which it can replace in the absence of management. However, scrub is an important habitat for birds and invertebrates (see Chapter 12) and its presence in association with grassland can enhance the nature conservation value of sites. It is not, however, advocated that scrub should be allowed to colonise at the expense of existing semi-natural grassland of high nature conservation value.

Some scrub types, though, are of particular nature conservation value in that they are rare, support uncommon shrub species or are relatively rich in woody species. These include the mixed scrub communities of the chalk and limestone (NVC community W21 (*Viburnum lantana* and *Brachypodium sylvaticum* sub-communities), and Box *Buxus sempervirens* scrub which is not specifically described by the NVC.

Long established mosaics of scrub, grassland and woodland, including transitions, which were created in the past by episodic grazing, coppicing and pollarding are now particularly rare in Great Britain (see Chapter 12, Section 12.1 and Hopkins 1996). These areas can support a range of tall-herb species together with their associated fauna which are rare in more intensively managed semi-natural grasslands.

Table 2.13 Shrubs, trees and woody climbers* of grassland scrub

Scientific name	English name	Grassland type colonised	NVC scrub community (see Table 2.12)
Acer campestre	Field maple	C, N	W21
A. pseudoplatanus	Sycamore	C, N	W21, W24, W25
Alnus glutinosa	Alder	WN, FM	W1, W2
Betula pendula	Silver birch	C, N, WN, A, FM	W1, W2, W21
B. pubescens	Downy birch	WN, N, A, FM	W1, W2, W24
Buxus sempervirens	Box	C	-
Clematis vitalba	Traveller's-joy	C	W21
Cornus sanguinea	Dogwood	C	W21
Corylus avellana	Hazel	C, N	W21, W22, W24
Crataegus monogyna	Hawthorn	C, N, WN, A, FM	W1, W2, W21, W24, W25
Cytisus scoparius	Broom	A	W23
Euonymus europaeus	Spindle	C	W21
Fagus sylvatica	Beech	C, N, A	W21, W24, W25
Frangula alnus	Alder buckthorn	WN, FM	W1, W2
Fraxinus excelsior	Ash	C, N, WN, FM	W2, W21, W24, W25
Hedera helix	Ivy	C, N, WN, A	W1, W21, W22, W23, W24, W25
Ilex aquifolium	Holly	C, N, A	W21
Juniperus communis	Common juniper	C	W21
Ligustrum vulgare	Wild privet	C	W21
Lonicera periclymenum	Honeysuckle	C, N, A	W21, W22, W25
Malus sylvestris	Crab apple	C, N	W21
Pinus sylvestris	Scots pine	A	-
Populus tremula	Aspen	WN, FM	-
Prunus padus	Bird cherry	C	-
P. spinosa	Blackthorn	C, N, A	W21, W22, W24, W25
Quercus robur	Pedunculate oak	C, N, A	W1, W21, W24, W25
Rhamnus cathartica	Buckthorn	C, N, WN	W21
Rosa arvensis	Field-rose	C	W21, W25
R. canina sect. (includes 10 species)	Dog-rose	C, N	W21, W22, W24, W25
R. pimpinellifolia	Burnet rose	C	-
Rubus fruticosus agg.	Bramble	C, N, WN, A	W1, W21, W22, W23, W25
R. idaeus	Raspberry	N, A	W22, W23, W25
Salix aurita	Eared willow	FM	W2
Salix caprea	Goat willow	N, WN	-

Scientific name	English name	Grassland type colonised	NVC scrub community (see Table 2.12)
S. cinerea	Grey willow	WN, FM	W1, W2, W21
Sambucus nigra	Elder	C, N	W21, W24, W25
Sorbus aria agg.	Common whitebeam	C, A	W21
S. aucuparia	Rowan	C, A	-
Taxus baccata	Yew	C	W21
Ulex europaeus	Gorse	C, N, A	W22, W23, W24, W25
U. gallii	Western gorse	A	-
U. minor	Dwarf gorse	A	-
Viburnum lantana	Wayfaring-tree	C	W21
V. opulus	Guelder-rose	C, N, WN, FM	W2

Key:
C : Calcareous grassland
N : Neutral grassland
WN : Wet neutral grassland
A : Acid grassland
FM : Fen meadow/rush pasture (marshy grassland)

* Table **excludes** non-native species. A few introduced shrubs nonetheless do invade semi-natural grassland and can present a conservation problem. These include species of cotoneaster (*Cotoneaster* spp.) which invade calcareous grassland in particular.

Table 2.14 National Vegetation Classification lowland scrub communities developed from grassland (After Rodwell 1991a)

W1	*Salix cinerea - Galium palustre* woodland (scrub). Colonising woody vegetation of wet mineral soils including wet neutral grasslands. Occurs in scattered localities throughout the British lowlands.
W2	*Salix cinerea - Betula pubescens - Phragmites australis* woodland. This type can develop by the direct invasion of fen meadows and rush pastures. Secondary examples are probably rare and scattered throughout the lowlands.
W21	*Crataegus monogyna - Hedera helix* scrub. This type includes the majority of "seral" thorn scrub in the British lowlands. It occurs on neutral to base-rich (calcareous) soils and is the result of invasion by shrubs and trees of grassland and other open habitats. It includes mixed "chalk and limestone scrub" which is represented by the *Viburnum lantana* and *Brachypodium sylvaticum* sub-communities. Widely distributed throughout the British lowlands.
W22	*Prunus spinosa - Rubus fruticosus* scrub. Develops from grassland and other open habitats on deep moist nutrient-rich soils. This scrub type is of widespread distribution through the British lowlands.
W23	*Ulex europaeus - Rubus fruticosus* scrub. Characteristic of moderately to strongly acid, free draining brown earth soils of pH 4-6. Colonises a range of acid grasslands and other open habitats. Of widespread distribution throughout the British lowlands and on the upland fringes.
W24	*Rubus fruticosus - Holcus lanatus* underscrub. Typical community colonising abandoned and neglected ground (including species-poor neutral grassland) on deep, moist, neutral brown-earth soils. Very widespread in the British lowlands.
W25	*Pteridium aquilinum - Rubus fruticosus* underscrub. Characteristic of deep, free draining neutral to moderately acid soils. In some situations it may occur as the result of colonisation of acid grassland.

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