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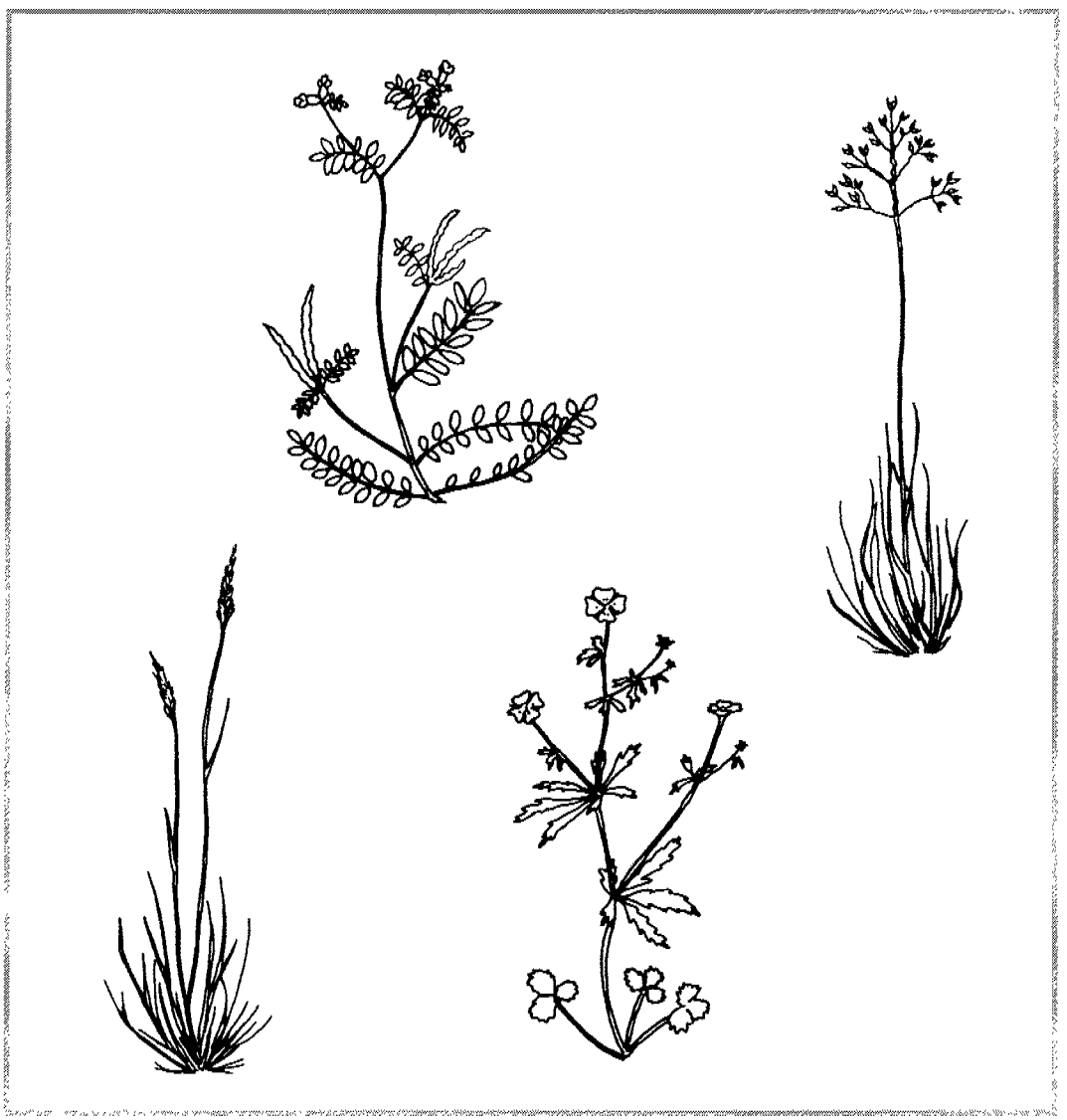

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Summary

1. The conservation of lowland acid grassland in England has not received as much attention in recent years as the conservation of neutral or calcareous grasslands. However, dry lowland acid grassland has been recognised as a key habitat in the Biodiversity Report for the UK and a Biodiversity Action Plan is due to be produced for it in 1998. The Plan will cover the National Vegetation Classification types of acid grassland that are mainly represented within the NVC communities U1 to U4. Improved knowledge of the habitat will be required to implement the Plan and English Nature therefore decided to commission a review of current knowledge on the extent of lowland acid grassland, its conservation interest and management and an assessment of any gaps in knowledge of the location and quality of remaining sites.

2. For the purposes of the review, acid grassland is defined floristically by reference to the NVC. The relationship of the main communities (U1 to U4) to other grassland and heath types is discussed as well as links with associated communities found in acid grassland landscapes, in particular inland sand dune (SD) communities and Bracken stands.

3. Comprehensive vegetation surveys of lowland acid grassland are lacking in England. Methods used to assess the current extent and distribution of the resource included examination of geology and soil maps, development of lists of plant species that could indicate the location and distribution of acid grassland, review of existing survey and Inventory information, and consultation with English Nature's Local Team staff and others in every EN Local Team area across England. Using this information, provisional estimates for the extent of component acid grassland communities are made for England as a whole and for each county. Likely totals are expressed as ranges within low, medium and high estimates. The total area of lowland dry acid grassland is suggested to be in the range 15,000 to 22,000 ha, with individual communities estimated as follows; 8,000 to 12,500 ha of U1; 3,000 to 5,500 ha of U2; 2,000 to 3,000 ha of U3; 3,000 to 5,000 ha of U4; 150 to 450 ha of inland SD10; 60 to 300 ha of inland SD11.

4. The nature conservation interest of the flora of acid grassland is considerable, and lowland acid grassland comprises a unique series of plant communities that make a significant contribution to the biodiversity of lowland England. The habitat has an undeserved reputation as being species-poor. In fact, the review shows that plant species richness per unit area in some stands equals or exceeds the richest lowland neutral and calcareous grasslands. Lowland acid grasslands, in particular U1, harbour a considerable number of rare and scarce vascular plants, including 17 nationally rare and 22 nationally scarce species. Maps of past and present distributions of species that are generally only found in acid grassland show that severe declines have occurred, resulting from habitat loss but also deterioration of habitat quality. Lack of management of remaining acid grasslands has led to the disappearance of species that depend on short, open grassland, even on protected sites such as National Nature Reserves. Acid grasslands are also significant for lower plants, of particular note is the lichen flora of U1 grasslands. There is growing recognition of the value of acid grassland, particularly U4, for fungi floras and this aspect of their nature conservation interest needs further investigation.

5. Lowland dry acid grassland shares a threatened bird fauna with dry calcicolous grassland. The habitat is of importance for a number of species of conservation concern (Red and Amber Lists), in particular, Stone Curlew and Woodlark. Declines in birds that require short turf have parallelled those for vascular plants and indicate the effect of lack of habitat management. Acid grassland forms part of habitat mosaics used by all widespread species of amphibians and reptiles and also is a component of habitats that are important for three rare species, Smooth Snake, Sand Lizard and Natterjack Toad. The invertebrate species assemblages of acid grassland have not been extensively studied but the habitat supports rare species such as

the Large Blue butterfly, and a number of specialist species. Acid grasslands can encompass significant amounts of bare ground, which are important for burrowing invertebrates.

6. Conservation of the nature conservation interest of acid grassland is largely dependent on the continuation or re-instatement of appropriate management. Grazing animals have a crucial role to play in conservation management and acid grassland forms an important part of forage for livestock in heathland habitat mosaics which are managed by extensive grazing. A landscape approach to habitat conservation will be needed if sustainable, extensive, pastoral systems are to be restored. The vital place of acid grassland in a functioning landscape of heathland and low-intensity arable farmland should be recognised and consideration given to the role of acid grassland in heathland re-creation and restoration schemes. Knowledge of the location of existing sites and past and present distributions of acid grassland flora as well as information on suitable soils can assist in defining potential areas for acid grassland re-creation, as demonstrated in the review.

7. Survey requirements fall into two main categories: first, locating remaining sites and assessing the type and extent of their acid grassland communities, in particular U1, and second, floristic assessment, which should include obtaining information on rare and scarce species. A provisional indicator species list is proposed to assist in the floristic evaluation of acid grasslands. Both types of audit are required to target conservation measures such as incentive schemes, and to prioritize action, as well as for monitoring conservation condition of grasslands and informing management decisions, for instance regarding appropriate grazing levels. Ten high priority areas for survey are identified in the review, plus 9 medium priority areas and 3 lower priority areas.

8. A provisional assessment of the relative importance of different areas of England for lowland acid grassland is presented as an interim measure before more comprehensive information on the resource becomes available. The assessment is based on the national and county information collected during the review and the results are described in relation to English Nature's Natural Areas. Classes used in the evaluation range from areas with very diverse and often extensive acid grasslands, where restoration at a landscape scale is particularly important, to areas with more fragmented acid grasslands of county importance and SSSI quality. The highest rated areas are: Breckland, the New Forest, Dungeness, the Dorset Heaths, the west Wealden Heaths, the south coast of Devon and Cornwall, the Sandlings and Suffolk coast, the Solent coast of Hampshire and the Isle of Wight, the Shropshire Hills (together with adjoining areas in Wales), and the Coversand Heaths of Lincolnshire and Nottinghamshire.

9. England has the bulk of the UK's lowland dry acid grassland resource although Wales has some outstandingly rich examples of U1-related stands. There is little readily available information on the European status of the habitat but in a European context the English resource appears to be very significant in terms of its extent.

1. Introduction

Semi-natural grassland within lowland England is a scarce and declining resource. This decline can largely be attributed to agricultural intensification although other factors such as neglect and scrub invasion, afforestation and increasing urbanisation have all had an impact.

As a result of these threats, conservation organisations have worked towards identifying and protecting the remaining semi-natural grasslands. The notification of SSSIs and acquisition of nature reserves has played an important part. In addition, important conservation mechanisms for protecting semi-natural grassland within the wider countryside are now available. The most significant wider countryside schemes are the Environmentally Sensitive Areas (ESA) scheme and the Countryside Stewardship Scheme (CSS), which provide incentive payments for the conservation management of semi-natural grasslands. However, to date, most attention has been focussed on calcareous and neutral semi-natural grasslands rather than acid grasslands, although in April 1996, the CSS was extended to cover all lowland acid grasslands. Relatively few surveys to locate and evaluate the nature conservation interest and management condition acid grasslands have been carried out. Conservation action has been correspondingly less, perhaps because their vascular plant component has been perceived as being less rich (though distinctive) when compared to calcareous or neutral grasslands.

A recent development has been the production of the Biodiversity Report for the UK (UK Steering Group 1995). Lowland acid grassland on dry soils is recognised as a key habitat in the Report and a Biodiversity Action Plan is due to be produced for it in 1998. Improved knowledge of the resource will be required to implement the Plan, for instance to target the CSS.

English Nature therefore decided to commission a review of current knowledge on the extent of dry lowland acid grassland, its conservation interest and management, and an assessment of any gaps in knowledge of the location and quality of remaining sites. In terms of the National Vegetation Classification the acid grassland types to be reviewed included U1 (Festuca ovina-Agrostis capillaris-Rumex acetosella grassland), U2 (Deschampsia flexuosa grassland), U3 (Agrostis curtsii grassland) and U4 (Festuca ovina-Agrostis capillaris-Galium saxatile grassland). These communities comprise the major part of BAP key habitat of lowland acid grassland.

The aims of the review were to:

- identify areas in England likely to have acid grassland
- assess the completeness of survey information
- make a provisional estimate of the extent of the total resource
- provide examples of the composition and management of acid grasslands
- review and summarize the conservation importance and management of acid grasslands
- provide an assessment of the priorities for botanical Phase 2 survey of defined geographical areas
- provide a provisional evaluation of the significance of acid grassland on a geographical basis and relate the resource to the UK and European context.

The review has largely involved a desk study of existing information and consultation with staff in Local and National Teams in English Nature, together with some staff from other organisations such as Wildlife Trusts. A limited amount of field survey of illustrative examples of acid grasslands was

undertaken in 1997. Volume I of the review provides the general picture of the resource and Volume II gives a more detailed assessment of the resource across the counties and Natural Areas of England. Appendix I of Volume I contains the examples of acid grassland sites, described by extracts of published data and data from 1997 survey work. Further survey details for sites visited in 1997 have been sent to the relevant Local Team.

Nomenclature

The conventions used in the review for species names are as follows:

Plants

Vascular Plants: Latin names follow Stace, C. (1991), except for Latin names within plant community names, as published in the NVC, to avoid confusion over the identity of these communities. The alternative NVC names following Stace are given in Chapter 2, where the NVC communities are described.

Mosses: Latin names follow Corley and Hill (1981) except for the genus *Hypnum* which follows Smith (1997), and *Racomitrium elongatum* which follows Frisvoll (1983).

Liverworts: Latin names follow Smith (1990).

Lichens: Latin names follow Purvis *et al* (1994).

Animals

English names, except for invertebrates which have English and Latin names, the latter follow the Recorder dictionaries (Hawkswell and Marshall 1995).

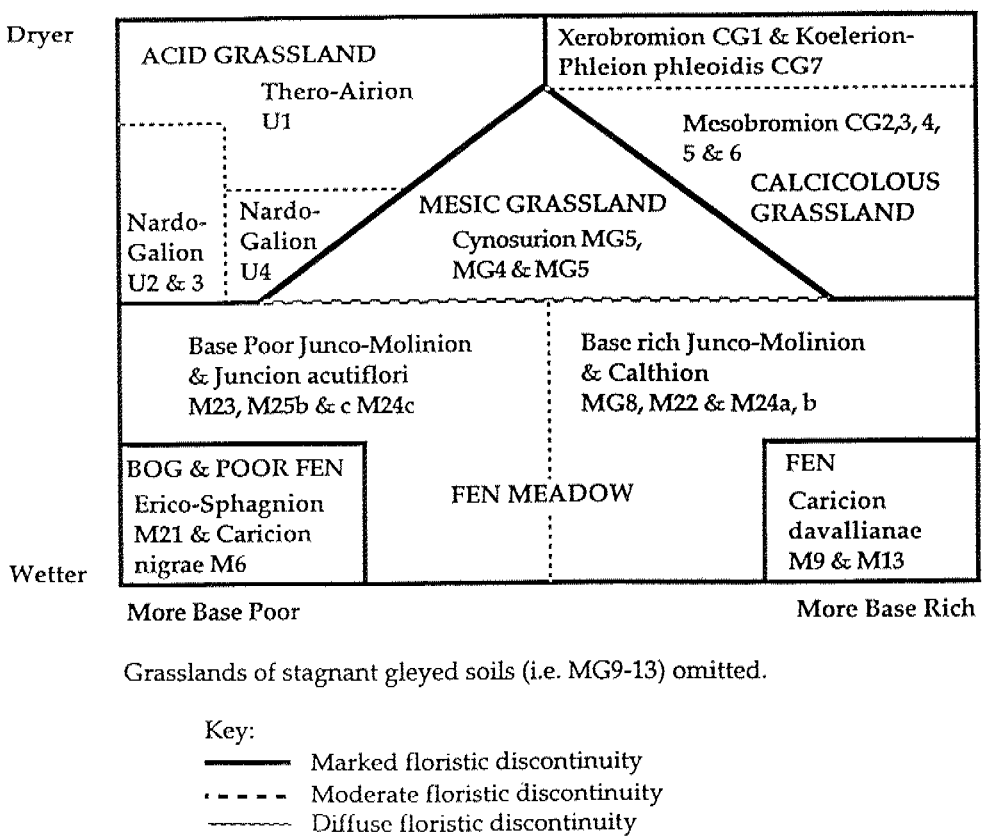
2. Definition of lowland acid grassland

2.1 Floristic definition, soil types and related vegetation

The definition of dry acid grassland adopted in this review is floristic, being based on the National Vegetation Classification (Rodwell 1992). The main communities which are included in the review (U1 to U4) are put under the umbrella term 'calcifugous' grassland by Rodwell (1992). 'Acid' grassland or 'calcifugous' (lime-hating) plants are associated with soils which have a chemical base status represented by a soil pH at some level below pH 7. However, 'neutral' grasslands also occur on soils with pHs of less than pH7, though these soils are usually more mildly acidic (nearer to pH7). There seems to be a lack of published information as yet on the soil pH and soil nutrient content of lowland acid grassland NVC communities. The measurement of soil pH is problematic but some examples which pre-date the NVC give an idea of characteristic levels. In Sherwood Forest, pH 4.3 was recorded for soil under *Deschampsia flexuosa* grassland (Marrs *et al* 1991). In south-west England, a record of pH 5.2 was made for soil under *Agrostis curtisii*-dominated grassland (Elmes and Wardlaw 1982a), and pHs ranging from 6.2 to 3.7 were recorded for soils of *Festuca-Agrostis* grasslands containing *Rumex acetosella* in Breckland grass heath (Watt 1940).

In terms of moisture status, dry acid grasslands are distinguished from wet communities in the NVC by Rodwell (1991) defining fen-meadow and rush-pasture (which incorporate wet acid grassland) as associated with soils that are moist for a substantial part of the year. However, the 'dry' acid grasslands themselves vary in moisture status from very dry U1 types to relatively moist U4 grasslands.

The relationship of dry acid grassland communities and other grassland communities to soil moisture and base status is shown in Fig 1. The diagram also includes the names of the Continental phytosociological affinities of these communities (Rodwell 1991, 1992).



Grasslands of stagnant gleyed soils (i.e. MG9-13) omitted.

Key:
- Marked floristic discontinuity
- Moderate floristic discontinuity
- Diffuse floristic discontinuity

Figure 1 Soil base status and moisture content of lowland grassland communities

The published NVC volumes lack, as yet, an overall key to the formation types in the classification eg the formations 'CG' (which covers calcicolous grasslands), 'M' (mires) and 'H' (heaths) are described in separate sections. An attempt is made below to draw the broad floristic distinctions between these formations and the formation 'U' which includes dry acid grasslands.

U - incorporates dry acid grassland

The Handbook for Phase 1 Habitat Survey (NCC, 1990) lists *Deschampsia flexuosa* , *Nardus stricta* , *Juncus squarrosus* , *Galium saxatile* and *Rumex acetosella* as species characteristic of acid grassland when frequent or abundant. Although *Juncus squarrosus* is much more characteristic of wet heath in the lowlands and *Nardus* can be prominent in *Junco-Molinion* communities, the list is generally useful.

In addition to these, there are other widespread indicative species such as the vascular plants *Aira praecox*, *Ornithopus perpusillus*, *Filago minima* and *Agrostis curtisii*, and the mosses *Polytrichum juniperinum*, *Polytrichum pilulifera* and *Pleurzium schreberi*. Many local species are also distinctive, especially within the more xeric types of U1 (Festuca ovina-Agrostis capillaris-Rumex acetosella) grassland.

M - incorporates wet acid grassland

Wet acid grasslands can be separated by the abundance of species such as *Molinia caerulea*, *Agrostis canina* and *Juncus acutiflorus* as well as the presence of species such as *Pedicularis sylvatica*, *Lotus pedunculatus*, *Carex panicea*, *Carex viridula oedocarpa*, *Carex nigra* and *Carex echinata*. Many of these species also occur in base rich fen meadow but are absent from dry acid grasslands.

H - Heaths

Heaths can be separated from acid grasslands by the presence of dwarf shrubs. However, the distinction can be very difficult, some herb-rich heath communities are essentially acid or even calcicolous grassland with a high cover of *Calluna vulgaris*. (For the purposes of this report, the term heath is used to indicate communities dominated by ericaceous species, and heathland is used to describe areas of rough grazing in which some heath is present).

CG - Calcicolous Grasslands

Acid and calcicolous grassland are separated geographically in many areas, but very gradual gradations occur in areas such as Breckland. Here the most practical definition appears to be the absence of calcifuges (lime-haters), eg *Rumex acetosella*, and the abundance of species traditionally regarded as calcicoles (lime-lovers) in calcicolous grasslands, eg *Helianthemum nummularium*, *Hippocrepis comosa* and *Scabiosa columbaria*. Supposed calcicoles such as *Thymus polytrichus*, *Cirsium acaule* and *Linum catharticum* can sometimes occur in acid grassland at low frequencies.

MG - Neutral (mesotrophic) Grasslands

The problem of separation of 'neutral' grassland from acid grasslands is rather similar to that of the separation of acid and calcicolous grasslands, in that species generally characteristic of communities such as MG5 or MG6, eg *Festuca rubra* and *Cynosurus cristatus* can also occur at lower levels within several acid grassland communities. Here the positive occurrence of acid grassland species appears to be the most practical method of separating the two types of grasslands.

2.2 Altitude and the definition of lowland acid grassland

The lower limit of lowland acid grassland is defined according to the transition to maritime grasslands on the coast. This limit is relatively easy to define and is usually considered as the switch from acid grasslands such as NVC community Festuca-Agrostis-Rumex grassland (U1), to maritime grasslands such as the Armeria maritima - Cerastium diffusum maritime therophyte community (MC5) and the Festuca rubra-Armeria maritima maritime community (MC8) (Rodwell in prep.).

The upper altitudinal limit of lowland grassland is much more difficult to define. The working definition at the start of the review was:

"Lowland acid grassland is generally found below 350 metres and does not include unenclosed rough grazing land above the moor wall."

From the consultations with Local Team staff it became clear that the definition of lowland acid grassland varies across the country. Many of those consulted found the 350m limit rather high. Land use definitions were found useful in some areas, especially the south-west. Here the boundaries of Less Favoured Areas are taken to mark the divide between lowland and upland, but it was commented that in this region at least, there was little ecological difference between the acid grasslands of the uplands and the lowlands. A common response, however, was that there was a greater difference between the acid grasslands of the enclosed upland fringes below 250 or 350m and those of truly lowland conditions beyond the hills, compared with upland fringe acid grassland the truly upland grasslands above the moor wall.

A common theme was that where acid grassland of interest occurred in the upland fringes, it tended to be parched acid grassland, Festuca-Agrostis-Rumex grassland (U1), with a strong lowland character, for example on south facing slopes of igneous rocks in Shropshire and Northumberland. The Welsh Phase 2 surveys of acid grassland experienced the same problem of defining lowland grassland. Often little land lay below 200m but 'lowland' plant communities such as MG5 could be found at altitudes of over 350m. Generally, upland fringe or fridd areas (often in the form of defunct enclosures immediately below the unenclosed upland grazings) were not included in assessments of lowland acid grassland (Dr Carrie Rimes, Countryside Council for Wales, pers. comm.). In the few instances where specific interest was attributed in England to more typical moist acid grasslands of the upland fringe, including Festuca-Agrostis-Galium grassland (U4), the interest tended to relate to the adjacent uplands, eg in West Yorkshire, the enclosed grasslands, including acid grasslands, are important feeding grounds for internationally important populations of waders breeding on the moors above. (Colin Newlands, English Nature, pers. comm.)

Upland fringe acid grassland can be extensive, eg in Cumbria, where it is considered that there is between 30,000-50,000ha of acid grassland below 300m but only between 500-1,000ha is found beyond the upland fringe (Ian Slater, English Nature, pers. comm).

The variability in altitudinal definition of lowland grassland and consequent variation in amounts of upland fringe grassland that could be included led to the following definitions being used in this review:

- **Upland acid grassland**

  Acid grasslands within extensive moorland grazings. Very rarely, distinctively lowland type acid grasslands may occur in favourable locations at lower altitudes.

- **Upland fringe grasslands**

  Acid grasslands within enclosed landscapes in the hills. These grasslands are often part of the same pastoral system as the nearby moors and generally have a closer ecological and land use relationship to the uplands than the lowlands. Very rarely, distinctively lowland-type acid grasslands may occur in favourable locations.

- **Lowland acid grasslands**

  Acid grassland beyond the hills.

  This report deals mainly with the last category, but grasslands of a distinctively lowland character which occur in the upland fringe or the uplands are also considered.

2.3 Description of core and associated lowland acid grassland NVC communities

2.3.1 Introduction

When considering the NVC, or any other vegetation classification, it is important to remember that such classifications are an abstraction of reality. Vegetation communities have no real existence and are simply convenient divisions of a continuum. An important function of a vegetation classification scheme is to provide an objective framework to allow meaningful comparisons to be made between different areas and sites. Given this, it should be remembered that transitions and odd stands are to be expected and the fact that a vegetation stand does not easily 'fit' into a classification does not necessary imply any lack of nature conservation interest.

The core and associated NVC communities which make up lowland acid grasslands are listed and briefly described below from Rodwell (1992) and Rodwell (in prep.), although some more recent experience is also incorporated. The NVC communities that are closely associated with acid grasslands in the lowlands are usually very localised in contrast to the core communities. As well as fragments of acid grasslands more typical of the uplands, these associated types include inland sand dune communities and species-rich Bracken stands.

2.3.2 Summary list of core and associated acid grassland NVC communities

Core NVC acid grassland communities and sub-communities	
U1	*Festuca ovina-Agrostis capillaris-Rumex acetosella* grassland U1a: Cornicularia aculeata-Cladonia arbuscula sub-community U1b: Typical sub-community U1c: Erodium cicutarium-Teesdalia nudicaulis sub-community U1d: Anthoxanthum odoratum-Lotus corniculatus sub-community U1e: Galium saxatile-Potentilla erecta sub-community U1f: Hypochaeris radicata sub-community
U2	*Deschampsia flexuosa* grassland U2a: Festuca ovina-Agrostis capillaris sub-community
U3	*Agrostis curtisii* grassland Undescribed lowland sub-communities
U4	*Festuca ovina-Agrostis capillaris-Galium saxatile* grassland U4a: Typical sub-community U4b: *Holcus lanatus-Trifolium repens* sub community U4c: *Lathyrus montanus-Stachys betonica* sub-community
Associated NVC acid grassland communities and sub-communities	
SD10	*Carex arenaria* community SD10b: *Festuca ovina* sub-community
SD11	*Carex arenaria-Cornicularia aculeata* community SD11b: Festuca ovina sub-community
U20	*Pteridium aquilinum-Galium saxatile* community U20a: *Anthoxanthum odoratum* sub-community, specifically species-rich variants
U2	*Deschampsia flexuosa* grassland U2b: *Vaccinium myrtillus* sub-community
U3	*Agrostis curtisii* grassland Undescribed upland sub-community
U4	*Festuca ovina-Agrostis capillaris-Galium saxatile* grassland U4d: *Luzula multiflora-Rhytidiadelphus loreus* sub-community U4e: *Vaccinium myrtillus-Deschampsia flexuosa* sub-community
U5	*Nardus stricta-Galium saxatile* grassland
U6	*Juncus squarrosus-Festuca ovina* grassland

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

Introduction

This is the main acid grassland type of the south and east of England and is almost entirely lowland in its distribution. It is sometimes referred to as lichen heath or grass heath and occasionally is called 'breckland grassland' (eg Rose, 1995) but this is an unsatisfactory name for general use as the community occurs widely beyond Breckland. The name 'parched acid grassland' is here proposed as a more comprehensive term and is used to denote U1 in this review.

The community (U1)

There are only three community constants listed by the NVC: *Festuca ovina* agg., *Agrostis capillaris* and *Rumex acetosella*. Of these only *Rumex acetosella* is largely confined to Festuca-Agrostis-Rumex grassland (U1). The preferential species vary with the sub-communities and are discussed below.

The distinction between Festuca-Agrostis-Rumex Grassland (U1) as a whole and the Festuca-Agrostis-Galium Grassland (U4) can be difficult to make. The NVC does not record any *Rumex acetosella* in 342 samples of U4 so the presence of this species alone is fairly diagnostic of U1, as delineated by the NVC. Associated species which are recorded reasonably frequently in U1, and which, like *Rumex acetosella*, were not recorded by the NVC from U4, include *Aira praecox*, *Erodium cicutarium*, *Aphanes* sp, *Teesdalia nudicaulis*, *Ornithopus perpusillus*, *Filago minima*, *Leontodon saxatilis*, *Pilosella officinarum*, *Plantago coronopus*, *Carex arenaria*, *Brachythecium albicans*, *Polytrichum juniperinum*, *Polytrichum piliferum*, *Cladonia arbuscula*, *Cladonia furcata*, *Cladonia portentosa* and *Coelocaulon aculeatum*.

At the extremes, U1 and U4 are very different communities, although the boundary is very diffuse. The Galium saxatile-Potentilla erecta sub-community (U1e) of parched acid grassland comes closest to U4 and separation can be difficult (Woods 1993). In Radnorshire, Woods (1993) describes U1c as having at least a few annual species such as *Aira praecox*, which are absent from U4.

The differentiation of U1 and U4 is therefore achieved marked by the absence of all of the above species from U4. If this reasoning is followed, then it is possible that the U4 community has been over-recorded in the south and east by past surveys. This is exemplified on the Humberside Coversand survey where most quadrats recorded as U4 contain *Rumex acetosella* (Wigginton 1990) and could be described as being closer to U1 than U4. A further problem is presented by rank, ungrazed, acid grasslands since much of the character of the two communities is lost in anonymous stands dominated by *Festuca ovina* and *Agrostis capillaris*.

***Cornicularia aculeata* (*Coelocaulon aculeatum*)-*Cladonia arbuscula* sub-community (U1a)**

This is a distinctive sub-community when well developed, with a high cover of lichens and mosses characteristic of very nutrient-poor soils, for instance the *Cladina* section of the lichen genus *Cladonia*, including *Cladonia arbuscula*, *Cladonia ciliata tenuis*, *Cladonia portentosa* and *Cladonia uncialis*, and the mosses *Dicranum scoparium* and *Polytrichum piliferum*.

The least indicative lichens are *Coelocaulon aculeatum* and *Cladonia furcata* which occur widely in other sub-communities. Some lichen determinations may be somewhat suspect in the NVC and perhaps should not be relied on too heavily (Dr. F. Rose, pers. comm. 1996). The cup *Cladonia* species are especially prone to mis-identification but the split between *Cladonia portentosa* and *Cladonia arbuscula* is also difficult and should always be confirmed by chemical spot tests.

Typical sub-community (U1b)

This sub-community is marked by the absence or limited development of the species assemblages characteristic of the other sub-communities, and therefore can include very impoverished swards. More usual however, is the presence of species typical of U1a and U1c but at lower densities than characterize U1a and U1c. The partition of stands between these sub-communities can thus present problems.

***Erodium cicutarium-Teesdalia nudicaulis* sub-community (U1c)**

This is the most species rich sub-community, with spring ephemeral annuals especially prominent. As well as the vegetation sampled by the NVC in Breckland, stands have been noted in the eastern Weald which closely match the described NVC community (Sanderson & Stanbury 1996).

Related stands have been recorded on shallow parched soils over basalitic rocks (Dalby 1991 and Woods 1993) or on mine waste (Regini 1994) in the north and west. Several surveys late in the season found problems in detecting this sub-community (Wigginton 1990, Smith & James 1995 & Smith 1996) but the abundance of the perennial *Erodium cicutarium* on very bare ground should at least indicate its likely presence in late summer.

***Anthoxanthum odoratum-Lotus corniculatus* sub-community (U1d)**

This sub-community is marked by the appearance of somewhat more base demanding species such as *Galium verum* and *Lotus corniculatus* and grades into Festuca ovina-Hieracium pilosella (Pilosella officinarum)-Thymus praecox (polytrichus) grassland (CG7) in Breckland. In the New Forest this assemblage of species in U1d is usually mixed with those of U1f, often with a scatter of calcicoles not recorded by the NVC.

***Galium saxatile-Potentilla erecta* sub-community (U1e)**

Close to both Festuca-Agrostis-Galium grassland (U4) and Deschampsia flexuosa grassland (U2), this sub-community is separated from the former by the presence of annuals and the latter by the low cover of *Deschampsia flexuosa* (less than 10%).

***Hypochaeris radicata* sub-community (U1f)**

This sub-community is represented by only fifteen samples in the NVC, and several authors, whilst recognising that it covers a distinctive type of south-western grassland, have found that the NVC fails to fully describe the range of vegetation which could be attributed to it (Leach *et al* 1994; Porley 1992 & 1993; and Woods 1993).

General characteristics of the sub-community include the prominence of rosette herbs including *Hypochaeris radicata, Leontodon saxatilis* and *Plantago coronopus* and a tendency for *Festuca rubra* to replace *F. ovina* agg. In Dorset and the New Forest, odd features occur in stands occurring on heavily grazed commons, and include the local abundance of *Danthonia decumbens* and *Nardus stricta* in communities which are firmly within the continental *Thero-Airion* phytosociological alliance and are closest to the U1f. Annual *Trifolium* and *Lotus* species and *Vulpia bromoides* are also characteristic of some stands but are not represented in the NVC samples.

2.3.4 *Deschampsia flexuosa* grassland (U2)

Introduction

This is a widespread community of acid soils in heathland and moorland areas, both in the uplands and lowlands. It occurs mainly as a component of extensive rough grazings or in relics of such systems. It often appears to replace heath where habitat degradation has occurred. This grassland community is rarer in the south-west where it is partly replaced by *Agrostis curtisii*-dominated grasslands. The 'common' name for this community is 'grass heath'.

The community (U2)

The community contains two constants; *Deschampsia flexuosa* at Domin cover abundance value of 4 (4-10%) or more, and *Calluna vulgaris* at Domin cover abundance value of 5 (10-25%) or less. The dominance of *Deschampsia flexuosa* is distinctive but this species is a natural component of several types of heath, especially Calluna vulgaris-Ulex minor heath (H2) and Calluna vulgaris Deschampsia flexuosa heath (H9). The partition of heath and grass heath is, of necessity, somewhat arbitrary.

***Festuca ovina-Agrostis capillaris* sub-community (U2a)**

This sub-community is marked by the presence of a number of typical acid grassland species such as *Galium saxatile, Potentilla erecta, Festuca ovina, Agrostis capillaris, Polytrichum piliferum* and *Rumex acetosella.* The distinction from related heath concerns low *Calluna* cover and the presence of a greater number of acid grassland species.

U2a is the main sub-community of U2 in the lowlands, where in many cases, it may be a recent artefact of lack of grazing. *Deschampsia flexuosa* is very sensitive to cattle, pony and rabbit grazing, although is less affected by sheep grazing. Grazing is likely to convert U2a to U1e or U4. Indeterminate stands are therefore to be expected and fairly rapid switches between the communities may be produced by changes in the grazing pressure.

***Vaccinium myrtillus* sub-community (U2b)**

This is an essentially upland sub-community characterised by the constants *Vaccinium myrtillus* and the moss *Pleurozium schreberi,* along with species such as *Empetrum nigrum* and *Eriophorum vaginatum.* This sub-community is unlikely to be encountered in much of the lowlands.

2.3.5 *Agrostis curtisii* grassland (U3)

Introduction

This is a localised community of acid soils in lowland heathland and upland moorland areas, confined to the south-west of the country. It is mainly a component of extensive rough grazings or relics of such systems. This community has attracted little previous attention and the NVC account is rather provisional. The most appropriate 'common' name is again 'grass heath'.

The community (U3)

The community is characterised by the dominance of *Agrostis curtisii.* The NVC table is drawn from only 18 samples. *Agrostis curtisii, Potentilla erecta, Calluna vulgaris, Festuca ovina, Galium saxatile* and *Danthonia decumbens* are constants. The range of variation covered by this community is probably at least as large as that for U2, but the NVC sampling was too limited to divide the community into sub-communities. Further sampling would probably reveal an upland *Vaccinium myrtillus* sub-community, a fairly diverse, grazed, lowland sub-community lacking *Vaccinium myrtillus,* and an impoverished, ungrazed, *Agrostis-curtisii* dominated sub-community.

In the lowlands there is a gradation from dry stands with *Aira praecox* to damper stands with *Molinia caerulea.* Occasional species such as *Stachys officinalis, Succisa pratensis, Carex montana* and *Serratula tinctoria* occur in flushed stands in the New Forest. *Agrostis curtisii* also occurs in several types of heath (Ulex minor-Agrostis curtisii heath (H3) and Ulex gallii-Agrostis curtisii heath (H4)) and a gradual merging between these heath types and U3 grass heath is likely to be frequently encountered.

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

Introduction

This community replaces the Festuca-Agrostis-Rumex grassland (U1) in the uplands and in the lowlands in the north and west, where rainfall is higher and evaporation is lower. It can cover large areas within extensive rough grazings and can replace heath communities under high levels of sheep grazing. To many conservationists it is synonymous with acid grassland, but a more accurate 'common name' would perhaps be 'moist acid grassland' to distinguish it from the Festuca-Agrostis-Rumex grassland (U1). This common name is used for U4 in the review.

The community (U4)

The distinction of this community from the Festuca-Agrostis-Rumex grassland (U1) is dealt with above. The NVC gives five community constants; *Agrostis capillaris*, *Anthoxanthum odoratum*, *Potentilla erecta*, *Festuca ovina* and *Galium saxatile*.

Typical sub-community (U4a)

This community is characterised by the sparse occurrence of species particular to other sub-communities.

***Holcus lanatus-Trifolium repens* sub-community (U4b)**

This sub-community is distinguished by the frequency of species typical of more nutrient-rich conditions such as *Holcus lanatus*, *Achillea millefolium*, *Trifolium repens* and *Cerastium fontanum*. It is essentially a transition between U4 and swards such as Lolium-Cynosurus grassland, Anthoxanthum sub-community (MG6b).

***Lathyrus montanus (linifolius)-Stachys betonica (officinalis)* sub-community (U4c)**

This sub-community has been defined by eighteen samples from the Derbyshire Dales, typically from areas of drift over limestone. It is defined as U4 grassland with species typical of calcicolous grasslands such as *Helictotrichon pratensis*, *Koeleria macrantha* and *Briza media*, and also species of more acid soils such as *Lathyrus linifolius*, *Stachys officinalis* and *Succisa pratensis*. *Viola lutea* is strongly characteristic of the sub-community.

The extent to which the sub-community occurs beyond the Derbyshire Dales is not clear. The *Stachys officinalis/Succisa pratensis* assemblage occurs widely in many communities including Cynosurus-Centaurea grassland Danthonia sub-community (MG5c), Agrostis curtisii grassland (U3) and Pteridium-Galium community (U20) and the occurrence of this assemblage in an acid grassland does not automatically imply it is synonymous with U4c.

Other sub-communities (U4d and U4e)

Two further sub-communities of U4 are described in the NVC (Luzula multiflora-Rhytidiadelphus loreus sub-community (U4d) and Vaccinium myrtillus-Deschampsia flexuosa sub-community (U4e)). Both of these are predominantly upland sub-communities.

2.3.7 *Nardus stricta-Galium saxatile* grassland (U5)

The NVC did not sample any vegetation dominated by *Nardus* in the lowlands. *Nardus* is in fact quite widespread in lowland acid soil areas but it mostly occurs as an associated species in unrelated wet

acid grassland (*Molina* and *Juncus* types), wet heath and mire. In the New Forest it can even be locally abundant in U1f vegetation. Vegetation dominated by *Nardus* (ie Nardus-Galium grassland (U5)) does occur in the lowlands but reported stands are small and appear intermediate with other acid grasslands (Wigginton, 1990).

2.3.8 *Juncus squarrosus-Festuca ovina* grassland (U6)

The NVC did not sample any *Juncus squarrosus*-dominated vegetation in the lowlands. It has been recorded (Wigginton, 1990) but most lowland *Juncus squarrosus* occurs in wet heath, where patches that are dominated by it bear little resemblance to U6.

2.3.9 *Carex arenaria* in inland lowland acid grasslands

Introduction

Carex arenaria occurs in sandy acid grasslands in Breckland, on Lincolnshire Coversand heaths, the west Wealden heaths and the sand terraces of the Hampshire Avon. The NVC recorded *Carex arenaria* in several sub-communities of Festuca-Agrostis-Rumex grassland (U1) with the highest cover found in the Anthoxanthum-Lotus sub-community (U1d) at Domin cover value 7 (34-50%). One survey of the Suffolk Breckland (Smith 1996) identified Carex arenaria-Festuca ovina-Agrostis capillaris grassland (SD12) from Cavenham and Icklingham Heaths. The constancy table produced, however, shows a vegetation indistinguishable from U1d in which the NVC allows a high cover of *Carex arenaria*. Carex-Festuca-Agrostis Grassland (SD12) is basically a northern grassland and it is unlikely that it occurs in inland southern sites. Two *Carex arenaria* communities have, however, been recorded from the lowlands and are described below.

Carex arenaria community, *Festuca ovina* sub-community (SD10b)

This sub-community of the *Carex arenaria* community includes stands dominated by tall, rank, *Carex arenaria*. For the most part it appears to be a result of lack of grazing, deriving from U1 or the Carex-Cornicularia Community (SD11). It has been recorded from the Weald by EPR in 1996, as well as from the east of England by other surveyors (Wigginton 1990 and Smith 1996).

Carex arenaria-Cornicularia aculeata (Coelocaulon aculeatum) community, *Festuca ovina* sub-community (SD11b)

This is distinguished from U1 sub-communities with *Carex arenaria* (U1b, U1c, U1d) by the high cover of the lichens *Coelocaulon aculeatum* and *Cladonia* species. It has been recorded from the Weald (Sanderson and Stanbury 1996) as well as the east of England (Wigginton 1990 and Smith 1996).

2.3.10 *Pteridium aquilinium* in lowland acid grasslands

Two Bracken dominated NVC communities are present in lowland acid grasslands: Pteridium aquilinum-Galium saxatile community (U20) in very acidic situations, and Pteridium aquilinum-Rubus fruticosus underscrub (W25) on less extreme soils and sometimes in ungrazed situations. Some stands of both communities can be quite herb-rich and can support a varied flora including grassland and woodland species, eg *Anemone nemorosa, Stachys officinalis, Succisa pratensis, Serratula tinctoria, Carex montana* and *Botrychium lunaria*.

3. Methods used to assess the extent of the resource

3.1 Introduction

Comprehensive information on the extent and types of lowland dry acid grasslands is lacking for England. To provide a provisional estimate of the extent of the resource, a range of methods were used, are are described in the following section.

3.2 Geology and soil

3.2.1 Geology

The Geological Survey's solid geology maps show the general distribution of rock types likely to have acid soils. However, some acidic soils have developed from material overlying more base-rich rock. General reference was made to the geology of each county and Natural Area (see Volume II) but soil information was found to be more useful for defining the likely extent of the acid grassland resource.

3.2.2 Soils

Soil maps not only reflect the influence of geology but also other factors such as topography and climate. As such they provide a much more sensitive way of assessing likely extent of ground conditions that would potentially support acid grassland. An important reference is the soil association map of England and Wales at 1: 250 000 scale (Soil Survey of England and Wales 1983). A generalized picture of the extent of acid soils in England was adapted from the soil association map (**Map 1a-1f**).

The broad groups shown on **Map 1**, and described below, incorporate soil associations where the predominant soil type is acidic in character, although other soil types will also occur in these areas.

- **Brown sands**: all soil associations where non-calcareous, sandy, soils, ie calcium carbonate content of less than 1% (Brown Sands) are dominant are shown, except for periodically waterlogged sands with clay-enriched layers (Gleyic Argillic Brown Sands). Only the Downham Association is dominated by the latter type of soil and is largely confined to the eastern margins of the Fens where sandy soils are affected by high groundwater. It does not appear to support any acid grassland. Brown sands tend to be heavily cultivated but where semi-natural vegetation occurs, acid grassland can often dominate over heath.

- **Lowland podzolic soils**: podzolic soils usually result from soil formation in acid conditions and often have an acid organic layer at the surface when the soil has not been disturbed by cultivation. The lowland group comprises well-drained Podzols and periodically waterlogged Gley Podzols. Semi-natural vegetation on these soils will usually be dominated by heath rather than acid grassland.

- **Brown podzolic soils**: these lack the bleached layer seen in other podzols and are termed Typical Brown Podzolic Soils. They are essentially upland and western soils and typically span the transition between upland and lowland conditions.

- **Upland acid soils**: this group includes truly upland soils, including mixtures of shallow soils over rock (Humic Rankers), podzols and gley soils with peaty or humus-rich topsoils (Humic Brown Podzolic soils, Stagnopodzols, Stagnohumic Gley Soils) and raw peat soils. The group is included to indicate the extent of purely upland conditions.

3.3 Distribution of characteristic plant species

Lowland acid grasslands harbour many distinctive species that tend to be confined or nearly confined to this habitat type. Plant distribution maps were therefore identified as a source of information that could be used to indicate areas where acid grassland may still survive in the lowlands. First, lists of characteristic plant species of lowland acid grassland and associated habitats were generated using the following sources:

- Identification floras (Streeter 1983 and Stace 1991)
- Local floras (Dony 1976, Lousley 1976, Trist 1979, Hall 1980, Ivimey-Cook 1984, Sinker *et al* 1985, Woods 1993, Rose 1995a and Brewis *et al*, 1996)
- Species accounts in:
  - ❑ Scarce plants in Britain (Stewart *et al* 1994)
  - ❑ The Atlas of the British Flora (Perring & Walters 1976)
  - ❑ The National Vegetation Classification (Rodwell 1992)
  - ❑ Grassland survey reports (Wigginton 1990, Dalby 1991, Sanderson 1994a, Smith & James 1995, Smith 1996, Sanderson & Stanbury 1996 and Byfield & Pearman, 1996).

Four groups of species were developed, and for three of these groups 'coincidence maps' of records on a 10 kilometre square basis were produced by the Biological Records Centre, Monkswood. The maps show the distribution of these groups of species and also the number of species belonging to the group in each 10km square. In addition three maps of individual species were produced to help define potential acid grassland areas. The groups and species were:

Species generally faithful to lowland acid grassland

This group consists almost entirely of species associated with parched acid grassland (Festuca-Agrostis-Rumex grassland U1) and to a much lesser extent, Bristle Bent grass heath (Agrostis curtisii grassland U3). The species are listed in **Table 1** and the list was used to produce **Map 2** which shows records from all dates. To get a more up-to-date picture, records from post-1970 were examined. However, eight species had not been recently updated by the BRC and thus the post-1970 map was somewhat misleading. To overcome this problem **Maps 3-4** were produced using only the 25 species that had been up-dated. **Map 3** shows all records and **Map 4** only post-1970 records of the up-dated species.

Species of ephemeral ponds

Species found in the mud of ephemeral ponds within acid grasslands form a distinctive group (**Table 3**). These species were used to produce **Maps 5-7**. Three maps were produced, showing pre-1970, post-1970 and all records.

Species of disturbed acid sandy soils

These species are sometimes associated with acid grassland, but are usually absent from the main grassland sward (**Table 4**). They are more often found in ungrazed situations such as low intensity arable land and waysides in acid grassland landscapes. This list of species was used to produced **Maps 8-10**. Three maps were produced showing pre-1970, post-1970 and all records.

Single species distributions

The species chosen were:

- *Carex arenaria*: a species confined to very sandy soils at its inland locations (**Map 11**). It is a key component of SD10 and 11 (sand-dune) communities and also occurs in U1 grassland.
- *Agrostis curtisii*: the dominant species of Agrostis curtisii grassland (U3) (**Map 12**).
- *Viola lutea*: an upland species which is fairly faithful to Festuca-Agrostis-Galium grassland (U4) grassland (**Map 13**). It indicates the areas with acid grassland of more upland character.

Species locally characteristic of acid grasslands

These species are also found in other habitats and therefore are not of value in mapping the national distribution of this habitat type (**Table 2**). However, they are listed in the report because when they are combined with the faithful species they provide a basis for an 'indicator species list' to measure the floristic quality of lowland acid grasslands (see Chapter 5).

3.4 County by county review of site-based information

3.4.1 Survey and Inventory information

Over the last two decades, English Nature has carried out a considerable number of Phase 2 grassland surveys using the NVC as a basis for vegetation mapping. However, there have been only a few specific acid grassland surveys. Summary reports from these surveys were examined.

As well as these few surveys, there have been other more general habitat surveys that have been carried out by NGOs, most especially the Wildlife Trusts, and Local Authorities to both the Phase 1 and Phase 2 level. English Nature has produced an inventory of lowland unimproved grasslands surveyed between 1980 and 1996 for each county (County Grassland Inventories). The Inventories are a collation of Phase 2 survey results and other accessible data. The Inventories show where unimproved grassland and its broad type has been recorded but do not specify the NVC community types. Instead they act as an index for more detailed site information (Jefferson *et al* 1997). Each County Inventory was inspected together with other sources, principally County Heathland Inventories and Biological Survey of Common Land reports. The Heathland Inventories show lowland sites which have heath vegetation (English Nature and Royal Society for the Protection of Birds 1994-1996).

3.4.2 Personal communication

The survey and Inventory information is very mixed in its level of coverage of acid grassland. Given this range in information, it was clearly important to establish personal contact with people with local knowledge in an attempt to fill in gaps in the existing data. This was done by contacting English Nature Local Team staff and in some cases other local conservationists. The people consulted are listed in **Appendix 3, Volume II**. Information was requested in a standardised way by using a questionnaire (see **Appendix 4, Volume II**)

In addition to the questions listed in **Appendix 4, Volume II**, Teams with upland areas in their remit were asked their opinion as to the separation between upland and lowland acid grassland (see Chapter 2).

3.5 Geographical framework: counties and Natural Areas

There were two possible national frameworks for presentation of the information collected by the above methods. Either counties or English Nature's Natural Areas could have been used. Counties had the advantage of being the form in which most of the existing data has been collected and presented, including the County Grassland and Heathland Inventories. In contrast, Natural Areas were a new concept and little existing data had been organised according to their boundaries. Ideally, the use of Natural Areas would be preferred for the description of natural resources, in that they represent areas with more coherent ecological meaning than do counties.

However, the fact that the existing data on both species and sites has been collected in the form of counties has meant that the review had to be organised by county. Wherever possible, reference is made to Natural Areas within counties. One problem was that the draft Natural Areas map originally used in the contract (**Map 14**) was significantly altered in the final version (**Map 15**). The information has been updated so that it relates to the new Natural Areas, except for **Map 1**, which shows soil types.

For each county the acid grassland resource is described according to a series of physical, geographical and historical headings. A summary review of the existing information available for acid grassland communities and flora that occur in the county is given and the results of consultations with local conservation officers also presented. Comments on management condition and nature conservation interest of acid grassland are also summarized. This county information is bound separately in **Volume II**.

For each county the data abstracted from survey reports were entered into a spread sheet. Estimates of the total area of the overall lowland acid grassland present were made for each county, together with estimates for each NVC community and sub-community where possible. The resulting tables are given for each county in **Volume II**, and are summarized for the whole of England in **Table 5, Volume I**.