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Definition and location of crags, scree and limestone pavement

10.1 Definition of crags, scree and limestone pavement

This chapter is concerned with the biological interest of rock exposed at the surface. Rock exposures occur as features such as cliffs or crags, gullies and ravines, boulders and scree, and limestone pavements. The geological and geomorphological interest of these features is dealt with in Chapter 4 Earth heritage features.

Exposures may occur in rocks of sedimentary, volcanic or metamorphic origin. The base status of the exposure varies from high to low, although areas of base-poor rock may contain thin strata or veins of calcareous material to give localised variation.

Limestone pavement is a particular type of rock habitat which occurs from sea level to mountain top. It is defined in law as "an area of limestone which lies wholly or partly exposed on the surface of the ground and has been fissured by natural erosion" (Wildlife and Countryside Act 1981, Section 34 (6)). This past natural weathering has formed a complex of deep crevices known as grikes interspersed with massive blocks known as clints.

The vegetation of rock habitats is characteristically discontinuous and often sparse. Soil cover is thin, skeletal or absent altogether. The vegetation includes two distinct types:

- Vegetation that uses the physical structure or form of the rock as a shelter from the extremes of climate or grazing. This includes ledge flora, scree communities, the flora of grikes of limestone pavement and remnant woodland on upland crags.

- Vegetation consisting of species that are poor competitors but can withstand or tolerate the stress caused by thin or absent soil, low nutrient levels, poor shelter and drought. This is true 'chasmophytic' vegetation, and includes the flora of cracks and fissures of rock faces, and the surface of clints of limestone pavement.

10.2 Location and extent of crags, scree and limestone pavement

Rock habitats are widespread throughout upland areas. They can occur in all situations within the landscape, from unenclosed mountain summits to enclosed valley grassland and all agricultural and other land in between. Calcareous rock faces and scree, especially those consisting of limestone, are particularly well represented in the uplands of northern England. Acidic rock exposures are present throughout the upland areas of England.

The physical and chemical nature of the parent rock determines the morphology and longevity of the rock exposure, as well as influencing the rates of weathering and erosion. The English uplands are characterised by harder rock types such as Carboniferous limestone, volcanic rocks, granites and hard sandstones, which tend to form permanent rock exposures.

The nature of the rock exposure is also determined by the mechanism creating the exposure. These geomorphological agents include glacial erosion, rivers, deep weathering, land slips and the actions of man. As these processes are responsible for erosion they are also agents of deposition. For this reason the uplands show a disproportionate amount of exposed rock and much of the lowlands mantled by a thick cover of soil, alluvium or glacial drift. Glacial and fluvial erosion are particularly centred on the uplands.

Limestone pavement is a type of rock exposure which, in Britain, is largely restricted to the north west of England, with small pockets in Wales, Scotland and Northern Ireland. This habitat has been thoroughly surveyed by Ward & Evans (1976) and English Nature (Webb 1995). It is restricted to areas of hard limestone which have been glacially scoured during the last ice age more than 10,000 years ago. The area of British limestone pavement is small and it is a scarce resource (Ward & Evans 1976), covering 3,000 ha in Britain, with 2,350 ha of this in England. British limestone pavements have been extensively damaged to meet the demand for decorative rockery stone. Stone has also been robbed historically from pavements to produce lime, build dry stone walls and to supply local building materials. Only 3% of the pavements surveyed by Ward & Evans (1976) were undamaged. About half of all the remaining limestone pavement in England occurs on the Craven District of North Yorkshire, with the remainder largely in Cumbria and north Lancashire.

There have been no comprehensive surveys of the extent of other forms of rock exposure (inland cliffs, crags and scree) in Britain, although some land cover surveys have produced estimates of bare rock. Surveys of the plant communities associated with these features are also scarce. Recent surveys of plant communities associated with rock exposures in three Cumbrian candidate Special Areas for Conservation, however, found that tall herb ledge communities were far more restricted in extent and distribution than had hitherto been suspected (Jerram 1997a, b & c).

Examples of calcareous chasmophytic vegetation (defined in these surveys as vegetation growing in fissures, crevices and directly on the rock), while relatively widespread over the sites as a whole, tended to be represented by very small ‘stands’ of vegetation. These were often no more than a metre in length or covering a couple of square metres at the most and were usually much smaller. They often consisted of only a few individuals of one or two vascular plant species. Siliceous (base-poor) chasmophytic vegetation was widespread, however, as was siliceous scree, but large areas of this scree was unvegetated owing to the continuance of natural scree forming processes. Eutric (base-rich) scree communities were confined to areas of limestone scree (Jerram 1997a, b and c).

Man-made rocky habitats also occur in the uplands. Quarries, for example, provide rock exposures and ledges as habitats for plants and animals. Mine spoil, for example from lead mines, supports specialised and often rare plants and animals (see Chapter 6 Moorland for more details).

Habitats and species of crags, scree and limestone pavement

10.3 Why crags, scree and limestone pavement are important

10.3.1 Crags and scree

Exposures of bare rock such as crags and scree support rare plant communities found only in these situations. Many of the communities are important in an international context and this is recognised by their inclusion in the Habitats and Species Directive (see 10.4.3). These plant communities contain nationally rare and scarce vascular plants, bryophytes and lichens (Tables 10.1, 10.2 and 10.4). Crags and scree also provide essential habitats for a variety of animals, including scarce invertebrates (Table 10.8) and birds of conservation concern (Table 10.6), such as peregrine falcon *Falco peregrinus*, golden eagle *Aquila chrysaetos* and ring ouzel *Turdus torquatus* that nest there. Several species associated with crags and scree are included in the UK Biodiversity Action Plan (UK Biodiversity Group 1998; UK Steering Group 1995).

In addition to species specifically associated with rock exposures, these features often provide important refugia for species intolerant of high grazing levels. In many locations these species, which include stands of high altitude woodland and scrub, have become restricted to ledges inaccessible to livestock.

10.3.2 Limestone pavement

Limestone pavements are a rare habitat in Europe. The UK holds a significant proportion of the resource within the EU and England has 78% of the British resource. Their special interest lies in the unusual plant assemblages they support (Table 10.5), together with their geomorphological and geological features and the unique landscape features they create. Their significance is recognised by the inclusion of limestone pavement in Annex 1 of the EC Habitats and Species Directive as a priority habitat. This means that this habitat is in danger of disappearance and its natural range mainly falls within the territory of the European Union (European Commission 1996).

The plant assemblages of limestone pavement include many rare and scarce vascular and non-vascular plant species (Tables 10.1 and 10.2). Certain rare lichens are also associated with this habitat (Table 10.4) and pavements provide habitats for rare and scarce invertebrate species (Table 10.8). In addition, areas of limestone pavement support various woodland and scrub types which are considered to be of international importance (Table 10.5).

Limestone pavement and some of the species associated with it are also included in the UK Biodiversity Action Plan (UK Biodiversity Group 1998; UK Steering Group 1995).

Ring ouzel

Limestone pavements are also of interest for their geological and geomorphological features, which reflect the glacial scouring of the last ice age and the post glacial weathering processes that have operated over the last 10,000 years. Pavements are well recognised for their scenic beauty and their contribution to the landscape.

Pavements often occur in a mosaic of other features of interest such as calcareous grassland, limestone scars and cliffs, scree, limestone woodland and scrub. These are often features of interest in their own right.

Further information: Chapter 4 Earth heritage features

10.4 Habitats and species of rock features, their nature conservation status and distribution

10.4.1 Vascular plants

Crags, scree and limestone pavement support a wide range of nationally rare and scarce plant species (Table 10.1). Crags shelter relict Arctic-alpine plants like mountain avens *Dryas octopetala*, alpine enchanter's nightshade *Circaea alpina* and alpine cinquefoil *Potentilla crantzii*. Crags and screes are important for their rich fern flora and because they act as a refugia for a number of rare species, including oblong woodsia *Woodsia ilvensis*, forked spleenwort *Asplenium septentrionale* and Killarney fern *Trichomanes speciosum*. Many of the British species of whitebeam *Sorbus* spp., several of which are endemic, are confined to cliffs, particularly on rocks of a calcareous nature. One example is the nationally rare Lancashire whitebeam *Sorbus lancastriensis*, which only occurs around Morecambe Bay. Most of the records of this species are from cliffs and rocks of the Carboniferous limestone (Rich & Baecker 1986, 1992).

Many species associated with ledges are found in the montane zone and are covered in Chapter 5. Examples of these include alpine catchfly *Lychnis alpina*, glaucous meadow-grass *Poa glauca*, alpine saxifrage *Saxifraga nivalis* and alpine mouse-ear *Cerastium alpinum*.

Grikes and other solution features of limestone pavement support rare and scarce plant species such as rigid buckler-fern *Dryopteris submontana*, downy currant *Ribes spicatum*, baneberry *Actaea spicata* and dark-red helleborine *Epipactis atrorubens*. Gilbert (1970) considers that 80% of the rigid buckler-fern population is confined to limestone pavement. It was formerly more widespread, occurring in upland areas with no limestone pavement, and its present dependence on the clefts of pavements is thought to be because these offer protection from grazing (Jermy 1994). Limestone pavements in Yorkshire are known to contain a significant proportion of the UK baneberry population (Usher 1980, 1986). Other plant species of note associated with limestone pavements include fingered sedge *Carex digitata*, bird's-foot sedge *Carex ornithipoda*, pale St. John's-wort *Hypericum montanum*, angular Solomon's-seal *Polygonatum odoratum*, narrow-leaved bitter-cress *Cardamine impatiens* and limestone fern *Gymnocarpium robertianum*. The grikes provide a cold humid microclimate where shade-tolerant plants, as well as species typical of calcareous woodland, occur.

10.4.2 Bryophytes and lichens

Rock exposures, particularly base-rich ones, support a large number of specialist bryophytes and lichens. Tables 10.2 and 10.4 show the nationally rare and scarce bryophytes and some examples of rare lichen species associated with rock exposures. Several of the bryophyte species are included in the UK Biodiversity Action (UK Biodiversity Group 1998; UK Steering Group 1995).

10.4.3 Plant communities

Table 10.5 shows the National Vegetation Classification (NVC) communities associated with rock exposures, together with their conservation status and distribution in upland Natural Areas.

Crags support plant communities of rock faces (chasmophytic vegetation), particular bryophyte and lichen assemblages, and species-rich tall-herb communities on montane and sub-montane cliff ledges. Screes are important for their rich fern flora and both crags and scree support common juniper *Juniperus communis* scrub, which is a very variable, local and unevenly distributed habitat type within Europe. All these habitats are important in an international context and this is recognised by the EC Habitats and Species Directive, which lists in Annex I six types of crag and scree habitat: eutric and siliceous screes, calcareous and siliceous types of chasmophytic vegetation on rocky slopes, eutrophic tall-herb communities and juniper formations (Brown *et al* 1997, Table 10.5).

It should be noted that the NVC only partially covers these habitat types. The communities described are frequently derived from very small numbers of samples, and these samples are often restricted geographically. The results of recent surveys suggest that more detailed sampling of scree, chasmophytic and ledge vegetation would reveal a number of sub-communities, and possibly new communities in addition to those described by Rodwell (1992 and in press; Jerram 1997a, b & c). In addition, the NVC does not distinguish communities of limestone pavements from other limestone woodland, grassland and open vegetation (rock) communities.

Limestone pavements support particular plant assemblages containing elements of these other limestone communities. It seems likely that most limestone pavements originally carried a cover of woodland, even in upland areas (Pigott & Pigott 1959). The woodland would probably be accompanied by a soil cover on the surface of the limestone. Tree cover was lost from the Craven Pennines by Iron Age times, with soil loss following. The present day general absence of trees on limestone pavements is maintained by grazing and climatic pressures. Tree-covered pavements are at present largely confined to north-east Wales and around Morecambe Bay. Here they include two internationally important woodland types, one composed of ash *Fraxinus excelsior*, wych elm *Ulmus glabra* and small-leaved lime *Tilia cordata*, and the other containing yew *Taxus baccata* (Table 10.5). Both these woodland types are included in the Habitats and Species Directive as priority habitats. Juniper scrub also occurs on some areas of limestone pavement.

In the continuum from wooded through scrubby to open pavements, their morphology offers a variety of microclimates, allowing the establishment of complex vegetation consisting of a mosaic of different communities (European Commission 1996). The transitions between these communities, as well as where pavements grade into other habitats such as species-rich limestone grassland, support a particularly diverse flora and fauna.

10.4.4 Birds

Rock exposures are used by a relatively small number of bird species. Ledges provide nest sites for raven *Corvus corax*, buzzard *Buteo buteo* and peregrine falcon, which use these situations because they are less disturbed and in some cases because of the lack of alternative sites, such as mature trees. Holes and crevices in scree provide nest sites for wheatear *Oenanthe oenanthe* and ring ouzel. All these birds forage elsewhere in the vicinity of the rock feature.

Birds characteristic of other upland habitats become associated with rock features where the habitat is integral to the interest of the area. For example wintering thrush flocks exploit autumn and winter berry crops on scrub and woodland associated with rock exposures and limestone pavement. Some species, for example raven and twite *Carduelis flavirostris*, may also use rock features for roosting. Table 10.6 lists bird species associated with rock exposures.

10.4.5 Invertebrates

Rock exposures provide habitats for a number of species of rare and scarce invertebrate species (Table 10.8). Molluscs such as *Vitrea subrimata, Clausilia dubia, Pyramidula rupestris* and *Pomatias elegans*, which inhabit moist places and are often nocturnal, occur in crevices and under loose rocks on limestone rocks, as does the pill woodlouse *Armadillidium pictum*. The shelter and humidity in the grikes of limestone pavement favour certain invertebrates, such as particular spiders and molluscs.

The high brown fritillary butterfly *Argynnis adippe*, which is listed in the UK Red Data Book as a vulnerable species and is included in the UK Biodiversity Action Plan (UK Steering Group 1995; Barnett & Warren 1995a), is associated with coppiced limestone pavement in north Lancashire and south Cumbria.

Important microhabitats are small pockets of soil, loose stones, moss and seepages of water over the rock surface. For a few species, the high temperatures and dry conditions associated with the exposed rock are of particular importance.

Solution hollows on limestone pavement have a very specialised aquatic fauna of species that are capable of tolerating the desiccation and high temperatures that occur when they dry out, including the midge *Dasyhelea saxicola*.

Yellow mountain saxifrage

10.5 Habitat and management requirements of species of rock features

The habitat and management requirements of key plant and animal species associated with crags, scree and limestone pavement are shown in Tables 10.1 (vascular plants), 10.3 (bryophytes), 10.7 (birds) and 10.9 (invertebrates).

Grazing-intolerant plant species of crags require a reduction in the grazing pressure on the surrounding land if they are to spread from their refugia. However, some plants of rocky terrain require certain levels of grazing. This may be because they are poor competitors, or they require bare ground to germinate or are intolerant of the shade cast by encroaching scrub.

To maintain populations of species associated with limestone pavement, the most important factor is to prevent damage or destruction of the pavement. In addition, many of the rare and scarce plant species thrive only where grazing is light or absent, and on wooded pavements some plants and animals benefit from woodland management such as coppicing.

Plants and animals associated with crags, scree and limestone pavement may require protection from damage or disturbance by walkers or rock climbers. Species associated with limestone pavement and screes and birds which nest on crags particularly require the habitat to remain intact and undisturbed.

Raven

Management of crags, scree and limestone pavement

10.6 Managing crags, scree and limestone pavement

Agricultural practices which occur on or around rock features include grazing, stone removal, applying surface treatments such as fertilisers or herbicides, and stock feeding. Other activities affecting rock features include recreation, such as walking and rock climbing, and woodland management. To maintain, and where necessary enhance, the nature conservation interests of crags, scree and limestone pavement, all these activities need to be at appropriate levels, locations or times, depending on the particular interest present.

10.6.1 Managing limestone pavement

Limestone pavements vary in their appearance, geological features and the flora they support. The differences reflect the geological structure of the rock and its formation during the ice ages, as well as climate, altitude and the more recent impact of man.

Pavements may be split into three broad types: open, scrubby and wooded. Open pavements have bare clints with vegetation largely confined to the grikes, although they may have scattered trees. These are largely the result of a long history of grazing management. Wooded pavements have vegetation cloaking the clint tops and a more continuous tree cover, although clearings may be frequent. These types of pavement have usually developed where grazing is low or absent. Woodland cover is the natural climax vegetation type on limestone pavement. Scrubby pavements form part of a continuum between open and wooded pavement. All three types are of conservation value because they form part of the complex mosaic of vegetation which is characteristic of limestone pavements (see 10.4.3) and areas of each should be retained. Features considered favourable for each type of pavement are given in Box 10.1.

Stone removal and disturbance

The first step in maintaining the interest of limestone pavement is to ensure that the pavement clints are not removed. Removing clints for use as decorative garden stone has been the major cause of loss of, and damage to, limestone pavement in Britain. Historically, stone has also been removed from pavements to produce lime, build dry stone walls and to supply local building materials. All limestone pavements will be covered by Limestone Pavement Orders (LPOs), which prohibit the removal of limestone from pavements (Webb 1995).

Disturbing and removing stone from limestone pavements is extremely detrimental to their geomorphological and geological interest. These landforms need initial glacial scouring to form, followed by thousands of years of sub-soil weathering to create the grikes and other solution features. Once damaged they will not re-form.

Disturbing and removing stone from pavements is also extremely detrimental to the plants and invertebrates of these habitats.

! Where clints are removed the grikes are reduced in depth and offer less shelter to plants. Most ferns, for example, die immediately.

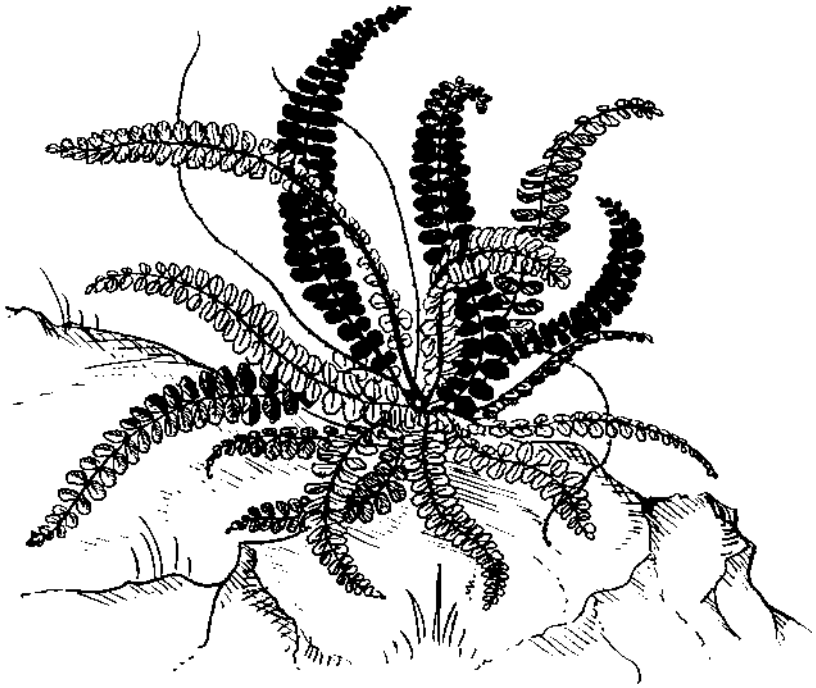
! The clint top solution features (runnels, pits, pans, etc) offer a variety of niches and microclimates to plants with different requirements, and these are immediately lost when clints are removed.

! Removal of clints is equally detrimental to invertebrate populations. It reduces cover, destroys the architecture of the grikes, which are important for web-building spiders, and changes the humidity, which will negatively affect the mollusc fauna.

! The debris from the extraction process fills the remnants of the grikes with chips of stone and rubble, and destroys these habitats.

! Lichens on the pavement, which grow very slowly indeed, are also lost with the extracted stone.

! All that remains when limestone pavement has been removed is horizontal scree, which cannot support the rare and specialised flora of intact pavement.



Maidenhair spleenwort

Box 10.1 Favourable features of limestone pavement

Open pavement

- A diversity of characteristic plant species, eg herb-robert *Geranium robertianum*, hart's-tongue fern *Phyllitis scolopendrium*, rigid buckler fern *Dryopteris submontana*, angular Solomon's-seal *Polygonatum odoratum*, downy currant *Ribes spicatum*, baneberry *Actea spicata*, dark-red helleborine *Epipactis atrorubens* and limestone fern *Gymnocarpium robertianum*.
- Wild flowers and ferns growing beyond the grikes and onto the clint tops, and producing flowers, seeds and spores, including species intolerant of grazing, eg bloody crane's bill *Geranium sanguineum* and baneberry.
- Scattered trees and shrubs of native species, eg hazel *Corylus avellana*, ash *Fraxinus excelsior* and juniper *Juniperus communis*.
- Abundant vegetation to encourage butterflies, spiders, snails and other invertebrates, eg fritillary butterflies.
- Transitions from pavement vegetation to other valuable habitats such as scrub, woodland, heath and species-rich grassland.

Scrubby pavement

- Scrub composed of native shrub species typical of the habitat, including abundant juniper and hazel stands.
- Frequent transitions between open and wooded pavement, because these are botanically the richest.
- A mosaic of habitat types, including scrub, open and wooded pavement, and species-rich grassland, to provide habitat diversity.

Wooded pavement

- Woodland composed of native species such as ash, hawthorn *Crataegus monagyna*, hazel, yew *Taxus baccata* and to a lesser extent oak *Quercus* sp and rowan *Sorbus aucuparia*.
- Open glades and woodland edges, to encourage butterflies and other invertebrates.
- Trees of all ages, to provide diversity in the woodland structure and height.
- Yew groves and juniper scrub, because these are native species typical of the habitat.
- Areas with mossy clints, which are important for invertebrates.
- Transitions from pavement vegetation to other valuable habitats such as scrub, woodland, heath and species-rich grassland.

Managing open limestone pavement

The majority of the higher altitude limestone pavement in England has been subject to heavy grazing, especially where it falls within common land, and this has led to an open nature. The lower altitude limestone pavements, which in England occur around Morecambe Bay, tend to be ungrazed and wooded and are dealt with below.

Heavy grazing generally lowers the species diversity of limestone pavements as it results in the vegetation being restricted to deep, narrow grikes. Plant species which are vulnerable to grazing or favour the top of the grikes, such as bloody crane's-bill *Geranium sanguineum*, lesser meadow rue *Thalictrum minus* and rigid buckler fern, are suppressed. Sheep are the main grazers of limestone pavements, but rabbits have a significant impact on some sites, not least because they are small enough to run along grikes and graze species not accessible to sheep.

Heavy grazing disturbs loose stones on and around pavements, and this reduces the likelihood of them being used by invertebrates which rely on stones for cover.

Restoration management of open limestone pavement

Restoration of heavily grazed pavements by total stock exclusion, for a limited period of five to ten years, may be the most effective way of improving the nature conservation interest of these pavements. This is likely to require fencing, and if so the impact of the fencing on adjacent grassland, as well as on agricultural and other land uses, should be considered. In many areas, a temporary exclusion of grazing could be beneficial to the nature conservation interest of the adjacent grassland because it is often heavily grazed. On many higher altitude pavements an additional complication is that they lie on common land, so permission to fence them will need to be sought from the Secretary of State for the Environment, once the commoners and all other relevant interest groups have been consulted.

Where the number of rabbits is significant and their grazing is restricting the abundance and diversity of plant species, rabbit *Oryctolagus cuniculus* control may be necessary (see Information Note 8).

Once the pavement has been returned to favourable condition the long-term maintenance regime of stocking at less than 1 ewe / ha (or cattle equivalent) should be introduced.

Maintenance management of open limestone pavement

Where pavements are considered to be in good (favourable) condition a maintenance management regime should be implemented. The optimum long-term stocking level to maintain the interest of English upland limestone pavements is less than 1 ewe / ha (or cattle equivalent).

For nature conservation interests, cattle are the preferred grazers for limestone pavement areas because they tend not to venture on to the uneven surface and hence the pavement remains little grazed. However, the pattern of land use around higher altitude pavements, at least, makes sheep grazing a more likely practice.

A stocking rate of less than 1 ewe / ha will generally involve a reduction in grazing for higher altitude limestone pavements. This will:

- increase species populations and species diversity;
- encourage grazing intolerant species, eg baneberry, lesser meadow rue;
- encourage species that favour grike top or clint top positions, eg bloody crane's bill;
- give more structure to the vegetation, with plants growing above the clints, including woody species such as hazel, hawthorn, yew and juniper;
- provide shelter for invertebrates, eg butterflies such as fritillaries and the northern brown argus *Aricia artaxerxes*;
- support a mosaic of species-rich grassland, heathland and pavement, with associated transitions and habitat edges.

Some grazing, however, is considered beneficial as it:

- prevents 'scrubbing up';
- maintains the interest of surrounding pasture;
- keeps geological and geomorphological interest features accessible.

A range of grazing regimes, from less than 1 ewe / ha, to some very lightly grazed situations and other areas completely ungrazed, is desirable to increase the diversity of the limestone pavement resource as a whole.

Rabbit control may be necessary in areas of limestone pavement where numbers are significant and rabbit grazing is restricting plant species abundance and diversity. See Information Note 8 on rabbit control in the uplands for more details.

Grazing does not harm the geomorphological or geological interest of limestone pavement. It is unlikely that even in the absence of grazing limestone pavements will become covered with scrub to such an extent that the geomorphological or geological interest will be harmed. It takes many years for vegetation to establish on pavements and, although grikes are warm, humid and stable environments, plants do not always survive beyond these niches.

Stock feeding

Stock feeding in areas of nature conservation interest can lead to nutrient enrichment and poaching of the ground, resulting in the loss of characteristic plants and animals. The following recommendations apply to stock feeding on limestone pavement and the surrounding habitats.

- seek to avoid stock feeding wherever possible but if unavoidable keep it to a minimum and normally in severe weather;
- do not place feed on areas of limestone pavement or any other areas of wildlife interest;

- where stock feeding is undertaken do not cause poaching to surrounding habitats (other than in sacrificial areas);
- locate a permanent feeder in a place with no conservation value and treat this as a sacrificial area;
- where this is not possible, feed in small quantities at widely scattered sites, avoiding using the same sites;
- or rotate the feeding sites to avoid excessive pressure on any one area.

Application of surface treatments and infilling

Fertilisers, slurry and farmyard manure can all seriously damage the flora and fauna of limestone pavements and associated semi-natural habitats. They should not be applied to limestone pavements or surrounding grasslands.

Limestone pavement and other karst (limestone) landforms are vulnerable to damage by dumping and infilling. Shakeholes and cave entrances are all too convenient dumps for farmyard rubbish. Many of the shakeholes and depressions on the Mendip Plateau, for example, have been lost in this way.

Managing scrubby limestone pavement

Scrubby limestone pavement may have features of both open and wooded pavement, with shrub species reaching a height of around 3 m. This habitat, especially where dominated by native species such as hazel or juniper, is valuable in its own right and it should be retained rather than changed into either wooded or open pavement.

Management of scrubby pavement involves removing invasive species such as bramble, *Rubus fruticosa* blackthorn *Prunus spinosa*, gorse *Ulex* spp and cotoneaster *Cotoneaster* spp where they are shading out the pavement flora. Where woodland cover threatens to dominate the pavement, coppice management or stock reintroduction at less than 1 ewe / ha should be considered.

Managing wooded limestone pavement

Wooded pavements have a closed canopy of trees and shrubs covering the clints, which are often cloaked with a dense moss carpet. Clearings and glades may be present, and the lower branches of yews and junipers may have developed into a broad skirt of foliage. While these pavements may not be open to domestic stock, wooded pavements may still be grazed or browsed by deer or rabbits.

In wooded pavements, management is required to maintain some open glades, both for plants of woodland edges and invertebrates, particularly butterflies. Many wooded pavements were traditionally managed as coppice woodland, but this practice has declined in recent decades, resulting in reduced species diversity in many cases (UK Steering Group 1995). Chapter 8 Woodland and scrub considers the pros and cons of different woodland management regimes in greater detail.

! Coppice or woodland management should be maintained where it is currently practised and should be reintroduced where it has lapsed. The introduction of coppicing to wooded pavements where it was not previously practised may enhance their nature conservation value, but there is probably some value in long-term rotations or maintaining high forest on some sites to provide diversity.

! Where pavements are managed as high forest, heavy thinning and selective felling should be used in rotation to open up the canopy and create glades. Where present, rides should be widened or at least maintained (Guest 1997).

! Yew and juniper should be retained and not felled or coppiced because they are native species characteristic of this habitat. Similarly, hazel should not be cleared, although it may be appropriate to coppice this species. Veteran trees, some of which may be very small because of the stressed conditions for growth, should also be retained.

! Many wooded pavements have been planted with, or invaded by, alien species such as sycamore *Acer pseudoplatanus*, beech *Fagus* spp, conifers and cotoneaster. Beech and conifers should be removed from pavements because they have an adverse effect on the underlying flora through shading, acidification and smothering, resulting from leaf or needle fall (Guest 1997). Cotoneaster should be removed because it ousts native species. Sycamore should also be removed where its presence is thought to threaten the nature conservation interest of a pavement.

! Deer control or fencing may be required on some wooded pavements, particularly where they are managed as coppice. Heavy deer browsing may prevent coppice re-growth.

! Dense growth of shrubs, such as blackthorn or bramble, can shade out a number of the more uncommon species associated with pavements, such as baneberry. Where this is occurring, or threatening to occur, scrub clearance should be carried out.

! Mossy clints support rare invertebrates such as the whorl snail *Vertigo augustior*. Such clints should be protected and the moss cover maintained.

Further information: English Nature 1993a; Craven Limestone Grassland Wildlife Enhancement Scheme (WES); Mercer & Evans 1997; Boxes 10.1 - 10.4.

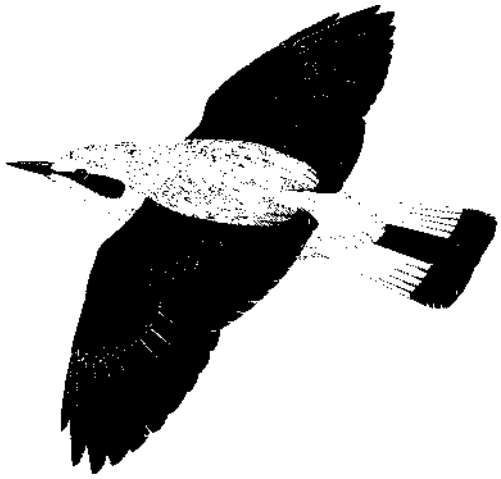
Box 10.2. English Nature Craven limestone grassland Wildlife Enhancement Scheme (WES)

The standard (Tier 1) Craven limestone grassland WES prescription is given below. This largely relates to areas of pavement within areas of limestone grassland.

- Graze at 1 ewe / ha (or equivalent or lower) for a continuous eight week period between 1 May and 31 August.
- At other times graze at 2 ewes / ha or equivalent.
- Cattle grazing in summer is preferable as they spend less time on the pavement than sheep.
- Lambs (to 31 October) and calves at foot are included.
- Stock feeding only in agreed areas of low nature conservation value.
- No applications of manure, fertiliser or lime.
- Fence at least one area of ungrazed land (preferably pavement) on the holding.
- Control rabbits if necessary.

As part of this scheme land owners are encouraged to exclude stock from areas of limestone pavement to promote woodland regeneration.

Examples of the effects of various stocking regimes are given in Box 10.3 and Mercer & Evans 1997.



Wheatear

Box 10.3 Examples of management on limestone pavement areas under the EN Craven limestone grassland WES

Malham-Arncliffe SSSI (Knotts)

Habitats:	A mixture of limestone pavement, calcareous grassland and acid grassland.
Management:	2 ewes / ha April No stock May-August *c* 1.25 ewe / ha September-October No stock November-March Cattle and sheep stocked.
Effects:	Limestone fern *Gymnocarpium robertianum* showed a 100% increase in shoot numbers in the pavement between 1994 and 1996. Northern brown argus *Aricia artaxerxes* butterflies appeared on the site in 1996.

Malham-Arncliffe SSSI (Clowder)

Habitats:	A mixture of limestone pavement, calcareous grassland and acid grassland, with scattered ash.
Management:	0.5 ewes / ha May-August 1 ewe / ha approx. September-October No stock November-April Cattle and sheep. Some protection of ash from grazing using 1.2 m tree shelters.
Effects:	Significant regrowth of ash in grikes, together with a probable increase in limestone fern abundance.

Malham-Arncliffe SSSI (West Gordale)

Habitats:	A mixture of limestone pavement, calcareous grassland and acid grassland.
Management:	
1993-1995:	1 ewe / ha for eight weeks between May-August 2 ewes / ha at other times Sheep only
1995 onwards:	2 ewes / ha May 4 ewes / ha September-November No stock at other times Sheep only
Effects:	Baneberry *Actaea spicata* showed increased fruiting and suspected increased patch size and number of plants. Lily of the valley *Convallaria majalis* re-recorded after 20 years absence.

Box 10.4 Further examples of management on limestone pavement areas

Southerscales Yorkshire Wildlife Trust Reserve, Ingleborough

A nature reserve of 43 ha with large areas of grassland amongst the pavement.
Stocking:

1 June-31 July	10 cattle	(equivalent to 1.1 ewes / ha)
1 August-31 August	10 cattle + 20 ewes	(equivalent to 1.5 ewes / ha)
1 September-31 October	100 ewes	(equivalent to 2.3 ewes / ha)
1 November-30 April	40 ewes	(equivalent to 0.9 ewes / ha)

If the site consisted of pavement alone stocking levels would need to be lower.

Gait Barrows National Nature Reserve, Lancashire

This low altitude site has no stock grazing, but deer control is carried out to protect areas of coppice regrowth. A programme of active coppicing is carried out to benefit both butterflies and the ground flora. Some areas of coppice are protected by deer-proof fences.

Whitbarrow National Nature Reserve, Cumbria (Cumbria Wildlife Trust Hervey Reserve)

A low altitude limestone grassland and pavement reserve. Grazing has recently been reintroduced at 0.7 ewes / ha from August to November.

Underlaid Wood, Marble Quarry & Hale Fell and Middlebarrow (Forest Enterprise woodlands in Cumbria with limestone pavement)

All these areas are actively managed as coppice. Areas of Corsican pine *Pinus nigra*, spruce *Picea* spp, beech and red cedar *Thuja plicata* are being progressively cleared to leave open pavement or limestone grassland.

Yew

Public access

At low levels public access is unlikely to have a significant effect on the nature conservation interest of limestone pavements. High levels of public pressure could result in trampling damage to the pavement flora, especially lichens and mosses, solution features and, on pavements where the clints are loose, could result in the dislodging of clints.

In situations where the encouragement of public access is thought to be beneficial serious consideration should be given to the public liability aspects of such action. This is because limestone pavements can provide a very unstable surface for walking, so there is a significant risk of visitors tripping or falling into grikes, which could result in serious injury. They are also very slippery when wet, in frost and when polished smooth by the passage of many feet.

10.6.2 Managing crags and scree

Grazing

Crags and cliffs are often the only areas free from grazing in upland situations, both above and below the fell wall. Even so, traditional upland breeds of sheep are remarkably agile and only the most inaccessible ledges remain totally free of grazing, particularly where stocking levels are high. Tall-herb ledge communities such as U17 *Luzula sylvatica – Geum rivale* community and the majority of plant species associated with ledges and rock faces are highly sensitive to grazing and are largely restricted to situations which are almost entirely free of grazing. Even on the largest upland sites this can mean that these communities and species are restricted to a few individual ledges and rock faces.

As a result of the high grazing pressures on many montane and moorland situations in England, many species and communities are frequently restricted to those rock exposures where the grazing pressure is lower (because of reduced accessibility to stock), in addition to those species which are truly associated with rock faces and ledges. In some circumstances the only areas of dry heath or woodland present are confined to these locations. In England, high altitude willow scrub (W20 *Salix lapponum-Luzula sylvatica* scrub) is reduced to a few isolated bushes of downy willow *Salix lapponum* on ledges inaccessible to sheep (Jerram 1997d). Under reduced grazing intensities this community extends on to hillsides away from rock ledges and the latter are indeed considered to be a sub-optimal habitat for this species (Mardon 1990 & 1996).

In situations where species or communities of nature conservation interest are restricted to inaccessible ledges by grazing, grazing levels on the surrounding land or management unit should be reduced to a level that will allow the spread of the species and/or community concerned. Chapter 6 Moorland, and Chapter 7 Meadows and enclosed pasture, give guidelines for appropriate stocking levels. Where it is not possible to reduce grazing levels in the grazing unit as a whole, consideration should be given to fencing off sections of hillside containing suitable habitat/conditions into which the species or community can spread (see Information Note 7 on fencing).

Fencing can be a contentious issue in moorland or montane situations, largely because of potential implications for access and other land uses, and the potential for its visual intrusion on the landscape. Where fencing is required on common land permission from the Secretary of State for the Environment

is required, once the commoners and all other relevant interest groups have been consulted and have agreed the proposal.

Heavy grazing of rocky habitats makes disturbance of individual stones and screes more likely. This reduces the likelihood of them being used as cover by invertebrates that live under stones (lapidocolous species). As with other upland habitats low, rather than high, stocking levels will be beneficial to the nature conservation interest of scree. It is not thought that scree requires a different management regime from that for the surrounding land. However, where scree forms a high proportion of the land cover, the stocking rate should be calculated for the vegetated area only.

Stone removal and disturbance

Use of stone for wall construction and repair is widespread and in most instances has had little impact on the nature conservation interest of rock features. However, the extensive use of stone and scree for major new projects such as footpath stone pitching and new wall construction could harm fragile plant and animal communities and destroy geological and geomorphological features.

Public access, recreation and human disturbance

Recreational activities and human disturbance can have significant, localised effects on the nature conservation interest of crags and screes.

Frequent disturbance by rock climbers can cause cliff-nesting birds, for example, peregrine, to abandon nests, either permanently, or for long enough for eggs to go cold, resulting in breeding failure. Such incidents are thought to be uncommon and there have been occasional examples of peregrines successfully rearing young on cliffs that are regularly climbed. It seems likely, however, that the small number of records for climbers disturbing peregrines is at least partly due to peregrines avoiding nesting on regularly climbed cliffs (King 1989).

Where climbing is considered to be a significant threat to the breeding success of peregrines, voluntary restrictions on climbing during the breeding season have been introduced by nature conservation organisations in conjunction with the British Mountaineering Council (BMC). These have by and large been successful and are respected by the majority of climbers, providing that they have been well publicised. King (1989) recommends that:

- Restrictions should only be imposed where peregrines are nesting on a climbed cliff.
- They should not be imposed in situations where birds might nest on a cliff or because a cliff is close to one on which peregrines nest.
- Publicity is essential and should be in the form of on-site signs, both at the base of the cliff and on the approach routes.
- In seasons where nesting fails or birds do not take up residency at all restrictions should be lifted for the remainder of that season.

Rock climbing, especially the establishment of new routes, can also damage the botanical interest of cliffs and ledges. The removal of vegetation from ledges ('gardening') can have a serious impact on the vegetation of crags. Evidence from Borrowdale in Cumbria shows that vegetation re-establishing after gardening is of significantly less interest than the vegetation present before the disturbance (Karen Slater, pers comm). This remains a significant issue in England.

Concern has recently been expressed about the effects of winter, or ice, climbing on rare arctic-alpine plants and an evaluation of this is currently being undertaken by the Lake District National Park (Lake District National Park Authority 1997a). The principal concern has been for climbing when snow and / or ice conditions are poor, that is there is only a very thin layer of snow / ice over the rock. The main reason for this concern is where there are only very small numbers (often fewer than ten) of individual plants present of some of the rarer species, which makes them highly susceptible to chance extinctions which could be exacerbated by plants being accidentally kicked off by a climber. Should a problem be found then restrictions on climbing in poor snow or ice conditions may be introduced (P. Davies, pers comm). Such restrictions should only be introduced following a detailed survey of plant locations and a study of climbing routes.

Scree is highly unstable in many situations and the fragile plant communities which develop within it are easily damaged by frequent trampling. Wherever possible new footpaths should be routed around, rather than across scree. This is particularly important on limestone scree as this can support a number of nationally rare and scarce plant species.

10.6.3 Managing bracken

Limestone pavements, other rock exposures and scree support many species of fern susceptible to the chemicals used to control bracken. Other plants of these habitats may also be adversely affected by chemical treatments for bracken control. With aerial spraying, even the drift of chemicals used on adjacent areas can be harmful to rock habitats, and large no-spray buffer zones are required around pavements, crags and scree to ensure that no adverse effects occur. Weed wiping chemicals directly onto the bracken or hand spraying are preferable to aerial spraying, but again buffer zones should be identified and adhered to. For further information on bracken management, see Information Note 6.

Table 10.1 Nationally rare and scarce vascular plants associated with crags, scree and limestone pavement in England

(Note: See also Chapter 5 for species predominantly of montane areas)

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Actaea spicata baneberry	LR-ns	Shaded sites on soils over calcareous rocks, such as on ledges of scars, in deciduous woods and in grikes in limestone pavement. It will tolerate dense shade but not competition from more vigorous plants.	! In sites where the plant is threatened by the growth of vigorous species, these should be controlled.	Cumbria Fells & Dales North York Moors and Hills Yorkshire Dales
Alchemilla glomerulans	LR-ns	A variety of ungrazed or lightly grazed habitats on base-poor rocks in mountains. In Teesdale, also in species-rich hay-meadows and roadsides.	! Prevent heavy grazing.	Border Uplands North Pennines Yorkshire Dales
Alchemilla wichurae	LR-ns	Damp, basic soils or rocks. See Table 6.1.	! Where it grows on track sides, it needs protection from trampling by walkers and off-road vehicles. ! Roadside populations need to be protected from agricultural enrichment which promotes the growth of coarse grasses.	Cumbria Fells & Dales North Pennines Yorkshire Dales
Allium ampeloprasum var. *babingtonii* Babington's leek	LR-ns	Rank vegetation on road verges or field edges which are not often cut or grazed. It can become quite invasive[1] and has increased its range.	! It is likely to benefit from moderate disturbance. ! It should not be cut and grazing should be at most light. ! At some sites, the growth of scrub may need to be controlled.	Dartmoor
Allium schoenoprasum chives	LR-ns	On thin soil in sparsely vegetated, rocky habitats which fluctuate between very wet and bone dry, often over limestone with winter annuals.	! Prevent destruction of the habitat, which otherwise requires little management.	Border Uplands Cumbria Fells & Dales
Arenaria norvegica ssp *anglica* English sandwort	Sched. 8 of WCA VU, EE	A stress-tolerant species of bare substrates, either on shallow, dry soils on the edge of limestone pavement or on frequently flushed slopes around the edges of flushes and mires. See Table 6.1.	! Where necessary, protect the sites from recreational damage by walkers and off-road vehicles. ! Control grazing at the sites to moderate levels. Levels of less than 1.5 ewes per hectare during the growing season have allowed populations to thrive. Moderate grazing is preferable to no grazing.	Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Asplenium obovatum lanceolate spleenwort	LR-ns	Frost-free, sheltered, shady crevices and ledges on exposures of non-calcareous rocks, cliffs and dry stone walls. Also where a slight seepage of permanent moisture occurs with very free drainage and good air movement.[2] It is intolerant of competition from dense flowering plants and heavy grazing by snails.[3]	! It is thought that this species may be sensitive to pollution of ground water and of air (Page 1982). Therefore sites should be protected from pollution, including agricultural run-off.	Bodmin Moor Cumbria Fells & Dales Dartmoor Exmoor and the Quantocks
Asplenium septentrionale forked spleenwort	LR-ns	Steep or vertical faces of hard, base-poor, dark-coloured volcanic and metamorphic rocks. Also on old earthy, unmortared walls on dry, south facing, unshaded slopes. It is intolerant of shade, waterlogging and competition from gorse and other shrubs.	! Landscaping or reclamation should avoid damage to the habitat. ! Where necessary, shrubs should be cleared away.	Cumbria Fells & Dales Dartmoor North Pennines
Asplenium trichomanes subsp. *pachyrachis* lobed maidenhair spleenwort	DD	Perpendicular calcareous rocks, in crevices or under overhangs or on walls where non-calcareous rock is used with calcareous mortar. Normally in well shaded sites with relatively high humidity. It seems to be intolerant of water retained in the crown and favours sites where it is sheltered from direct rain.	! Plants on walls are vulnerable to destruction when walls are cleaned or maintained and should be protected from this.	Border Uplands North York Moors and Hills Pennine Dales Fringe
Cardamine impatiens narrow-leaved bitter-cress	LR-ns	Shaded places including grikes in limestone pavement, deciduous woodland, scree, riverbanks and damp roadsides, often on calcareous rocks.	! Prevent the destruction of limestone pavement.	Clun and North West Herefordshire Hills Cumbria Fells & Dales Dark Peak White Peak Yorkshire Dales
Carex digitata fingered sedge	LR-ns	Open woods and on scree and the shaded ledges of limestone quarries. Always on soil with a high calcium content, high pH (7.3-8.0), good drainage and some protection from drying-out. Some shade is required but the plants will die out under dense shade, leaving dormant seed which will germinate following disturbance.	! Prevent destruction of limestone pavement and afforestation. ! Woodland management such as lopping, felling, clearing of rides or coppicing would benefit this species at some sites.	Cumbria Fells & Dales North York Moors and Hills Pennine Dales Fringe Shropshire Hills White Peak

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Carex muricata muricata prickly sedge	CR Priority	Bushy and grassy areas on steep, dry limestone slopes. It may be intolerant of heavy grazing and is found in rather scrubby sites.[4] But may also be out-competed in the absence of grazing.[5]	! Prevent succession towards woodland. ! Avoid heavy grazing, but do not eliminate grazing. ! See Species Action Plan (UK Biodiversity Group 1998).	Yorkshire Dales
Carex ornithopoda bird's-foot sedge	LR-nt	Open, calcareous grassland on Carboniferous limestone, often on thin, parched soils, which require light grazing to maintain the open character of the vegetation. See Table 6.2.	! Maintain light or moderate levels of grazing.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales
Circaea alpina Alpine enchanter's nightshade	LR-ns	Open and usually shaded or north-facing seepage areas or stream sides. The main method of reproduction is probably by rhizome but it does fruit freely. It may have declined owing to competition with the closely related and much more vigorous hybrid, *C.* x *intermedia*. See Table 8.1.	! Protect sites from drainage.	North Pennines White Peak Yorkshire Dales Cumbria Fells & Dales
Dianthus deltoides maiden pink	LR-ns	In sandy grassland or heath and amongst detritus on rocky exposures, especially on sunny slopes on soils with some base content, such as those derived from Silurian sandstones, basalt, mica-schist or Carboniferous limestone. Usually growing where the sward is broken by bare rock or soil. In Derbyshire it grows in fairly tall species-rich vegetation on metalliferous spoil. Although susceptible to heavy grazing, at many sites it requires some grazing to maintain an open sward.	! Control levels of grazing and other disturbance to moderate levels. ! See Species Action Plan (UK Biodiversity Group 1998).	Border Uplands Clun & North West Herefordshire Hills Dark Peak North Pennines North York Moors and Hills Shropshire Hills White Peak
Draba muralis wall whitlow grass	LR-ns	An overwintering annual of Carboniferous limestone, growing on open, unstable soils with a pH of more than 6.5, on stony ground such as the edges of screes or quarry debris where there is enough soil to support it, sometimes in very open ash woodland. It avoids the shallowest and driest soils.[6]	! Protect sites from habitat destruction.	Border Uplands Dark Peak Forest of Bowland White Peak Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Dryas octopetala mountain avens	LR-ns	Shallow, well drained soil over limestone or base-rich rock. See Table 5.1.	! At some sites, the populations need to be protected from erosion caused by walkers or heavy grazing by livestock or rabbits.	North Pennines Yorkshire Dales Cumbria Fells & Dales
Dryopteris submontana rigid buckler-fern	LR-ns	Pockets of moist, freely draining soils in Carboniferous limestone pavement, cliffs or rough screes. It needs some protection from grazing and from strong winds, thriving best where there is a layer of at least 15-20 cm of reasonably sheltered but not stagnant air above its rhizome. Such conditions are usually found in the bigger grikes or amongst large boulders but some plants grow on the surface amongst scrubby wood of yew, juniper or hawthorn. It is intolerant of heavy shade.[2]	! Sites should be protected from limestone quarrying and removal of limestone pavement. ! Grazing levels should be controlled to preferably light, or moderate, levels to encourage the establishment of young plants.	Cumbria Fells & Dales Forest of Bowland North Pennines White Peak Yorkshire Dales
Epipactis atrorubens dark-red helleborine	LR-ns	Carboniferous or magnesian limestone scree or pavement. Sites include exposed, bare scree, well wooded limestone pavement and especially wide, shallow grikes filled with small, broken scree in thinly wooded situations. Damage by deer and rabbits reduces its reproductive capacity, and often only inaccessible spikes set seed. It does not tolerate deep shade, nor heavy browsing or grazing, particularly in summer.	! Limestone pavement, cliffs and some screes may not require management. ! Some sites need protection from quarrying of limestone. ! Light grazing or cutting of scrub may benefit some populations; grazing by sheep between September to April to leave a sward of about 10 cm tall with up to 10% bare ground is suggested for grazed sites. ! See Rich (1997) for more details.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales
Euphrasia ostenfeldii	LR-ns	Exposed and very well drained habitats, usually with very limited cover of vascular plants, including limestone rock ledges and fine gravel screes.	! Protect sites from habitat destruction.	Cumbria Fells & Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Gymnocarpium robertianum limestone fern	LR-ns	Broken ground, usually cracks and fissures, on limestone screes and pavement. It thrives on sunny, exposed rocks and can tolerate light woodland cover, sometimes occurring in shady grikes, but not dense shade or stagnant air. It seems to be sensitive to pressure of grazing, especially by sheep but also rabbits and deer; it can be slowly excluded if dense growths of dog's mercury or hawthorn develop.[2]	! Protect sites from limestone quarrying and removal of limestone pavement. ! Prevent excessive growth of dense woodland. ! Some sites may require grazing to be controlled if this species is to thrive.	Black Mountains and Golden Valley Cumbria Fells & Dales Exmoor and the Quantocks North Pennines Oswestry Uplands Southern Pennines White Peak Yorkshire Dales
Helianthemum canum hoary rock-rose	LR-ns	Limestone exposures and cliffs, especially in exposed south-facing sites prone to summer drought. Often on the upper parts of exposures and in sparse vegetation on shallow soil near the edges of cliffs. Moderate grazing may allow the species to colonise adjacent grassland.[4]	! Protect sites from habitat destruction.	Cumbria Fells & Dales North Pennines
Helianthemum canum spp *laevigatum* hoary rock-rose	VU, EE	On granular sugar limestone, on loose and open gravel and in more open grassland. Often on humus-rich but skeletal soil on a broken rocky slope. Growth and reproduction are suppressed by heavy grazing by sheep or rabbits.	! Those parts of the population currently protected from grazing should continue to be fenced. ! Grazing in other areas should if possible be reduced.	North Pennines
Hornungia petraea Hutchinsia	LR-ns	In open vegetation with bare soil which is dry in summer and moist in winter, on south or southwest facing slopes on Carboniferous limestone. A certain amount of disturbance by grazing can be beneficial.	! Protect sites from habitat destruction.	Cumbria Fells & Dales Oswestry Uplands White Peak Yorkshire Dales
Hypericum linariifolium toadflax-leaved St. John's-wort	LR-nt	Steep rocky slopes with a southerly aspect in open areas surrounded by woodland in steep inland valleys, where thin soils have developed over acid rocks. It is a poor competitor and needs patches of bare soil to germinate. Past declines have been associated with invasion of scrub onto formerly open habitats and fire is also considered to be a risk to the species. It may be that the species is also vulnerable to introgression with *Hypericum humifusum*.	! Where relevant, scrub removal should be used to keep the vegetation open. ! So far as possible sites should be protected from fire damage.	Dartmoor

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Meconopsis cambrica Welsh poppy	LR-ns, I	Moist, shady, rocky places, often under trees and usually on base-rich soils.	! Protect sites from destruction	Exmoor and the Quantocks
Minuartia hybrida fine-leaved sandwort	LR-ns	Dry, weathered, calcareous rocky slopes, also quarries, old walls, road verges and railway banks and sidings. In arable and grassland sites it is susceptible to agricultural 'improvement'.	! Protect sites from destruction. ! Where relevant, protect sites from damaging agricultural practices.	Pennine Dales Fringe White Peak Yorkshire Dales
Minuartia verna spring sandwort	LR-ns	Open or semi-open short grassland over calcareous rocks, among limestone rocks and scree or on old lead and zinc mine spoil, often associated with sites liable to soil erosion. Also on base-rich rock ledges and gullies, often at high altitude. The distribution is mainly restricted to sites with an annual rainfall of at least 100 cm and the species is susceptible to summer drought.[7] It is threatened by insufficient grazing, which allows the sward to become too closed for the species.[4]	! Protect major sites from destruction. ! Where possible, sites should be heavily grazed. Other forms of disturbance may be required where heavy grazing cannot be arranged.	Cumbria Fells & Dales Dark Peak North Pennines Pennine Dales Fringe South West Peak White Peak Yorkshire Dales
Orobanche alba thyme broomrape	LR-ns	Parasitic on plants of thyme on rocky slopes below low cliffs. Newly germinated seedlings can be damaged by grazing, especially by rabbits.	! Protect sites from destruction.	Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Polemonium caeruleum Jacob's-ladder	LR-nt	Cool, moist, north-facing slopes of Carboniferous limestone. It is sensitive to drought and relies on a damp microclimate, often on damp north-facing slopes with a light canopy of trees or scrub, on thin organic soils. Grazing suppresses flowering and is thought generally to be undesirable, but on those sites prone to succession to woodland, very light and occasional grazing might be needed to maintain the appropriate structure of the vegetation. Cattle are thought to cause less damage than sheep.[8] See Table 8.1.	! The following management prescriptions are thought appropriate but are still experimental. ! Where sites are part of grazing units, grazing by cattle between early September and the end of December for one in every three years; density of stock should be low enough to prevent poaching. ! Occasional mowing or strimming, for example once every three years may be a substitute where grazing is not practicable. ! Where populations are confined by grazing to ledges, fencing off the adjacent vegetation and reducing grazing there may allow the population to expand. ! Where plants grow in dense shade, thinning of the canopy may benefit the plants. ! For more details, see Rich (1997).	Border Uplands Yorkshire Dales Dark Peak
Polygonatum odoratum angular Solomon's-seal	LR-ns	Limestone in ancient woodland or limestone pavement, preferring well drained steep slopes or small cliffs. Plants do not appear readily able to colonise new sites.	! Protect sites from quarrying of limestone and removal of limestone pavement.	Yorkshire Dales Cumbria Fells & Dales White Peak
Potentilla crantzii alpine cinquefoil	LR-ns	Steep, dry faces and ledges of calcareous and base-rich rocks or close-grazed calcareous grassland. See Table 5.1.	! Populations which are accessible to stock should be protected from heavy grazing.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales
Potentilla fruticosa shrubby cinquefoil	LR-ns	In Teesdale, in cracks between boulders in the bedrock of river banks and islands and on silty stabilised shingle banks and islands. In the Lake District on rock ledges and cracks in rock faces. See Table 5.1.	! Protect sites from habitat destruction. ! Protect from grazing.	Cumbria Fells & Dales North Pennines Pennine Dales Fringe
Potentilla neumanniana spring cinquefoil	LR-ns	Open vegetation on seasonally parched, skeletal soils in base-rich habitats, such as limestone crags and scree. It can persist under light scrub but disappears with prolonged exposure to shade. Some, mainly lowland, sites have been lost as rank vegetation and scrub develops with the cessation of grazing.	! Some sites may require control of rank grasses or scrub, by cutting or grazing.	Cumbria Fells & Dales Oswestry Uplands White Peak Yorkshire Dales

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Ribes spicatum downy currant	LR-ns	Rocky woods on basic soils. The species is hard to identify except when in flower and is thought to be under-recorded.	! Protect major sites from habitat destruction.	Border Uplands Yorkshire Dales North Pennines Pennine Dales Fringe Cumbria Fells & Dales
Sedum forsterianum rock stonecrop	LR-ns	Open grassland on rocks and scree, usually in open, dry situations such as rock faces and broken cliffs, although occasionally in wet woodland. It seems to have become more common and may benefit from increased grazing.	! Protect major sites from destruction.	Clun & North West Herefordshire Hills Exmoor and the Quantocks Oswestry Uplands Shropshire Hills
Sesleria caerulea blue moor-grass	LR-ns	Open communities on shallow, well drained rendzina soils in areas of Carboniferous or Permian limestone. Also in scree, crevices and ledges of scars, extending some way onto the usually non-calcareous overlying drift so long as this is shallow. Sometimes found in the light shade of limestone ash woodland. Moderate grazing seems to benefit the species.[4]	! Protect major sites from destruction. ! Moderate grazing should be maintained.	Border Uplands Cumbria Fells & Dales Pennine Dales Fringe North Pennines White Peak Yorkshire Dales
Sibthorpia europaea Cornish moneywort	LR-ns	Humid microclimates in sheltered sites on acidic soils and rocks. Often growing above small streams and ditches, usually shaded, also at the edge of granite massifs where there are numerous streams.	! Protect sites from changes in the hydrology and water regime.	Bodmin Moor Dartmoor Exmoor and the Quantocks
Sorbus lancastriensis	LR-nt, EE	Rocky scrub and woodland on Carboniferous limestone.	! Protect major sites from habitat destruction and damage to individual trees.	Cumbria Fells & Dales
Sorbus porrigentiformis	LR-ns, E	Rooted into the crevices of cliffs and exposures of Carboniferous limestone or Old Red Sandstone, usually in well lit places, sometimes under a canopy of trees.	! Protect sites from destruction.	Exmoor and the Quantocks

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Sorbus rupicola	LR-ns	Steep rocky slopes or cliffs of limestone.	! Protect major sites from destruction.	Cumbria Fells & Dales Exmoor and the Quantocks North Pennines Oswestry Uplands White Peak Yorkshire Dales
Sorbus vexans	VU, EE	Open woodland of sessile oak *Quercus petraea* on steep slopes of Old Red Sandstone or slate.	! Protect sites from destruction. ! If the populations become threatened by the spread of rhododendron, then this should be controlled.	Exmoor and the Quantocks
Thlaspi caerulescens alpine penny-cress	LR-ns	A pioneer colonist of metalliferous mine wastes and river gravels contaminated with lead, zinc and cadmium, often in limestone areas but also on shales. Usually in open vegetation but able to persist in a more closed turf. It is threatened by insufficient grazing, which allows the sward to become too closed for the species.[4] See Table 5.1.	! Protect major sites from destruction. ! Where possible, sites should be heavily grazed. Other forms of disturbance may be required where heavy grazing cannot be arranged.	Border Uplands North Pennines White Peak Yorkshire Dales
Trichomanes speciosum Killarney fern	Sched. 8 of WCA Annex IIb VU Priority	The larger, vascular form of this fern, or sporophyte, is extremely rare and grows in conditions of high humidity, permanent running groundwater and extreme shelter, often in very low light. Typically it is found in wet caves, steep-sided ravines or under over-hanging rocks, occasionally it is epiphytic on tree-boles. The gametophyte has been discovered to be much more common and new sites are still found regularly, in very dark, damp recesses in natural rock, often sandstone or shales. It reproduces asexually and persists at very low levels of light where competition, even from bryophytes and algae, is minimal.[3]	Research into the management needs of this species is on-going. **Sporophyte:** ! Maintain the microclimate, particularly the water regime and water quality. ! Protect sites from the attentions of collectors by maintaining strict confidentiality. **Gametophyte:** ! Protect known sites from habitat destruction until the autecology and distribution of the species are better understood. ! See Species Action Plan (UK Steering Group 1995).	**Sporophyte**: Cumbria Fells & Dales, Pennine Dales Fringe. **Gametophyte**: Border Uplands, Cumbria Fells & Dales, Dark Peak, Dartmoor, Exmoor and the Quantocks, North York Moors and Hills, Pennine Dales Fringe, Southern Pennines, South West Peak, Yorkshire Dales[9]

Plant species	Status	Habitat requirements	Management requirements	Distribution by upland Natural Area
Veronica spicata ssp. *hybrida* spiked speedwell	LR-ns	On rocks or shallow soil on cliff ledges, in crevices, on cliff tops and exposures mostly of Carboniferous limestone. It is moderately tolerant of shade and competition but can be out-competed by the development of scrub of native or introduced species. It will tolerate but not flower under heavy grazing.	! Protect sites from destruction. ! Where necessary, control the spread of scrub. ! Stock should be excluded from grazed sites from June to September to optimise seed production (Rich 1997).	Cumbria Fells & Dales Yorkshire Dales
Woodsia ilvensis oblong woodsia	Sched. 8 of WCA LR-nt Priority	Among hard, neutral igneous rocks facing north. See Table 5.1.	! Populations of this species have been damaged by collecting in the past and are still considered to be vulnerable. Site confidentiality should be maintained. ! See Species Action Plan (UK Biodiversity Group 1998).	Cumbria Fells & Dales

Key to Table 10.1

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

Red list categories

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

Biodiversity Action Plan (BAP)

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

Sources

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

1. K. Hearn, pers comm
2. Page 1982.
3. R. Cooke, pers comm
4. I. Taylor, pers comm
5. R. Goodison, pers comm
6. Rich 1991.
7. Grime, Hodgson & Hunt 1990.
8. Rich 1997.
9. F. Rumsey, pers comm.

Table 10.2 Nationally rare and scarce bryophytes associated with crags, scree and limestone pavement in England

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Aloina ambigua	LR-ns	Floors of limestone quarries, also on banks, soil, crumbling mortar on walls and on base-rich sandstone.	Bodmin Moor Cumbria Fells & Dales
Amblyodon dealbatus	LR-ns	Cliffs and gravel where flushed by calcareous water. See Table 6.2.	Border Uplands Cumbria Fells & Dales North Pennines Yorkshire Dales
Amblystegium compactum	LR-ns	In extensive, dense mats on limestone in deep shade, including damp rocks and soil below overhanging crags.	Border Uplands Pennine Dales Fringe South West Peak
Amblystegium confervoides	LR-ns	A calcicolous species typically occurring on limestone rock in shaded sites, usually in woodland. It is found in deep clefts in rock-faces, or on vertical faces of rock-scars or boulders, often amongst or shaded by robust bryophytes. Also growing on lumps of limestone on the ground in woodland and on damp basic rocks in the hills.	Forest of Bowland Pennine Dales Fringe South West Peak
Andreaea rothii subsp. *rothii*	LR-ns	On more-or-less exposed, periodically wet, acid rock.	Dark Peak
Anomobryum filiforme var. *concinnatum*	LR-ns	Montane and lowland rocks. See Table 5.2.	Border Uplands Yorkshire Dales
Anomodon longifolius	EN	On shaded, steep or vertical limestone or basic sandstone rocks, often in wooded valleys and ravines and on limestone rock-ledges.	Pennine Dales Fringe
Barbilophozia atlantica	LR-ns	Dry acid block-screes, rocky ravines, loch-side boulders and shady sandstone crags and river gorges.	Cumbria Fells & Dales Dark Peak Border Uplands South West Peak Yorkshire Dales
Bartramia hallerana	LR-ns	On usually dry, moderately calcareous rock crevices and overhangs in wooded ravines and on mountain cliffs.	Cumbria Fells and Dales Yorkshire Dales
Brachydontium trichodes	LR-ns	On vertical or slightly overhanging faces of ravines, mountain cliffs and boulders, on the sides of small boulders in stony flushes and on stones in stable screes and old quarries. Unshaded sites probably always have a north to east aspect. The substrate, which may be moderately calcareous to strongly acid, is most commonly sandstone but can be any of a wide range of soft siliceous rocks, including the crumbling weathered surfaces of igneous rocks such as granite and basalt.	Cumbria Fells & Dales Bodmin Moor Border Uplands North Pennines South West Peak

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Bryum elegans	LR-ns	Limestone rocks and turf. See Table 5.2.	Forest of Bowland Yorkshire Dales
Bryum intermedium	LR-ns	A calcicole forming green tufts on bare damp soil in sand dunes and quarries, on roadsides and waste ground, sometimes also on rock ledges and walls. This species is widely overlooked and probably occurs in many upland Natural Areas.	Border Uplands Cumbria Fells & Dales (and probably others)
Bryum pallescens	LR-ns	In dense tufts, green above and reddish-brown below, on soil in quarries, in crevices in rocks and walls, on concrete and mine-waste. It is tolerant of heavy metals. This species is widely overlooked and probably occurs in many upland Natural Areas.	Cumbria Fells and Dales Forest of Bowland (and probably others)
Bryum riparium	LR-ns	Crevices in rocks in stream-beds and other habitats. See Table 6.3.	Cumbria Fells and Dales Forest of Bowland
Calypogeia integristipula	LR-ns	Sandstone and gritstone rocks, and sandy or peaty banks in woodland and other shaded lowland and montane places. See Table 5.2.	Border Uplands North Pennines South West Peak Yorkshire Dales
Campylium calcareum	LR-ns	A strong calcicole, growing on limestone rocks and earth. See Table 8.2.	Border Uplands North Pennines North Yorkshire Moors & Hills White Peak Yorkshire Dales
Campylopus schwarzii	LR-ns	Among and on wet rocks. See Table 6.2.	Cumbria Fells & Dales
Campylopus setifolius	LR-ns	Found in a variety of moist acid habitats including on rock ledges and in block-screes. See Table 6.2.	Cumbria Fells & Dales
Campylopus subulatus	LR-ns	Unshaded, acid, gravelly and sandy places. See Table 6.2.	Forest of Bowland Cumbria Fells & Dales Bodmin Moor
Campylostelium saxicola	LR-ns	Wet or periodically flushed, acid or mildly basic sandstone, shale or slate blocks and stones in low-lying shaded ravines, gullies and wooded rivulets; also in damp crevices in bedded sandstone walls of shaded wooded ravines.	Border Uplands Cumbria Fells & Dales
Cephaloziella massalongi	VU	Confined to copper-bearing rocks and associated soils, chiefly on stony slopes of mine waste or the silt washed from it and in wall crevices around disused copper mines, in moist to wet situations.	Bodmin Moor

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Cephaloziella nicholsonii Greater copperwort	LR-nt, E Priority	Confined to copper-bearing rocks and associated soils, chiefly on stony stream-sides influenced by copper-rich rocks.	Bodmin Moor Exmoor and the Quantocks
Cephaloziella stellulifera	LR-ns	Most records are from mine-waste or from coastal sites, where it grows on heathland, soil in rock crevices on cliffs and in turf on cliff-tops. Also occasionally on heathy tracks or sandy ditch-banks inland, especially in plantations.	Bodmin Moor Exmoor and the Quantocks North Pennines Pennine Dales Fringe
Cololejeunea rossettiana	LR-ns	On shaded basic rocks, often limestone, in gorges, streams and woods and amongst other bryophytes or as pure patches on sheltered limestone rocks, cliffs and caves. Typically on dry rocks in humid situations but occasionally epiphytic on other bryophytes.	Cumbria Fells & Dales Forest of Bowland North Pennines Pennine Dales Fringe White Peak Yorkshire Dales
Colura calyptrifolia	LR-ns	Forming small dense pure patches or as scattered stems amongst other liverworts on damp, shaded rocks and boulders in humid situations including sheltered ravines, rocky gorges, low-lying wooded stream sides, lake sides and damp north- or east-facing montane cliffs. Also epiphytic on heather stems on steep, shaded block-strewn slopes and on conifer trunks. Favours mildly basic rocks.	Cumbria Fells & Dales Yorkshire Dales
Coscinodon cribrosus	LR-ns	On dry, very acidic, frequently friable slate or shale, in exposures or on walls. Also sometimes on harder rocks such as granite.	Cumbria Fells & Dales North York Moors and Hills Yorkshire Dales
Cynodontium jenneri	LR-ns	Acid rocks, usually sheltered or in light shade, rarely on stone walls, occasionally on sandy soils in woodland.	Cumbria Fells & Dales
Dicranella crispa	LR-ns	In a wide variety of habitats but apparently absent from markedly acid or basic substrates. Most typical on disturbed open soil on banks of gravel, clay, loam or sand by roads, rivers and streams. Also on rocks, especially vertical sandstone.	Yorkshire Dales
Dicranodontium uncinatum	LR-ns	On acid humus in sheltered moist north- to east-facing sites such as under heather on rocky slopes and on mountain cliff-ledges. At lower altitudes, locally abundant on north-facing periodically irrigated near-vertical rock-faces and in similar sites in wooded ravines.	Cumbria Fells & Dales Forest of Bowland

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Didymodon nicholsonii	LR-ns	Stones and tree roots on the banks of streams and rivers where subject to periodic flooding, sometimes embedded in alluvial sand or detritus.	Cumbria Fells & Dales Border Uplands Forest of Bowland Yorkshire Dales
Ditrichum cornubicum Cornish path-moss	CR, EE Priority	Only known location in the world is from copper-mine waste in two granite areas of Cornwall. See Species Action Plan (UK Steering Group 1995).	Bodmin Moor
Ditrichum plumbicola	LR-nt	Restricted to lead-mine spoil that is largely devoid of vascular plants, occurring in small pure patches or as scattered plants.	North Pennines
Encalypta rhaptocarpa	LR-ns	Dry or seasonally moist crevices and crumbling earthy ledges on limestone, highly calcareous schists or basalt or other soft, basic igneous rocks. See Table 5.2.	North Pennines Yorkshire Dales
Eurhynchium striatulum	LR-ns	A strict calcicole, confined in the uplands to areas of limestone where it occurs on dry shaded stones, rocks, walls and tree-roots, often forming quite extensive patches.	Yorkshire Dales
Fissidens limbatus	LR-ns	On compacted soil or on thin soil over rock. See Table 8.2.	Cumbria Fells & Dales Exmoor and the Quantocks Forest of Bowland White Peak
Funaria muhlenbergii	LR-ns	A calcicole forming yellowish green patches or found as scattered shoot on bare soil among rocks, in turf, on anthills or on thinly earth-covered rocks.	Cumbria Fells & Dales Oswestry Uplands White Peak Yorkshire Dales
Glyphomitrium daviesii	LR-ns	On dry, exposed, often sun-exposed or periodically irrigated south- or west-facing exposures or boulders of basic igneous rocks-such as basalt, gabbro and peridotite.	Cumbria Fells & Dales
Grimmia arenaria	LR-nt	In crevices of hard slatey rocks, especially on roadside walls.	Cumbria Fells & Dales
Grimmia atrata	LR-ns	Heavy-metal-bearing rocks. See Table 5.2.	Cumbria Fells & Dales
Grimmia laevigata	LR-ns	On exposed acidic to slightly basic rock, on cliffs, on exposures, by rivers and on roofing slates.	Dartmoor Exmoor and the Quantocks Oswestry Uplands White Peak

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Grimmia lisae	LR-ns	Forming tufts, usually silt- and grit-encrusted, on rocks below flood-level beside streams and rivers and by lakes. Also found occasionally on rock exposures away from water. Sometimes locally abundant.	Cumbria Fells & Dales
Grimmia montana	LR-ns	On hard, exposed granite.	Cumbria Fells & Dales Dartmoor Shropshire Hills
Grimmia orbicularis	LR-ns	Usually on exposed dry rocks, especially Carboniferous limestone and on walls; commonly associated with rocks with a high heavy-metal content. It is apparently susceptible to atmospheric pollution.	Border Uplands Cumbria Fells & Dales White Peak
Grimmia ovalis	VU	Forming tufts or cushions on dry exposed basic to neutral rocks, especially basalt and dolerite.	North Pennines Cumbria Fells & Dales[1]
Gymnostomum calcareum	LR-ns	On limestone rocks or calcareous basalt, particularly where soft, slightly moist and shaded; very rarely on the mortar of walls. Usually in low-lying, sheltered situations.	Pennine Dales Fringe White Peak Yorkshire Dales
Hedwigia integrifolia	LR-ns	On dry, acid or mildly basic angular detached boulders, usually sun-exposed with a south to west aspect, in block screes, on moorland and below cliffs. Most frequent on basic igneous rocks of gabbro, basalt, dolerite, tuff and peridotite and is absent from cliff-faces and artificial habitats except, rarely, dry stone walls. Mainly at low and moderate altitudes.	Cumbria Fells & Dales
Hypnum hamulosum	LR-ns	A calcicole of sheltered rocks. See Table 5.2.	Cumbria Fells and Dales
Jungermannia subelliptica	LR-ns	In moist habitats on rocks. See Table 5.2.	Border Uplands Cumbria Fells & Dales Exmoor and the Quantocks Forest of Bowland
Lophozia gillmanii	LR-nt	Mossy, constantly-irrigated basic rock ledges and in mossy base-rich flushes and rocks by streams.	Yorkshire Dales
Lophozia heterocolpos	LR-ns	On damp calcareous rocks. See Table 5.2.	North Pennines Yorkshire Dales
Mielichhoferia mielichhoferiana var. *elongata*	VU	On vertical faces of shale in a series of narrow, steep gullies with constantly trickling streams.	North Yorkshire Moors & Hills
Mnium thomsonii	LR-ns	In dense, pale green / red tufts or patches on basic rock-ledges and in crevices in basic rocks.	Cumbria Fells & Dales White Peak Yorkshire Dales

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Myurella julacea var. *julacea*	LR-ns	Usually as scattered shoots growing amongst other base-loving bryophytes on dry or slightly irrigated soil in cracks on calcareous rock ledges, usually of north to east aspect.	Yorkshire Dales
Nardia geoscyphus	LR-ns	On moist basic soil on rock ledges and at the foot of mountain cliffs; also on sandstone rocks or on sandy or peaty soil in wet heaths or by water, often on banks. The habitat ranges from relatively dry to very wet, including stream sides and lake shores, sometimes submerged for most of the winter.	Border Uplands Dark Peak Dartmoor Forest of Bowland North Pennines Oswestry Uplands Southern Pennines South West Peak
Orthothecium rufescens	LR-ns	Forming dense, vinous-red silky patches on damp, periodically flushed north- to east-facing steep, often vertical sheltered montane or sub-montane cliff-faces of limestone, calcareous mica-schist, basalt or other basic volcanic rocks; also on damp, shaded limestone walls of low-lying ravines.	Cumbria Fells & Dales Yorkshire Dales
Pedinophyllum interruptum	LR-ns	On sheltered moist Carboniferous limestone rock ledges and ravine walls, less often on boulders. In one site, on Millstone Grit which receives basic floodwater.	Cumbria Fells & Dales North Pennines Yorkshire Dales
Philonotis arnellii	LR-ns	Circum-neutral non-calcareous soil and rock crevices in intermittently flooded or flushed places, typically on crumbling earth on rocky banks in light shade; also woodland rides, heathy tracks, mud, floors of quarries and basic mountain-cliffs.	Border Uplands Cumbria Fells & Dales Forest of Bowland Shropshire Hills
Philonotis caespitosa	LR-ns	On moist or wet non-calcareous soil and rocks, where flushed or flooded by slightly basic mineral-rich water, for example in springs, stream sides, ditches, marshes, boggy fields, margins of lakes and reservoirs, track sides, quarries and dripping rocks.	Bodmin Moor Border Uplands Cumbria Fells & Dales Dark Peak Exmoor and the Quantocks Forest of Bowland Pennine Dales Fringe Southern Pennines Yorkshire Dales
Plagiopus oederiana	LR-ns	On basic rock-ledges and in crevices, such as gills, ravines and valley woods, wooded limestone scars and north-facing crags. It grows mostly on hard calcareous rocks, typically at moderate altitudes on the Carboniferous Limestone of northern England, but sometimes ascending to high mountain cliffs and gullies.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Plagiothecium cavifolium	LR-ns	On moist, basic mountain rock-ledges, where it may be associated with a wide variety of other calcicoles. Less often on siliceous rock-ledges at lower altitudes, sometimes where the basic influence is only slight.	Cumbria Fells & Dales Yorkshire Dales
Plagiothecium laetum	LR-ns	Woodland and among boulders. See Table 8.2.	Cumbria Fells & Dales Border Uplands Clun & North West Herefordshire Hills North Yorkshire Moors & Hills Shropshire Hills South West Peak
Pleurochaete squarrosa	LR-ns	In limestone grassland, in turf on sea-cliffs and on stony limestone ground, rarely on limestone pavement. It may grow in scrubby ground and in light shade, but is most common in open habitats. Inland it is most common on open, stony, unproductive calcareous soils.	Bodmin Moor Cumbria Fells & Dales Exmoor and the Quantocks South West Peak
Pohlia filum	LR-ns	A calcifuge species almost exclusively confined to soils of very low organic content. It grows mostly on damp sandy or gravelly soils, by streams and rivers, on rocks, on sandy tracks and roadsides.	Border Uplands
Pohlia flexuosa	LR-ns	On moist sandy or gritty soils in rocky places by streams and waterfalls in montane regions, often in very sheltered locations which are noted for hygrophilous liverworts. Also steep sandy riverbanks and less frequently in rock crevices.	Bodmin Moor Dark Peak Cumbria Fells & Dales Forest of Bowland Southern Pennines
Pseudoleskea catenulata var. *catenulata*	LR-ns	Forming dense dark- or olive-green patches on calcareous rocks in the hills on Carboniferous limestone, preferring dry open sites, often south-facing, where there is little competition. See Table 5.2.	North Pennines Yorkshire Dales
Racomitrium affine	LR-ns	On moist or intermittently moist acid rocks, walls and roof tiles.	Cumbria Fells & Dales
Racomitrium sudeticum	LR-ns	On dry or moist acid rocks, occasionally on soil in the mountains.	Cumbria Fells & Dales Dark Peak Dartmoor North Pennines Yorkshire Dales
Radula aquilegia	LR-ns	Most frequently as pure patches growing on mildly basic boulders and vertical rock-walls in wet, wooded ravines, in the submontane or even montane zone.	Cumbria Fells & Dales

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Rhabdoweisia crenulata	LR-ns	On shaded ledges and crevices of siliceous rock in humid or damp situations, often under overhangs. Typically on north-facing crags, among boulders in scree and in ravines, especially near waterfalls. Usually on acid substrates but occasionally on basic rock. See Table 5.2.	Border Uplands Cumbria Fells & Dales Yorkshire Dales
Rhynchostegiella curviseta	LR-ns	Damp stones, tree-roots, walls and banks. See Table 8.2.	Exmoor and the Quantocks
Rhytidium rugosum	LR-ns	Open grassland and on limestone rock-ledges. See Table 6.3.	Cumbria Fells & Dales North Pennines White Peak Yorkshire Dales
Riccia subbifurca	LR-ns	On moist, thinly vegetated soil on rock-ledges and rocky slopes, banks of lanes, streams and ditches, the edges of pools and reservoirs and in gardens and arable fields. Usually on acidic soils but also over limestone and basic igneous rocks.	Bodmin Moor Yorkshire Dales
Scapania praetervisa	VU	Wet limestone boulders and rock exposures on river banks.	Yorkshire Dales
Schistidium agassizii	LR-nt	On rocks and stones at or near the flood-zone of fast-flowing rivers and large streams.	Cumbria Fells & Dales North Pennines
Schistostega pennata	LR-ns	A calcifuge species of shaded soil and rocks. See Table 8.2.	Bodmin Moor Dartmoor Exmoor and the Quantocks Shropshire Hills Southern Pennines South West Peak Yorkshire Dales
Seligeria acutifolia	LR-ns	On moist, shaded limestone rocks, where it grows in crevices and under overhanging rocks.	North Pennines White Peak Yorkshire Dales
Seligeria brevifolia	VU	A single small tuft on Millstone Grit in a moist, shaded situation under overhanging rock.	Dark Peak
Seligeria donniana	LR-ns	On shaded or well-sheltered calcareous rocks, usually limestone, most often on cliffs but also in crevices, under overhangs, in the entrances to pot-holes and on small limestone fragments on the ground in woodland.	Dark Peak North Pennines Oswestry Uplands White Peak Yorkshire Dales

Plant species	Status	Typical habitat	Distribution by upland Natural Area
Seligeria pusilla	LR-ns	A minute plant of shaded basic rocks such as the vertical and overhanging surfaces of cliffs and ravine walls, especially on limestone but also sometimes on basalt and calcareous sandstone.	Border Uplands Cumbria Fells & Dales Dark Peak Forest of Bowland North Pennines White Peak Yorkshire Dales
Seligeria trifaria	LR-ns	On lightly shaded, vertical or overhanging Carboniferous limestone rocks down which water seeps. Occasionally in similar situations on other hard limestone.	North Pennines Yorkshire Dales
Targionia hypophylla	LR-ns	On earthy, sandy or rocky roadside banks and on thin layers of soil over walls and rocks; usually in sites which dry out in summer. Although not a strict calcicole, it is often associated with limestone or basic igneous rocks.	White Peak Cumbria Fells & Dales[1]
Thamnobryum angustifolium Derbyshire feather-moss	CR, EE Priority	On a shaded limestone rock in a ravine, growing by a calcareous spring, where it is inundated in winter but dry in summer. See Species Action Plan (UK Steering Group 1995).	White Peak
Tortella densa	LR-ns	In the crevices of limestone rocks and more rarely on bare soil among rocks and in grassy flushes. A strong calcicole, it occurs on various types of limestone, but especially on the Carboniferous. Most stations are at moderate altitude in exposed situations. Also on heavy metal mine-waste in northwest England.	Cumbria Fells & Dales North Pennines Yorkshire Dales
Tortula subulata var. *graeffii*	LR-ns	Soil and rocks. See Table 8.2.	Yorkshire Dales
Trichostomopsis umbrosa	LR-ns	Damp, shady, calcareous places, often on mortar at the base of walls that are backed by earth, such as railway arches. Also recorded from shaded soil in old limestone quarries.	White Peak
Trochobryum carniolicum	CR	Damp calcareous sandstone or impure limestone rocks beside streams.	Border Uplands
Weissia controversa var. *crispata*	LR-ns	A calcicole of bare soils which are relatively stable and not frequently disturbed, found on cliffs, in quarries and among limestone and other calcareous rocks including limestone pavement.	Cumbria Fells & Dales
Weissia controversa var. *densifolia*	LR-ns	Open ground rich in heavy metals, especially on spoil heaps and diggings around old lead mines but also in natural habitats, such as on rotten rock-ledges in the Lake District and river gravels with high levels of zinc in Northumberland.	Bodmin Moor Exmoor and the Quantocks Forest of Bowland North Pennines
Zygodon gracilis Nowell's limestone moss	EN Priority	On Carboniferous rocks and dry stone walls in the Craven Pennines.	Yorkshire Dales

Key to Table 10.2

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DD - data deficient
LR-nt - Lower risk - near threatened
LR-ns - Lower risk - nationally scarce
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SCC - Species of conservation concern from UK Steering Group 1995 and UK Biodiversity Group 1998.

Sources

Most information from Hill, Preston & Smith 1991, 1992, 1994, and Hodgetts, Palmer & Wigginton 1996.
1. D. Ratcliffe, pers comm.

Table 10.3 Bryophytes of upland rock habitats in England: general habitat and management requirements

Plants	Habitat requirements	Management requirements
Plants growing on tors, cliffs and in gorges.	Such sites generally require minimal interference.	! Climbing and walking may need to be controlled, where important populations of bryophytes are threatened by disturbance.
Plants growing on walls, including soil-capped walls.	Relatively undisturbed walls of suitable substrate.	! Repair of walls, where unavoidable, should be carried out with care by workers who have been made aware of the whereabouts of important areas for bryophytes and using compatible materials. ! Some sites may require protection from excessive trampling.
Plants growing on block screes, rock crevices and limestone pavement.	Such sites generally require minimal interference.	! Protect sites from quarrying.
Plants growing on heavy-metal-bearing rocks and soil or in quarries.	Such sites generally require minimal interference.	! Protect important sites from further excavation, either commercially or by amateurs. ! Protect sites from inappropriate reclamation or landscaping.
Plants growing on rocks in and by rivers, streams and tarns.	Many such species rely on fluctuating levels and flows of unpolluted water.	! Protect important sites from regulation of flows and from drainage or forestry operations upstream which would change the yearly pattern of flows. ! Protect sites from pollution by agricultural or other chemicals.

Sources

P. Lambley, pers comm and Species Action Plans (UK Biodiversity Group 1999 and UK Steering Group 1995).

Table 10.4 Examples of red list lichens of crags, scree and limestone pavement in England

Plant species	Status	Typical habitat	Distribution
Bryoria nadvornikiana	VU	Sandstone cliffs.	Northumberland
Collema fragile	VU	Limestone.	Northwest Yorkshire
Collema parvum	VU	River gorge on limestone.	Yorkshire Dales
Endocarpon adscendens	EN	Rocks by rivers.	Mid-west Yorkshire
Gyalecta ulmi elm gyalecta	Sched.8 of WCA, EN	Now only on limestone, formerly on elms.	Northumberland
Ionaspis heteromorpha	VU	Limestone at high altitudes.	Northern Pennines
Ionaspis melanocarpa	VU	Limestone pavement at about 750 m altitude.	Teesdale
Lecanora achariana tarn lecanora	Sched.8 of WCA, CR	Nutrient-enriched boulders by a tarn.	Cumbria
Lecanora epibryon	VU	Turf and dry stone walls.	North Yorkshire
Lecidea inops copper lecidea	Sched.8 of WCA, EN	Copper-rich mine waste.	Lake District
Peltigera venosa	VU	Basic soil often near waterfalls, mine-tips, cliff-ledges, and turf-capped walls.	North Pennines
Pertusaria melanochlora	EN	Sheltered boulders of dolerite.	Dartmoor
Stereocaulon symphycheilum	EN	Mine waste.	Cumbria
Umbilicaria crustulosa	VU	Crags.	Cumbria

Key to Table 10.4

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Sources

P. Lambley, pers comm and Church *et al* 1996.

Table 10.5 Plant communities associated with crags, scree and limestone pavement in England

NVC code	NVC name[1]	Inclusion in Annex 1 of the Habitats Directive[2]	Significance in England[3]	Upland Natural Areas where community occurs
Tall-herb communities				
U15	*Saxifraga aizoides-Alchemilla glabra* banks	--	L	Cumbria Fells & Dales
U16	*Luzula sylvatica-Vaccinium myrtillus* tall-herb community	--	UK	Border Uplands North Pennines Cumbria Fells & Dales
U17	*Luzula sylvatica-Geum rivale* tall-herb community	Eutrophic tall herbs	L	Border Uplands North Pennines Yorkshire Dales / Pennine Dales Fringe Cumbria Fells & Dales
Fern communities				
U19	*Thelypteris limbosperma-Blechnum spicant* community	--	L	North Pennines Yorkshire Dales / Pennine Dales Fringe Cumbria Fells & Dales Exmoor & the Quantocks
U20	*Pteridium aquilinum-Galium saxatile* community See Chapter 6: Moorland	--	I	All upland Natural Areas except White Peak Oswestry uplands
U21	*Cryptogramma crispa-Deschampsia flexuosa* community	Siliceous scree	L	Border Uplands North Pennines Yorkshire Dales / Pennine Dales Fringe Cumbria Fells & Dales

NVC code	NVC name[1]	Inclusion in Annex 1 of the Habitats Directive[2]	Significance in England[3]	Upland Natural Areas where community occurs
Calcareous grassland				
CG9#	*Sesleria albicans-Galium sterneri* grassland See Chapter 7: Meadows and enclosed pasture	Semi-natural dry grasslands and scrubland facies on calcareous substrate (*Festuco brometalia*) (important orchid sites*)	I	Border Uplands North Pennines Yorkshire Dales / Pennine Dales Fringe Cumbria Fells & Dales Southern Pennines
Acid grassland				
U4	*Festuca ovina-Agrostis capillaris - Galium saxatile* grassland See Chapter 6: Moorland	--	L	All upland Natural Areas except Oswestry Uplands
U5	*Nardus stricta-Galium saxatile* grassland See Chapter 6: Moorland	--	L	All upland Natural Areas except Oswestry Uplands
Open vegetation				
OV37	*Festuca ovina-Minuartia verna* metalliferous grassland See Chapter 6: Moorland	--	Not specified	Yorkshire Dales / Pennine Dales Fringe White Peak
OV38#	*Gymnocarpium robertianum-Arrhenatherum elatius* community	Eutric scree	Not specified	Cumbria Fells & Dales Yorkshire Dales / Pennine Dales Fringe White Peak Oswestry Uplands
OV39#	*Asplenium trichomanes-Asplenium ruta-muraria* community	Chasmophytic vegetation on rocky slopes: Calcareous sub-types	Not specified	Cumbria Fells & Dales Yorkshire Dales / Pennine Dales Fringe White Peak
OV40#	*Asplenium viride-Cystopteris fragilis* community	Chasmophytic vegetation on rocky slopes: Calcareous sub-types	Not specified	Cumbria Fells & Dales Yorkshire Dales / Pennine Dales Fringe

NVC code	NVC name[1]	Inclusion in Annex 1 of the Habitats Directive[2]	Significance in England[3]	Upland Natural Areas where community occurs
Woodland and scrub				
W8#	*Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland See Chapter 8: Woodland and scrub	*Tilio acerion ravine* forests*	Not specified	Not specified
W9#	*Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland See Chapter 8: Woodland and scrub	*Tilio acerion ravine* forests*	Not specified	Not specified
W21#	*Crataegus monogyna-Hedera helix* scrub See Chapter 8: Woodland and scrub	*Juniperus communis* formations on heaths or calcareous grasslands	Not specified	Not specified

Key to Table 10.5

1. National Vegetation Classification (NVC) from Rodwell 1992 and 2000, status and distribution from Drewitt & Manley 1997

2. Taken from Brown *et al* 1997
   * Priority habitat

3. Taken from Drewitt & Manley 1997
   I Internationally scarce with UK representation
   UK Well developed in UK but represented elsewhere
   L Well developed in Europe
   Note At the time of the production of this document, the two Natural Areas now known as the Yorkshire Dales (no 8) and the Pennines Dales Fringe (no 15) were combined as one Natural Areas.

The flora of limestone pavement is best described as encompassing elements of these community types, and limestone pavement is a priority habitat in Annex 1 of the Habitats Directive.

Table 10.6 Breeding birds associated with crags, scree and limestone pavement in England

(Note: See also Chapters 5, 6 and 7 for species predominantly of montane areas, moorland or grassland)

Bird species[1]	Birds of conservation concern in the UK[2]	Listed on Schedule 1 of the 1981 Wildlife & Countryside Act	Listed on Annex 1 of the EC Birds Directive	No of British 10 km squares with breeding records 1988-90	% of breeding records in upland ITE squares in Britain[3]	Main upland habitat associations	Principal upland Natural Areas supporting the species (including those not containing montane areas) *= major/important areas[4]
Buzzard *Buteo buteo*	-	-	-	1,174	47.6	Woodland and enclosed land	2, 4*, 8, 10*, 41*, 42*, 58*, 60*, 87*, 92*, 94*
Golden eagle *Aquila chrysaetos*	Amber list	!	!	216	88.9	Moorland and montane areas	10* extinct elsewhere
Peregrine *Falco peregrinus*	Amber list	!	!	719	61.6	Moorland and montane areas	4, 8, 10*, 12, 14, 15, 25, 87*, 94
Wheatear *Oenanthe oenanthe*	-	-	-	1,339	60.6	Montane areas, moorland and enclosed land	2*, 4*, 8*, 10*, 12, 14, 15, 17, 25, 29, 30*, 41, 42, 58, 60, 87, 92*, 94
Ring ouzel *Turdus torquatus*	Amber list	-	-	401	93.5	Moorland and scrub	2, 4*,8*, 10*, 12, 14*, 15(?), 17, 25, 29, 30, 42, 87, 92*
Raven *Corvus corax*	-	-	-	783	52.0	Moorland and montane areas	4*, 10*, 41*, 42*, 58*, 60*, 87*, 92*, 94*, extinct elsewhere but recolonising.

Key to Table 10.6

1. Upland breeding bird species as identified in Stillman & Brown 1998.
2. Birds of conservation concern from RSPB 1996.
3. From Bunce & Barr 1988, using the 13 ITE land classes which were regarded as upland (information not available on an English basis).
4. The following 18 Natural Areas are classed as upland by English Nature:

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

Table 10.7 Habitat and management requirements of birds associated with crags, scree and limestone pavement in England

Species	Habitat requirements	Management requirements relevant to crags, scree and limestone pavement
Buzzard *Buteo buteo*	! Strong association with woodland and enclosed grassland at the moorland fringe. ! Nest placed in isolated or woodland trees or occasionally on rock ledges, usually within woodland. ! Adults feed over all types of open country - moors, acid grasslands, tilled land and pastures and meadows - taking earthworms from pastures and tilled land and small mammals, road kills and other carrion from hill and roadsides. ! Adults bring food to dependent young in nest. ! Present throughout the year.	! Maintain natural drainage & wetland features such as pools & flushes. ! Create small wet areas by blocking existing drains & grips. ! Do not re-seed or plough permanent pastures. ! Do not apply surface applications unless this has been a traditional practice. ! Retain scrub & scattered trees on steep slopes. ! On gentle slopes graze or cut scrub in rotation. Provide a range of habitats by clearing 10% of scrub each year once it is 10 years old. ! Scarify ground where old scrub stands have been cleared to promote regeneration. ! Plant native tree species on areas of low nature conservation interest. ! Fence off areas where there is some scrub to allow natural regeneration.
Golden eagle *Aquila chrysaetos*	! Associated with remote, open country with cliffs or widely scattered woodland. ! Nest placed on rock ledge on tall cliff or in large forest tree. ! Adults forage on grouse, rabbits and carrion found mainly on moorland but also over enclosed land, particularly in winter. ! Adults bring food to dependent young in nest. ! Birds present throughout the year, nesting February to July.	! Manage to encourage grouse and rabbit abundance, and to increase the amount of carrion available.
Peregrine *Falco peregrinus*	! Nest placed on undisturbed steep crags, cliff ledge, chimney or ledge on tall building. ! Adults forage on waders, grouse and pigeons caught over moorland, enclosed grasslands and urban areas. ! Adults bring food to dependent young in nest. ! Present throughout the year.	! Limit recreational disturbance during February-June to nest sites and potential nest sites.

Species	Habitat requirements	Management requirements relevant to crags, scree and limestone pavement
Wheatear *Oenanthe oenanthe*	! Nest in hole in ground or wall, in bracken clump, beneath stones, on enclosed farmland, moorland or scree. ! Adults forage for invertebrates over bare ground or short swards on heather moors, stream sides, lake shores and enclosed farmland. ! Adults bring food to dependent young in nest. ! Birds usually present during extended breeding season, March to September.	! Maintain natural drainage and wetland features such as pools and flushes. ! On steep slopes retain scrub such as gorse and juniper and scattered trees such as hawthorn and rowan. ! Where burning is desirable use a rotation of at least 20 years on steep slopes, at the moorland edge and in gullies and cloughs so that the heather can grow tall. ! Where bracken is controlled, cut or spray after the breeding season in late July / early August and leave a buffer zone near streams and gullies. ! Leave areas of bracken on steep slopes or gullies. Only spray areas where the underlying sward is still intact and likely to recover and target the invading edge for control.
Ring ouzel *Turdus torquatus*	! Preference for nesting in areas of sloping land, particularly ghylls and stream sides and, rarely, trees. ! Nest on ground in tall heather or bracken litter or in hole in wall or rock crevice. ! Adults forage in short swards in enclosed fields, unenclosed moors, especially *Vaccinium* when fruiting. ! Adults bring mainly invertebrate food to the nest for the chicks. ! Relatively heavily grazed areas near to nest sites, with damp, short, earthworm-rich swards for feeding, may be important but key feeding habitats and foods require further study. ! Birds present early April to end September Absent from uplands in non-breeding season.	! On steep slopes retain scrub such as gorse and juniper and scattered trees such as hawthorn and rowan. ! Fence off areas where there is some scrub to allow natural regeneration. ! Where burning is desirable use a rotation of at least 20 years on steep slopes, at the moorland edge and in gullies and cloughs so that the heather can grow tall. ! Leave some areas unburnt to allow scrub and scattered trees to grow. ! Where bracken is controlled, cut or spray after the breeding season in late July / early August and leave a buffer zone near streams and gullies. ! Leave areas of bracken on steep slopes or gullies. Only spray areas where the underlying sward is still intact and likely to recover, and target the invading edge for control.

Species	Habitat requirements	Management requirements relevant to crags, scree and limestone pavement
Raven *Corvus corax*	! In the uplands, nest on ledges on cliff or quarry faces, and less frequently in trees (preferably conifers) which are isolated, in small woods or at the edges of plantations (not deep in large forests), and on buildings. ! Adults forage over open country for a variety of food, particularly carrion but also living animals, on moorland, enclosed and cultivated land, and roadsides. ! Opportunist feeders, scavenging carrion such as sheep, rabbit, hare, other small mammals and birds. Also take live animal prey such as small rabbits and other small mammals, reptiles, amphibians and invertebrates. Can be major predators of eggs and chicks of other birds. Some vegetable material, such as seeds, buds, berries and cereal grains, is also eaten. ! Food brought to dependent young in nest by adults. ! Early nesters and disturbance to nests when young present can affect growth. ! Present throughout the year.	! Maintain moorland trees and undisturbed cliffs for nesting. ! Manage to encourage rabbit and carrion availability.

Table 10.8 Nationally rare and scarce invertebrates associated with crags, scree and limestone pavement in England

Invertebrate species		Nature conservation status	Typical habitat	Distribution in England (not currently available in terms of Natural Areas)
Scientific name	**English name**			
Moths				
Entephria flavicincta	Yellow-ringed carpet moth	Nationally Scarce A	Feeds on *Saxifraga hypnoides* on rock ledges, but in gorges and ravines.	Yorkshire Dales
Butterflies				
Argynnis adippe	High brown fritillary	RDB2	Breeds in sunny, sheltered areas containing a warm, sparse ground flora with violets. The two main habitats are bracken-dominated areas and limestone rock exposures, usually where scrub or woodland has recently been cleared.	Three main strongholds in north Lancashire, south Cumbria, Dartmoor and Exmoor. Also a few populations in the southwest midlands (Herefordshire, Worcestershire and Shropshire)
Flies				
Dactylolabis sixmaculata	Cranefly	Nationally Scarce B	Limestone soil and open soils with moss - larvae develop in moss.	Cumbria, Yorks, Durham and Peak District limestone. Also Somerset
Dasyhelea lithotelmatica	Midge	RDB2	Larvae live in water filled (temporarily) solution hollows on the surface of limestone pavement.	Southern Cumbria and Yorkshire limestone pavements
Platyparaea discoidea	Picture-winged fly	RDB3	Stem miner in giant bell flower in woods or limestone pavement.	A few woods in Yorkshire Dales (and single wood on magnesian limestone in South Yorkshire)
Beetles				
Eudectus whitei	Rove beetle	Nationally Scarce A	Under stones and in moss on mountain summits.	On summits of Three Peaks in Yorkshire Dales, although possibly now extinct there
Geodromicus longipes	Rove beetle	Nationally Scarce B	In *R. lanuginosum* and under stones on mountain tops.	Cumbria and perhaps Staffordshire
Leistus montanus	Ground beetle	Nationally Scarce A	Under stones on mountain tops.	Lake District

Invertebrate species		Nature conservation status	Typical habitat	Distribution in England (not currently available in terms of Natural Areas)
Scientific name	**English name**			
Notiophilus neothuans	Ground beetle	Nationally Scarce B	Under stones, especially in mineral-rich sites such as land mire spoil.	Yorkshire Dales
Oxypoda soror	Rove beetle	Nationally Scarce B	In moss and under stones on mountains.	Old records from Skiddaw in Cumbria
Spiders				
Entelecara errata	Money spider	Nationally Scarce B	Under stones on mountain tops.	Northumberland
Erophrys jpetrensis	Jumping spider	Nationally Scarce B	Under rocks in uplands (and under stones in lowland heath).	North Yorkshire - also southern heaths
Lepthyphantes pinicola	Money spider	Nationally Scarce B	Mainly under stones on mountains but also on moorland.	Yorkshire, Cumbria and Staffordshire
Lepthyphantes whymperi	Money spider	Nationally Scarce B	In cavities among rocks on mountains.	Lake District
Pardosa trailli	Wolf spider	Nationally Scarce B	Under stones and in scree on mountains.	Lake District
Rugathodes bellicosus	Comb-footed spider	Nationally Scarce B	Under stones on high ground (but at sea level in Scotland). Mountain tops and moorland in England.	Yorkshire Pennines and the Lake District
Theridion belliosum	Comb-footed spider	Nationally Scarce B	Among boulders (also on rocky coasts).	Pennines, Lake District and Northumberland
Tiso aestivus	Money spider	Nationally Scarce B	Under stones above 600 m.	Lake District
Snails				
Clausillia dubia	Door snail	Nationally Scarce B SCC	Bare limestone rocks (and walls) and scree.	Craven Pennines - just extends to East Cumbrian limestone
Vertigo alpestris	Whorl snail	Nationally Scarce A	Screes, rocks, dry stone walls, also stones in woods.	South Cumbria, northeast England
Vertigo angustior	Narrow-mouthed whorl snail	Annex II RDB1 Priority	Limestone pavement and damp grassland.	Gaitbarrows, Lancashire
Vitraea subrimata	Glass snail	Nationally Scarce A	Limestone scree, walls, rocks, in limestone grassland.	Limestone areas in Cumbria / S lakes, Craven Pennines and County Durham

Invertebrate species		Nature conservation status	Typical habitat	Distribution in England (not currently available in terms of Natural Areas)
Scientific name	**English name**			
Crustacea				
Armidillidium pictum	Pill woodlouse	RDB3	In moss and leaf litter on limestone and other base rich rocks (eg Dolerite) pavements, exposures and gorge.	Cumbria and Dales Carboniferous limestone

Key to Table 10.8

Annex II	Annex II of the Habitats and Species Directive
RDB	Red Data Book (Hyman & Parsons 1992)
RDB1	Red Data Book category 1 Endangered
RDB2	Red Data Book category 2 Vulnerable
RDB3	Red Data Book category 3 Rare
Nationally Scarce A	15-30 10 km squares of national grid
Nationally Scarce B	30-100 10 km squares of national grid
Priority	Priority species in the UK Biodiversity Action Plan (UK Biodiversity Group 1998; UK Steering Group 1995)
SCC	Species of conservation concern in the UK Biodiversity Action Plan (UK Biodiversity Group 1998; UK Steering Group 1995).

Table 10.9 Habitat and management requirements of invertebrates associated with crags, scree and limestone pavement in England

Invertebrates	Habitat requirements	Management requirements
Species of limestone pavement	! Molluscs and some other invertebrates require moist, sheltered places such as rock crevices, grikes and under loose rocks. ! Certain specialised aquatic species require water-filled solution hollows. ! Certain species require particular or abundant limestone pavement vegetation as food or shelter. ! Certain species, particularly butterflies, require coppiced woodland or scrubby pavement.	! Prevent disturbance or removal of the pavement. ! Maintain light or no grazing. ! Maintain woodland and scrub management, such as coppicing, to provide open glades and woodland edges. ! Encourage non-intervention areas.
Species of micro habitats on the rock surfaces	Pockets of soil, moss, leaf litter and seepages of water over the rock surface.	! Prevent disturbance or removal of rock habitats. ! Maintain light or no grazing. ! Encourage non-intervention areas.
Species which live under stones (lapidicolous)	Undisturbed stony areas, fairly stable screes.	! Prevent disturbance or removal of rock habitats. ! Maintain light or no grazing. ! Encourage non-intervention areas.