7.5 Other management

7.5.1 Mowing

Mowing can act as a partial substitute for grazing where this is not feasible. The constant mowing found on golf courses and air fields, as at Greenham Common (Porley 1993 and EPR 1995), has maintained the flora of species-rich acid grassland. However, this management is not ideal for the fauna (Kirby 1992), and a better method is to use occasional mowing to encourage increased rabbit grazing. Mowing may be an effective technique for managing small, isolated, sites. cuttings should always be removed from the grassland to prevent nutrient enrichment.

7.5.2 Bracken

In dealing with bracken, it is important to evaluate its conservation interest or potential interest in providing structural diversity before attempting to eradicate it, (Pakeman and Marrs 1992). Bracken growing on podzolic soils, which could support heath, can generally be treated with eradication as the aim, but Bracken on brown earths is more problematic. Where stands with little litter accumulation have plant species such as *Hyacinthoides non-scripta, Anemone nemorosa* or *Convallaria majalis,* which are generally absent from acid grasslands, or have species which are suitable for invertebrates, especially violets *(Viola* spp.) then eradication is not advisable. Such areas can harbour declining species such as the High Brown Fritillary, *Argynnis addipe,* (Warren and Oates, 1995) or rare plants such as *Gladiolus illyricus* (Pakeman and Marrs 1992). If this is the case, an alternative is rotational late summer harvesting of Bracken litter, possibly for composting, combined with cattle and/or pony grazing. This prevents the smothering build up of bracken litter and hence plant species diversity is maintained, but allows moderate amounts of litter accumulation which is important for over wintering invertebrates or basking butterfly larvae (Warren and Oates 1995). Grazing alone may be able to maintain suitable conditions, for instance on the fringes of Dartmoor where several sizeable populations of High Brown Fritillary occur (Warren and Oates 1995).

7.5.3 Gorse and other scrub

Gorse is a important structural component of many acid grasslands and supports a rich invertebrate fauna. Other scrub species such as Broom and Hawthorn can occur locally and provide nectar sources. Gorse requires rotational management by cutting or burning in order to retain dense cover and shelter (Michael 1996). In ungrazed conditions this rotation may be as short as 10-12 years but in traditional grazed systems, such as the New Forest, it is usually much longer due to winter browsing of young Gorse, especially by ponies. Other species can also be managed by rotational cutting. Scrub may need to be controlled where it is invading grassland, for details on techniques see Crofts and Jefferson (1994) (Michael,1996).

7.5.4 Soil disturbance

Bare ground is a very important feature of acid grassland. In the past it was often produced as a consequence of exploitation, for example intensive grazing or mineral exploitation , but in modern conditions, where development is controlled and grazing is often lacking, special provision may be needed to maintain the bare ground component of sites. Past work in Weeting Heath in Breckland (Dolman 1992b and Dolman & Sutherland 1992) indicates that shallow soil disturbance by rotovation is highly beneficial to the specialist flora and fauna of the grass heaths, but that deeper disturbance by ploughing is much less beneficial.

Much recent work on heathlands has been carried out on the question of whether to strip or bury organic layers that have built up on ungrazed heathlands. The aim of this practice is usually to reduce

the dominance of coarse grasses, and to encourage the growth of Heather (Bacon, 1996). In grazed situations, these coarse grasses are suppressed, and humus build-up is slow.

Methods for removing the organic layer are expensive and can leave unsightly piles of waste. Burying the organic matter by use of a turf burying machine may be more acceptable but runs the risk of burying the seed bank and invertebrates present in the litter layer. There is also the possibility of damaging archeological remains. There is clearly a need for long term trials of different methods and their impacts. Without re-introduction of adequate grazing there is a danger that soil manipulation may be only a palliative measure, but could be useful as a short-term solution.

7.6 Habitat diversity and scale of management

In the past there has been a widespread failure by English conservationists to appreciate the crucial role of acid grasslands, and habitat diversity in general, within lowland heathland landscapes. This has led to what Clive Chatters of the Hampshire Wildlife Trust has aptly termed the 'grouse moor syndrome'. ie the concentration on the conservation of Heather stands whilst a massive decline has occurred in heathland species that specialise in associated habitats. The latter have suffered a much more serious decline than the heath specialists (Tubbs 1991, Byfield and Pearman 1995 and 1996 and Sanderson 1995b).

While small areas of parched acid grassland rich in annual plant species can be conserved with rabbit or livestock grazing, perhaps combined with mowing or rotovating, the conservation of other acid grassland species such as birds requires conservation management of much larger areas. The restoration of functioning heathland and grassland systems would require the recreation of the entire pastoral infrastructure including associated low-intensity farmland as well as hundreds of hectares of rough grazing.

Dolman (1992a) suggests the restoration of entire landscapes including low intensity farms, for the recovery of populations of dry grassland birds while Tubbs (1996) points out the vital importance of extensive pastoralism, including associated arable land, in conserving much of Europe's biodiversity, and the threats this is under from abandonment and intensification. The large-scale restoration of functioning cultural landscapes is more likely to provide a sustainable basis for biodiversity conservation than conserving existing habitats alone.

7.7 Restoring and re-creating acid grassland

Restoring diverse landscapes that include acid grassland will require large-scale habitat restoration and re-creation. Experiments to this end are already underway in two distinct situations; first restoring open heath or grass heath by clearing woody species, and second by re-creating these habitats from abandoned arable land. Information on areas with suitable soils and past concentrations of acid grassland species, as described in previous chapters, can assist with the targeting of these re-creation and restoration efforts.

7.7.1 Restoration

The clearance of planted trees or colonised trees and scrub is technically much the same, but can have different land use and political implications. Where the soils under the trees and shrubs have been little altered, the regenerating vegetation is usually close to that of the original heath or grass heath vegetation. An example of restoration is the clearance on the Dorset Heaths carried out by Forest Enterprise, the RSPB and others. (FC 1991).

7.7.2 Re-creation

Re-creation is most likely to succeed where soils are very sandy and free-draining. In these situations the impact of high inputs of artificial fertilisers, made during the period the land was in arable production, is less likely to persist in the long-term. Historical examples of arable reversion include parts of Breckland (Lambley 1994c) and the areas of heathland cultivated during and after the Second World War in the New Forest (Tubbs 1987). The main features of these examples is that they are now largely acid grasslands rather than heath, they can be exceptionally rich in uncommon and declining species, and that they bear little relationship to the vegetation of podzolic soils which have a longer history of lack of disturbance. In the New Forest, even where Heather has recolonised, a remarkable herb-rich community, undescribed by the NVC, has developed. The herb-poor heaths that are regarded as characteristic of lowland dry heaths seem to be essentially communities of highly leached podzols which can take hundreds of years to develop. In the New Forest, most low productivity heath has developed on land abandoned in the Bronze Age, while fields abandoned in medieval times still differ in vegetation from older heath, especially in the amounts of Gorse (Tubbs, 1987).

Recent attempts to create Heather-dominated heath have also created acid grassland of interest, more or less by default. An interesting example was seen by the author at Manton Warren in North Lincolnshire in 1997. Here about 6ha of arable land on very sandy soils was put into Countryside Stewardship in 1992. By 1997 it had been colonised by 11 acid grassland indicators (Table 8), including *Carex arenaria* and *Filago minor* and two nationally scarce species, *Hypochaeris glabra* and *Vulpia ciliaris ambigua*. The field was dominated by an early successional form of U1c, and the ungrazed vegetation in two small exclosures indicated that heavy rabbit grazing was important in suppressing coarse grasses and herbs in the rest of the field. Active blow outs and a sand dune had also developed. Interestingly, this striking site had been considered a failure as no Heather had colonised, whereas it actually had considerable nature conservation interest. A similar area of acid grassland developing on former arable is described in Breckland by Marrs (1985).

This evidence suggests that attempts to produce only heath from reverted arable land may be misguided. Abandoned arable land on poor soils will generally be more easily converted to species-rich acid grassland, including mosaics with grass and herb-rich heath. Interestingly, Dutch conservationists studying the New Forest 'brecks' have shared this conclusion and are allowing short dry grassland to develop on former arable land included within heathlands in the Netherlands, to which grazing has been restored, rather than attempt to restore heath (Prins 1992). These acid grasslands on reverted arable land can form part of a habitat mosaic with heath restored by clearance of woody species, as part of a restored, extensive, pastoral system.

8. Survey requirements and priorities

The following section relates to the requirements and priorities for assessing the location, extent and conservation interest of the acid grassland habitat and flora. There may need to be other work on fauna, particularly invertebrates.

8.1 Existing vegetation data

There are only a limited number of vegetation surveys of areas with rich and important examples of lowland acid grassland. Some detailed Phase 2 surveys have been carried out or have been commissioned by NCC and EN in key acid grassland areas, and these are listed below:

- Ferry *et al* (1990), Dungeness
- Wigginton (1990), Humberside Coversands
- Soden (1991), Sherwood Forest U2 grass heaths
- Porley (1992), selected acid grasslands of Dorset
- Porley (1993), Greenham Common
- Smith & James (1995) and Smith (1996), Suffolk Brecklands
- Steven (1995), Windsor Park.

Other Phase 2 surveys directed at neutral and calcicolous grasslands also recorded acid grasslands when they were found in association with these grassland types (see **Volume II**). The Biological Surveys of Common Land were also found to be useful, in spite of being basically Phase 1 surveys, as the NVC communities present are often mentioned (see **Volume II**).

There is also a considerable amount of survey work being carried out by NGOs, but most of these do not map or identify NVC communities, making it difficult to relate the results to any national context. Phase 1 surveys are especially problematic. The determination of acid grassland appears at times rather inconsistent and it is clear than the NVC is crucial to a proper understanding of the acid grassland resource of England. An example is given by the Biological Survey of Common Land of Hertfordshire (Francis *et al*, 1990); this identified 55ha of unimproved acid grassland which included wet acid grassland and 44ha of semi-improved acid grassland, most of which appeared to be permanent pasture (MG6b). Francis *et al* (1990) point out, however, that a 1988 Hertfordshire County Council Phase 1 survey recorded 480ha of acid grassland on the same commons.

As well as these vegetation data, much plant species data are held by the Biological Records Centre, local record centres and vice-county recorders. These data are most accessible when published in local floras. Some modern county floras proved to be invaluable sources of data, with the Shropshire (Sinker *et al* 1985) and Northamptonshire (Gent & Wilson, 1995) floras being especially informative.

8.2 Survey and monitoring requirements

There are two main requirements for data on acid grassland vegetation:

- Phase 2 surveys to provide better information on the types, extent and patterns of distribution of the NVC communities, especially the parched acid grassland community (U1), and its sub-communities.

- The floristic assessment of acid grassland sites, including rare and scarce species, possibly using the provisional indicator list (**Table 8**) proposed here as a measure of diversity.

In the past, the primary purpose of Phase 2 surveys has been to find new sites of SSSI quality. While many acid grassland sites of high value will already have been included within SSSIs as part of larger habitat mosaics, there are still important sites in heathland areas which have been excluded from nearby SSSIs because they lack Heather. Agriculture improvement and development have damaged or threatened such sites in Hampshire and Dorset in recent years (Colebourn 1994 and Sanderson & Stanbury 1996). In addition the value of the acid grassland component of existing SSSIs has often not been determined. Such information is needed to inform management decisions. Phase 2 surveys should thus have two main priorities:

- The surveying of known sites of importance including SSSIs, for acid grassland resource assessment and for monitoring and management baseline purposes, Smith & James (1995) and Smith (1996) are good examples of this type of data collection.

- Surveying heathland areas for habitats, including acid grassland, either fringing, or in the vicinity of heaths. Such sites may have been over-looked due to past prejudices against habitat not dominated by ericaceous shrubs.

NGOs should be encouraged to identify NVC communities during surveys, of their reserves and County Wildlife Sites. While the second requirement for floristic assessments can be met at least in part by Phase 2 survey, records could be augmented by existing site records held by vice-county recorders, local record centres etc. One-off visits during Phase 2 surveys rarely record all the species of interest present.

As far as possible surveying should be concentrated in May and early June when ephemeral species are identifiable. Some species such as the annual *Lotus* species appear later, and follow up surveys would be needed to fully establish the flora of an acid grassland site. Work on the important fungi floras of acid grassland also needs to be encouraged.

8.3 Development of the NVC

The NVC has been a great boon to understanding acid grasslands but there are a few points where further investigation is needed. The most important are:

- Full characterisation of Festuca-Agrostis-Rumex grassland, Hypochaeris sub-community (U1f). This is under-sampled in the NVC and stands that are referable to it, or are related to it, cover a wide range of complex variation.

- Should herb-rich transitions between MG5c and U4 resembling, but not identical to, CG/U4 transitions (U4c), of the White Peak be described as U4c? If not, how should they be treated?

- Sub-communities of U3 need to be defined.

- The characterisation of scree and cliff vegetation related to, but not contained within, U1 needs attention.

8.4 County and Natural Area survey priorities

The following assessment of survey priorities is based on information gained during the county by county review (see **Volume II**). In some areas, Phase 2 surveys are in a priority, while in others the review of existing data, floristic assessments, or sample Phase 2 surveys for monitoring purposes may be more important. The following assessment covers the priorities for lowland acid grasslands only (**Map 23**). Several other areas require further neutral grassland surveys and these should cover any acid grassland found in sites being surveyed for neutral grassland.

- ***High Priority***

  Bedfordshire, Cambridge & Buckinghamshire: Bedfordshire Greensand Ridge (NA53). Phase 2 survey and floristic assessment.

  Cornwall & Devon: Cornish Killas and Granites (NA95), South Devon (NA91), West Penwith (NA96), The Lizard (NA97). Assessment of condition, extent and conservation needs of cliff-top, U1f, grassland.

  Dorset: Dorset Heaths (NA81) and Isles of Portland and Purbeck (NA82). Floristic assessment of acid grassland in south east Dorset, bringing together existing data. Possible follow-up Phase 2 surveys.

  Hampshire: The New Forest (NA77). Phase 2 surveys of selected areas of acid grassland for monitoring purposes.

  Hampshire, Surrey and West Sussex: Wealden Greensand (NA70). Phase 2 surveys where detailed information is lacking and overall floristic assessment.

  Herefordshire, Shropshire and Staffordshire: Midlands Plateau (NA43). Phase 2 survey and floristic assessment of acid grasslands in heathland areas in the south west of the Midlands Plateau, centred on Kidderminster.

  South of Former Humberside, Lincolnshire and Nottinghamshire: North Lincolnshire Coversands and Clay Vales (NA34), Trent Valley and Rises (NA33) and Lincolnshire and Rutland Limestone (NA38). Phase 2 survey and floristic assessment of unsurveyed acid grasslands and dunes on Coversand is a high priority. The floristic assessment of heaths surveyed outside the optimum season, and monitoring, particularly of incentive schemes, are moderate priorities.

  Norfolk: Breckland (NA46): Phase 2 surveys, including monitoring baselines, and floristic assessment.

  North East England: North Northumberland Coastal Plain (NA1) and Border Uplands (NA2). Phase 2 survey for monitoring purposes of selected Whin Sill sites.

  Suffolk: Suffolk Coast and Heaths (NA49). Phase 2 surveys and floristic assessment of the Sandlings acid grasslands.

- *Medium Priority:*

  Cornwall & Devon: Cornish Killas and Granites (NA95), Bodmin Moor (NA94), The Culm (NA93). Assessment of the role of lowland acid grassland, especially U3, in heathland ecology and biodiversity.

  Essex: London Basin (NA66). Phase 2 survey and floristic assessment of north-east Essex.

  Hampshire, Surrey and Berkshire: London Basin (NA66). Phase 2 surveys in heathland areas and Thames river terraces, where detailed information lacking, and overall floristic assessment.

  Isle of Wight (NA76): Floristic assessment of acid grassland and at least sample Phase 2 surveys.

  Kent: Wealden Greensand (NA70) and North Kent Plain (NA68). Floristic assessment of acid grasslands and sample Phase 2 surveys.

  Norfolk: North Norfolk (NA47) and The Broads (NA48). Phase 2 surveys, including monitoring baselines and floristic assessment.

  Nottinghamshire: Sherwood (NA32). Phase 2 survey and floristic assessment of any U1 acid grasslands in the Sherwood Forest area.

  Shropshire: Shropshire Hills (NA42) and Clun and North West Herefordshire Hills (NA58). Phase 2 survey and floristic assessment of U1 grasslands, including outposts in upland areas.

  South Yorkshire, North Yorkshire and Nottinghamshire: Vale of York and Mowbray (NA16), Vale of Pickering (NA18), Humberhead Levels (NA22). Phase 2 survey and floristic assessment of any acid grasslands left in Doncaster heathland areas and in the Vales of North Yorkshire.

- *Low Priority*

  Cumbria: Eden Valley (NA9). Location and condition of characteristic lowland acid grassland species that have been recorded on brown sand areas north of Penrith (**Map 1**).

  Oxfordshire: Midvale Ridge (NA64). Phase 2 surveys of acid grassland remaining on the Midvale Ridge.

  Wiltshire: Thames and Avon Vales (NA63) and Berkshire and Marlborough Downs (NA79). Phase 2 surveys and floristic assessment of any surviving acid grasslands on Greensand and remaining areas in Savernake Forest.

9. Geographical assessment of the nature conservation value of lowland acid grassland in England and the UK and European context for England's acid grassland

9.1 Statutory and non-statutory conservation measures

Lowland dry acid grasslands have not featured prominently in statutory nature conservation evaluations in England compared to other lowland grassland types. In an assessment of numbers of acid grassland SSSIs, NCR sites and NNRs, Jefferson and Robertson (1996) found that the habitat was represented on 12% of NNRs, 11% of NCR sites and 18% of SSSIs, among sites which included lowland grassland. Comparable figures for dry calcareous grassland were 55% of NNRs, 71% of NCR sites and 45% of SSSIs. Figures for dry neutral grassland were 37% of NNRs, 20% of NCR sites and 42% of SSSIs. On a geographical basis lowland acid grasslands were scarcely considered outside of Breckland in the assessment of habitats of national interest published as the Nature Conservation Review (Ratcliffe, 1977).

There are two problems that have probably contributed to the relative lack of attention that the habitat has received in the past. One is semantic; the term acid grassland is associated with some very species-poor habitats in the uplands and if a lowland acid grassland was found to be species-rich then many biologists have called the habitat something else. Fortunately the NVC has introduced much more rigour into habitat description. The second is both semantic and ecological; before the 1960s the term heathland applied to all the open vegetation within the heathland landscape of rough grazings, and the old floras do not recognise a separation between acid grassland and heathland. After the 1960s, heathland rather mysteriously came to mean stands dominated by ericaceous dwarf-shrubs i.e. the 'grouse moor syndrome'. Simultaneously myxomatosis resulted in the crash of rabbit populations. As a result there were declines in most populations of rare and local acid grassland species (Rose, 1995a) and many previously rich acid grasslands became genuinely species-poor.

The preceding chapters in this review have described the significant nature conservation interest of lowland dry grassland. Key features of nature conservation interest are:

- Lowland acid grassland comprises a unique series of plant communities that contribute to the biodiversity of lowland England.
- Lowland acid grassland is far richer in rare and scarce vascular plant species than dry heath.
- Lowland acid grassland shares a threatened bird fauna with dry calcicolous grassland.
- Lowland acid grassland supports rare and scarce invertebrates.
- Lowland acid grassland forms part of the habitat mosaic utilized by rare reptiles and amphibians.
- Lowland acid grassland is an integral part of heathland landscapes and an essential component for their sustainable management by extensive grazing.

There are now a range of measures, as well as statutory site designation, that can be used to conserve lowland acid grassland. The Wildlife Enhancement Scheme on SSSIs provides positive payments to land managers to maintain or restore the wildlife interest of SSSIs. The Coversand WES is an example where acid grassland is benefitting from management under the scheme (see **Volume II**). Several Environmentally Sensitive Areas include acid grassland, in particular the Breckland ESA. Smaller areas occur in others, for example, West Penwith ESA (coastal acid grassland), South Downs ESA

(acid grassland on drift overlying chalk) and The Shropshire Hills ESA (parched acid grassland on south-facing hill slopes). Like the ESA scheme, the Countryside Stewardship Scheme offers land managers incentive payments to conserve habitats. The Old Meadows and Pastures landscape type in the scheme is aimed at lowland neutral and acid grassland while the Historic Landscapes includes wood-pasture and parklands that may contain acid grassland (see example in **Appendix 1**). Currently, a Biodiversity Action Plan is being developed for lowland dry acid grassland, which was recognised as a key habitat for conservation in the main report of the UK BAP Steering Group (1995).

9.2 Assessment of lowland acid grassland in England

Implementation of the conservation measures described above requires knowledge of the location, extent and relative nature conservation interest of lowland acid grasslands and the survey priorities given in the preceding chapter attempt to indicate where information is lacking. In the interim, the following assessment of the relative value of different parts of England for acid grassland has been made based on the data collected for this review. It is very provisional and is only intended as a guide. It should be reviewed in the light of further information that becomes available through responses to this report and from additional data collection. Acid grasslands outside the areas below are still likely to be of value in relation to the biodiversity of a county or Natural Area.

The summaries for particular areas include the main conservation issues in those areas. Habitat restoration refers to restoring good habitat condition on existing sites, possibly with some creation of new habitat. Landscape restoration refers to the large scale restoration of functional pastoral landscapes. In many areas some restoration has already commenced. The areas listed below are shown on **Map 24**, and are divided into four categories, plus a list of areas with intrinsic interest as transitions from lowlands to uplands. The Natural Areas within which the acid grassland areas occur are also listed below and shown on **Map 24.**

Category A

The most important areas, which have diverse and usually large scale grass heath or heathland ecosystems with rich acid grassland floras and faunas. The best examples of their type. Includes acid grassland sites of NCR quality. Landscape restoration vital.

A1 Breckland (NA 46)

The premier acid grassland area in the country, with extensive examples of the typical mix of acid grassland communities of eastern England, including blown sand communities. Juxtaposition with calcicolous grasslands and meres. Exceptionally rich flora and fauna, including a typical, if threatened, bird fauna. There is a need to increase grazing levels and on existing grassland and for extensive re-creation of semi-natural habitats (landscape restoration).

A2 The New Forest (NA 77)

The other large surviving area of acid grassland in England and the best example both of acid grassland associated with heath, and of the south-western mix of acid grassland communities and species. Exceptionally rich flora and fauna, including the only stable dry grassland bird assemblage in the lowlands still occupying acid grasslands. Extensive pastoralism survives but may need support in the face of huge social and recreational pressures. There is the potential to reverse the fragmentation caused by 19th century enclosures (landscape restoration).

A3 Dungeness (Kent and Sussex). Romney Marshes (NA 71)

The best example of acid grassland on a coastal shingle structure and nationally the largest stands of lichen-rich parched acid grassland (U1a). Breeding Wheatear present. Much past damage, and long term potential for restoration needs considering (landscape restoration).

A4 The Dorset Heaths (NA 81) and Isles of Portland and Purbeck (NA 82)

Much damaged by lack of grazing management but still harbours an exceptionally rich flora and is an integral part of very important and still quite extensive heathland. Corfe Common is an exceptional south-western acid grassland site in its own right. Extensive landscape restoration is vital for retrieving these heathlands.

A5 West Wealden Heathlands (Surrey, Hampshire and Sussex). Wealden Greensand (NA 70)

Large scale heathland ecosystems survive with rich grasslands, transitional between southern and eastern heathlands. Very rich flora including lichens.

A6 South coast of Devon and Cornwall. South Devon (NA 91) and Cornish Killas and Granites (NA 95)

The coast between Start Point and Looe encompasses the best south-western cliff top acid grasslands, including a superb ephemeral flora. Landscape restoration of the wider grassland habitat here and elsewhere in the south-west is necessary if Chough is to re-establish in England.

A7 Sandlings and Suffolk Coast. Suffolk Coast and Heaths (NA 49)

Similar to Breckland but acid grassland less extensive and calcicolous grassland absent. As well as the grass heaths, parched acid grassland frequent on the inland side of shingle structures. Rich flora and relic dry grassland bird fauna. Landscape restoration essential.

A8 Solent Coast (Hampshire and Isle of Wight) (NA 76). South Coast Plain and Hampshire Lowlands (NA 75) and NA 76.

Includes St Helen's Duver, the most species-rich, coastal dune, acid grassland recorded, and several other coastal sites on shingle structures, dunes and cliff tops with collectively a very rich flora. Habitat restoration more important than landscape restoration.

A9 Welsh and Shropshire Hills (Shropshire, Radnorshire and Montgomeryshire). Shropshire Hills (NA 42) and Clun and North West Herefordshire Hills (NA 58)

A scatter of small sites, the best of which are in Wales, including Craig Breidden. The area includes the richest and most well developed examples of parched acid grassland on rock outcrops and associated chasmophytic vegetation. Habitat restoration more important than landscape restoration.

A10 Coversand Heaths (South Humberside, Lincolnshire and Nottinghamshire). North Lincolnshire Coversands and Clay Vales (NA 34) and Trent Valley and Rises (NA 33)

Much fragmented and degraded in the past, but one of the few areas outside Breckland containing blown sand communities and calcicolous grassland as well as acid grassland. Recent WES restoration and Countryside Stewardship acid grassland creation have enhanced the value of this area. Previous information indicated that the area was too degraded to be included in category A but surveys as part of this review showed it had considerable value (see **Appendix 1**). Risby Warren is an exceptional site in

its own right with over 50ha of U1c and mobile sand dunes. The area is one of the most floristically rich areas of acid grassland north of the Bristol to Wash line. Landscape restoration essential.

Category B

The following list of areas are either less diverse than those in Category A, but still rich in some groups, or represent less extensive ecosystems. However, they remain vital to the national biodiversity and the national distribution of the acid grassland resource. Includes the best outlying stands. May include sites of NCR quality for their acid grasslands. Landscape restoration a very high priority.

B1 Thames Valley Heaths (Surrey, Hampshire and Berkshire). London Basin (NA 66)

Includes a southern rather than eastern mix of acid grassland communities, which are associated with heathland and river terraces. Collectively a rich flora survives but the area is much damaged by fragmentation and neglect. Windsor Park includes outlying stands of moist acid grassland (U4) associated with ancient trees and rich grassland fungi floras. Landscape restoration essential. Greenham Common is an exceptional site in its own right.

B2 Kidderminster Heaths: (Hereford and Worcester, Shropshire, Staffordshire). Midlands Plateau (NA 43)

A floristically rich area of acid grassland north of the Bristol to Wash line. It includes outlying examples of the eastern mix of communities and species. Habitat and landscape restoration required.

B3 Malvern Hills and Castlemorton Common (Hereford and Worcester). Malvern Hills and Teme Valley (NA 57)

Includes acid grassland on thin soils over rock, and associated extensive acid grassland. Interesting flora with some south-western species at the limit of their range. Wheatear bred until recently. Pastoral system collapsing and landscape restoration required.

B4 Northumberland Whin Sill. North Northumberland Coastal Plain (NA1) and Border Uplands (NA 2)

Well-developed examples of parched acid grassland on shallow soils on igneous outcrops with a rich flora in an area far from the main concentrations of acid grassland. The best *Thero-Airion* vegetation on rock in England but not as important as the eastern Welsh sites. Habitat restoration required.

B5 Cornish coast from St Austel to Hartland Point. Cornish Killas and Granites (NA 95), West Penwith (NA 96) and The Lizard (NA 97)

The internationally important Lizard heathland and coastal cliffs includes very important maritime therophyte grasslands (MC5) but the area of U1f cliff top acid grassland is apparently much more limited. However, the west and north of Cornwall does include good stands of cliff top acid grassland as a part of important habitat complexes. There is a need to evaluate the lowland Agrostis curtisii (U3) grasslands of the south-west in general. These have a high intrinsic interest due to international rarity and if the best examples, once located, are included here in an expanded area, such an area might merit Category A status. Landscape restoration a priority for coastal grasslands to provide Chough habitat.

Category C

Areas which are somewhat degraded, usually by habitat fragmentation, in comparison to the categories above, but which are significant in terms of the national distribution of acid grassland resource. The potential for habitat and landscape restoration to enhance the national significance of these areas is high. Most good quality stands should ideally be included within SSSIs. Landscape restoration a priority in most areas.

C1 North Norfolk (NA 47)

An eastern area which has lost most of its acid grassland to habitat destruction. The formerly rich flora and fauna has seriously declined. Landscape restoration essential if this conservation value is to be restored.

C2 Waveney and the Broads (NA 48) and East Anglian Plain (NA 50)

An eastern area with acid grassland found on river terraces and in sandy areas of flood plains. It has lost much of its acid grassland to habitat destruction but a rich flora has been recorded quite recently and local survival of acid grassland is indicated. Landscape restoration essential.

C3 Kent, north of the Downs. North Kent Plain (NA 68)

Consists of small and fragmented sites but a quite rich flora recorded overall. Habitat restoration required.

C4 Kent, Greensands. Wealden Greensand (NA 70)

Consists of small and fragmented sites with some larger parklands and a heathland with a relatively rich flora recorded overall. Habitat restoration required.

C5 Devon Redlands (NA 90)

Includes surviving heathlands with a fairly rich surviving grassland flora. Habitat or, ideally, landscape restoration required.

C6 North east Essex. London Basin (NA 66)

Very fragmented remains of former heathlands which have suffered high loss of acid grassland flora. Landscape restoration required.

C7 Midvale Ridge (NA 64) (Oxfordshire)

Once contained important outlying stands of eastern type acid grassland. Several small fragments with scarce species survive but are highly fragmented. Landscape restoration urgent. The best surviving area, Frilford Heath is still of considerable significance.

C8 Bedfordshire Greensand (NA 53) (Bedfordshire, Cambridgeshire and Buckinghamshire)

Very fragmented remains of former heathlands which have lost many acid grassland plant species. Landscape restoration required.

C9 Humberhead Levels (NA 22) (South Yorkshire, Nottinghamshire and North Yorkshire)

Very fragmented remains of former heathlands which have suffered heavy losses of acid grassland flora. Landscape restoration required.

C10 Sherwood (NA 32) (Nottinghamshire)

Very fragmented remains of former heathlands with a moderately rich flora. Sizeable patches of U2 grasslands survive but parched acid grasslands appear to have been much reduced. Landscape restoration required.

C11 Lincolnshire, Ancaster Area. Lincolnshire and Rutland Limestone (NA 38)

Very highly fragmented remains of former plant communities on blown sand, associated with limestone grass heaths. A moderately rich flora survives including rare species. Landscape restoration required.

C12 Sefton Coast, Merseyside. Urban Mersey Basin (NA 26)

Areas of acid grassland with some southern acid grassland species associated with very rich and important dune systems. Habitat restoration required in overall complex.

C13 Dartmoor (NA 92) (Devon)

Surprisingly rich lowland acid grassland flora on the fringes of the extensive system of moorland commons.

Category D

Areas of importance to biodiversity at a county level in terms of the acid grassland habitat. Ideally all areas should include SSSIs containing representative stands of acid grassland. Habitat restoration usually essential but areas are of lower priority for landscape restoration.

D1 Avon Commons. Bristol, Avon Valleys and Ridges (NA 62)

Small fragments of parched acid grassland with locally uncommon species.

D2 Cumbria, north of Penrith. Eden Valley (NA 9)

Concentrations of characteristic lowland acid grassland plants have been recorded from this area but their current condition is unclear.

D3 Sussex, High Weald (NA 72)

Much heathland and pasture woodland has been lost to enclosure. Extensive under-grazed heathland survives in Ashdown Forest but the acid grassland flora appears to have always been poor.

D4 Forest of Dean. Dean Plateau and Wye Valley (NA 61)

Pasture woodland and heathland complex mostly destroyed by conversion to plantation but interesting range of acid grasslands associated with forest clearings, coal waste and neutral grasslands in small fields. The area includes an important grassland fungi site. Landscape restoration could greatly increase the value of the area.

D5 Leicestershire, Charnwood (NA 39)

Relic heathland and parkland with some lowland acid grassland features. Interesting transition to upland grassland.

D6 Leicestershire, Trent Valley and Rises (NA 33)

A few lowland acid grassland sites survive in this area and are important for the county's biodiversity.

D7 Wiltshire, Spye Park and Savernake areas. Thames and Avon Vales (NA 63) and Marlborough and Berkshire Downs (NA 79)

Small areas of relic acid grassland contribute to the county's floristic diversity. Savernake Forest includes relic areas of pasture woodland and is a high priority for landscape restoration.

D8 Northamptonshire Acid Grasslands. Midlands Clay Pastures (NA 44)

Contains tiny relicts of heathland with acid grassland which are important to the floristic diversity of the county.

Lowland/Upland Transition Areas

The following areas contain essentially lowland acid grasslands in a largely upland or upland fringe environment, and have intrinsic interest in representing the transition from lowland to upland conditions, irrespective of their value for lowland acid grasslands. See the county accounts in **Volume II** for more details and also the categories above.

Leicestershire, Charnwood Forest (see D5)

Staffordshire, Cannock Chase

Cumbria, north of Penrith (if still present) (see D2)

Cumbria, southern Lake District

Shropshire Hills (see A9)

Northumberland Whin Sill (see B4)

Dartmoor (see C13)

9.3 United Kingdom context

9.3.1 Introduction

England has the bulk of the lowland dry acid grassland resource of the UK. Estimates for the extent of the habitat in Wales and Scotland are given below. Northern Ireland does not appear to have well-developed examples of lowland dry acid grassland. (Paul Corbett, Environment and Heritage Service pers comm).

9.3.2 Wales

Dry acid grasslands are likely to be widespread in the lowlands of Wales with a total of 421ha of dry acid grasslands recorded by Phase 2 surveys in Wales. This total is mostly made up of Festuca-Agrostis-Galium grassland, U4, with less than 1 ha of Deschampsia flexuosa grassland (U2) and 10 ha of parched acid grassland (Festuca-Agrostis-Rumex grassland, U1). (Dr Carrie Rimes, Countryside Council for Wales, pers. comm.) An overall estimate for lowland acid grassland (excluding upland fringes) is 2,000ha (Dr David Stevens CCW pers. comm). The distribution of characteristic acid grassland species (**Maps 2** to **4**) show that these occur in two situations, on the coast and in the eastern hills where the accumulated moisture deficit is greater than 100mm (**Map 18**) (Bendelow and Hartnup 1980).

Over most of Wales, with its low moisture deficit, the lowland acid grassland flora is poorly developed. The coastal flora includes *Agrostis curtisii* in the Gower, and other south-western species include *Chamaemelum nobile, Lotus subbiflorus, Erodium maritimum, E. moschatum, Trifolium ornithopodioides* and *Viola lactea*. There is a strong possibility that there are some interesting examples of the south-western types of acid grassland including Agrostis curtisii grassland (U3) and Festuca-Agrostis-Rumex grassland Hypochaeris sub-community (U1f) in coastal habitats, including heathland and cliff top grassland.

In the east there are two spectacular sites on basic igneous rocks at Stanner Rocks, Radnorshire and Craig Breidden, Montgomeryshire. Woods (1993) gives an excellent NVC based account of grasslands in Radnor. The most widespread forms of parched acid grassland (U1) is the Potentilla-Galium sub-community (U1c) found on shallow, dry, soils on banks in heaths and within larger areas of moist acid grassland (U4). On road banks and church yards the Anthoxanthum-Lotus sub-community (U1d) also occurs widely. On extremely heavily grazed commons in central and east Radnor the quite extensive areas of the Typical sub-community (U1b) are associated with ephemeral ponds, which harbour what are probably the largest stable populations of *Pilularia globulifera* in Britain outside the New Forest.

On bare and rocky ground, richer stands related to the Erodium-Teesdalia sub-community (U1c) with species such as *Moenchia erecta, Filago minima, Dianthus deltoides* and *Teesdalia*. Stands of the Hypochaeris sub-community (U1f) are noted on rock outcrops, with *Sedum anglicum*. On Stanner Rocks both U1c and U1f and related chasmophytic communities occur with a remarkable selection of national rarities and local species: *Scleranthus perennis perennis, Trifolium strictum, Lychnis viscaria, Veronica spicata, Sedum fosterianum* and *Geranium sanguineum*. Stanner Rocks and Craig Breidden are the best examples of U1 type communities on basic igneous outcrops in Britain. Otherwise the acid grasslands of the east of Wales are similar to those of Shropshire.

Moist acid grassland (U4) is mainly upland in character but the Holcus-Trifolium sub-community (U4b) extends into the lowlands. Important, species-rich, enclosed meadows have been described as U4c (data provided by Dr David Stevens CCW) but these could perhaps equally well be described as acidic MG5c. They have *Centaurea nigra* as a constant and the typical herb assemblage of *Succisa, Stachys officialis, Lotus corniculatus* and other species. Only the presence of *Festuca ovina* at constancy level V distinguishes these stands from what would be described as herb-rich, low productivity, MG5c in areas such as Hampshire.

9.3.3 Scotland

The extent and character of lowland acid grasslands is less well known than in Wales but there is thought to be less than 5,000 ha in total (Jane MacKintosh, Scottish Natural Heritage, pers. comm.). In a review of Scottish NVC surveys, Cooper and MacKintosh (1996) found that U1, U2 and U4 were all recorded from Scotland. Several surveys in eastern Scotland, notably the Borders, found U1d. Along shingle riverbanks of Tayside and Deeside, vegetation descriptions suggested that communities

similar to U1b and U1c might be present, although there was insufficient information available to be certain. These records for U1 extend the distribution of the community in Britain beyond that described by the published NVC (Rodwell 1992). A few surveys recorded U2, mostly U2a, on the upland fringes. U4 was also recorded in upland fringes, particularly somewhat improved U4b. Occasionally U4a and U4c were recorded. The authors report that, although the U4c sub-community was only sampled in the Derbyshire Dales in the published NVC, it has been recorded more widely, and some records were made in Scottish surveys.

In Scotland the characteristic lowland acid grassland flora (**Maps 2** to **4**) has been recorded mainly from areas with an accumulated moisture deficit of more than 75mm (**Map 18**) (Birse & Dry, 1970) with smaller concentrations of species recorded from river valleys in the Highlands. In some areas these species are found in coastal dune systems and on river gravels but in the south-east they are also found on outcrops of volcanic basalt, andesite and tuffs in areas such as the Sidlaw Hills, Moncrieff Hill south of Perth, and Arthur's Seat, Edinburgh. From personal experience (NA Sanderson) these rocks can support communities related to parched acid grassland Festuca-Agrostis-Rumex grassland (U1) and calcicolous grassheath Festuca-ovina Hieracium pilosella-Thymus praecox grassland (CG7). These acid grasslands probably represent some of the northern-most occurrences of this type vegetation and they are thus likely to be of high intrinsic interest.

9.4 European context

The following brief review attempts to set the lowland dry acid grasslands of England in a European context, although there is relatively little information readily available on European grasslands.

9.4.1 Vegetation

Rodwell (1992, 1996) provides an analysis of the European phytosociological affinities of the NVC communities. These European affinities are described below, and related to the Corine Biotope Classification (Commission of the European Community, 1991) and the Interpretation Manual of the European Habitats (EC DGXI 1995) which defines Annex 1 Habitat Directive types.

***Festuca ovina - Agrostis capillaris - Rumex acetosella* grassland (U1)**

Rodwell (1992) regards U1 as being included within the *Sedo-Scleranthetea* class of vegetation of dry sandy soils and thin soils over rock, and within this, as being best placed in the *Thero-Airion* alliance. Rodwell (1996) includes U1 in the *Koelerio-Corynephoreta* class and the *Plantagini-Festucion ovinae* alliance, rather than the *Thero-Airion* alliance. Related associations within the *Thero-Airion* alliance (*sensu* Rodwell 1992) are recorded from the Netherlands, Germany and Poland. *Aira praecox* itself is an endemic western European species extending to south-west Finland, the Czech Republic and north-west Italy (Sell & Murrell 1996). The *Thero-Airion* appears to be mainly a feature of warm Atlantic and sub-Atlantic climates where summer droughts occur consistently, winter growth is possible and leaching is significant. It seems to be associated with heathlands and inland blown sand deposits. It has few affinities with steppe communities which are typical in areas where calcium carbonate accumulation becomes more significant than leaching and winter growth is not possible.

The *Thero-Airion* is included in Corine under Dry Siliceous Grasslands (35) as 35.2 Medio-European Open Siliceous grasslands, either as 35.21 Dwarf Annual Siliceous Grasslands or 35.22 Perennial Open Siliceous grasslands. These types are open formations on dry siliceous soils of Atlantic, sub-Atlantic and Mediterraneo-montane distribution. They are often species-poor and have a strong representation of annuals. The *Sedo-Scleranthetea* in Corine is listed under Dry Calcareous Grasslands and Steppes (34) as 31.4 Middle European Pioneer Swards, which are open, thermophilic formations on sandy or rocky ground, in non-Mediterranean lowland to montane areas. U1 grassland is not listed on Annex 1 of the Habitats Directive (92/43 EEC).

Deschampsia flexuosa grassland (U2)

Rodwell (1992) regards Deschampsia flexuosa grassland (U2) as being best placed within the *Nardo-Galion* alliance of the *Nardo-Callunetea* class. Whilst the driest stands have some *Thero-Airion* features, these cannot be considered as typical of this alliance. Rodwell (1996) places U2 in the *Nardo-Callunetea* class but in the *Violon caninae* alliance, which covers unfertilized mat-grass pastures at lower altitudes. Deschampsia flexuosa grasslands are listed in Corine as 35.13 Deschampsia flexuosa Grasslands under 35.1 Atlantic Matgrass Swards and Related Communities. Although U2 is within 35.1, it is not a habitat listed under this category in Annex 1 of the Habitats Directive. In Britain, species-rich examples of CG10 and CG11 are regarded as representing type 35.1, and only occur in upland areas.

Deschampsia flexuosa is a cosmopolitan species widespread across temperate Eurasia and mountains in the south of North America (Sell & Murrell 1996). In Europe it is found on dry acidic soils in boreal and temperate forests and is a typical component of heath and acid grasslands derived from these woods (Polunin & Walters, 1985).

Agrostis curtisii grassland (U3)

Rodwell (1992) does not directly suggest phytosociological affinities for U3 but implies that it belongs within the *Nardo-Galion* alliance. Its position appears similar to U2, with the driest stands transitional to *Thero-Airion* but the bulk firmly within the *Nardo-Galion*. Rodwell (1996) places U3 in the *Violion caninae*.

The community is not identified in Corine but presumably should be included under the 35.1 Atlantic Matgrass Swards and Related Communities. *Agrostis curtsii* is confined to south-west Europe and north Africa (Sell & Murrell 1996), where it is mainly found as a component of heathlands. *Agrostis curtsii* grasslands are commonly regarded as having been derived from heath (Rodwell, 1992) and, because of this perception, do not appear to be considered as a separate type. Some New Forest U3 grasslands, however, are relatively stable communities, found on brown earths as opposed to the podzols found under *Agrostis curtsii* heaths (H3). These New Forest examples have probably remained distinct from heath for hundreds of years. The extent of these stable *Agrostis curtisii* grasslands in Europe, as opposed to recently derived grasslands, is totally unknown. U3 is not an Annex 1 Habitats Directive type.

Festuca ovina - Agrostis capillaris - Galium saxatile grassland (U4)

Rodwell (1992) regards U4 as clearly referable to the *Nardo-Galion* (*Violion caninae* in Rodwell 1996). In Corine, U4 is include within 35.12 Agrostis-Festuca grasslands, under 35.1 Atlantic Matgrass Swards and Related Communities. There appear to be few equivalents to these *Festuca-Agrostis* swards in continental Europe. U4 is not an Annex 1 Habitats Directive type.

Carex arenaria communities

The Carex arenaria dune community (SD10) is regarded by Rodwell (in prep) as having greatest affinities with the *Ammophilion* alliance, and in Rodwell (1996) it is referred to the *Ammophilion arenariae*, vegetation of young to fixed dunes, within the *Ammophiletea arenariae* class. In Corine, *Carex arenaria* grasslands are described as being closed, acidophilous grasslands, on fixed sands dominated by Carex arenaria (35.15). It is not an Annex 1 type. Rodwell (in prep) regards the Carex arenaria-Cornicularia aculeatam community (SD11) as best included within the *Corynephorion* alliance. Rodwell (1996) places SD11 in the *Koelerio-Corynephoretea* class, along with U1, and in the *Corynephorion canescentis* alliance. The *Corynephorion* is found on acid coastal and inland sands from the Netherlands into Poland. Corynephorus grasslands are included in Corine as 35.23 within

35.2 Medio-European Open Siliceous Grasslands and also 64.11, inland dune, pioneer, grasslands under fluvio-glacial inland dunes (64.1)

Corynephorus may also in occur in Corine type 64.2, Breckland inland dunes. SD11 forms part of an Annex 1 type called Open Grassland with *Corynephorus* and *Agrostis* of Continental Dunes (64.1 and 35.2). The Interpretation Manual (EC DGXI 1996) also includes SD12 in this type. However, only examples of the Annex 1 type with Corynephorus have been proposed as Special Areas for Conservation in the UK and one site has been selected in Breckland (Brown *et al* 1997).

Other communities

Acid grasslands more typical of the uplands, Nardus stricta - Galium saxatile grassland (U5), and Juncus squarosus - Festuca ovina grassland (U6) are placed in the *Nardo-Callunetea* class by Rodwell (1992, 1996). In Rodwell (1992), U5 is in the *Nardo-Galion* alliance (re-named *Violion caninae* in Rodwell 1996), while U6 is in the *Juncus squarrosi* (*Nardo-Juncion squarrosi* in Rodwell 1996). In Corine, U5 is within 35.11 Mat-Grass Swards, while U6 is within 37.3 Oligotrophic humid grasslands. Neither is an Annex 1 type.

Pteridium aquilinum - Galium saxatile stands (U20) do not feature in Europe according to Rodwell (1992). Rodwell (1992, 1996) places U20 in the class *Quercetea robori - petraeae* class, *Quercion robori-petraeae* alliance, as it seems to be best regarded as an anthropogenically derived replacement for oak and oak-birch woodland on acid soils. The Corine type for these woodlands is 41.5 Acidophilous Oak Forests. Bracken stands are not an Annex 1 type.

9.4.2 Extent of lowland acid grassland in Europe

Two reports which refer to the extent of dry grasslands in Europe were consulted. Wolkinger and Plank (1981) provided little information of use. For them dry grassland is synonymous with calcicolous grassland (class *Festuco-Brometea*). *Sedo-Scleranthetea* vegetation is only briefly mentioned.

Van Dijk (1991) reviewed the status of semi-natural grasslands in Europe. His review indicated a general lack of data on acid grassland but what information could be obtained was described. In the entry for Great Britain, the acid grasslands (order *Nardetalia*) of the uplands are assumed to be important, due to them being very rare in the lowlands of the continent. No mention is made of *Sedo-Scleranthetea* vegetation in Britain.

For Germany, interesting information exists for the individual Länder. In Lower Saxony, acid grasslands i.e. *Corynephorion, Thero-Airion, Armerion elongatae* and *Violo-Nardion* (*Nardo-Galion*) covered only 1,048ha scattered over 110 sites. In Nordrhein-Westfalen, acid grasslands (order *Nardetalia*) are recorded as covering 38ha with reports of a great decline in area. The *Nardo-Galion* is regarded as having practically disappeared. Baden-Württemberg still has 11,500ha of acid grasslands (order *Nardetalia*) and in Bavaria there are 4,409ha of acid grasslands (type unknown).

For France, little information is available but 5,000ha of species rich acid grassland with abundant *Arnica montana* is mentioned as being under threat in the High Vosges. The 100,000s of hectares of species-rich *Nardus* grassland of the Massif Central, however, are not mentioned. For a illustration of the extensive nature of this habitat see plate 21 in Polunin & Smythies (1988). No other useful information was given.

No very definite conclusions can be made from this information as *Sedo-Scleranthetea* vegetation has hardly been recorded and appears to be rare now in the western European lowlands. *Nardo-Galion* vegetation is very restricted in the lowlands due to loss of habitat and is also threatened in the uplands, although more extensive stands exist here. The impression gained from existing information is that the

Sedo-Scleranthetea vegetation of lowland England is very significant in terms of its extent in a European context.

9.4.3 Flora

A detailed biogeographical account of the British and Irish flora has recently been published (Preston and Hill 1997). In this paper species are classified by their occurrence in one or more major biomes (north to south: Arctic, Boreal, Temperate, Southern) and their longitudinal distribution (west to east: Oceanic, Suboceanic, European, Eurosiberian, Eurasian, Circumpolar). The combination of these categories gives 43 floristic elements. The species listed in Table 1 as being those generally faithful to lowland acid grassland in England are categorised by Preston and Hill as follows:

European Boreo - Temperate

Thymus serpyllum

Eurosiberian Boreo - Temperate

Dianthus deltoides

Oceanic Temperate

Festuca longifolia
Viola lactea

Suboceanic Temperate

Ornithopus perpusillus

European Temperate

Filago minima
Sagina subulata
Scleranthus perennis
Teesdalia nudicaulis
Vicia lathyroides

Eurosiberian Temperate

Herniaria glabra
Potentilla argentea
Veronica verna

Suboceanic Southern - Temperate

Chamaemelum nobile
Erodium maritinum
Lotus subbiflorus
Moenchia erecta
Trifolium ornithopodioides

European Southern - Temperate

Corynephorus canescens
Hypochaeris glabra
Lotus angustissimus
Trifolium striatum

Eurosiberian Southern - Temperate

Apera interrupta
Medicago minima
Silene conica
Stellaria pallida

Mediterranean - Atlantic (includes eastern Mediterranean)

Gladiolus illyricus
Trifolium glomeratum
Trifolium suffocatum
Vulpia ciliata

Submediterranean - Subatlantic (includes south-western parts of Central Europe)

Crassula tillaea
Trifolium scabrum
Trifolium subterraneum

Compared to the total flora of Britain and Ireland there is a much greater representation in Table 1 of Southern Temperate (39.4% *vs* 20%) and Mediterranean elements (21.2% *vs* 7.9%). This finding fits with the lowland habitat characteristics of parched acid grassland in England, especially relatively low summer rainfall and/or freely draining substrates. There is also a greater representation of Oceanic and Suboceanic species in Table 1 compared to the flora as a whole (21.2% *vs* 12.6%). This western character of the parched acid grassland flora in England is probably more significant in terms of European biogeography than the 'continental' element of this flora, which is best developed in Breckland. Preston and Hill (1997) identify 'continental' species as those rare in the Oceanic zone of Europe. Only three species (*Dianthus deltoides, Thymus serpyllum* and *Veronica verna*) are classed as 'continental' among the species in Table 1.

The sub-species *Scleranthus perennis prostratus* of eastern England is endemic (Stace 1991) and *Vulpia ciliata ambigua* is a near-endemic, being confined to a few localities in Belgium and north-west France in mainland Europe (Sell and Murrell 1996).

10. Acknowledgements

This project was funded under EN Contract No. VT2.1C. The author is especially grateful for the very helpful input from English Nature's Local Team staff and other conservationists, in particular Dr Francis Rose, Ted Green, Simon Leach, Colin Newlands, Nick Hodgetts, Brian Edwards, Paul Edgar, Dr Colin Pope, Mark Crick, Tim Smith, Clive Chatters, Paul Darby, Christine Bennett and Paul Gately. In addition to these people, the author particularly thanks the landowners and occupiers for their permission to visit sites, and national specialists in English Nature, Phil Grice, Ron Porley, Ian Taylor, David Sheppard, Martin Drake, Tony Gent and Heather Robertson for their useful ideas and information. In addition staff from the other country agencies provided helpful information, in particular Carrie Rimes and David Stevens of the Countryside Council for Wales, Jane MacKintosh of Scottish Natural Heritage, Paul Corbett of the Environment and Heritage Service, Northern Ireland, and Henry Arnold of the Biological Records Centre.