Wildlife and land use in the uplands 2

Tables

Wildlife in the uplands

2.1 Introduction

The English uplands are important for their wealth of habitats and species, supporting unique combinations of plants and animals and including a blend of southern and northern elements (Ratcliffe 1988). They also contain diverse and widespread earth heritage interests. A summary of these interests, with reasons why they are considered to be important, is given below.

Wildlife and earth heritage interests are considered to be important for a variety of reasons. For example, they may be internationally or nationally:

- rare or scarce;
- threatened or fragmented;
- declining;
- restricted in distribution;
- limited in extent or number;
- at the edge of their range;
- important in England because a significant proportion of the UK or international habitat, population, or interest, occurs there;
- important in England because they are particularly well developed or representative in England when compared to Europe or the rest of the world.

Consequently, the nature conservation importance of different features is defined and expressed in different terms. For example, plants are identified as being nationally rare or scarce on certain criteria, birds are identified as being of conservation concern on different criteria, and the status of invertebrates is defined by other criteria again. Some species are legally protected and many habitats and species are included in the European Community (EC) Habitats and Species Directive and the UK Biodiversity Action Plan (see 2.5). Further details on the nature conservation interests of the uplands and their importance can be found in the chapters on specific habitats.

2.2 Habitats

The uplands of England represent the largest area of 'semi-natural' habitat remaining in England. Most of Britain's vegetation is generally referred to as 'semi-natural' (Tansley 1939) because it has been modified by people to some degree. Semi-natural vegetation is composed of native species with structural affinities and community processes corresponding to those of natural vegetation, although the abundance of species, and in some cases the actual species composition, has been changed by man's activities (Thompson & Horsfield 1990).

Upland dry and, to a lesser extent, wet heath, blanket mires and acid grasslands form some of the largest continuous tracts of semi-natural habitat in Britain. Because they contain these large areas of semi-natural habitat, the uplands have long been recognised as a resource of high nature conservation value. It is not just the extent of these habitats which gives them their importance; many of the communities present are internationally scarce and some are largely confined to the UK (see Table 2.1, Brown *et al*

1997; Drewitt & Manley 1997). These include National Vegetation Classification mire communities such as M17 *Trichophorum cespitosum-Eriophorum vaginatum* blanket mire, M16 *Erica tetralix-Sphagnum compactum* wet heath and M26 *Molinia caerulea-Crepis paludosa* mire; heath communities such as H4 *Ulex gallii-Agrostis curtisii* heath, H8 *Calluna vulgaris-Ulex gallii* heath and H21 *Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium* heath; CG9 *Sesleria caerulea-Galium sterneri* grassland and limestone pavement.

This unique representation and mosaic of habitats and vegetation structures, supporting many rare and unusual plant and animal species, results from the variation in altitude, climate, geography, geology, topography, soils and land use (Thompson *et al* 1995c). An altitudinal gradient of climate produces zones of vegetation in response to the changing conditions for plant growth. With increasing altitude, temperature is reduced, whereas wind speed, rainfall and cloud cover increase (Barry 1981). A typical upland vegetation zonation in England today would be represented by meadows, enclosed pastures and woodland in the valley bottom and on the lower slopes, through to sub-montane communities (dwarf shrub heaths, grasslands and blanket bogs) with occasional scrub and woodland on higher ground, and finally montane communities (grassland, moss- or lichen-heath) above the climatic tree limit, around 650 m (Ratcliffe 1991).

Further information:
All vegetation communities: Rodwell 1991, 1992, 1995 and 2000.
Grasslands: Jefferson 1996, Jefferson & Robertson 1996a.
Mountains & moorlands: Drewitt & Manley 1997; Ratcliffe & Thompson 1988; Thompson *et al* 1995c.
Woodlands: Reid, Kirby & Cooke 1996; Kirby & Reid 1997.
Scrub: Hopkins 1996.
Freshwater wetlands: English Nature 1997b; Gardiner 1996.

2.3 Species

Upland habitats support a wide range of vascular and non-vascular plants, invertebrates, birds, mammals, amphibians, reptiles and fish. Some of these are restricted to upland habitats while others have a wider altitudinal range and may be numerous in the uplands as a result of the lowlands becoming less suitable. Many species are of international, national or local importance. Some of these species are included in the UK Biodiversity Action Plan (see 2.5, UK Biodiversity Group 1998 and 1999; UK Steering Group 1995). The conservation status, distribution in England by Natural Area, and habitat and management requirements of significant upland plants and animals is given in more detail in Chapters 5-10.

2.3.1 Plants

Nationally rare and scarce plants occur throughout the uplands in a variety of habitats. These species are often restricted in their distribution because their usual habitats are now also restricted in extent and distribution, or have become unsuitable through management practices such as heavy grazing, fertiliser application or drainage.

Semi-natural calcareous grasslands, for example, support species such as Teesdale violet *Viola rupestris* and spring gentian *Gentiana verna*. Bird's-eye primrose *Primula farinosa* and bog orchid *Hammarbya*

paludosa can be found in upland flushes. Blanket and valley mires can support species such as tall bog sedge *Carex magellanica* and small cranberry *Vaccinium microcarpum* and uncommon bryophytes like *Sphagnum austinii* and *Cephalozia loitlesbergeri*. Alpine catchfly *Lychnis alpina* and alpine saxifrage *Saxifraga nivalis* are present on some high altitude rock ledges. Heaths may have populations of dwarf cornel *Cornus suecica*, pale dog-violet *Viola lactea* and the rare eyebright *Euphrasia vigursii*. Woodlands, particularly those on limestone, may hold populations of species such as narrow-leaved helleborine *Cephalanthera longifolia*, angular Solomon's-seal *Polygonatum odoratum* and lady's slipper orchid *Cypripedium calceolus*, while acidic woods can be important for bryophytes, including English rarities like *Tritomaria exsecta* and *Jubula hutchinaiae*, and lichens.

Knowledge of the distribution, status and conservation needs of lichens and fungi is unfortunately patchy and therefore lichens are mentioned only briefly and fungi have not been considered at all in this edition of the handbook (but see Ing 1992).

2.3.2 Birds

The English uplands support an internationally important assemblage of breeding birds (Ratcliffe 1990a & b). Many of these are considered to be of conservation concern for reasons such as historical population decline (RSPB 1996). British breeding birds that are positively associated with the uplands are identified in Stillman & Brown (1998) and their definition of upland birds and list of species relevant to England are used in this handbook.

The bird communities on blanket bogs and in high mountain areas, which include waders such as golden plover *Pluvialis apricaria* and dunlin *Calidris alpina,* are unique in species mixture and as important outliers of largely Arctic Eurasian distributions. Heathlands support their own particular assemblage of birds, including red grouse *Lagopus lagopus scoticus* and merlin *Falco columbarius*. Many of the species associated with the uplands, such as the golden eagle *Aquila chrysaetos*, peregrine falcon *Falco peregrinus* and hen harrier *Circus cyaneus*, are of conservation concern in Europe and are listed on Annex 1 of the EC Birds Directive (see 2.5 and Brown & Grice 1993). The upland fringes support species such as twite *Carduelis flavirostris*, black grouse *Tetrao tetrix* and curlew *Numenius arquata*.

2.3.3 Invertebrates

Invertebrates are also an important part of the upland biological community, both on land and in freshwater systems. Although some species are common with widespread distributions that include lowland habitats, many species are unique to the uplands. Examples include the whorl snail *Vertigo geyeri* of base-rich flushes, the ground beetle *Nebria nivalis*, which lives on mountain top scree and boulder fields, the broad-bordered white underwing moth *Anarta melanopa* of high altitude heath, the crab spider *Clubiona norvegica* which lives among *Sphagnum* on moorland, the hoverfly *Platycheirus melanopsis* of high altitude grassland and the white-clawed crayfish *Austropotamobius pallipes* of calcium-rich rivers and streams.

In general, the invertebrates have not been studied as much as other species groups. Consequently, information on their populations, distribution and ecological requirements is more scant than for other species groups. Nevertheless, the invertebrates have important functions as herbivores, decomposers and food sources for other animals. For example, cranefly larvae are an important food for many

moorland breeding birds. Rare and scarce invertebrates associated with the uplands are identified in the following chapters.

2.3.4 Mammals

There are relatively few species of mammal for which the upland habitats in England are of special conservation importance. The exception is the mountain hare *Lepus timidus*. This species, which is native to Scotland, is only present in the Peak District in England where it is an introduced species.

For some species, the uplands today are the significant strong-hold in England. However, these species, now restricted to a fragment of the former range, would once have been widespread in both lowland and upland habitats. Examples are the pine marten *Martes martes* and the red squirrel *Sciurus vulgaris*. These two species are now found in predominantly upland conifer forests, although there is currently some debate as to whether the pine marten occurs in England.

Upland habitats, especially moorland, can maintain very large populations of small mammals. Field voles *Microtus agrestis* can be found in large numbers in rough grassland areas of moorland, although they occur at only low densities in heather moorland. Shrews *Sorex* spp. can also be found in large numbers in moorland habitats, the pygmy shrew *Sorex minutus* more so than the common shrew *Sorex araneus*. These small mammals are widespread and abundant elsewhere in England, but have conservation significance as they form an important food source for many upland predators, eg short-eared owl *Asio flammeus*.

Deer, notably red deer *Cervus elaphus,* sika deer *Cervus nippon* (an introduction) and roe deer *Capreolus capreolus,* can be numerous in upland habitats, particularly in the south west, although in England, upland populations are not as large as they are in the Scottish Highlands. The conservation significance of deer relates primarily to their impact on vegetation structure and diversity, and the requirement to manage numbers to prevent damage to habitats.

2.3.5 Amphibians and reptiles

Amphibians and reptiles are found in the English uplands but no species are exclusive to upland areas; indeed most would typically be described as lowland species. However, the uplands do hold large populations of many species, such as the adder *Vipera berus*. Upland habitats, notably moorland and newly planted woodland, are valuable habitats for adders. These snakes are becoming scarcer in lowland habitats in part owing to disturbance and habitat loss and fragmentation. Grass snakes *Natrix natrix* also occur in the uplands.

Two species of lizard occur in upland habitats: the common (or viviparous) lizard *Lacerta agilis* and the slow worm *Anguis fragilis.* Both species occur in a wide range of habitats throughout England and can be common in moorland, open woodlands and grasslands.

Although six species of amphibian are found in the uplands, these habitats are more frequently associated with just three: the common frog *Rana temporaria*, common toad *Bufo bufo* and the palmate newt *Triturus helveticus.* Some upland areas, such as the Peak District, have important populations of great crested newts *Triturus cristatus*. The smooth newt *Triturus vulgaris*, although usually described as

a 'lowland species', is also found in upland areas. The natterjack toad *Bufo calamita* is mostly associated with lowland heathland, coastal dunes and salt marshes, but a recent discovery of a population in the Cumbrian Fells and Dales Natural Area shows that this species too can inhabit upland habitats.

2.3.6 Fish

Fish are an important component of freshwater ecosystems and the English uplands contain some species of particular nature conservation importance. These include the rare vendace *Coregonus albula*, schelly *C. lavaretus* and arctic char *Salvelinus alpinus*, which are all relics of ice age populations. Other important species include the bullhead *Cottus gobio*, allis shad *Alosa alosa*, twaite shad *A. fallax*, grayling *Thymallus thymallus*, and the sea, river and brook lampreys *Petromyzon marinus*, *Lampetra fluviatilis* and *L. planeri*. Upland rivers also form important spawning grounds for Atlantic salmon *Salmo salar*.

Further information:
Vascular plants: Jermy *et al* 1978; Palmer 1994 & 1996; Perring & Farrell 1983; Stewart *et al* 1994; Wigginton 1999.
Non-vascular plants: Church *et al* 1996; Hodgetts 1992, 1993b; Palmer 1994 & 1996; Purvis *et al* 1992; Schumaker *et al.* 1993.
Fungi: Ing 1992.
Birds: Batten *et al* 1990; Brown & Grice 1993; Grice *et al* 1994; RSPB 1996.
Invertebrates: Bratton 1991; Hyman & Parsons 1992; JNCC Invertebrate Site Register (ongoing).
Mammals, reptiles and amphibians: Mitchell-Jones 1996; Mitchell-Jones & Gent 1997.

Slow worm

Table 2.1 Habitats Directive Annex 1 habitat types present in upland Natural Areas of England, with National Vegetation Classification and Biodiversity Action Plan equivalents

Habitats Directive Annex 1 habitats (by Corine habitat type)[1]	National Vegetation Classification[2]	UK Biodiversity Action Plan Broad habitats[3]
Heaths		
31.11 North Atlantic wet heaths with *Erica tetralix*	M14, M15, M16, H5	Dwarf shrub heath
31.2 Dry heaths (all sub-types)	H1-H4, H7-H10, H12, H16, H18, H21	Dwarf shrub heath
31.4 Alpine and sub-alpine heaths	Alpine heaths: H13-H15, H17, H19, H20, H22 Subalpine heaths: H10, H12, H16, H18, H21	Montane habitats
Scrub		
31.88 *Juniperus communis* formations on heaths or calcareous grasslands	W19, W21	Calcareous grassland Dwarf shrub heath
Grasslands		
34.2 Calaminarian grasslands	Not specified	-
34.31-34.34 Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	CG1-CG9	Calcareous grassland
35.1 Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and sub-mountain areas in continental Europe)*	CG10, CG11	Calcareous grassland
36.32 Siliceous alpine and boreal grasslands	U7-U10	Acid grassland
37.31 *Molinia* meadows on chalk and clay (*Eu-Molinia*)	M24, M26	Acid grassland Fen, marsh and swamp
37.7-37.8 Eutrophic tall herbs	U17	Montane habitats
38.8 Mountain hay meadows (British types with *Geranium sylvaticum*)	MG3	Neutral grassland

Habitats Directive Annex 1 habitats (by Corine habitat type)[1]	National Vegetation Classification[2]	UK Biodiversity Action Plan Broad habitats[3]
Bogs, mires and fens		
51.1 Active raised bogs*	Not specified	Bogs
51.2 Degraded raised bogs (still capable of natural regeneration)	Not specified	Bogs
52.1 Blanket bog (active only*)	M17, M18, M19	Bogs
54.5 Transition mires and quaking bogs	M4, M5, M9, S27	Fen, marsh and swamp
54.12 Petrifying springs with tufa formation (*Cratoneurion*)*	M37, M38	Fen, marsh and swamp
54.2 Alkaline fens	M9, M10, M13	Fen, marsh and swamp
54.3 Alpine pioneer formations of *Caricion bicoloris-atrofuscae**	M10, M11, M12	Fen, marsh and swamp
Rocky habitats		
61.1 Siliceous scree	U18, U21	Inland rock
61.2 Eutric Scree	OV38 and other forms with no NVC equivalents	Inland rock
62.1 & 62.1A Chasmophytic vegetation on rocky slopes: Calcareous sub-types	OV40, OV39 and other forms with no NVC equivalents	Inland rock
62.2 Chasmophytic vegetation on rocky slopes: Silicicolous sub-types	U21 and other forms with no NVC equivalents	Inland rock
62.4 Limestone pavement*	Not specified	Inland rock
65 Caves not open to the public	N/A	
Woodland		
41.13 *Asperulo-Fagetum* beech forests	W12, W14	Broadleaved, mixed and yew woodland
41.4 *Tilio-Acerion* ravine forests*	W8d-g, W9	Broadleaved, mixed and yew woodland
41.53 Old oak woods with *Ilex* and *Blechnum* in the British Isles*	W10e, W11, W17	Broadleaved, mixed and yew woodland
42.A71-42.A73 *Taxus baccata* woodland*	W13	Broadleaved, mixed and yew woodland

Habitats Directive Annex 1 habitats (by Corine habitat type)[1]	National Vegetation Classification[2]	UK Biodiversity Action Plan Broad habitats[3]
Freshwater habitats		
Standing water		
22.11 & 22.31 Oligotrophic waters containing very few minerals of Atlantic sandy plains with amphibious vegetation: *Lobelia*, *Littorella* and *Isoetes*	*Littorelletalia*-type vegetation	Standing open water and canals
22.12 & (23.31 and 22.32) Oligotrophic to mesotrophic standing waters of plains to subalpine levels of the Continental and Alpine Region and mountain areas of other regions, with vegetation belonging to *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetae*	Standing water Types 2 and 3 (oligotrophic) and Type 5 (mesotrophic) (Palmer 1989)	Standing open water and canals
22.12 & 22.44 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* formations	Not specified	Standing open water and canals
22.13 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	*Hydrocharition* and *Magnopotamion*-type vegetation	Standing open water and canals
22.14 Dystrophic lakes	Not specified	Standing open water and canals
Running water		
24.2 Floating vegetation of *Ranunculus* of plain and submountainous rivers	*Ranunculus* community subtypes 1&2	Rivers and streams

Key 1. Listed on Annex 1 of the EC Habitats Directive.
* Priority habitat types from Annex 1 of the EC Habitats Directive
2 National Vegetation Classification (NVC, Rodwell 1991, 1992, 1995 and 2000). Interpretation of habitats taken from Brown *et al* (1997).
3 Broad habitats taken from Table 1 of UK Biodiversity Group (1998).

2.4 Earth heritage features

A vast range of geological and geomorphological interest is present in the uplands of England. For a relatively small country, England has a complex geological history, demonstrated by the diverse geology and landscape. The geological history of England is important worldwide because many of the names given to geological time units originate from place names or type localities (a reference site with which all rocks of a similar age and geological type can be compared) in England.

The English uplands contain examples of past geological conditions and processes, such as ice ages and glaciation, tropical seas leading to limestone formation, river deltas leaving coal deposits, deserts resulting in sandstones, and mountain-building activity creating folding, mineralisation, volcanic and metamorphic rocks. Areas where these processes and their results are well illustrated are valued for reference purposes, as well as for their potential for education and research.

The uplands have been continually evolving since their formation and are still undergoing modification by a series of geomorphological processes. Upland areas illustrating these processes, such as mass movement, fluvial activity, karst landscape evolution and a range of other eroding or depositing processes, represent further important examples for reference and education.

Further information: King *et al* 1996; JNCC Geological Conservation Review Series (ongoing); Chapter 4 Earth heritage features.

2.5 International, national and local nature conservation obligations

The uplands are covered by a range of international, national and local obligations in relation to nature conservation in England. These reflect and protect the significant nature conservation value of the English uplands, and are summarised below and in Table 2.2 .

2.5.1 The Habitats and Species Directive

The European Union (EU) has powers to make laws which apply across the Community. Directives are one of the most commonly-used types of European law. They generally set out a series of deadlines for action, which Member States must meet by creating or modifying their own legislation. The United Kingdom meets the obligations of European Directives by bringing in laws that are introduced into Parliament, either as Bills or Regulations (English Nature 1994d; HMSO 1994b; UK Steering Group 1995).

The Directive (Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) commonly known as the Habitats and Species Directive gives Europe-wide protection to certain rare and endangered habitats, plants and animals, on land and sea. Those which are particularly threatened are singled out as Priority Habitats or Species. The Directive was developed by the European Union to meet the commitments made by world leaders at the Earth Summit in Rio de Janeiro in 1992, where the Convention on Biological Diversity was signed. It builds on work already done under the Birds

Directive (see below) and provides for the creation of a network of protected areas across the European Union to be known as the 'Natura 2000' series.

The Natura 2000 series will contain some of the most outstanding wildlife sites in Europe. Together they will represent the range, variation, quality and biodiversity of the most endangered habitats and species in Europe (Brown *et al* 1997; European Communities 1992). The Natura 2000 network of protected sites will consist of Special Areas of Conservation (SACs) designated under the Habitats Directive and Special Protection Areas (SPAs) designated under the Birds Directive. In England, land which becomes part of the Natura 2000 series will also be notified as Sites of Special Scientific Interest (SSSIs).

The habitats included in the Habitats and Species Directive which occur in the English uplands are shown in Table 2.1. The animal and plant species listed in the Directive and relevant to the English uplands are indicated in the relevant chapters of the handbook. The Directive also gives certain species of flora and fauna strict protection prohibiting their deliberate capture, killing, disturbance, destruction or sale.

In England, proposed SACs include the North Pennine Dales Meadows, South Dartmoor Woods, the Asby Complex (limestone pavements, *Molinia* meadows and limestone grassland), Moorhouse-Upper Teesdale (blanket mire, limestone grassland, hay meadows, chasmophytic vegetation, eutric and siliceous scree, flushes, montane heath and juniper scrub) and The Stiperstones and The Hollies (dry heath). Further proposals were announced in 2000.

2.5.2 Birds Directive

The EC Birds Directive (Directive 79/409/EEC on the conservation of wild birds) requires Member States to take special measures to conserve the habitat of two categories of birds. These categories are (under Article 4.1 of the Directive) certain listed rare or vulnerable species, and (under Article 4.2) regularly occurring migratory species. Particular attention must be paid to the protection of wetlands, especially wetlands of international importance. Member States are required to designate the most suitable areas for the relevant species as SPAs and these also form part of the Natura 2000 series. Like SACs, the SPAs are also notified as SSSIs. The Directive has been in force for some years now and many SPAs have already been designated in Britain, including the Bowland Fells, North Pennine Moors and South Pennine Moors.

2.5.3 Wildlife and Countryside Act 1981

The Government's nature conservation policies are implemented mainly through the Wildlife and Countryside Act 1981 (as amended). The Act provides for the protection of endangered species of animals and plants and for the protection and management of important habitats. It does this through a series of Sites of Special Scientific Interest (SSSIs) of which there are now over 4,000 in England, covering more than 6% of the country. SSSIs are selected according to published guidelines reflecting the importance of features and species (Ellis *et al* 1996; Nature Conservancy Council 1989).

The Countryside and Rights of Way (CROW) Act, which received Royal Assent on 30 November 2000 replaces and revises parts of the Wildlife and Countryside Act. The new CROW Act is in five parts:

- Part I. Access to the Countryside.
- Part II. Public Rights of Way and Road Traffic.
- Part III. Nature Conservation and Wildlife Protection.
- Part IV. Areas of Outstanding Natural Beauty.
- Part V. Miscellaneous

From 30 January 2001, the CROW Act revises the site protection mechanisms of the Wildlife and Counryside Act within England and Wales. In respect of SSSIs the main aims of the CROW Act are to secure their better protection and management.

2.5.4 Ramsar Convention on Wetlands of International Importance

The Ramsar Convention (the Convention on Wetlands of International Importance especially as Waterfowl Habitat) agreed in Iran in 1971, was the first international nature conservation agreement to be concluded. The objectives are to stem progressive encroachment on, and loss of, wetlands now and in the future. A wetland is defined as being an area of fen, marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt. In signing the Convention in 1973 and ratifying it in 1976 (HMSO 1976), the UK Government accepted a commitment to promote both the conservation of particular sites and the wise use of wetlands within its territory. Under this Convention many sites in England, such as Esthwaite Water and Malham Tarn, have now been designated 'Ramsar sites'.

2.5.5 Biodiversity Action Plans

Biodiversity put simply is 'the variety of life'. Following the Earth Summit in Rio de Janeiro in 1992, the *UK Biodiversity Action Plan* was published two years later (Department of the Environment 1994a). This sets out a strategy for the next 20 years for conserving and enhancing the biological diversity within the UK, and contributing to the conservation of global biodiversity through all appropriate mechanisms. As part of the UK Biodiversity Action Plan (BAP), a Biodiversity Steering Group was established which produced a report to initiate implementation of the UK BAP (UK Steering Group 1995). This identified habitats and species which were considered to require Habitat or Species Action Plans to further their conservation (see Table 2.1 for the BAP habitats identified; BAP species are identified in the following relevant chapters). Habitat Action Plans have been produced, including the following upland habitats (UK Biodiversity Group 1998; UK Steering Group 1995): limestone pavements, purple moor grass and rush pastures (*Molinia - Juncus*), upland hay meadows, upland oakwoods, upland mixed ashwoods, wet woodland, and various freshwater habitats. Further Habitat Action Plans were published in 1999 (UK Biodiversity Group 1999), including upland heathland, blanket bog and upland calcareous grassland. Species Action Plans have also been produced for a range of species, some of which are relevant to the uplands (UK Biodiversity Group 1998; UK Steering Group 1995). The lists of habitats and species have been amended since the initial report and Habitat and Species Action Plans continue to be produced and pursued.

Further information: Council of Europe 1996.

2.5.6 Sustainable land-use

Agenda 21 is the international action plan for sustainable development. It came out of the Earth Summit, held in Rio de Janeiro in 1992, and sets out the actions which national governments should implement to achieve sustainable development.

The UK Sustainable Development Strategy (Department of the Environment 1994b) sets out the future agenda for achieving sustainable development in the next century. 'Sustainable development' is defined as "development which meets the needs of the present without compromising the ability of future generations to meet their needs".

English Nature's approach to land use involves the concept of 'environmental sustainability'. This means maintaining the environment's natural qualities and characteristics and its capacity to fulfil its full range of functions, including the maintenance of biodiversity. To achieve environmental sustainability, environmental considerations must be integrated into all levels of policy formation, development and land use planning.

In Chapter 28 of Agenda 21, local authorities are encouraged to adopt a sustainable development strategy, a Local Agenda 21 for their community. This is essentially about community involvement and partnerships to get consensus and action towards sustainable development. Priority actions identified include integrating environment and development, changing consumption patterns, promoting sustainable human settlements, environmentally sound resource and waste management, and sustainable agriculture and rural development. Many local planning authorities have embarked upon putting Local Agenda 21 into practice through initiatives such as environmental strategies or audits, State of the Environment reports, environmental appraisal of development plans and urban initiatives.

Table 2.2 Main protection mechanisms for upland areas in England

Mechanism	Enabling legislation (where appropriate)	Principal organisation(s) involved
Site of Special Scientific Interest (SSSI)	S.28 1981 Wildlife & Countryside Act (1985 Amendment)	English Nature
National Nature Reserve (NNR)	S.19 1949 National Parks & Access to the Countryside Act S.35 1981 Wildlife & Countryside Act	English Nature
Local Nature Reserve (LNR)	S.21 1949 National Parks & Access to the Countryside Act	Local Planning Authorities, English Nature
Areas 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 the Regions (DETR)
Wetland of International Importance (Ramsar site)	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitats (Iran) 1971.	DETR, English Nature, Joint Nature Conservation Committee (JNCC)
Special Protection Area (SPA)	Article 4 of the EEC Directive on the Conservation of Wild Birds (79/409/EEC)	DETR, English Nature, JNCC
Special Area of Conservation (SAC)	Article 7 of the EC Habitats & Species Directive (92/43/EEC)	DETR, English Nature, JNCC
Local Plan Policies	Various	Local Planning Authorities, National Park Authorities

Land use in the uplands

2.6 Introduction

Farming, especially livestock production, has been the dominant force in shaping and creating upland landscapes and habitats. Field sport management and forestry have also been influential. In addition, recreation and public access have become increasingly important. Other land uses to have shaped the uplands include mining and quarrying, water supply and power generation. This section briefly outlines the historical background and the current situation regarding agriculture, field sports, forestry, recreation and other land uses in the English uplands.

2.7 Historical background to land use in the uplands

The uplands have been substantially modified by people, either directly, through activities such as tree-felling, burning, agricultural 'improvement' and livestock grazing, or indirectly, through pollution. All have resulted in structural and floristic changes to the vegetation and consequently the fauna. In the uplands, most widespread human activities have included intensifying natural processes, such as fire, and grazing the land with sheep, cattle and deer (Thompson & Horsfield 1990). It is these management practices that maintains and modifies many of the open communities now present in the uplands and prevents their reversion to woodland.

About 7,000 years ago, forest cover in Britain was at its greatest and most of the ground below 600 m in England was probably wooded. Thereafter, early man began to clear the forests to create arable and grazing land (Godwin 1975). Extensive deforestation occurred in the upland areas of England, other than the Lake District, between 2,600 and 2,100 years ago, in the pre-Roman Iron Age. Extensive deforestation in the Lake District occurred around 1,700 years ago (post-Roman). Local temporary clearances did, however, occur before these dates (Birks 1988). By a thousand years ago, the woodland cover in the uplands was probably less than 20% of the land area (see Chapter 8 Woodland and scrub).
During the early Bronze Age (*c.* 4,000-3,000 years ago), the British climate was warmer and drier than it is today and there was a considerable amount of farming in the uplands (Ingrouille 1995). This did not just involve livestock grazing, but included a good deal of arable cultivation as well. Following a population decline some 3,000 years ago, agricultural activity in the uplands declined. At about the same time, the climate became wetter and cooler. Upland soils started to change, becoming more acidic and podzolised as a result of the changes in vegetation cover initiated by forest clearance and in climate. In wetter areas and on higher ground, soils became waterlogged in the absence of trees to intercept and transpire rain water. These processes led to the development of the blanket peats and, in drier areas, the heaths seen today. There is no general date for blanket bog formation; it may have been initiated in different parts of England at any time between 7,500 and 2,000 years ago, depending on altitude and topography (Birks 1988).

From around 3,000 years ago onwards the distinction between the land use in the uplands and lowlands became increasingly marked, with most intensive agricultural activity occurring in the lowlands (below 300 m), and only extensive livestock rearing occurring in the uplands. The use of the uplands for sheep grazing intensified in the Middle Ages and some of the extensive areas of acid grassland probably originated from this period. Woodland clearance continued and by about AD 1800 little native woodland

remained, the surviving relics being mainly of oak wood or mixed broadleaved forest (Ratcliffe 1988).

Stock rearing, particularly sheep although in some areas also cattle, now dominates over much of the uplands, but in some areas goats and cattle were once more important. The other main influence, dating from about 1840, has been the management of upland heath for red grouse *Lagopus lagopus scoticus*, which feed chiefly on dwarf shrubs, especially heather *Calluna vulgaris*. Management of moors for grouse increases the extent of dwarf shrubs, particularly heather, mainly by rotational burning. In the second half of the twentieth century, there has been considerable loss of heather moorland through overgrazing. Those moors still managed for grouse have also seen reductions in grouse populations.

Today's farming character has evolved rapidly over a relatively short time. Farming practices were transformed by the Enclosure Acts (1802 to 1844), and the subsequent industrialisation of Britain (Cole, Kernon & Knightbridge 1996). In the early part of the twentieth century, farming was in recession and during the 1930s much land was abandoned. But during World War II there was pressure for the UK to increase food production and thereby reduce the risk of shortages. Government policy and grant aid sought to increase the amount of agricultural production. The Agriculture Act 1947 provided, for the first time, guaranteed prices and markets for agricultural products. In addition, technological developments since the 1940s, particularly in machinery, use of pesticides and plant and animal genetics, have caused massive changes.

Agricultural land use intensified greatly as a result, especially in the lowlands and, later and more slowly in the uplands. The agricultural productivity of land was increased by draining, ploughing, reseeding and the use of fertilisers. Into the 1970s, fields were enlarged to accommodate new machinery, and hedgerows and trees were removed. Further agricultural 'improvements' were made through the use of herbicides and genetic manipulation of grass species, the most notable being perennial rye grass *Lolium perenne*. There has since been a wide scale switch from hay to silage making, owing to the latter's better feeding quality and reduced dependency on dry weather for a quality product. Financial incentives became available for farmers to 'improve' moorland by draining, and the use of supplementary feeding on moorland increased. This allowed stock to be kept on hill land at higher densities and for longer periods of time, leading to all year round and more intensive use of the uplands, with vegetation being grazed in spring and autumn when is it most susceptible to grazing damage. Technical advances in livestock farming led to larger, more productive stock being kept, and a reduction in the labour force employed on farms led to a decline in shepherding and appropriate burning management. The last half century or so has seen a further decline in the extent of arable crops, particularly cereals, but also root crops grown in upland areas.

The above, coupled with the introduction of Government subsidies, led to a progressive increase in the number of sheep on hill land. This is illustrated by MAFF census data, which indicates that, in 1977, 71% of moorland rough grazing in England and Wales was stocked at less than two ewes per hectare, whereas in 1987 71% of this land was stocked at between two and six ewes per hectare (Felton & Marsden 1990).

Changes in agricultural management practices have contributed to the decline in semi-natural vegetation. Awareness has increased of environmental problems caused by farming practice, and concerns about the negative effects of agriculture on the environment started at the official EU level in the mid-1980s (Brouwer & van Berkum 1996). Recognition of the indirect effects of agricultural support mechanisms

available in the British Less Favoured Areas (LFA) on the biodiversity of the uplands is increasing (Egdell, Smith & Taylor 1993; Felton & Marsden 1990). The role of farmers in the protection of the rural environment and management of the landscape has also been recognised more fully, with farmers being increasingly rewarded for environmentally sustainable management (Brouwer & van Berkum 1996).

During the twentieth century, there has been a considerable expansion of the woodland cover in upland England. This has largely been government sponsored and implemented by the Forestry Commission. The majority of the woodland planted has been in the form of non-native coniferous tree species, particularly sitka spruce *Picea sitchensis*. In some parts of upland Britain, these recent conifer plantations cover very extensive areas of former moorland. The non-native broadleaved species, such as sycamore *Acer pseudoplatanus*, have also been widely planted on lower ground, but such plantations are rarely as large as those composed of conifers.

Further details of agricultural and forestry changes and policies, and their impact on the ecology of the uplands, are given in later sections. Since the 1980s, Agri-environment schemes have been implemented to provide incentives for land managers to conserve and enhance features of wildlife, landscape or archaeological interest. Details of these schemes are also given in the following sections.

2.8 Agriculture in the uplands

Agriculture is the dominant land use in the uplands. The main agricultural enterprises comprise sheep and beef, and the major influence on these enterprises is the implementation of the Common Agricultural Policy (CAP) in the UK including the system of LFAs. The chief vegetation types used by agriculture in the uplands comprise grassland, heathland, bog and woodland. Increasingly, the link between wildlife and land management is being made and Agri-environment schemes are being pursued.

Further information: English Nature 1997g.

2.8.1 Less Favoured Areas (LFAs)

LFAs were introduced in 1975 under the European Directive (75/268) on mountain and hill farming in certain areas. This Directive and its amendments have since been incorporated into Council Regulation (EC) 950/97, and are further amended by the Rural Development Regulation under Council Regulation (EC) 1257/99). The original objective of LFA policy was to "ensure the continuation of farming, thereby maintaining a minimum population level or conserving the countryside in certain less favoured areas".

Under the original Directive, three categories of LFA are defined. Broadly, these are mountain areas, areas in danger of depopulation, and other areas with specific handicaps. In the United Kingdom, all LFAs (with the exception of the Isles of Scilly) are designated under the second category (Article 24 of Council Regulation (EC) 950/97). This essentially depends on the presence of land where agricultural productivity is low, economic results are lower than the national average, and there is a low or dwindling population reliant on agriculture.

For the purposes of UK legislation, there are two types of LFA, according to the severity of the handicaps of agricultural production. These are designated as the 'Severely Disadvantaged Areas' (SDA) and 'Disadvantaged Areas' (DA). In both types, agricultural production is either severely restricted or

restricted in its range by virtue of the adverse soil, relief, aspect or climate, or by a combination of these. In England, 1,627,000 ha of the LFA are Severely Disadvantaged and 586,700 ha are Disadvantaged (I. Condliffe, pers comm).

Within the LFA boundary (Figure 1.1), farmers are eligible for financial assistance which is additional to the market support and structural incentives of the CAP. These include enhanced rates of grant and special payments for livestock farming (see 2.8.4 and Box 2.1).

LFA policy has recently been reviewed as part of the Rural Development Regulation under the EU's Agenda 2000 CAP reforms. This has led to a greater emphasis being placed on sustainable farming systems associated with maintaining and enhancing wildlife habitats in the uplands. Farmers will also have to follow "good farming practices compatible with the need to safeguard the environment and maintain the countryside". In line with the need to 'decouple' subsidy payments from production, the basis of payment for LFA subsidies (formerly the Hill Livestock Compensatory Allowances) will change under Agenda 2000. Payments under the new Hill Farm Allowance (HFA) Scheme will be made for each hectare of land rather than for each ewe or cow.

The English LFA covers some 2.2 million ha of which roughly 1.8 million ha is agricultural land. In total, the LFA covers around 17% of England, accounting for 19.6% of the agricultural area. The moorland line encloses some 0.8 million ha. Common land accounts for some 0.2 million ha of the agricultural land in the LFAs. There are approximately 17,000 agricultural holdings in the English LFA (MAFF 2000).

Further information: HMSO 1997; Glossary; National Economic Development Countil 1990; National Farmers Union 1997.

2.8.2 Grades and types of agricultural land

The MAFF Agricultural Land Classification (MAFF 1988) provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. The Agricultural Land Classification grades are described in Table 2.3 in terms of the types of limitation that can occur, typical cropping range and the expected level and consistency of yield.

Some 73.9% of all agricultural land in England and Wales is in Grades 1, 2 or 3, ie excellent to moderate quality (MAFF News Release 277/96). Within the LFA, agricultural land comprises a high proportion of Grade 4 and 5 land, ie poor or very poor agricultural land.

Land classification grades of increasing agricultural value generally represent decreasing nature conservation value, although there are important exceptions. For example, some of the very threatened and fragmented remnants of semi-natural habitat and associated populations occur on land of higher agricultural value. However, in general the environmental quality of a given piece of land will be strongly linked to its current use.

The following terms are frequently used to describe certain types of farmed land in the uplands:

- **In-bye land** - enclosed pasture and hay meadow, usually in the valley bottom and 'in by' the farm, which is accessible to farm machinery and may have been cultivated by ploughing, reseeding or fertilising.

- **Allotment or intake land** - enclosed land which usually consists of agriculturally poor- quality, unimproved pasture 'taken in' from the hill and consequently adjacent to moor or fell land (although it may also include some agriculturally improved land).

- **Moor or fell land** - unenclosed, unimproved grazings above the fell wall which consist of dwarf shrubs, blanket and other mires, grassland and montane vegetation.

Associations can be made between upland land-use types and the characteristic plant communities that appear within them. Table 2.4 identifies the vegetation types typically found within these land-use categories (Manley & Smith 1994), using the National Vegetation Classification (Rodwell 1991, 1992).

MAFF, the Department of the Environment, Transport and the Regions (DETR) and English Nature are currently examining alternative approaches to land classification in the uplands to more fully reflect the objectives of the Rural Development Regulation (RDR).

Further information: Section 2.10 on forestry in the uplands; Chapter 8 Woodland and scrub.

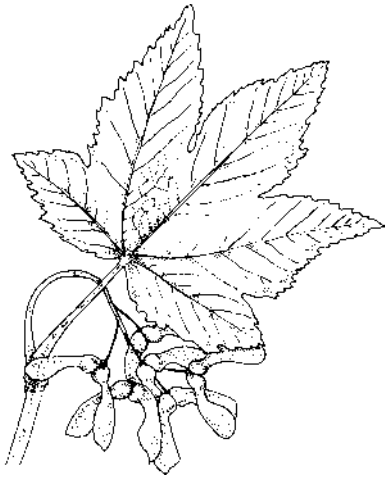


Table 2.3 MAFF Agricultural Land Classification (ALC)

Grade 1 - excellent quality agricultural land Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and this commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality. Estimated area of ALC grade within the LFA: 0.006%
Grade 2 - very good quality agricultural land Land with minor limitations which affect crop yield, cultivations or harvesting. A wider range of agricultural and horticultural crops can usually be grown, but on some land in the grade there may be reduced flexibility owing to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1. Estimated area of ALC grade within the LFA: 0.5%
Grade 3 - good to moderate quality agricultural land Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown, yields are generally lower or more variable than on land in Grades 1 and 2. Estimated area of ALC grade within the LFA: 9.1% **Sub-grade 3a - good quality agricultural land** Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops. **Sub-grade 3b - moderate quality agricultural land** Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass, or lower yields of a wider range of crops, or high yields of grass which can be grazed or harvested over most of the year.
Grade 4 - poor quality agricultural land Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (eg cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very drought-prone arable land. Estimated area of ALC grade within the LFA: 37.5%
Grade 5 - very poor quality agricultural land Land with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops. Estimated area of ALC grade within the LFA: 46.6%

Source: MAFF 1988

2.8.3 Agricultural enterprises

Agricultural enterprises in the uplands depend primarily on hill sheep and suckler cows. However, dairy farming also occurs in some areas, particularly the White Peak and around the fringes of higher land in other Natural Areas. There is also limited arable, mixed and organic farming. The type of livestock farming practised depends heavily on the nature of the land available. For example, the North Pennines Natural Area contains nearly 60% Grade 5 agricultural land and supports mostly sheep and mixed sheep and cattle enterprises. In contrast, the Oswestry Uplands Natural Area comprises 60% Grade 3 and above land, and this Natural Area supports predominantly dairy farms (information based on Parish Statistics).

Upland farming is generally a low input - low output system. The amount of energy, in terms of feed and chemicals, imported into the uplands is usually low, although this has been increasing since the World War II. Where winter feed cannot be made on the farm, it has to be bought in, or stock must be sold off in autumn or wintered away on lowland farms. This allows the maximum use of summer grazings while reducing the number of mouths to be fed in the winter (Haines 1982). Farms in the LFA generally do not produce animals for immediate slaughter (ie finished), but produce the store stock which is fattened, or used for breeding other stock for fattening, on lowland farms. However, increasingly in some areas, farms are finishing stock themselves rather than producing store animals.

In 1997 there were 22,056 LFA farms in England (Parsisson and Moxey 1999). Of these, some 46.2% were full-time and 53.8% were part-time holdings. Over the period 1990-1997, there was a reduction in the number of full-time farmers in the English LFA (Parliamentary Question 28/798). This trend is broadly consistent with the overall decline in the number of farmers in agriculture generally. Despite the large area covered by the average LFA farm, 40% had a business size less than the minimum considered sufficient to maintain a full-time holding (Parliamentary Question 24/5/97). Average net farm income (NFI) for LFA cattle and sheep farms in England has fallen by 76% from its peak in 1996/97. The continuing strength of the Pound relative to the European Currency Unit (later the Euro) over the period has been a factor in the drop in farm incomes.

For cattle and sheep farms in the LFAs in England, net farm income has fallen 27% in 1999/00 and 47% the previous year. The fall in incomes in 1999/00 was due in the main to a fall in sheep enterprise output, reflecting year on year declines in sheep prices and a fall in Sheep Annual Premium receipts. For dairy farms in England (including lowland), NFI fell by 35% in 1999/00, a fall of 78% from the peak of 1995/96. In addition to the strength of sterling, low market prices and the knock-on effects of BSE have all contributed to a continuing decline in upland farm incomes. Incomes on LFA farms are notoriously erratic and, when compared with other agricultural sectors such as dairy, cereals and cropping, remain low.

After land and buildings, livestock represent the bulk of the farmer's capital, and livestock subsidies, the sale of livestock and related products form the majority of the revenue. There is a mixture of financial support mechanisms for these enterprises and farm incomes in the LFAs are underpinned by European and UK agricultural policy.

Further information: 2.8.4 and Box 2.1; Glossary; Information Notes 2-5; Nix annual publication; Scottish Agricultural College annual publication.

Upland and hill farms

The farming systems prevalent in the uplands fall into two categories: hill farms and upland farms. These largely correspond to the productivity of the land; upland farms are more productive and more likely to support a mixed livestock enterprise.

In England, true hill farms are confined to the North Pennines, the Bowland Fells, Dartmoor, the North York Moors and the Lake District fells. These farms concentrate on sheep production through self-replenishing flocks. They consist predominantly of rough grazing land, mainly composed of unenclosed,

unimproved moorland and allotment, perhaps with some permanent or long-term grassland, and little in-bye land.

Upland farms are more productive and are more likely to support a mixed livestock enterprise. These farms have a greater proportion of enclosed in-bye and agriculturally improved grassland; between 10-60% of the farm area (Felton & Marsden 1990). This makes them better able to support more demanding livestock than that found on hill farms, such as upland-lowland cross-bred ewes and suckler cows. Some dairy cattle may also be kept. In-bye land may also be used for making conserved fodder (silage, hay) and fattening lambs, although beef cattle are generally sold off for fattening on lowland farms.

For hill and upland sheep enterprises income typically comprises of:

- lamb, draft ewe and wool sales;
- Sheep Annual Premium (SAP);
- Hill Livestock Compensatory Allowances (HLCA) (now Hill Farm Allowance) – see 2.8.4.

For hill and upland beef enterprises, it is typically based on an income comprised of:

- calf sales;
- Suckler Cow Premium (SCP);
- Beef Special Premium (BSP);
- Hill Livestock Compensatory Allowances (HLCA) (now Hill Farm Allowance).

Payments from environmental schemes are becoming increasing important sources of income in some areas and farmers are increasingly looking to supplement incomes from diversification.

The sheep enterprise

Sheep production is the major agricultural activity in upland England and is central to the economy and ecology of these areas. Over the last 50 years, technical innovations and the implementation of government policy have combined to change the upland sheep industry.

Each of the British hill areas has its own breed of sheep, many of whose names indicate their origin - Swaledale, Scottish blackface, Welsh mountain. These produce hardy ewes which are able to survive in harsh conditions and have good mothering tendencies. They are not usually as productive as the sheep breeds found in the lowlands and lambing percentages are generally low.

The simplest sheep farming system practised is the rearing of store sheep, where lambs are born in spring and remain with their mothers until weaning in late summer. The lambs are then sold off the farm as store lambs at special sales held in the autumn. These animals are bought by farmers with land at lower altitudes and will be fattened there before slaughter. The rationale behind this system is that there is insufficient grazing available by late summer to bring lambs into a finished condition, ie fit for slaughter. In recent years some of these lambs have been sold for export and more upland farmers are finishing their own animals.

On hill farms, a proportion of the ewe lambs are normally kept for breeding in the home flock. This perpetuates the self-sustaining flock and only rams are bought in. Ewes are generally sold from the hill

flock at between four and five years old, when they are considered too old to continue to thrive in the hills. These ewes are not sold for slaughter, but as draft ewes which go for further breeding on upland and lowland farms where they respond well to the improved conditions.

Although sheep graze hills with few or no stock proof boundaries, the flocks generally graze the same piece of land. The home range of a discrete group of sheep is called the heft (or heaf), and this term can also be used to describe a section of the flock. Lambs learn from their mothers to keep to this area. However, in some areas this hefting ability is being lost, exacerbated by the decline in shepherding and the increase in supplementary feeding. The result is that the nature and pattern of sheep grazing on the hills has radically changed since World War II. Along with increases in numbers of sheep, this has contributed to overgrazing.

The hefted flock is generally sold along with the farm, and is called 'bound to the ground' or 'a bound flock'. This is because a new flock would wander and not know where to find shelter or food in severe weather. During the winter, some flocks are moved on to lower ground, but many remain on the unenclosed land throughout.

Further information: 2.8.4 and Box 2.1; Information Notes 2 and 3 on sheep breeds and farming systems.

The beef enterprise

In the English uplands, beef farming usually involves producing suckler calves and rearing store cattle. Suckler calves are usually born in spring and remain with their mothers until weaning in late summer and sale in the autumn. Some are born in the autumn and remain with the cow for the next 6-10 months. At this stage, they are not fit for slaughter (not finished) because they are too small, and have to be fed for at least an extra year before being slaughtered. This is usually not possible on an upland farm, where there is insufficient feed to carry calves in addition to the breeding stock over the winter. The young animals are therefore sold as store cattle to lowland farms for finishing. The breeding cows are usually kept on in-bye land or housed over the winter.

Further information: 2.8.4 and Box 2.1; Information Notes 4 and 5 on cattle breeds and farming systems.

Table 2.4 Upland land use types and their associated semi-natural NVC communities (excluding woodland and scrub)

NVC code	NVC name	In-bye	Intake (Allotment)	Moor or Fell	Montane
	Heaths				
H4	*Ulex gallii-Agrostis curtisii* heath		✔	✔	
H8	*Calluna vulgaris-Ulex gallii* heath			✔	
H9	*Calluna vulgaris-Deschampsia flexuosa* heath		✔	✔	
H10	*Calluna vulgaris-Erica cinerea* heath		✔	✔	
H12	*Calluna vulgaris-Vaccinium myrtillus* heath		✔	✔	
H18	*Vaccinium myrtillus-Deschampsia flexuosa* moss-heath		✔	✔	✔
H19	*Vaccinium myrtillus-Cladonia arbuscula* heath				✔
H21	*Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium* heath		✔	✔	
	Mires				
M1	*Sphagnum auriculatum* bog pool community		✔	✔	
M2	*Sphagnum cuspidatum/recurvum* bog pool community			✔	
M3	*Eriophorum angustifolium* bog pool comunity			✔	
M4	*Carex rostrata-Sphagnum recurvum* mire		✔	✔	
M6	*Carex echinata-Sphagnum auriculatum/recurvum* mire		✔	✔	
M8	*Carex rostrata-Sphagnum warnstorfii* mire				✔
M10	*Carex dioica-Pinguicula vulgaris* mire	✔	✔	✔	
M15	*Scirpus cespitosus-Erica tetralix* wet heath		✔	✔	
M16	*Erica tetralix-Sphagnum compactum* wet heath		✔	✔	
M17	*Scirpus cespitosus-Eriophorum vaginatum* blanket mire		✔	✔	
M18	*Erica tetralix-Sphagnum papillosum* raised and blanket mire			✔	
M19	*Calluna vulgaris-Eriophorum vaginatum* blanket mire		✔	✔	
M20	*Eriophorum vaginatum* blanket and raised mire		✔	✔	
M23	*Juncus effusus/acutiflorus-Galium palustre* rush pasture	✔	✔	✔	
M25	*Molinia caerulea-Potentilla erecta* mire	✔	✔	✔	
M26	*Molinia caerulea-Crepis paludosa* mire	✔	✔		
M32	*Philonotis fontana-Saxifraga stellaris* spring		✔	✔	
	Acid grasslands				
U3	*Agrostis curtisii* grassland		✔	✔	
U4	*Festuca ovina-Agrostis capillaris*	✔	✔	✔	
U5	*Nardus stricta-Galium saxatile* grassland		✔	✔	
U6	*Juncus squarrosus-Festuca ovina* grassland		✔	✔	
U7	*Nardus stricta-Carex bigelowii* grass heath				✔
U10	*Carex bigelowii-Racomitrium lanuginosum* moss heath				✔
U15	*Saxifraga aizoides-Alchemilla glabra* banks				✔
U16	*Luzula sylvatica-Vaccinium myrtillus* tall herb community				✔
U17	*Luzula sylvatica-Geum rivale* tall herb community				✔

NVC code	NVC name	In-bye	Intake (Allotment)	Moor or Fell	Montane
U20	*Pteridium aquilinum-Galium saxatile* community		✔	✔	
	Calcareous grasslands				
CG9	*Sesleria albicans-Galium sterneri* grassland	✔	✔	✔	
CG10	*Festuca ovina-Agrostis capillaris - Thymus praecox* grassland	✔	✔	✔	
CG11	*Festuca ovina-Agrostis capillaris-Alchemilla alpina* grass heath				✔
	Mesotrophic grasslands				
MG3	*Anthoxanthum odoratum-Geranium sylvaticum* grassland	✔			
MG5	*Cynosurus cristatus-Centaurea nigra* grassland	✔			
MG6	*Lolium perenne-Cynosurus cristatus* grassland	✔			
MG7	*Lolium perenne* leys and related grasslands	✔			
MG8	*Cynosurus cristatus-Caltha palustris* grassland	✔			
MG9	*Holcus lanatus-Deschampsia cespitosa* grassland	✔			
MG10	*Holcus lanatus-Juncus effusus* rush pasture	✔			

Source: Manley & Smith 1994; Rodwell 1991b, 1992.

2.8.4 Agricultural policy

With agriculture the dominant force in the uplands and wildlife value very much dependent on the type of land management practised, agricultural policy is critical in maintaining and enhancing the natural heritage of the uplands. The links between agriculture and wildlife have become increasingly recognised and future developments in agricultural policy are likely to strengthen them still further.

In the UK, the agricultural support system is determined by the Common Agricultural Policy (CAP, see below) and the UK Government's policies. The CAP is influenced by the General Agreement on Tariffs and Trade (GATT) and the World Trade Organisation (WTO), and is implemented by the UK Government. The parts of CAP most relevant to the uplands are those relating to the beef and sheepmeat regimes, provisions on improving the efficiency of agricultural structures and the Rural Development Regulation. All these terms and their implications are explained below. Implementation of the Agenda 2000 agreement on CAP Reform will have considerable influence on agricultural and rural development policy in the future.

Further information: Box 2.1

The General Agreement on Tariffs and Trade (GATT)

The General Agreement on Tariffs and Trade (GATT) was first signed in 1947 by 23 countries and came into force in January 1948. The next round of discussions on the future of world trade will occur in the **World Trade Organisation (WTO)** talks, and commenced in 2000. The WTO is the body that was established following the conclusion of the GATT Uruguay Round in 1993 to progress the debate on the liberalisation of world trade. The WTO was set up in January 1995 as the new and more powerful

successor to the GATT, which has now ceased to exist. GATT's functions have passed to the WTO, but the name is still used to refer to the 1994 trade agreement which resulted from the Uruguay Round. The GATT's membership has grown to 128 countries and several countries are currently going through the WTO process.

The next WTO round will cover further liberalisation measures for agriculture, including further cuts in agricultural support, tariffs and export subsidies. It will determine the policies that will apply to world trade, and therefore agriculture, thereafter.

The Common Agricultural Policy (CAP)

For more than 30 years, agricultural production in the European Union (EU) has been governed by the Common Agricultural Policy (CAP). The original objectives of the CAP are specified in Article 39 of the 1957 Treaty of Rome, and are as follows:

- to increase agricultural productivity by promoting technical progress and by ensuring the rational development of agricultural production and the optimal utilisation of the factors of production, in particular labour;
- to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;
- to stabilise markets;
- to ensure stability of supplies;
- to ensure that supplies reach consumers at reasonable prices.

The main reason for such government intervention policies was (and still is) considered to be to encourage agricultural productivity so as to ensure farmers a satisfactory and equitable standard of living, and to stabilise agricultural markets and farmers' incomes (Brouwer & van Berkum 1996). No objectives relating to the environment and nature are specified in Article 39 of the Treaty of the European Union, nor in other Articles of the separate agriculture section of the Treaty (Articles 38-47).

Traditionally the CAP objectives have been achieved through a range of measures, such as guaranteed prices to farmers, quotas, tariffs on imports and subsidies for exports. It provides the financial support mechanisms for farmers and the framework within which they operate.

A number of important developments have occurred in recent years, including the MacSharry reforms of the CAP which were agreed in 1992, the GATT agreement in 1994 and the enlargement of the EU and now Agenda 2000. The 1992 reform of the CAP, together with the GATT agreement (see below), set firm rules which currently govern the trading relationships of the EU and the rest of the world.

The **MacSharry reforms** of the CAP in 1992 had wide-ranging implications throughout agriculture in Britain. Some of their aims were to improve the competitiveness of EU agriculture, to restore market balance and to stimulate less intensive production methods (Brouwer & van Berkum 1996). Measures adopted were aimed at reducing surplus production, reducing price support and improving the

environmental soundness of agricultural production. In connection with the last aim, the reforms included a requirement for all European Union Member States to set into operation a programme to encourage environmentally sensitive farming, forestry and provisions for early retirement. These are the **Accompanying Measures** - the Agri-Environment Regulation, an Afforestation Regulation and an Early Retirement Regulation. In the UK, the Government decided not to implement the retirement option because it was not felt to be necessary. The forestry option was adopted, and was felt to be covered by existing woodland grant schemes. The **Agri-Environment Regulation** provides for a financial aid scheme to encourage farmers to introduce or continue farming practices which are compatible with the protection of the environment and management of the countryside. The UK Government is currently implementing this via the Agri-Environment Programme (see 2.8.5 on agri-environment schemes).

Currently, most of the funding available to agriculture goes directly to Commodity support, while the Accompanying Measures receive minimal funding by comparison. Spending in the UK under the CAP was £3,193 million in 1998/9 and was forecast to fall in 1999/2000 to £2,924 million. This reduction occurs mainly in connection with a fall in BSE-related expenditure. Other expenditure on agricultural support schemes in the UK is estimated to be £248.5 million in 1999/2000 compared with £388.7 million in 1998/99. This expenditure includes grants for conservation, exchequer funding of accompanying measures and assistance for agriculture in special areas. Included in this is expenditure on agri-environment schemes which, in England, are expected to reach £87.4 million in 1999/2000 compared with £44 million in 1996/97.

Successive governments have recognised the need to continue efforts to reform the CAP, with payment directed more towards the encouragement of environmentally beneficial and sustainable farming (Cole, Kernon & Knightbridge 1996). There also appears to be a growing consensus that a further liberalisation of agricultural trade is inevitable in the years ahead, which could require the dismantling of farm support policies. The major external pressures for CAP reform include future pressure from the WTO (see under GATT below) to remove production subsidies to balance world trade and the costs of accession of Central and Eastern European countries to the EU. Other factors exacerbating budgetary pressures are changes in consumption patterns and levels, the general constraints on government expenditure, and deficits and debt levels for the EU countries preparing for European Monetary Union.

Agenda 2000

In July 1997 the European Commission (EC) published *Agenda 2000: for a stronger and wider Europe*. The primary aim of Agenda 2000 was to deepen the reforms of the CAP started in 1992, in preparation for the next round of WTO negotiations and the enlargement of the EU. The UK Government published draft regulations for reform in this country in 1998 and a consultation process followed. Agenda 2000 is intended to run from 1 January 2000 through to 2006.

The Agenda 2000 CAP reform proposals were agreed in March 1999 and their implementation commenced on 1 January 2000. This has been an attempt by the EU to alter fundamentally the balance of subsidies away from production-based payments and towards an integrated approach to the rural economy. Minor reforms have been made to the arable, beef and dairy regimes although, unfortunately, there has been no reform of the sheepmeat regime. The new Rural Development Regulation or 'Second pillar' of the CAP includes changes to measures on LFAs, agri-environment measures and afforestation of agricultural land. Of particular note are:

- provision for the introduction of environmental conditions across all commodity regimes;
- provision for 'modulation' on direct payments to release money for agri-environment schemes;
- arrangements for changing LFA support from HLCA headage based payments to an area basis and linked to environmentally sustainable farming (the new Hill Farm Allowance Scheme);
- potential for using the 'beef national envelope' to encourage extensive beef production;
- extension of rural development measures, including in England new measures on enteprise and training beyond the farm-gate.

The main instruments of the European Union (EU) beef and sheepmeat regimes, as implemented in the UK, are the various livestock subsidies and the intervention arrangements for beef. These policies concentrate on maintaining the farming community through direct payments on livestock production, in the form of headage payments on breeding ewes and cattle, and price support measures. However, some elements of these have changed as a result of Agenda 2000 with a move away from headage payments towards area-based payments. Other elements will also change.

Further information: Brouwer & van Berkum 1996; English Nature *et al* 1998; English Nature, Countryside Agency and Countryside Council for Wales 1999.

Livestock quota

Livestock quotas form part of the CAP livestock commodity regimes and were introduced in 1993 to control the level of meat production and the cost of the CAP. Farmers can only claim Sheep Annual Premium and Suckler Cow Premium for the number of animals for which they hold quota (Box 2.1 and below).

Sheep and beef quota was originally allocated to producers, based on the number of animals they had at a given time (the reference year). A national quota reserve now operates to distribute surrendered quota. The quota is tied to the producer not the holding and is fully transferable by sale or lease. However, sheep quota is 'ring-fenced', which in the UK means that quota allocated to an LFA lamb producer cannot be transferred out of the LFA. The exception is quota made available through participation in an extensification programme (see Box 2.2). Farmers are then allowed to transfer sheep quota to lowland producers in other environmental schemes requiring the reversion of arable land to grass.

From 1998 onwards, producers were allowed to lease out sheep quota for a period of one, two or three years, and after the leasing period, there had to be a gap of at least two years. The intention of this rule was to ensure that producers used their quota for claiming premium, and to prevent them from leasing out quota indefinitely. Another rule prevented a recipient of national reserve quota from leasing out any quota in the year of receipt and in the following two years.

Sheep quota allocations are equal to the number of ewe premiums paid to a producer in 1991, provided that a claim was also made in 1992. There are rules relating to sheep quota sale and leasing, quota transfer, non-use of existing quota, and allocation of quota from the reserve. Special rules apply to those

farmers who have reduced sheep numbers owing to participation in an environmental scheme, such as Environmentally Sensitive Area Schemes, the Countryside Stewardship Scheme and the now defunct Moorland Scheme (Box 2.2).

Suckler cow quota exists for Suckler Cow Premiums and individual producer's quotas were based on the number of eligible cows on the farm in 1992, minus 1% to provide for a national reserve. There is no upper limit to the amount of quota an individual producer can hold. As with sheep, transfers of quota without land or with part of a holding are subject to a siphon into the national reserve of 15%.
Member States are limited on the total number of animals receiving Beef Special Premium (see Box 2.1).

Overgrazing and environmental conditions

Environmental conditions are attached to all the main livestock and hill subsidy schemes (Hill Livestock Compensatory Allowances (now HFA), Sheep Annual Premium, Suckler Cow Premium and Beef Special Premium, see MAFF 1996b). The Government concluded in the early 1990s that headage payments could not be allowed to encourage overgrazing or the use of unsuitable supplementary feeding which would cause significant environmental damage. The UK, therefore, sought and obtained EU legislation to enable Member States to introduce environmental cross-compliance measures into livestock schemes.

For the purposes of the livestock schemes, overgrazing is legally defined as:

". . . . grazing land with livestock in such numbers as adversely to affect the growth, quality or species composition of vegetation (other than vegetation normally grazed to destruction) on that land to a significant degree."

Unsuitable supplementary feeding is defined as:

". . . . providing supplementary feed (other than to maintain livestock during abnormal weather conditions) in such a manner as to result in damage to vegetation through excessive trampling or poaching of the land by animals or excessive rutting of vehicles."

Before 1992, the term ‘overgrazing’ was used by agriculturalists to indicate when sheep health was threatened due to the inadequate provision of nutrition. Regulations governing the HLCA subsidies inferred ‘overgrazing’ when “poor animal condition and sustained undue recourse to supplementary feed” occurred. Since 1992, the definition of overgrazing was extended to cover damage to the quality or diversity of the vegetation, as defined above.

English Nature has devised a method for assessing whether heather moorland is being grazed sustainably (English Nature 1995b) and this is used by the Farming and Rural Conservation Agency (RCA) and MAFF as the basis for environmental cross-compliance measures.

Box 2.1 The main instruments of the European Union (EU) meat regime as implemented in the UK

Each of the main livestock schemes (Sheep Annual Premium, Beef Special Premium, Suckler Cow Premium and Hill Livestock Compensatory Allowance Scheme - now the Hill Farm Allowance Scheme) has rules that enable MAFF to reduce or withdraw premium payments if overgrazing or unsuitable supplementary feeding takes place.

Sheep Annual Premium (SAP)

Under the sheepmeat regime, premium payments come from the EU, and via MAFF, to producers in England. This market support mechanism aims to cover the difference between the representative market price of lambs, as calculated for the EU as a whole, and the annual support price set by the EU (the Basic Price). Advance payments are made based on estimated prices for the marketing year. There is an additional supplement payable to qualified Less Favoured Area (LFA) producers.

Payment of ewe premium is restricted by the amount of quota held by the producer. It is paid on a per head basis on eligible ewes at least 12 months old on the last day of the retention period (15 May) or which have given birth to a lamb by that date. Farmers must keep at least 10 sheep and they must be kept for the 100 days retention period which runs from midnight 4 February to midnight on 15 May.

SAP payments are not subject to a stocking rate limit. This makes it worthwhile for farmers to have as many sheep as is feasible (but subject to the overgrazing rules), given the quota, technical and financial limitations imposed by the individual business.

Beef special premium (BSP)

This scheme forms part of the beef regime and is administered in England by MAFF. The premium is paid on male beef cattle. Premium may be claimed twice in the life of a steer (castrated animal) and once in the life of a bull (uncastrated animal). The first application for a steer may be made when the animal is at least seven months old **and** under 20 months. For the second application steers must be at least 20 months old. Bulls must be at least seven months old when the application is made; there is no upper age limit. Producers may submit no more than 12 claim forms each year.

There is no upper limit on the number of animals, in each age range, claimed in any one year. The previous limit of 90 animals in each age roup has been abolished. Payment is conditional on cattle being retained on a holding for two months following a claim and on stocking density restrictions.

Member States are limited on the total number of animals receiving Premium, if the limit is exceeded the payments will be reduced to bring the claimed animals down to the UK limit.

Producers claiming on a total of 30 animals or less are exempt from this reduction.

Box 2.1 The main instruments of the European Union (EU) meat regime as implemented in the UK (continued)

Suckler cow premium (SCP)

The purpose of this scheme, which forms part of the EU beef regime, is to support the incomes of specialist beef producers. Premium is fully funded by the EC and is paid on suckler cows belonging to a herd used for rearing calves for meat production. For the 2000 scheme, the premium rate per suckler cow is £102.15. The scheme opens for claims each year generally on 1 July to 6 December, with late claims accepted up to 31 December subject to penalties. Eligible animals are cows of a meat producing breed or the offspring of a cross with at least one parent being an animal of a meat producing breed or beef/dairy cross. Dairy cows are not eligible for premium and farmers must not sell or deliver milk products from their holding. However, the scheme is open to small dairy producers who hold no more than 180,000 kg (174,780 litres) of milk quota.

Animals on which premium is claimed must be kept on the producer's holding for a retention period of 6 months. In-calf heifers can be used as replacements for suckler cows lost or disposed of during the retention period.

Premium payments are limited by the number of units of quota held by a producer and are also restricted by a maximum stocking density limit of 2 LUs per hectare of forage area. There is no LFA premium and MAFF administers the scheme in England.

Under Agenda 2000 reforms from 1 January 2000, UK SCP quota has been reduced by 5.5%. Also, claims can include up to 20% heifers.

Extensification Payment Scheme (EPS)

An extensification payment is available to farmers who receive Beef Special Premium (BSP) or Suckler Cow Premium (SCP), and who meet specific stocking density levels. Producers must indicate their intention to claim Extensification payments at Section 5 of form IACS 2 (2001) or Section 4 of form IACS 2 (F) (Forage) (2001) for 'Forage - Only Farmers'.

Claims are assessed on the basis of Livestock Units (LUs) per hectare (Ha). LUs are allocated to all bovine animals aged six months or over on farm and sheep claimed under the Sheep Annual Premium Scheme.

Two Scheme options exist: 'Standard' and 'Simplified'. The Standard option requires the average stocking density for the year to be equal to or below a specific level. This is determined by assessing the Livestock Units on a producer's holding on six census dates. Census dates are chosen randomly throughout the year within two month periods (ie a date for January/February, a date for March/April etc) and are announced retrospectively. The Simplified option requires the producer to maintain stocking density equal to or below a specified level throughout the year.

Box 2.1 The main instruments of the European Union meat regime as implemented in the UK (continued)

Slaughter Premium Scheme (SPS)

Introduced in January 2000, Slaughter Premium provides direct support to all producers of domestic cattle and operates on a calendar year basis.

The Scheme is divided into two categories: the Slaughter Premium Scheme (SPS) and the Veal Calf Slaughter Premium Scheme (VCSPS). Each scheme has a limit to the number of animals which may be claimed in the UK. If the limits are exceeded payments will be reduced to bring the claimed animals down to the UK limit.

SPS further divides by age: TUM (animals over eight and under thirty months of age) and OTM (over thirty month) animals. In England, MAFF Regional Service Centres (RSCs) operate the scheme for UTM cattle and the Intervention Board operates the scheme for OTM cattle.

To be eligible for SPS, cattle must be kept on the holding for a retention period of two months immediately prior to slaughter, must be slaughtered within one month of leaving the holding and must be claimed on within six months of leaving the holding for slaughter.

VCSPS is payable on calves of more than one and less than seven months of age, with a carcase weight of less than 160 kg. For calves more than one and less than three months old, the retention period is one month. Calves aged three to six months old (inclusive) must be retained on farm for two months immediately prior to leaving the holding for slaughter. The period in which slaughter must take place and claims be submitted is the same as for SPS. All claims in England must be submitted to Worcester RSC.

A maximum of 12 claim forms may be submitted for each element of the Scheme: ie 12 claim forms for VCSPS, 12 for under 30 month cattle and 12 for over thirty month cattle.

Hill Farm Allowance Scheme (HFA) in England

The new area-based HFA scheme replaced the headage-based Hill Livestock Compensatory Allowance Scheme in 2001 as part of Agenda 2000. Different arrangements apply in the different countries of the United Kingdom.

The HFA scheme is designed to supplement the income of farmers in the Less Favoured Areas. It aims to "contribute to the maintenance of the social fabric in upland communities through support for continued agricultural land use, and to help preserve the farmed upland environment by ensuring that land in LFAs is managed in a sustainable way". Payments are part-funded by the EU under the Rural Development Regulation 1257/1999.

Payments are made per hectare and have three elements: basic payment per hectare of eligible LFA forage land, 'environmental enhancement' payments of 10 or 20%, and extra payments under a 'safety net' for the first three years of the scheme. The basic payment is paid at different rates for moorland (as defined by the Moorland Line) and common land, non-moorland SDA and non-moorland DA land. Payments also differ according to farm size.

HFA claimants must be IACS-registered, have the use of at least 10 hectares of eligible LFA forage area and keep breeding sheep and/or suckler cows. In addition, there is a minimum stocking density of 0.15 LU/ha (although those in a recognised environmental scheme may stock at a lower density) and farmers must follow 'Good Farming Practice' as defined in the England Rural Development Programme.

Agenda 2000 reforms has focussed LFA payments more explicitly on environmentally sustainable farming systems. Payments under the new Hill Farm Allowance Scheme will be paid on an area-basis rather than per head of livestock as under current HLCAs to farmers following "usual good farming practices compatible with the need to safeguard the environment and maintain the countryside. . . ."

2.8.5 Environmental land management schemes

The largest environmental land management schemes are implemented under EC Regulation 1257/99 (the Rural Development Regulation) which aims to encourage agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside. These schemes are operated under EC rules and have to be approved by the Commission but there is considerable national flexibility as to the details. Expenditure is funded partly by the EC and partly through national budgets. In 1999-2000 some £86 million was spent in England on payments to farmers under agri-environment schemes. The schemes are all subject to regular review.

Modulation, whereby Member States can 'recycle' a proportion of direct CAP payments to farmers into certain measures of the Rural Development Regulation, will provide significant additional resources for the agri-environment programme. For example, expenditure on agri-environment schemes in England is expected to total £1 billion over the seven years of the England Rural Development Programme.

Agri-environment schemes in the English uplands comprise:

- Environmentally Sensitive Areas Scheme (see also Box 2.2 and Table 2.5);
- Countryside Stewardship Scheme (including elements of the now defunct Moorland Scheme) (see also Box 2.2);
- Organic Farming Scheme (see also Box 2.2).

A number of other environmental land management schemes also are relevant to the uplands. These include nature conservation project grants and the Wildlife Enhancement Scheme operated by English Nature, woodland schemes operated by the Forestry Commission and MAFF and part funded by the EC, Objective 5b grants in designated areas funded by the EC (now replaced by the Rural Enterprise Scheme), LIFE funding from the EC and a wide range of grants and schemes from National Park Authorities and local authorities.

Agri-environment schemes are likely to become more important in the future; they are the only compulsory element of Agenda 2000's Rural Development Regulation.

Details of these environmental land management schemes and grants are given in Boxes 2.2 and 2.3.

Table 2.5 Upland Environmentally Sensitive Areas (ESAs) in England

ESA	Principal habitat types	Total eligible area (ha)
Tranche I - designated 1987		
Pennine Dales	Hay meadows, pastures & allotments	39,100
West Penwith	Moorland, in-bye pasture (plus archaeological interest)	6,900
Tranche II - designated 1988		
North Peak	Heather moorland, shrubby heath, in-bye grassland, rough grazing	50,500
Clun	Hay meadows, oak woods	18,900
Tranche III - designated 1993		
Exmoor	Heather & grass moorland, grassland	67,700
Lake District	Grass & heather moorland, meadows & pastures. lowland, wetland	219,300
South West Peak	Heather & grass moorland, grassland	27,000
Tranche IV - designated 1994		
Dartmoor	Heather & grass moorland, grassland	89,000
Shropshire Hills	Moorland, grassland	34,900

Box 2.2 Agri-environment schemes available in the English uplands

Environmentally Sensitive Areas (ESAs)

Aim:	Provide incentives for farmers to follow prescribed environmentally beneficial agricultural practices and to reduce pressure on 'traditional farming systems'.
Administration:	Designated, funded and administered by MAFF.
Date of launch:	First ESAs designated in 1987, followed by further designations in 1988, 1993 and 1994.
Target areas:	Nine existing upland ESAs (total number 22), covering a wide variety of habitats and features, as shown below.
Habitat types:	See Table 2.2.
Mechanism:	Voluntary management agreements with participating farmers, some covering the whole farm holding, others covering only part of the holding.
Agreement contents:	A wide range of management requirements and restrictions.
Additional options:	Conservation plan grants for capital works, eg tree planting, hedgerow management, repair of stone walls and traditional buildings, and bracken control. Public access tier to provide new opportunities for public access and other quiet recreation.
Agreement period:	10 years, with an optional break clause after five years.
Scheme review dates:	England Rural Development Plan (RDP) mid term, and at end of seven year plan.
Total area:	22 existing ESAs in England cover some 10% of the agricultural land area. See below for eligible areas in upland ESAs.
Percentage take up:	See Table 2.4.
Cost of scheme:	£41 m in 1999/2000 and likely to remain more or less constant in the next few years.

Box 2.2 Agri-environment schemes available in the English uplands (continued)

Countryside Stewardship Scheme

Aim:	Provide incentives for land managers to follow prescribed environmentally beneficial agricultural practices.
Administration:	Funded and administered by MAFF.
Date of launch:	First launched in 1991. Enhanced upland options launched in 1999.
Target areas:	Nationwide, landscape types rather than designated areas.
Habitat types:	Landscape types include uplands, chalk & limestone grassland, lowland heath, watersides, coast, historic landscapes, old traditional orchards, old meadows and pastures, the countryside around towns and Community Forests, traditional field boundaries and the margins of arable fields. Upland landscape category includes moorland restoration, conversion of agriculturally improved land to moorland, restoration and conservation of upland hay meadows, restoration and conservation of in-bye, intake or allotment pastures, protection of archaeological and historic remains, restoration of landscape features, eg hedgerows, stone walls & gill woodlands and improved opportunities for public access.
Mechanism:	Voluntary management agreements with participating farmers, covering the features concerned. While it is not a whole farm scheme, it does promote good conservation management on all land managed by the applicant.
Agreement contents:	A wide range of management requirements and restrictions to protect, enhance and re-create features on the land.
Additional options:	Capital grants, such as for the restoration of ponds and field boundaries such as stone walls and hedge banks, hedgerow management, tree and shrub planting and management, scrub management, bracken control and the provision of fencing and water supplies. Public access tier to provide new opportunities for public access and other quiet recreation. Under the new option introduced in 1999 a whole farm upland survey is required and must accompany any applications for Countryside Stewardship.
Agreement period:	10 years, with no five-year break clause.
Cost of scheme:	£35.5 million allocated for 2000/01, rising to £126 million in 2006/07.

Box 2.2 Agri-environment schemes available in the English uplands (continued)

Moorland Scheme

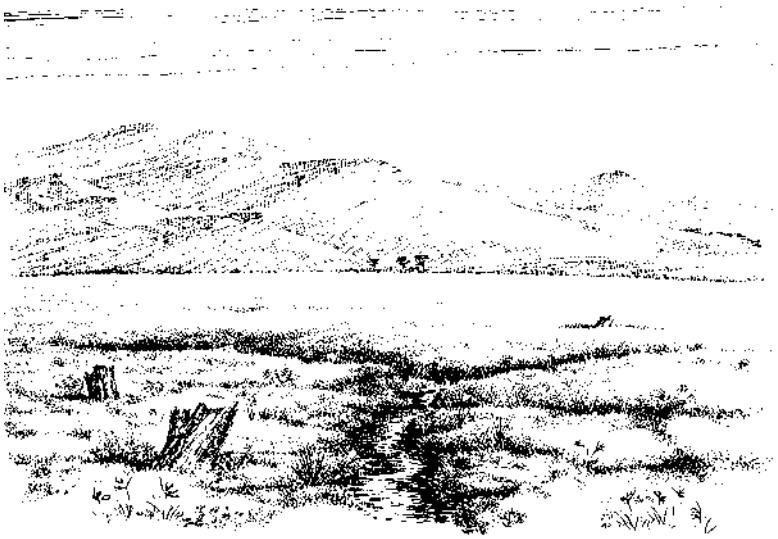
This scheme closed in 1998 and is now incorporated into the Countryside Stewardship Scheme under the upland options.

Aim:	To encourage the conservation and enhancement of heather and other shrubby moorland vegetation.
Administration:	Funded and administered by MAFF.
Date of launch:	First launched in 1995.
Target areas:	Available to producers farming heather moorland in LFAs but outside ESAs, with moorland grazing units shown on the Moorland Map of England 1992 (MAFF), of at least 20 ha in size and with at least 25% heather coverage (including other dwarf shrubs).
Mechanism:	Voluntary management agreements with participating farmers, who received an annual payment for the removal of each ewe eligible for HLCA payments.
Agreement contents:	Stocking levels at certain set limits and an agreed moorland management plan covering heather cutting and burning, shepherding, supplementary feeding and erection of temporary fencing. On non-heather moorland, further rules applied to the use of pesticides and fertilisers, cultivation operations, fencing, drainage, and to features such as farm buildings, boundaries, historic and archaeological features, watercourses, ponds, pastures and meadows, and woodland and hedges.
Additional options:	Additional stock reductions paid for if environmental benefits resulted. Capital grants for, eg temporary fencing, bracken spraying.
Agreement period:	Five years.
Scheme review dates:	Three years from launch, ie 1998.

Box 2.2 Agri-environment schemes available in the English uplands (continued)

Organic Farming Scheme

Aim:	To aid farmers who convert land to organic production.
Administration:	Administered by MAFF.
Date of launch:	1999.
Target areas:	Country-wide.
Mechanism:	Voluntary agreements with participating farmers.
Agreement contents:	Each hectare of land converted receives a certain sum over five years according to land type. There is a minimum eligible size of 1 ha. Participants are required to maintain the organic status of their unit while aid is being paid on any part of it. Participants must register for conversion with one of the organic inspection bodies or with the United Kingdom Register of Organic Food Standards (UKROFS), and provide a conservation plan. Payments are additional to other subsidies.
Agreement period:	Five years.
Cost of scheme:	£10 million in 2001/02 rising to £23 million in 2006/07.



Box 2.3 Environmental land management schemes and grants available in the English uplands

Wildlife Enhancement Schemes (WES)

Aim:	To secure the active management required to maintain and enhance the nature conservation interest of Sites of Special Scientific Interest (SSSIs).
Administration:	Established and run by English Nature.
Date of launch:	Pilot schemes in 1991 & 1992, became part of English Nature's management agreement approach 1996.
Target areas:	Sites of Special Scientific Interest (SSSI).
Habitat types:	A variety of habitats around the country, and current upland WES include: • North Pennines moorland; • Yorkshire Dales meadows and pastures; • Pennine Dales meadows, pastures and allotments; • North York Moors meadows and pastures; • Juniper in Northumbria; • Lake District Wethers pilot.
Mechanism:	Voluntary management agreements with participating farmers, who receive annual standard payments and/or fixed costs payments for capital works.
Agreement contents:	Standard management prescriptions for different habitats.
Agreement period:	Normally for an initial term of not more than three years.
Cost of scheme:	£3.66 m for 1999/2000 (total amount for all WES schemes, including lowland).

Nature Conservation Project Grants: These are grants up of to 50% of costs, available from English Nature for projects which further nature conservation. They are aimed at new projects for maintaining or managing sites and species of nature conservation importance. Examples include work on nature reserves, such as fencing, scrub control, water level management, coppicing, hire or purchase of equipment or materials, and interpretative facilities. The establishment of key posts in voluntary nature conservation bodies and other innovative projects which further nature conservation are also considered.

Wildlife and Landscape Conservation and Amenity Planting Grants: These are grants of up to 50% or more that are available from Local Authorities and National Park Authorities. Examples include hedgerow planting and improvement, heather management, bracken control, and work on ponds, green lanes and ditches. Grants are also available for archaeological and geological conservation.

Local Authority Management Agreements: Local Authorities and National Park Authorities have statutory powers to enter into environmental agreements with land owners and private individuals. These aim to maintain or enhance the landscape, protect wildlife, provide access and cater for recreation. Some Authorities have developed special schemes covering whole farms, for example, the North York Moors Farm Scheme.

Box 2.3 Environmental land management schemes and grants available in the English uplands (continued)

Woodland Grant Scheme: This scheme provides grants for a range of woodland management and establishment options and is available from the Forestry Commission. Applicants are required to work in accordance with a five year plan of operations approved by the Forestry Commission. Included in the scheme is a Woodland Improvement Grant aimed at helping to deliver the Habitat and Species Action Plans from the UK Biodiversity Action Plan in existing woodlands. In addition there is a native woodland challenge initiative in National Parks.

The Woodland Grant Scheme and related initiatives change regularly so for further current details, contact the Forestry Commission.

Farm Woodland Premium Scheme: This is open to farmers throughout England and encourages the planting of new woods on land currently in productive agriculture. It is run by MAFF although there is a joint application procedure with the Forestry Commission's Woodland Grant Scheme.

LIFE III (LIFE-Nature)

The third phase of the European Commission's Financial Instrument for the Environment (LIFE III).

Aim: The general objective of the LIFE fund is to contribute to the development of EU environmental policy, in particular the integration of the environmental concerns into other policies and the implementation and updating of environmental legislation. As under LIFE II, there are three areas of eligible activity, each with their own priorities and procedures. These are LIFE-Nature, LIFE-Environment and LIFE-Third Countries. This information relates to LIFE-Nature solely.

Administration: Funding comes from the European Union, from the European Structural Funds, via the Department of the Environment, Transport and the Regions (DETR). Completed applications to DETR by end September, and to Commission by October.

Date of Launch: LIFE III launched in 2000.

Mechanism: There are two sorts of projects eligible for funding under LIFE-Nature:

1. Nature conservation projects on SPAs, SACs and certain species. To be eligible under this category, projects will have to contribute to the implementation of the Birds Directive, the Habitats Directive and the Natura 2000 network and contribute to maintaining or restoring natural habitats and species populations to a favourable conservation status as defined by the Habitats Directive. These projects will have to relate to:
   - a site proposed by a Member State under the Habitats Directive, ie submitted formally by DETR to the Commission as a Candidate SAC; or
   - a site classified under the Birds Directive as an SPA; or
   - a species in Annex II or IV of the Habitats Directive or in Annex I of the Birds Directive.

2. In addition there are three new types of project that will be eligible, known as accompanying measures and include:
   - measures to prepare projects which involve partners in several member states (starter measures);

Box 2.3 Environmental land management schemes and grants available in the English uplands (continued)

- measures which exchange experiences between projects (co-op measures)
- measures to monitor and evaluate projects and disseminate their results, including the results of projects decided upon during the preceding phases of LIFE (assist measures).

Funding: Generally provide up to 50% funding of approved proposals (although this can rise to 75% in exceptional cases). Preparatory or exchange projects can receive a maximum 100%

Rural Enterprise Scheme

Aim: To provide assistance for projects that help to develop more sustainable, diversified and enterprising rural economies and communities.

Administration: The Rural Enterprise Scheme is part-funded by the EU and part-funded and administered by MAFF regional offices. A similar scheme operates in Objective 1 areas, part-funded by MAFF, part-funded by the EU and administered by Government Offices.

Date of launch: October 2000.

Target areas: England-wide, except in the Objective 1 areas of Cornwall and the Isles of Scilly, Merseyside and South Yorkshire.

Mechanism: Grant scheme based on a project plan jointly agreed between MAFF and the applicant. Funding varies depending upon the project and in particular its commercial return.

Measures available under the Rural Enterprise Scheme are:

- setting up of farm relief and farm management services;
- marketing of quality agricultural products;
- basic services for the rural economy and population;
- renovation and development of villages and protection and conservation of the rural heritage;
- diversification of agricultural activities and activities close to agriculture to provide multiple activities or alternative incomes;
- agricultural water resources management;
- development and improvement of infrastructure connected with the development of agriculture;
- encouragement for tourist and craft activities;
- protection of the environment in connecting with agriculture, forestry and landscape conservation as well as with the improvement of animal welfare.

Cost of scheme: Total funding available from MAFF and the EU is £152 over seven years.

NOTE: This just covers successor schemes to Objective 5b. It does not cover Objective 2 administered by the Department of the Environment, Transport and the Regions (DETR) or the Vocational Training Scheme which could help with training on environmental practices, nor grants offered by other bodies.

2.8.6 Agriculture and biodiversity

Agriculture has intensified over the last 60 years, encouraged by high levels of subsidy. Changes that have taken place since the 1940s include the agricultural improvement of in-bye, allotment and unenclosed moorland by fertilisers, herbicides, reseeding and drainage. One of the main changes in Britain is the loss of upland heath vegetation through agricultural improvement, usually to grassland (Bunce & Barr 1988). There has also been a large-scale switch from hay to silage making. Example statistics include the following (Cole, Kernon & Knightbridge 1996; Egdell , Smith & Taylor 1993; Fuller 1987; Parry, Bruce & Harkness 1981; RSPB 1984):

- an estimated 0.25 million hectares of upland semi-natural vegetation has been lost by mechanical cultivation to give agriculturally improved pasture;
- since 1930, the area of unimproved grassland in upland and lowland England and Wales has declined by 97%;
- the area of rough grazing (excluding commons) fell by 5% from 1979 to 1994, mostly as a result of conversion to improved grassland and forestry plantings in upland areas;
- the number of ewes in the Severely Disadvantaged Area (SDA) of England increased by around 40% between 1976 and 1994;
- the remaining area of rough grazing was stocked at a higher rate, with additional nutrition being provided by feed in the form of hay and silage.

Much of the biodiversity of the uplands depends for its survival upon low intensity or mixed vegetation management. The intensification which has occurred has had widespread effects on this biodiversity. There has been a significant loss of semi-natural vegetation in the uplands since the 1940s, and a decline in the distribution of moorland and other birds. Examples of the effect of agriculture on upland biodiversity are given below (Thompson *et al* 1995c).

- There has been a net loss of 20% of heather moorland in England and Wales between 1947 and 1980, with heavy grazing by sheep accounting for 67% of the total change in moorland cover. Grassland, bracken or forestry have generally replaced heather moorland.
- Of 40 bird species using moorland, 40% are declining in distribution in Britain.

Effects of grazing on vegetation

The type and breed of grazing animal influences the effect of grazing on the vegetation. This is because different animals select different plants in the vegetation and have different biting methods. Different types and breed of animals also vary in their habits and trampling impact. This is summarised in Box 2.4, but see Armstrong 1998 for further details.

The type, age and structure of vegetation being grazed also influences the impact of grazing. Upland vegetation communities vary in their appeal to grazing animals as well as their ability to withstand grazing, reflecting their species composition and growth form.

The mix of vegetation types in any upland area determines the pattern and seasonal variation in grazing. Areas dominated by palatable grasses will attract most grazing pressure, with surrounding vegetation types, such as dwarf-shrub heaths, being next in line. Small flushes, springs and grass under bracken can also be favoured by grazing animals, and a very high concentration of grazing may occur in a very small area, such as in base-rich locations in more acid or peaty soils.

In areas of mixed heather and grass, the majority of the heather grazing occurs in the autumn, winter and spring. This is before, and after, sufficient grass growth is available for the livestock. The morphology of the heather plant makes it relatively tolerant of moderate defoliation. Regular removal of heather shoots helps to stimulate and maintain the plant in a juvenile state in which growth is active and the development of potential competitors is suppressed (Gimingham 1972). However, although removal of 40% of the current season's shoots of healthy and vigorous heather by grazing may be tolerated, 80% removal cannot (Grant *et al* 1982). For example, the percentage flowering of heather, as well as the current year's growth increments, are much reduced by heavy grazing. For monitoring heather condition in ESAs, ADAS have used the following "suppression thresholds" which are derived from "desirable levels of utilisation" given by Sibbald *et al* (1987) and used in the MLURI Hill Grazing Management Model (Grant & Armstrong 1993).

Table 2.6 Suppressive levels of biomass utilisation

Heather type	Approximate age	Utilisation threshold
Young (pioneer stage)	0-5 years	40%
Intermediate (building stage)	5-15 years	10%
Old (mature/over mature)	> 15 years	5%
Blanket bog	-	15%

Source: P. Anderson

However, only the 40% figure is derived from experimental work (Grant *et al* 1978, 1982) and the determination of suppressive thresholds of biomass utilisation around the country is the subject of ongoing MAFF-funded research. Palmer (1997), using an empirical model of the annual shoot production of heather, suggests that ". . . . previously published estimates of the utilisation levels that heather can tolerate without a reduction in shoot production may be too high. For pioneer and early building heather, estimated threshold utilisation levels are 16% in summer and 24% in autumn. Furthermore, it is suggested that any level of utilisation will reduce the rate of increase of heather ground cover after burning".

It is also of note that shoot utilisation and threshold levels of utilisation may have different meanings. Shoot utilisation is generally used for the mean % by weight of the current/previous year's growth lost, but has sometimes been used for the % of shoots grazed (eg in some of the methods of MacDonald & Armstrong 1989). Suppression is normally defined as the level of utilisation at which heather is reduced in biomass or cover, or does not increase, but has sometimes been used for the levels at which heather production is reduced compared with ungrazed situations (eg Palmer 1997).

Heather is particularly vulnerable to damage from an excess of grazing in the spring and autumn when its reserves are being mobilised or stored, and to a slightly lesser extent in winter. The recent trend to overwinter stock on moorland is a significant cause of heather loss on moorland. Traditional grazing regimes tended to keep numbers which could be sustained by the heather present. Alternatively, stock were wintered on lower ground and off the hill. But recent trends have included an increase in the number of sheep being wintered on the unenclosed land and an increase in supplementary feeding.

Generally, species with growing points high above ground level suffer most from heavy grazing or repeated mowing. Heather *Calluna vulgaris* falls into this category and this makes it a useful indicator species. It produces characteristic growth forms indicative of the past grazing pressure (MacDonald 1993). Grasses with buried apical meristems, such as purple moor-grass *Molinia caerulea*, are ensured a degree of protection from grazing. Bilberry *Vaccinium myrtillus* also has growing points on its underground stems (rhizomes) and hence tends to be more resistant to grazing than heather.

Heather

Box 2.4 Grazing characteristics of large herbivores in the uplands

Sheep

Sheep graze by biting and shearing the vegetation and only have lower incisors. They are highly selective grazers and search for and select out the most palatable species. This may lead to the loss of some herb and grass species and the spread of unpalatable grasses. Where it is available, sheep will preferentially graze bent *Agrostis* spp., fescue *Festuca* spp., wavy hair-grass *Deschampsia flexuosa* and reseeded grassland. They tend to avoid grazing mat-grass *Nardus stricta*, except in early spring, unless little else is available or it is in an intimate part of a bent/fescue sward. When grazing pressure is high, sheep eat round the edges of *Nardus* tussocks and can keep it in check. Lowering the grazing pressure slightly can then cause it to spread, but lowering it further will allow other plant species to compete and the *Nardus* is likely to remain as it is, or even decline. This effect depends on the soils since *Nardus* does relatively better on more acid, moister soils (H. Armstrong, pers comm).

Sheep tend to avoid rushes and purple moor-grass when other vegetation is available. However, in the absence of more palatable grasses, *Molinia* may be grazed in spring and summer when a flush of new growth makes it more palatable and nutritious. Young heather is eaten regularly when it is intermittently mixed with grass, but sheep generally only move onto heather when live, green, palatable grasses are unavailable.

Wethers (castrated male sheep) are believed to be less selective in their grazing than ewes and are thought to eat rough vegetation more readily than ewes, although there is no documented evidence as yet. Hence they have the potential to limit the spread of less palatable grasses. They were traditionally kept as a proportion of hill flocks, because they tend to be more territorial than ewes and maintain the flock's heft or grazing area against intruding sheep. They were also used to occupy the worst ground of the farm. The practice of keeping adult wethers has declined, primarily due to the shift in public taste from mutton to lamb: mature wethers are too large and fat for today's markets. The move away from keeping wethers has also been influenced by the subsidy and quota systems, which are based on ewes.

Cattle

Cattle are less selective grazers than sheep and tend to wrap their tongues around vegetation and pull. They can also bite and shear vegetation, having only lower incisors, like sheep. They cannot graze short grassland efficiently but, because of their larger gut size, they have a greater ability than sheep to digest poor quality forage (Armstrong 1996). As a result they are more likely to move onto mat-grass or purple moor-grass in summer. They may be more effective in controlling mat-grass because they consistently ingest more of this species than do sheep (Grant *et al* 1985, 1987). They are also thought to be effective in controlling the spread of purple moor-grass, but only if grazing occurs early in the season when this grass is at its most palatable and susceptible to grazing effects.

Cattle readily graze rushes *Juncus* spp and at moderately high stocking levels can significantly reduce their extent in a field. They will graze sharp-flowered rush *Juncus acutiflorus* in preference to soft rush *J. effusus* and compact rush *J. conglomeratus* and this can lead to the replacement of the former by soft rush in some circumstances. Cattle grazing can be used to control rushes without eliminating them, which is beneficial to nesting waders, and may reduce the need to use pesticides or mowing to control them. However, high stocking levels during the breeding season may be damaging to wader populations because of the increased risk of nest and chick trampling. Cattle may also help to control the spread of bracken *Pteridium aquilinum* through trampling effects.

Box 2.4 Grazing characteristics of large herbivores in the uplands (continued)

Horses and ponies
Horses and ponies also occur on unenclosed hill land. They graze by biting the vegetation and have upper and lower incisors. They tend to graze more palatable species selectively, but will eat coarse grasses and scrub. Where it is present, they may graze heather in winter in the absence of more palatable vegetation. As with cattle, they can cause damage to dwarf shrubs through trampling, but may help to control the spread of purple moor-grass and bracken.

Red deer
Red deer, like sheep, graze by biting and shearing the vegetation and only have lower incisors. They are selective feeders, choosing particularly grass-dominated vegetation types (Reynolds 1998). Seasonal declines in grass abundance and digestibility, and the need for shelter, result in an increase in the use of other vegetation types during the autumn and winter. At this time, browsed vegetation, particularly dwarf-shrubs, predominates in the diet.

Source: Armstrong 1998

Grazing and changes in vegetation type

Grazing can affect the productivity and structure of vegetation, and may cause it to change from one type to another. For example, ericoid-dominated communities may be replaced by grass-dominated communities, such as *Agrostis/Festuca* (Welch 1974), or by *Nardus*-, *Molinia*- and *Juncus squarrosus*-dominated communities, depending on the conditions (eg King 1960; Welch 1984a, b & c). The direction of change of the vegetation owing to grazing is determined by the initial vegetation type, the underlying solid and drift geology, the resulting soil and hydrology, and the slope and aspect (see Rodwell 1991, 1992). It will also be affected by the impact of other management practices such as burning and drainage. Less extreme increases or a relaxation of the grazing pressure can alter the vegetation structure without actually causing a change from one type to another.

Even though heather and other dwarf shrubs are less palatable than grasses, utilisation rates by stock can be very high if there is nothing else to eat. The loss of heather from an area can occur very slowly, or it may happen relatively quickly, ie 5-10 years, particularly in the presence of heavy grazing and too frequent burning. Heather areas, where they abutt good grassland and grazing pressure is highest, can decline significantly from the edges of the dwarf shrub community in that time (H. Armstrong, pers comm). Receding heather edges occur because sheep tend to graze predominantly on grassy swards and so heather adjacent to the grassland will receive the most grazing once grass growth slows and stops. The reason heather decline does not happen instantly is because this species has good root reserves and only the current year's shoots are generally eaten. Bracken may also predominate over heather when it is heavily grazed and burnt.

Where the grazing pressure is relatively low, heather and other plants mature and this can give rise to greater stand heterogeneity (Gimingham 1972). Shrubs may become established or the heath may be replaced by other vegetation types, such as bracken-dominated stands. However, degeneration of heather does not always occur in the absence of management, as heather can regenerate vegetatively by layering (adventitious rooting of stems) and stable stands of heather can develop (MacDonald *et al* 1995).

The effects of grazing (and burning) on moorland habitats, particularly the replacement of dwarf shrub heath and mire communities by grasses, heath rush *Juncus squarrosus* and cotton-grass *Eriophorum* spp. dominated communities have been documented (Ratcliffe 1959; Rawes & Williams 1973; Tansley 1939) and more recently reviewed (Felton & Marsden 1990; Thompson *et al* 1995c). Increasing grazing pressures have been shown to have a major influence on moorland condition and to have contributed to changes from dwarf shrub moor to grass moor.

Anderson and Yalden (1981) found that the upland vegetation of a large part of the Peak District, mapped in 1913 as having 36% of the vegetation dominated by heather, was dominated by graminoids. Similarly, aerial photographs have indicated that in Cumbria since the 1940s 70% of heather-dominated vegetation has been replaced by unimproved vegetation dominated by graminoids (Nature Conservancy Council 1987).

Dwarf shrubs are not the only group to decline in the face of heavy grazing. Tall herb and fern communities become restricted to cliff ledges and other inaccessible sites, while the regeneration of any shrubs or woodland is also prevented. The plants and animals typically associated with heather moorland, tall herb communities, scrub and woodland are generally more highly prized, in nature conservation terms, than those associated with the acid grassland or bracken *Pteridium aquilinum* communities which replaces them (Evans & Felton 1987). However, this does depend on the particular interest being considered and the way the heather moorland is being managed.

Further information: Stewart & Eno 1998; Chapter 6 Moorland; Chapter 7 Meadows & enclosed pasture.

Effects of agricultural burning on vegetation

Man has influenced upland vegetation using fire for a long time, perhaps since the Mesolithic period (Mowforth & Sydes 1989). Burning has been practised for the management of vegetation, principally for stimulating new growth of grasses or heather. The most commonly burnt upland vegetation type is dwarf-shrub heath, although some burning of blanket bog, enclosed and unenclosed grassland, bracken and scrub is also undertaken. It is strictly controlled by law and can only be conducted in winter (see Chapter 6 Moorland).

Like grazing, burning can have a major effect on the species composition of moorland communities, particularly when the vegetation is burnt more frequently than once every eight or so years. At high burning frequencies, particularly when combined with moderate to high grazing levels, the dwarf-shrub component of heath and blanket mire communities can be substantially reduced or even eliminated. On dry heath this will result in mat-grass becoming dominant, or bristle bent *Agrostis curtisii* in the south west of England, while on wet heath and blanket mire hare's-tail cotton-grass *Eriophorum vaginatum* or purple moor-grass will be favoured.

Grassland burning, or 'swaling' is traditionally practised in some areas of the English uplands and in general, 'individual' burns are much more extensive than those upland areas managed for grouse (see 2.9.1). In the south west, for example on Exmoor, large areas of unenclosed land are dominated by purple moor-grass. These areas are traditionally used as summer pasture for sheep and cattle. They are stocked fairly heavily during the summer months and large areas are burnt every spring to produce younger, more palatable herbage. *Molinia* is relatively unpalatable except when young, when it can be of high quality feeding value, and is able to regenerate vigorously after being burnt. Such a high

frequency of burning is probably responsible for the dominance of *Molinia* here, because it gives this species a competitive advantage on wet soils, and has resulted in the agricultural and ecological impoverishment of these moors. Small-scale burning combined with early summer grazing may be the best way to diversify such areas (see Chapter 6 Moorland).

In addition, shrubs such as gorse *Ulex* spp are burnt to help stock to move around the land and encourage an initial flush of grass growth. Further information on burning is included in Chapter 6 Moorland. The effects of burning for grouse moor management are discussed in the next section and in further detail in Chapter 6 Moorland.

2.9 Field sport interests in the uplands

2.9.1 Grouse shooting

In northern England, the principal shooting interest on moorland is for grouse. The large-scale management of heather moorland for red grouse first started in the early nineteenth century and reached a peak towards the end of that century and the beginning of the twentieth. There has been some decline in management for grouse in some areas, but it still remains a major land use in the North Pennines, Yorkshire Dales, Forest of Bowland and North York Moors.

Grouse moor management involves regular burning to maintain heather in the young, highly productive age-class on which grouse prefer to feed. This young growth has to be in close proximity to taller heather, which is used for nesting and cover. As a result, moors managed for grouse tend to be burnt to produce a mosaic of stands of heather of different ages, rather than the more extensive pattern of large burns associated with management for grazing alone. Grouse moors tend to be burnt on an eight- to fifteen-year cycle.

Moorland management for grouse has had an important role to play in maintaining the extent of open heath and some of its wildlife. Grouse shooting helped to retain the dwarf shrub cover of grouse moors after the Second World War when agricultural pressures converted much moorland to grass moor. In many areas, heather moorland survived where the shooting interest has provided the incentive, the will and the money to retain it.

Some grouse moors support a range of vegetation structures, from areas of short heather and bare ground to unburnt areas. Additional wildlife benefits can be gained from grouse moors which maintain areas of unmanaged or less intensively managed moor, which retain or encourage native woodland and scrub, and which reverse moorland drainage.

However, rotational and relatively frequent burning involved in grouse moor management has a profound effect on the vegetation present and can lead to swards dominated by heather with few other species and only limited areas of taller and older stands of dwarf shrubs. Repeated burning also affects the species composition of the invertebrate fauna. Therefore, burning will benefit some species and disadvantage others. Whether or not it is beneficial for wildlife will depend upon the nature conservation interests present and the objectives for the area concerned.

Moorland drainage used to be widely practised, with the intention of improving the heather cover for grouse, but this trend has now declined. The benefits for grouse are debatable and it has adverse effects on wildlife, including the loss of wet habitats and the erosion of peat, which causes undesirable changes in freshwater habitats.

A number of pests and diseases cause problems on grouse moors, particularly the parasitic ticks and worms that affect grouse, and are controlled to maximise grouse populations. Grouse moor management also involves a high degree of predator control which may benefit some other breeding birds. The unnaturally low population size of many birds of prey in upland England, eg hen harrier, is widely attributed to their persecution as predators of grouse. The illegal killing of birds of prey still occurs on grouse moors, despite the protection afforded by the Wildlife and Countryside Act 1981.

Further information: Hudson & Newborn 1995; Chapter 6 Moorland.

2.9.2 Deer management

During the nineteenth century many estates in the uplands of Britain began to be managed primarily for red deer. Originally creatures of the woodland, these animals were forced to adapt to the open upland habitat as the area of woodland decreased and management of it intensified. In the moorland situation, there are herds of red deer on Exmoor, in the Lake District and the Southern uplands of Scotland, but the greatest numbers are to be found in the Scottish Highlands. Here herds are only partly managed as a field sport resource, with venison being an additional source of income. Numbers are controlled to some extent by annual culling, which is necessary in the absence of natural predators such as the wolf *Canis lupus*. Outside Scotland, populations are also controlled to some degree in certain areas, and in the south west they are managed as a field sport resource.

Native deer (roe *Capreolus capreolus* and red) still occur in upland woods and can have very great impacts on the conservation management of the woods in both a positive and negative way. Browsing, antler damage, and grazing of ground vegetation can cause local, and sometimes widespread effects. Deer damage is probably a more significant problem in woodlands than in open upland habitats. Control can be by shooting, or a combination of different approaches such as fencing, using tree guards and shelters, applying chemical and physical repellents and providing alternative feeding areas. Fencing can, however, cause mortality in game birds, and many deaths, particularly in Scotland, occur when black grouse *Tetrao tetrix* and capercaillie *Tetra urogallus* fly into these fences.

Further information: Langbein 1997; Chapter 8 Woodland and scrub; Chapter 6 Moorland.

2.9.3 Pheasant shooting

Pheasant releases for shooting occur in some upland woods for field sport purposes. This practice can have implications for nature conservation interests where non-native shrubs are planted within native broadleaved woodlands; where release pens are sited in areas of nature conservation interest or where they can cause soil erosion; and where straw bales are used to provide cover in areas of nature conservation interest.

Further information: Carrol & Robertson 1997; Chapter 8 Woodland and scrub.

2.10 Forestry in the uplands

Three main woodland and forestry management systems can be distinguished in the English uplands. These are:

- plantation forestry based mainly on large-scale conifer forests;
- broadleaved woods actively managed for timber or wood products, mainly as high forest, but with small areas of worked coppice;
- other mainly broadleaved woods (including most of the semi-natural woodland) which is not actively managed for wood products, but may be contributing to other outputs such as landscape, recreation and sheltered grazing.

There will also be some woods which do not fit into any of these woodland and forestry management systems but these are thought to be less than 10% of the whole (K. Kirby, pers comm).

Further information: English Nature 1994b; Chapter 8 Woodland and scrub.

2.10.1 Plantation forestry

Some of the earliest large-scale conifer plantations in England were established by water companies in the uplands around reservoirs, such as Thirlmere in the Lake District. The main expansion occurred, however, following the establishment of the Forestry Commission in 1919.

Key points:

- predominantly coniferous with sitka spruce *Picea sitchensis* as the main tree species;
- large-scale forests forming the matrix of the landscape, either private or state-owned depending on location;
- stands managed as high forest with clear fells for the most part probably between 10 and 50 ha, of rotations 30-60 years, with re-stocking by planting, and the process heavily mechanised and with relatively little thinning;
- there is some conservation interest attached to the plantations (eg raptors in places) but is more often associated with the non-plantation elements (eg open spaces, remnant broadleaved stands, the woodland interface with other habitats);
- negative nature conservation attributes include loss of open ground habitats and possible increased predation of breeding birds on adjacent open land caused by predators using plantations as cover and for breeding;

- commercial/production-orientated as they are the main source of home-grown timber in England.

2.10.2 Broadleaved woods actively managed for wood production

Most broadleaved woods in the uplands have been managed for wood or timber in the past. Important products included charcoal, swill baskets and bark, as well as wood for buildings, farm implements, fencing and so on. Frequently the woods were coppiced, but this system was virtually extinct by about 1930 except in a few places. Many woods were last cut over in the two World Wars. Recently, there has been a small-scale revival of coppice, for example in Cumbria, and of interest in managing broadleaved woods generally for timber as high forest. Initiatives such as Coed Cymru in Wales have had particular success with encouraging farmers to manage their woods. Nevertheless, the proportion of broadleaved woods in the uplands where wood production is a significant or the main objective is always likely to be relatively small, not least because growth rates are much lower than in lowland broadleaved woods.

Key points:

- predominantly native broadleaves but beech and sycamore are locally important as timber trees;
- relatively small woods (less than 50 hectares) forming patches in the landscape, mainly in the upland fringe, and mainly privately owned (but often large estates);
- mainly now treated as high forest, but with some worked coppice, eg in south Cumbria, and small scale (1-10 ha) clear-fells or group felling, with rotations of 15-30 years for coppice or 100-150 years for high forest, and re-stocking mainly by planting (except for coppice), with a low level of mechanisation;
- conservation interest (if any) associated with the woodland itself or with the interface between woodland and other habitats, and may or may not be improved by management;
- protection against grazing and browsing animals essential especially during re-stocking;
- commercial/production considerations significant but unlikely to be sole driving force in management of the woodland - conservation, landscape or field sport issues also likely to be important.

2.10.3 Broadleaved woods not managed primarily for wood production

Probably 50-70% of broadleaved woods in the uplands receive no management or else management is driven by objectives other than wood production (eg grazing, shelter, field sports, amenity, conservation), with any timber harvested regarded as a bonus. In many instances, very little management is required to maintain their nature conservation value.

Key points:

- predominantly semi-natural;

- mainly small (less than 20 ha), forming patches and linear features in the upland fringe (but extending to higher altitudes and poorer soils than the previous category), mainly privately owned (frequently farmers with no particular woodland interest or experience, but locally organisations such as the National Trust and County Wildlife Trusts are important);

- conservation value associated with the wood itself or with the interface between woodland and other habitats;

- very little financial return from the woods, but often very high conservation or landscape value and some agricultural value as sheltered grazing (but this has never been quantified).

2.10.4 Forestry systems and other land uses

Commercial upland forestry is almost totally independent of the upland agriculture system except in so far as they compete for land and can provide employment in the overall rural economy. Forested areas are important in terms of the landscape, field sport interests, recreation and other aspects of upland land use, while being set within an agricultural context, often with field sport interests. Decisions about whether and how the woods are managed may be influenced by implications for the farming business. For example, removing the woodland from the grazing area will affect the subsidy payments received by farmers. Decisions will also depend on whether farmers have the capital to pay for fencing or the skill and time to manage the wood themselves.

Commercial forestry can be important locally in the context of pheasant, fox and stag hunting. The value of the forest for different species depends on the growth stage, for example black grouse are mainly found in the younger stages of the plantation growth. Both plantations and semi-natural stands may be important for other forms of recreation, such as walking, cycling and bird watching.

Forestry may provide some potential for farmers to shift the balance of their productive output away from food products, but in most cases this is only likely to be undertaken by those with a strong interest in forestry. More often, new forest plantings are likely to occur on large estates or when land changes ownership.

2.10.5 National forestry policies

Forestry in the uplands is covered by national forestry policies which, amongst other things, aim for:

- a steady expansion of the tree cover of Great Britain, to increase the many diverse benefits that forests provide;

- the sustainable management of existing woods and forests;

- woods that are currently broadleaved to remain so;

- the special interest of ancient semi-natural woods to be maintained.

The main way these policies are promoted is via the grants and regulatory activities of the Forestry Commission. All felling (with small exceptions) requires a licence from the Forestry Commission and a re-stocking condition is normally imposed. This may cause problems where substantial tree removal is desirable, for example, on bogs or heaths, but it is generally advantageous. Re-stocking and new planting on open ground attract grants with a variety of special supplements for particular situations (see Box 2.3). Any forestry work coming before the Forestry Commission is also expected to meet basic environmental standards and guidelines which to varying degrees take account of nature conservation requirements. A public register of new planting and felling applications is maintained by the Forestry Commission.

2.10.6 Forestry and biodiversity

Modern plantations can have a significant effect on the biodiversity of upland areas. For example RSPB (1995) summarised the effects of afforestation on blanket bog

- hydrological disruption due to intensive drainage;
- peat wastage resulting from drainage;
- peat drying owing to drains and increased evapo-transpiration;
- generally lowered water table;
- shading by the canopy and accumulation of needles;
- fertiliser application;
- acidification of ground water;
- vegetation changes;
- loss of open moorland species;
- changes in rates, sedimentation loads, nutrient content or pH of run-off from afforested peatlands affecting associated freshwater systems.

Similar effects are produced on drier moorland habitats.

Large conifer plantations do have some nature conservation interest and they can be important for some birds, particularly goshawk *Accipter gentilis*, siskin *Carduelis spinus* and crossbill *Loxia curvirostra*. Nightjars *Caprimulgus europaeus* have also colonised some upland plantations. This interest, however, is more often associated with the establishment and re-stocking phases, and the non-plantation elements such as open spaces and rides, which frequently contain semi-natural habitats such as dry heath, blanket mire, raised mire, grasslands or limestone pavement and remnant broadleaved stands. Conifer plantations also extend the available habitat for red squirrel and pine marten.

2.11 Public access and recreation in the uplands

Visitors have long been attracted to upland areas. Increasingly in urbanised societies, people feel the need to escape to areas that are perceived to be wild and natural landscapes (Poore 1992). These areas provide a source of inspiration and recreation which satisfies the more spiritual values of solitude, enjoyment and enrichment, the feelings of physical excitement, exhilaration, healthiness and contentment.

The uplands are used for a variety of recreational activities. These include hill walking, fell running and orienteering, mountain biking, horse riding, rock climbing, gill scrambling, caving, paragliding and handgliding. Motor cycles and four-wheel drive vehicles are also used, and in water environments, canoeing and angling are popular. Visitor support is beneficial to the local economy of upland areas, and there is great potential for raising visitor awareness of and support for the various land uses present, as well as nature conservation.

The majority of people involved in recreation in the uplands arrive by car. This means that the areas around car parks are often the most heavily visited, and in some areas further parking provision is required. The concentration of visitors around car parks provides an ideal opportunity to inform the public about the wildlife and land use of the area, via visitor centres for example. However, large visitor numbers can increase footpath erosion, the incidence of accidental fires and other problems associated with recreational activities.

When compared with factors such as climatic change, grazing or fire, recreational impacts may be of little long-term conservation significance. Nevertheless, in some situations they may be the critical last link in a chain of limiting factors (Ratcliffe 1990b). Mountains and hills can be vulnerable to the impacts of recreation. Some habitats, such as those in wet areas and on rock outcrops, are fragile and of high nature conservation value for the plants and animals they support. Many areas are valued for their aesthetic appeal as well as their wildlife interest. Activities such as hill walking have led to a loss of vegetation, erosion and discernible scars in the last few decades, but this tends to be on a rather localised basis. Damage can be exacerbated by four-wheel drive vehicles, motor cycles, horse riding, mountain bikes and runners using unsurfaced rights of way.

Erosion and scars are readily seen, but less obvious, and more difficult to quantify, is the long-term effect of disturbance on birds, mammals and invertebrates. However, there is currently little evidence to suggest that disturbance leads to anything other than localised problems for animals.

Although more of a problem in Scotland, skiing occurs in certain places in the English uplands and can damage the vegetation. More widespread activities in England are rock climbing and gill scrambling, which can adversely affect fragile and rare plant communities and disturb breeding birds. Another recreational activity, caving, can damage underground features and disturb bats.

It is possible to manage recreation, to help the general public gain access to and a greater understanding of the uplands, without putting the special value of these areas at risk. The managers of upland areas can build on an alliance between users' interests and their own aims, remembering the importance of the contribution made by visitors to rural economies.

Significant proportions of the uplands are designated as National Parks where two equal statutory purposes apply. These are, "to conserve and enhance natural beauty, wildlife and cultural heritage", and, "to promote opportunities for the understanding and enjoyment of" their special qualities. It should be possible to reconcile any conflicts by cooperation between the relevant interests and the National Park Authorities, through careful planning and management. This is being actively pursued and achieved in many National Parks in England. A great deal of recreation can take place without causing problems, provided that it is well planned and managed. Good planning of visitor management is essential, relating the type of management to the type of recreation in the area concerned.

Nature reserves exist in the English uplands and are owned and managed by a variety of bodies, such as English Nature, the RSPB and Wildlife Trusts. They support a variety of wildlife interests and have various arrangements for public access and recreation.

The Countryside and Rights of Way Act embraces major new legislation on access, and follows a long consultation period (Department of the Environment, Transport and the Regions 1998a).

Further information: Countryside Commission & Countryside Council for Wales 1997; Federation of Nature & National Parks of Europe 1992; Sports Council & Countryside Commission 1995; Scottish Natural Heritage 1997; Ramblers Association 1998; English Nature 2000a, 2000b; Information Note 10 Management of public access; The Association of National Park Authorities and individual National Park Authorities.

2.12 Other land uses in the uplands

2.12.1 Mineral extraction

Quarrying for stone and, locally, mining are significant land uses in the uplands. Quarrying can result in the loss of semi-natural habitats and earth heritage features, affect adjacent habitats through changes in the water table and result in increased sediment loading of watercourses, which can damage freshwater ecosystems. However, some quarries may have wildlife value once extraction has ceased, either in their own right or where habitat re-creation opportunities exist. They may also expose geological strata of scientific interest.

Mining was once a major feature of many upland areas and while the majority of mines are now abandoned many moorlands are littered with old mine shafts, adits and spoil heaps. Some areas of mine spoil are of significant nature conservation interest. This is principally where the mining has been for metals such as lead or copper. Here the toxic spoil supports characteristic metalliferous grassland communities which are entirely restricted to these situations and include a number of rare and scarce plant species.

Further information: English Nature 1997a, 1998a.

2.12.2 Water supply

Water companies now own or manage substantial areas of ground in the uplands. Upland areas provide the principal water catchment areas for much larger geographical regions. Rainfall is usually greater at these altitudes than in adjoining lowlands and water from mountains provides the source of most rivers

and streams on which lowland peoples depend for water supplies. The quality, quantity and timing of water yield from mountain catchments are therefore of considerable social and economic importance. These are all affected by the land use in the catchment.

Different types of vegetation intercept and impede the flow of rainwater to differing extents. Woodland and scrub, for example, slow the passage of water from hill sides to rivers to a far greater extent than grasslands as trees have a greater surface area onto which rain will fall, preventing it reaching the ground immediately. Some of this water then evaporates back into the atmosphere without ever reaching the ground. Of the water that does reach the ground, trees will take up a greater proportion through their roots than grasses and herbs because of their size, and again this is passed back into the atmosphere via evapo-transpiration. Because rainwater takes longer to reach the ground in woodland than in grassland there are fewer rapid fluctuations in river levels where catchments are wooded than there are in unwooded catchments. As a result there is less erosion and sediment load in water from wooded catchments than from unwooded ones.

The urbanisation of the population in the nineteenth century led to a need for increased water supplies in towns and cities which could not be met from local supplies. As a result a number of large valleys were flooded and water levels in existing lakes were raised to create reservoirs. The majority of these reservoirs were created in upland areas and today water companies are major landowners in the uplands. One consequence of the building of reservoirs was the loss of areas of semi-natural habitat and in some instances this has resulted in the loss of areas of very high nature conservation interest, such as in upper Teesdale and on Bodmin Moor.

Many upland stream, rivers and water bodies have been developed as a source of drinking water for private and public supply. Water is abstracted directly from surface or ground waters, thereby posing a threat to water levels and flow regimes downstream of the abstraction point. Water may also be abstracted for non-consumptive use, for example by hydro-electric power stations or by fish farms. Abstraction can lead to significant impacts on the wildlife of freshwater systems and wetlands.

Further information: Chapter 9 Freshwater habitats

2.12.3 Power generation

Since the late 1980's there have been increasing numbers of wind power farms built in upland locations as they are consistently windy. Wind farms require some land take, though this is usually small, but it can lead to loss of semi-natural habitat. Semi-natural habitat may also be lost during the construction phase. Concern has also been raised as to the effect of wind farms on bird populations, both breeding and migratory, in their vicinity owing to increased disturbance and loss of habitat and the potential for increased risk of bird strikes where wind farms are built in heavily used flight paths. Many upland areas are protected from wind farm developments to a certain degree as they lie within National Parks, the planning committees of which are currently vigorously opposed to such schemes, primarily on landscape grounds.

Further information: English Nature 2000c.

2.12.4 Military training in the uplands

The Ministry of Defence (MoD) owns a significant area of the uplands, managed primarily for military use. Examples include training areas on Dartmoor, at Otterburn in Northumberland and at Warcop in the North Pennines. Large parts of these areas are largely free from human disturbance because they are overshoot zones for firing ranges. The majority of military ranges and training areas are closed to the public for at least part of the time. For this reason, they can be extremely valuable for wildlife, particularly breeding birds, and can contain rare plant species. The MoD is also actively pursuing management for wildlife on its training grounds.

Parts of specific training areas can be subject to heavy use and certain types of military machinery, eg tanks, or types of training activity, are monitored to help reduce damage or repair predicted damage. All large training areas have Conservation Groups and sustainable military training use is the overall target of the MoD.

A number of military radar establishments are also located on areas of moorland. There are usually areas in the immediate vicinity of the radar that are fenced off from livestock and are largely unmanaged owing to potential radiation hazards. Areas of moorland habitat which are unmanaged, such as these, are uncommon and are useful in research into moorland ecological processes.

Further factors influencing the uplands

2.13 Pollution

Atmospheric pollution, effluent discharge and eutrophication of fresh waters all affect upland ecosystems.

Atmospheric pollution has been a major cause of recent vegetation change in the uplands (Birks 1988). Oxides of sulphur and nitrogen are released during the combustion of fossil fuels and are deposited either dry or, combined with moisture in the atmosphere, as acid rain. Brown & Farmer (1996) have found that sulphur and nitrogen deposition exceed their critical loads in many upland Natural Areas and that this is likely to be having a significant impact on their nature conservation interest. The widespread development of infertile, acidic soils is the principal ecological factor characterising the long-term ecological history of the uplands. These soils result from the acidic nature of much of the local bedrock, coupled with intensive leaching under a cool, moist climate. Long-term, natural soil acidification has been greatly increased by recent, rapid acidification caused by acid atmospheric deposition in certain upland areas.

Certain ecological changes in the Southern Pennines, for example, are almost certainly responses to the atmospheric pollution of the industrial revolution. These changes include the virtual disappearance of *Sphagnum* from blanket mires (Lee, Tallis & Woodin 1988; Tallis 1964). Atmospheric pollution may be partly to blame for the recent increase in the extent and rate of blanket mire erosion in the Southern Pennines (Tallis 1985), as well as intense land use, although some of this erosion is thought to be part of natural processes. It has also been suggested that the high deposition of soot after the start of the industrial revolution may have been involved in the change from heather moor to the dominance of purple moor-grass in South Wales (Chambers, Dresser & Smith 1979). Atmospheric pollution may also affect species of montane heaths such as woolly hair-moss *Racomitrium lanuginosum* and stiff sedge *Carex*

bigelowii that obtain nutrients from water droplets in cloud and fog (occult deposition) (Lee, Tallis & Woodin 1988).

In areas where the soil cannot counteract the acid depositions, surface waters can become acidified. Other pollution effects on fresh waters include localised nutrient enrichment from stock faeces, or eutrophication of water bodies resulting from the run-off of organic and inorganic fertilisers applied to the surrounding land. Effluent discharges into fresh waters include organic effluent such as farm waste or sewage, and toxic effluent such as sheep dip, pesticides and herbicides. All these pollution effects can alter the fauna and flora of freshwater systems.

Further information: Bobbink *et al* 1998; Kirkbride 1996; Lee 1998; New Phytologist 1998; Woodin & Farmer 1993; Chapter 9 Freshwater habitats.

2.14 Erosion and sedimentation

Erosion of upland soils, resulting in vegetation loss and increased amounts of sediments in water systems, arises from natural causes and various activities such as drainage, burning, bracken control, heavy grazing, forestry and recreational activities such as walking, mountain biking and off-road driving. Erosion and the sediment it produces disrupt the natural hydrology of the adjacent water courses and surrounding catchment area, altering flow rates and changing patterns of deposition and flooding. Sediment in the water can affect the aquatic flora and fauna, by shading plants and silting rocky habitats used by invertebrates and spawning fish.

The erosion of soil by water is caused when rainfall is so intense that the soil cannot absorb it by infiltration. It then runs over the surface as sheets or is concentrated in runnels and streams. Where there is no vegetation cover the water picks up soil particles as it moves over the surface. Gullies soon form and once present they will continue to eat back at their heads into previously uneroded soils and can cause the further loss of vegetation cover (Dasmann & Poore 1979).

Stock trampling on banks and shores of freshwater systems can also lead to erosion and increased levels of suspended solids in fresh waters. This can reduce light levels in the water, smother plant and animal species, and alter the constituent communities.

Erosion is, however, a natural process and scree slopes, for example, are a result of natural erosion caused by freeze-thaw action. Erosion tends to become a problem when human activities exacerbate natural processes.

Further information: MAFF 1997c, 1998e; Tallis 1997; Chapter 9 Freshwater habitats.

2.15 Climate change

It is possible that upland habitats may be influenced by climatic changes associated with the greenhouse effect (Bardgett *et al* 1995). There is a growing consensus that increasing amounts of carbon dioxide and other greenhouse gases (eg methane and nitrous oxide) in the atmosphere will lead to an increase in average temperature of 2.5 °C by the year 2100 (Hadley Centre 1997). It is also estimated that by the 2050s average summer temperatures in the UK might have increased by about 1.4 °C and winter

temperatures by 1.5 °C (Climate Change Impacts Review Group 1996). Increasing temperatures may influence the future extent and distribution of upland vegetation, both directly through changes in the productivity of moorland soils and vegetation, and indirectly through increased opportunities for land improvement and cropping, and an extension of the grazing season. This could have fundamental consequences for agriculture, wildlife and recreation.

It is possible, for example, that changes in the geographical distribution of heather-dominated vegetation will occur (Bardgett *et al* 1995). One model predicts a reduction of approximately 25% in the current extent of blanket bog with increases in temperature in the order of 3 °C. It is thought that the loss in area of blanket bog is likely to result from increased evapo-transpiration from peat soils and a subsequent increase in peat decomposition rates, producing a shift in vegetation type to more productive dry heath and acid grassland. Another model predicts that bracken could expand its altitudinal range as a result of global warming and become more difficult to control (Marrs & Pakeman 1995).

Sophisticated computer models of the global climate system are used as the basis for predicting climate change. A new set of climate change scenarios for the UK has recently been developed and provides greater detail than the CCIRG study referred to above (Hulme & Jenkins 1998). However, it must be recognised that although climate models are driven by the best available scientific evidence, they do still contain an element of uncertainty.

Further information: Department of the Environment, Transport and the Regions 1998b; Loh 1997.