The European context of British Lowland Grasslands

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5 Upland hay meadows

5.1 Summary of the BAP Habitat Type

This is the traditionally-managed hay meadow vegetation of the sub-montane zone of northern Britain, found mainly within the in-bye fields of Pennine and Lake District farms with scattered occurrences in Northumberland and Scotland, and also on road verges, graveyards, river banks and woodland clearings where similar environmental conditions prevail. It corresponds with MG3 *Anthoxanthum-Geranium* grassland, the British representative of the Polygono-Trisetion alliance which is widely distributed through the sub-montane and montane zones of western and central Europe and characterised by various contingents of plants of harsh climatic conditions in swards managed in a traditional fashion for hay crops. However, as here, this vegetation is gravely threatened by a decline in traditional management with a shift to more intensively managed grassland or abandonment. Surviving stands of 6520 Mountain Hay Meadows have been designated under Natura 2000 but coverage across Europe is only moderately good.

5.2 Synonymy

NVC MG3 *Anthoxanthum-Geranium* grassland.

Annex 1 6520 Mountain hay meadows.

EVS 26103 Triseto-Polygonion bistortae.

EUNIS E2.2 Coarse permanent grassland and tall herbs, usually mown but little grazed, E2.3 Mountain hay meadows, E4.5 Alpine and subalpine enriched grassland.

5.3 Character and distribution of the NVC constituents

A single NVC community, MG3 *Anthoxanthum odoratum-Geranium sylvaticum* grassland, is included within the BAP Habitat Type and its known distribution is shown in Figure 27. This vegetation is the most distinctive element of traditionally-managed hay meadows on moderately fertile soils in the sub-montane zone of northern Britain, now largely confined to a few valley heads between 200 and 400m in the Yorkshire Dales, Lake District and Durham, with some outliers further north in Northumberland and Scotland (Cooper & MacKintosh 1996). It occurs also on road verges, graveyards, river banks and field margins where similar environmental conditions and treatments prevail. In Rodwell (1992), two sub-communities were characterised from such grazed and mown meadows, one somewhat more improved than the other, with a third (lacking a published data table) from habitats like road verges mown for amenity reasons but largely ungrazed. Subsequent more localised studies have provided a more detailed profile of the vegetation and its distribution, for example in the Yorkshire Dales National Park (Pacha 2004). Scottish riverbank stands can differ somewhat in their floristics (Cooper & MacKintosh 1996) being transitional to M27 *Filipendula-Angelica* tall-herb fen (Rodwell et al. 1998). There have been very extensive losses of this vegetation with agricultural improvement and many stands represent transitions to more eutrophic and impoverished grassland types. Also, further south in the upland fringes of
Figure 27  BAP Upland Hay Meadows (MG3 *Anthoxanthum-Geranium* grassland)
Britain and on northern flood plains like the Derwent Ings, vegetation intermediate between this community and traditionally managed lowland meadows like the MG5 Centaurea-Cynosurus and MG4 Alopecurus-Sanguisorba grasslands can be seen. The most recent detailed estimate of extent of the Anthoxanthum-Geranium meadows through northern England was 640ha (Cooch & Rodwell 1996).

5.4 The BAP type and its constituents in Northern Ireland

Although vegetation managed as meadow does occur at higher elevations in Northern Ireland, it is usually of the Purple Moor Grass and Rush Pasture type. *Geranium sylvaticum* occurs in grassland in one location in the province (Feystown ASSI in County Antrim), but in overall composition the sward there most closely resembles a type of MG5 Cynosurus-Centaurea meadow.

5.5 Character and significance of the UK habitat in the wider European context

Within a wider European frame, the kind of vegetation included in this BAP Habitat is clearly recognisable as part of the Triseto-Polygonion (or, as it is still often called, the Polygono-Trisetion, a form of the name that is now known not to be the original). This alliance includes low-input meadows of well-drained, relatively fertile mineral soils through the sub-montane and montane zones of northern and central Europe. Traditionally, it has been included within the Arrhenatheretalia, the order of European pastures and meadows of more fertile soils (see Table 6), but Mucina *et al.* (1993) took a narrower view of the alliance, retaining the Polygono-Trisetion, as they called it, for the more strictly montane Central European meadows and placing this, along with two other alliances of high altitude grasslands, in the new order Poo alpinae-Trisetalia. The sub-montane meadows like our own Anthoxanthum-Geranium grassland these authors placed in the Phyteumo-Trisetion alliance, a group first defined by Passarge (1969), within the Arrhenatheretalia. This is the view summarised in Rodwell *et al.* (2002).

An excellent overview of the Central European Triseto-Polygonion in its broader sense has been provided by Dierschke (1981), with subsequent additions from Theurillat (1992). Essentially, the alliance represents a montane counterpart to the unimproved lowland grasslands included within the Arrhenatheretalia, an altitudinal shift which is neatly shown in maps and graphs for the meadows of the Harz and Thuringia in Hundt (1964, 1966), summarised in Ellenberg (1988), and which, in Britain, we see most clearly in the contrast between MG5 Centaurea-Cynosurus grassland and MG3 Anthoxanthum-Geranium grassland. Species of the Molinio-Arrhenatheretea form a consistent element of the vegetation with grasses such as *Festuca rubra*, *Poa pratensis* and *P. trivialis*, forbs like *Trifolium repens*, *T. pratense*, *Ramunculus acris*, *Cerastium fontanum*, *Plantago lanceolata*, *Leontodon hispidus*, *Achillea millefolium* and climbers such as *Vicia cracca* and *Lathyrus pratensis* more or less common throughout. *Trisetum flavescens*, the grass which gives its name to the alliance (and to many of the continental associations that are the counterparts of our own grassland) is very frequent throughout but this is really an Arrhenatheretalia plant, widespread also at lower altitudes. Other species of this class that occur commonly in the Triseto-Polygonion are *Dactylis glomerata*, *Leucanthemum vulgare*, *Heracleum sphondylium*, *Lotus corniculatus*, *Taraxacum officinale* and *Veronica chamaedrys*. Other frequent plants occurring through the alliance that are of broader phytosociological affinity include *Agrostis capillaris*, *Anthoxanthum odoratum*, *Briza media* and *Luzula campestris*. 
More especially characteristic of the Triseto-Polygonion alliance itself are the big ladies’ mantles of the *Alchemilla vulgaris* agg. and also *Polygonum bistorta*, this latter being the other species used to name the alliance but one which, elsewhere in Europe as in Britain (Preston et al. 2002), is not entirely confined to higher altitudes though it is often related to locally harsh climates (Ellenberg 1988). Apart from the most easterly representatives of the alliance, these grasslands are also characterised by *Geranium sylvaticum*, *Trollius europaeus* and *Helictotrichon pubescens* and, except in the higher Alps, by *Festuca pratensis*, *Rumex acetosa*, *Holcus lanatus* and *Cynosurus cristatus*. *Sanguisorba officinalis* which, with us, is virtually constant in our Upland Hay Meadows, is more patchy in this kind of vegetation elsewhere in Europe, while *Phyteuma spicatum*, occasional to frequent across much of the continental Triseto-Polygonion is, in Britain, a Red Data Book plant now surviving in different habitats (Wigginton 1999, Wheeler & Hutchings 2002).

Dierschke (1981) recognised three major groups of meadows, ranked as sub-alliances within the Polygonio-Trisetion, that can be related to regional climatic differences with changes in latitude and altitude across Europe. Within the sub-montane zone of northern and western Europe, the sub-alliance Lathyro-Trisetetenion is the characteristic meadow type, with *Lathyrus linifolius*, *Poa chaixii*, *Anemone nemorosa*, *Crepis mollis*, *Alopecurus pratensis*, *Centarea nigra*, *C. jacea* and *Campanula rotundifolia* preferential. Our own *Anthoxanthum-Geranium* upland hay meadows are very similar to one of the two major associations within this group, the Geranio sylvatici-Trisetetum Knapp 1951 which is essentially Sub-Atlantic in distribution. It has been described from the hills of the Ardennes in Belgium (Lambert 1965), the Rhineland mountains and Mittelgebirge of Germany (Büker 1942, Knapp 1951, Baeumer 1956, Wilmanns 1956, Boeker 1957, Oberdorfer 1957, Lötschert 1973), Austria (Mucina et al. 1993), the Czech Republic (Moravec et al. 1995) and Hungary (Borhidi 2003). Essentially similar meadows have been described by Pålsson et al. 1994 as the 5.2.2.4 *Geranium sylvaticum*-typ, including the Skogstorkenebb from Norway (see also Fremstad 2002), the Metsänkurjenpolviniitty of Finland and the Skogsnävaängs of Sweden. At higher latitudes in Scandinavia and Greenland, some of the distinctive Upland Hay Meadow plants appear in the ‘Park Meadows’ of the Adenostylion alliariae, vegetation we see in Britain in the high altitude mountain ledge U17b *Luzula-Geum* community (Nordhagen 1928, 1936, 1943, Sjörs 1954, Böcher 1954).

The other main association in this sub-alliance, the Meo-Festucetum (RTx. 1937) J. & M. Bartsch 1940, is more characteristic of the Sub-Continental sub-montane zone occurring in the Vosges in France (Issler 1942, Bardat et al. 2004), central and southern Germany (Tüxen 1937, Bartsch & Bartsch 1940, Oberdorfer 1957, Hundt 1964, Klapp 1965, Trautman 1973, Vogel 1977), Poland (Matuszkiewicz 1982) and (as the Meo-Cirsietum heterophyllae Blažková 1991) in the Czech Republic (Moravec et al. 1995). *Meum athamanticum* is the best diagnostic species for this association, with *Galium hercynicum* and *Arnica montana* less frequently preferential. Interestingly, a very few Lake District meadows and some Scottish streamside stands of vegetation of the upland hay meadow type have a striking abundance of *Meum* (Cooper & MacKintosh 1996), a Continental Northern plant (not western European as described in Stewart et al. 1994) and scarce with us. Dierschke (1981) also grouped within this first Triseto-Polygonion sub-alliance some related Sub-Continental meadows such as the Cardaminopsidi-Agrostietum Moravec 1965 and Melandrio-Trisetetum Moravec 1965 described from the Czech Republic (Moravec et al. 1995).

The second sub-alliance, the Campanulo-Trisetenion, Dierschke (1981) retained for the Triseto-Polygonion meadows of the Jura and the Alps where there is a definitive shift to a
high montane character. Here, characteristic alpine preferentials indicative of the harsh climatic conditions at such altitudes are *Campanula scheuchzeri*, *Myosotis alpestris*, *Rhinanthus alectorolophus*, *Viola tricolor* ssp. *subalpina* and *Crocus albiflorus*. The most widespread association, the Trisetetum flavescentis (Guyot 1920) Beger 1922 usually has additional character species such as *Rumex alpestris*, *Phleum alpinum*, *Veratrum album* and *Crepis pyrenaica* and has been described from Switzerland (Guyot 1920, Beger 1922, Marschall 1947), Austria (Dierschke 1979, Mucina et al. 1993) and Italy (Credaro & Pirola 1975). Since Dierschke’s study, Doniță et al. (2005) have also reported the Trisetetum from Romania. The closely similar Geranio lividi-Trisetetum G. & R. Knapp 1953 with *Geranium phaeum* agg. has also been reported from Austria (Knapp & Knapp 1953, Mucina et al. 1993) and the Trisetetum lapponicum (Brockm.-Jerosch 1907) Marschall 1947 with *Salvia pratensis* from Switzerland (Brockmann-Jerosch 1907, Marschall 1947).

Essentially similar meadows occur at higher altitudes in the Swiss and French Jura (Simeray 1976, Bardat et al. 2004), further west in France in the Cévennes (Braun-Blanquet 1915), Auvergne (Luquet 1926) and Massif Central (Schaminée 1993) where the occurrence of *Narcissus radiiflorus*, *N. poeticus* and *N. pseudonarcissus* adds an especially striking note, nicely caught in the illustration of the Monts du Forez on page 80 in Rodwell et al. (2002). Julve (1993) also includes a similar Triseto-Heracleetum pyrenaici (Braun-Blanquet 1915) Hundt 1964 from the French Pyrenees. Theurillat (1992), using literature from France, Germany, Austria and Italy incorporated these meadows into a new Campanulo-Trisetetion association, the Anthrisco-Trisetetum, which includes extensive regional variation. Somewhat improbably for us, it is *Anthriscus sylvestris*, a plant we are used to seeing as a sign of eutrophication or of intermittent management in our own Upland Hay Meadows, that helps give this group of grasslands its floristic coherence. Julve’s (1993) name for this sub-alliance is the Violo lutea ssp. sudeticae-Trisetetion.

Dierschke’s (1981) third sub-alliance, the Alchemillo-Trisetetion includes high altitude meadows which retain a basic similarity to the Triseto-Polygonion and sometimes have alpine plants such as *Rumex alpestris*, *Poa alpina* and *Phleum alpinum* but which are additionally characterised by *Alchemilla walasii*, *A. crinita*, *Cardaminopsis halleri* and *Crocus scepusiensis*. These are the sub-alpine meadows of the Tatra and west Carpathians like the Gladiolo-Agrostietum (Szafer et al. 1927, Pawłowski et al. 1960, 1962, Stuchlikova 1967, Kornaś 1967, Kornaś & Medwecka-Kornaś 1967, Hadach 1969, Matuszkiewicz 1984) where *Gladiolus imbricatus*, *Centaurea jacea* ssp. *oxylepis* and *Cruciata glabra* are diagnostic species.

### 5.6 Coverage in Natura 2000

The Natura 2000 Habitat 6520 Mountain hay meadows is defined (CEC 2003) as including species-rich mesophile hay meadows of the montane and sub-alpine levels (mostly above 600 metres) usually dominated by *Trisetum flavescens* and with *Heracleum sphondylium*, *Viola cornuta*, *Astrantia major*, *Carum carvi*, *Crepis mollis*, *C. pyrenaica*, *Bistorta major* (*Polygonum bistorta*), *Silene dioica*, *S. vulgaris*, *Campanula glomerata*, *Salvia pratensis*, *Centaurea nemoralis*, *Anthoxanthum odoratum*, *Crocus albiflorus*, *Geranium phaeum*, *G. sylvaticum*, *Narcissus poeticus*, *Malva moschata*, *Valeriana repens*, *Trollius europaeus*, *Pimpinella major*, *Muscari botryoides*, *Lilium bulbiferum*, *Thlaspi caerulescens*, *Viola tricolor* ssp. *subalpina*, *Phyteuma halleri*, *P. orbiculare*, *Primula elatior*, *Chaerophyllum hirsutum* ‘and many others’. The distribution of SACs designated for this habitat is shown in Figure 28 and the proportions of the sites that are represented in each country are Austria (3%), Belgium (8%),
Finland (5%), France (15%), Germany (44%), Italy (12%), Spain (1%), Sweden (3%), United Kingdom (3%), Czech Republic (1%), Hungary (3%), Poland (1%), Slovakia (2%), and Slovenia (1%).

There is no explicit reference to phytosociological synonyms within the definition and the only corresponding categories given are vegetation types in the UK and Nordic countries. The species list includes some of the distinctive species of the Triseto-Polygonion, though the description hardly communicates the particular floristic and structural characteristic of the alliance. Nonetheless, almost all the EU countries which have designated sites for this habitat have interpreted it as equivalent to the Triseto-Polygonion as it is represented within their own country. In Britain, the Natura 2000 Habitat is taken to correspond exactly with MG3 Anthoxanthum-Geranium meadow though, as shown above, it is not true to say, as in the UK Interpretation Manual (Jackson & Mcleod 2002), that our own examples are unlike Upland Hay Meadows elsewhere in Europe. Indeed, part of the vegetation included within the designations for France (Bensettiti et al. 2005), Germany (Šymank et al. 1998) and Austria (Ellmauer & Traxler 2000) is just the kind of Geranio-Trisetetum which is more or less identical to our own meadows. In these three countries, a range of other Triseto-Polygonion meadows is included within the designations. In other cases, as in Germany (Šymank et al. 1998), other grasslands are included such as some of the cattle pastures of more fertile soils in the sub-alpine zone that are placed in the Poion alpinae.

In other cases, where phytosociological definitions are not included within the country interpretation manuals, species lists and descriptions sometimes indicate clearly that countries have designated an equivalent vegetation type to the Triseto-Polygonion: the Lk2 Horské Kosné lúky biotope from Slovakia, for example (Vicheníková & Polák 2003). More ambiguous is the interpretation of Slovakian Mountain Trisetum Grassland provided in Šeffer et al. (2002) which includes both 6520 Mountain hay meadows and 6230 Species-rich Nardus grasslands, a mixture of vegetation types also known from western Europe where there has been a shift from mowing to grazing in higher altitude grasslands of this kind (eg. Schaminée1995). Likewise, beyond the EU, the 1.1.3 Mesophytic and meso-xerophytic grasslands of higher altitudes (900-1800m) and 1.2.8 Mesophytic and meso-xerophytic grasslands of lower altitudes (< 900m) which Meshinev et al. (2005) have grouped within the 6520 Mountain hay meadows are also somewhat ambiguous in their composition, although both the brief description and photograph in Kavrukova et al. (2005) again suggest a generous definition that includes some more calcifuge pastures.

5.7 Key threats to the habitat

Reliable oral evidence suggests that the extent of Upland Hay Meadows has declined dramatically, particularly from the middle of the last century when subsidies for agricultural improvement became more substantial. Continued monitoring and survey (Critchley et al. 2004, Pacha 2004) have shown that, despite statutory protection and agri-environment funding, there has been no halt to the loss and deterioration of this habitat and its flora. In the Common Standards Monitoring of Designated Sites: First Six Year Report (Williams 2006), 42% of SSSI features and 38% of Natura 2000 features under the Neutral Grassland head (including also Lowland Meadows) were in Favourable condition, 26% and 25% respectively in Unfavourable Recovering, and 31% and 37% in Unfavourable. Among the random sample of non-statutory English sites for the BAP Upland Hay Meadows included in Hewins et al. (2005), only 7% were found to be in Favourable condition, the lowest score of any of the grasslands surveyed.
Figure 28  Annex I 6520 Mountain hay meadows

NATURA 2000 data notified to the European Commission by EU Member States and supplied by the European Topic Centre on Biological Diversity, Paris.
Farm studies and experimentation have provided informative insights into just how the various elements of the traditional treatment play a part in controlling the composition and structure of the vegetation. Cooper et al. (1997) summarised much of the information on the ecology and conservation value of Upland Hay Meadow vegetation and Jefferson (2005) has reviewed much of the more recent and experimental work. In the past, mixed stock rearing was the norm, usually with cattle tied in stalls through the winter, though, more recently, sheep have predominated in the Pennines and Lake District. Fertilising, apart from the dung and urine of the grazing stock, has been with one (sometimes two) dressings of farmyard manure each year, with occasional liming and additions of superphosphate. Any change which disrupts this management regime might be expected to have some kind of impact on the composition and structure of the vegetation - and on the productivity of the meadows which has been the rationale for their existence before the period when interest focused on their wildlife value.

Rates of application of farmyard manure under traditional regimes have varied considerably (Simpson & Jefferson 1996, Rodwell et al. 2006) but seem to have been more substantial than and less damaging than either current conservation management recommends (Croft & Jefferson 1999) or than some experimentation suggests (Smith 2005). Past farm practice and the existing character of the grassland, soil and microbial population are probably crucial in moderating the effect. The addition of chemical fertilisers in small amounts is not unknown from traditional farms (Rodwell et al. 2001a) and indeed it may be that natural levels of phosphate in the soils (Critchley et al. 2004) require occasional upgrade, but a more substantial shift from farmyard manure to chemical fertilisers and slurry has been very widespread and is known to affect the balance between grasses and dicotyledons (Jones 1984) and to diminish species-richness (Smith 1988, 1994), even where other elements of traditional management are retained.

Periodic ploughing of meadows for arable cultivation in times of national emergency has certainly occurred on traditional farms and has left a lasting mark in the floristic composition of the meadow vegetation, even when the interval has been brief and there was no fertilising with chemicals: the contrast between the Briza and Bromus sub-communities of MG3 Anthoxanthum-Geranium grassland probably reflects such interventions (Rodwell 1992). More extensive ploughing and reseeding of meadows on deeper soils with rye-clover mixes, together with more frequent cutting for silage, rather than hay, has been the biggest general change in the management of these grasslands in the sub-montane zone, as with the Lowland Meadows (UK Biodiversity Group 1998). This is a shift that has had implications, not just for individual farms, but at landscape scale because surviving stands have suffered fragmentation. Evidence suggests that for both the flora (Pacha 2004) and bird populations (Small 2002) such changes affect the survival and integrity of the remaining populations.

In this country, the traditional treatment that has sustained this vegetation has involved winter and spring grazing, a shut-up in early May with removal of stock to the open hill grazings, a single mowing from late June onwards when periods of fine weather permit, and aftermath grazing in the late summer and autumn (Bradshaw 1962, Rodwell 1992). Substantial changes in the timing and intensity of grazing affect the character of the sward, with some spring grazing essential for maintaining the characteristic contingent of dicotyledons (Smith & Rushton 1994). However, heavy and prolonged spring grazing was related to deterioration in the meadows of the Pennine Dales Environmentally Sensitive Area (Critchley et al. 2004). Radical changes in mowing times also have an effect: despite the interest in the colourful forbs in this vegetation, by traditional hay-cut time it is grasses that generally predominate by
dry weight (Edwards 1999, Taylor 2004) and late cutting has been shown to favour certain grass species (Smith et al. 1996a). Though deeper rooted dicotyledons may bring up trace elements from below, for the farmer an abundance of denser grass tissue in the hay is essential for the stock (Raven Frankland pers. comm.). The timing of the cut also affects which species contribute ripe seed in the drying hay that is able to enter the soil seed bank: the phenology of the Upland Hay Meadow is a rich and complex process in itself (Cooper et al. 1997) and a midsummer cut is most productive in this respect (Smith et al. 1996b). Elsewhere in Europe, where these meadows have been a traditional feature of the sub-montane and montane zones, complete abandonment of mowing is a widespread threat.

It is clear from farm diaries (Smith & Jones 1991, Rodwell et al. 2001a, b) that differences in weather from year to year have a marked influence on the timing and duration of hay-making and subsequent grazing of the aftermath, as well as on the size and quality of the crop. Such a flexible responsiveness, together with the spatial diversity of unimproved soils across the in-bye land of the sub-montane zone, has contributed greatly to the local distinctiveness of meadows from farm to farm, even from field to field, and year to year. On farms where high quality Upland Hay Meadows survive, inflexible application of agri-environment regulations, with fixed dates for hay-cutting and a narrow view of the need for maintaining soil fertility and hay productivity and quality, can therefore themselves be potentially damaging to the species-richness and diversity of the vegetation and the intimate inter-relationship between wildlife quality and agricultural value. Though most English Upland Hay Meadows were included within the then ESA schemes by the late 1980s (Jefferson 2005), the latest report indicates little progress towards restoration of any species-richness within semi-improved grasslands within the Pennine and Lake district landscapes (Critchley et al. 2004).

More diffuse dangers to the Upland Hay Meadow include background deposition of atmospheric nitrogen which may well have played some part in the general eutrophication of meadow and verge vegetation within the landscape where the habitat occurs. Some distinctive meadow plants, such as Geranium sylvaticum, survive surprisingly well among nitrophilious rank grassland and tall-herb vegetation, like various kinds of MG1 Arrhenatherum sward (Pacha 2005), though verge populations isolated from meadows have a less diverse genetic fingerprint (Napper 2003) and also flower earlier there thus limiting out-breeding with meadow populations.

Geranium sylvaticum is a Northern Montane plant with a striking lower altitudinal limit in Britain. This may be partly related to its vernalisation requirement (Hill 2001) but also important may be a need for low winter temperatures to prevent respiratory rundown of its carbohydrate and protein resources in the bulky rhizome, a reserve which it is able to draw on quickly after the temperature rises above the growing point in early May. Rising winter temperatures, already recorded in the Upland Hay Meadow landscape (Rodwell et al. 2001b), might be expected to threaten this plant’s ability to retain such resources and its key role in this kind of vegetation. Loss of a sub-montane floristic element would leave the Upland Hay Meadows with a floristic composition essentially resembling MG5 Centaurea-Cynorusus grassland.
5.8 Conservation initiatives

The UK BAP Action Plan for Upland Hay Meadow states that between 500 and 1,000ha of the habitat are protected within 75 SSSIs, with Jefferson (2005) providing the more precise figure of around 770ha. Cooper et al. (1996) gave the generous upper figure for MG3 Anthoxanthum-Geranium grassland as 640ha of which only 50% was designated as SSSIs at that time. Management agreements are in place for many of these SSSIs. Three sites for this habitat are NNRs and, under the Habitats Directive, 59 SSSIs have been included within two composite SACs designated partly for 6520 Mountain hay meadows, which Averis et al. (2004) state as protecting 700ha or 70% of the total resource in the UK. These SACs constitute about 3% of the total number for this Annex I habitat across the EU. Particularly within the Pennine Dales Environmentally Sensitive Area, where Upland Hay Meadows are especially important, considerable effort has gone into recruitment for agri-environment schemes aimed at their recovery. However, the most recent re-survey of monitored quadrats (Critchley et al. 2004) shows that there is no apparent improvement in sward quality in the short term. In their random sample of non-statutory English sites for Upland Hay Meadow, Hewins et al. (2005) showed no significant difference in condition between stands within and outside agri-environment agreements but many more of the grasslands shown to be improved agriculturally were outside schemes.

As with many traditionally managed grasslands, the diversity of fields of Upland Hay Meadows is often very striking and Flora Locale is one initiative that aims to foster such local distinctiveness through the local sourcing and use of the British and Irish wild flora. To promote good practice, it maintains a website with an on-line library, hosts an electronic network, publishes advisory notes, organises a training programme and produces two regular newsletters, one specifically for northern Britain. With its encouragement, the Yorkshire Dales Hay Time project, hosted by the Yorkshire Dales Millenium Trust, aims to enhance at least 120ha of MG3 Anthoxanthum-Geranium grassland, as well as 100ha of MG5 Cynosurus-Centaurea Lowland Meadow grassland over the next 3½ years. It uses its own machinery and contractor to harvest seed from existing local meadows for introduction into fields where the swards are being restored, generally through some agri-environment scheme. With a likely local shortage of seed, it is expected that some will probably have to be obtained from road verges.

5.9 Research needs

This kind of vegetation is now one of the best surveyed of all UK grasslands and one that is already well researched but a concerted effort is needed to coordinate existing data sources on a spatial platform to ensure an integrated response to threats and the precise identification of further research needs across the remaining range.

Simple studies by Edwards (1999) and Taylor (2004) have provided the first real indication of the productivity of Upland Hay Meadow vegetation, and this can be surprisingly high. With the continuing research interest in particular holdings and experimental sites, there is everything to be said for some whole-farm studies to calculate the balance of costs and benefits for herbage production and biodiversity in this kind of agricultural system. The appraisal of studies on soil microbes, mycorrhizae and soil fertility in Upland Hay Meadow systems (eg. Smith et al. 2005) should help understand what further research is needed into below-ground components of this habitat.
Germination studies (Smith & Jones 1991) have shown that the seed bank in the soils of traditional hay meadows do not reflect the existing composition of the vegetation, though more account needs to be taken of the germination requirements of particular species, such as the vernalisation essential for *Geranium sylvaticum* (Hill 2002). Such needs, like the conservation of over-wintering rhizome stores, are of critical interest with the prospect of climatic warming whose impact on the distinctive sub-montane element of Upland Hay Meadows might be severe. With the continuing fragmentation of Upland Hay Meadows (Pacha 2005) and the loss of genetic diversity in surviving road verge populations of *Geranium sylvaticum* (Napper 2003), further work also needs to be done on the prospect of recruitment of such key species to the flora in stands that are undergoing restoration.

The attempted restoration of MG3 *Anthoxanthum-Geranium* grassland at Colt Park has been documented by Smith *et al.* (1996c, 2000) and Smith (1997) where swards approximating to MG3 *Anthoxanthum-Geranium* grassland have been produced mainly by a combination of spring and autumn grazing, later cutting dates and the addition of seed, with or without chemical fertiliser. Such experiments need continued monitoring to obtain added value from investment while evidence suggests that further work is needed to understand the optimal levels of spring grazing, particularly within current agri-environment schemes.

Two wider aspects of the context in which Upland Hay Meadows occur merit further attention. Research by Smith & Jones (1991) and Rodwell *et al.* (2001a, b) has shown just how fruitful a source of information diaries can be about the yearly round of farm operations. An electronic database for New House Farm at Malham (Rodwell *et al.* 2001a) could serve as a model for wider research which needs to be integrated with understanding the social fabric through which such farming has been sustained – for example through reminiscence therapy with aging farmers.

Second, Upland Hay Meadows were formerly part of the habitat of the corncrake and remain of significance within the landscapes used by waders such as lapwing, curlew, snipe and redshank, some of which have drastically declined. Research by Small (2002) and Pacha (2005) has shown how important a landscape-scale approach is for understanding the survival of such fauna and the distinctive vegetation on which they somehow depend.
6 Purple Moor Grass and Rush Pastures

6.1 Summary of BAP Habitat Type

These are vegetation types of poorly-drained, usually acidic, peaty gleys and shallow peats in the lowlands in which Molinia caerulea and Juncus acutiflorus figure prominently, along with a distinctive associated poor-fen flora. Typically found on undulating plateaux and gentle slopes, streamsides and river valleys, they have been traditionally used for mowing a litter crop and/or for grazing, the best examples being those with mosaics of various constituent plant communities reflecting the differing ground conditions and variable extensive management. Though the terms ‘fen-meadow’ and ‘pasture’ can be rather loosely used with reference to this habitat to denote edaphic preferences, the former is best reserved here to indicate a mowing treatment, while the latter ought to be used for the vegetation when it is exclusively grazed. There can be little floristic difference between stands found on mineral soils and on shallow peats. More species-poor vegetation on deeper peats (more than 0.5m), while excluded from the BAP Habitat Action Plan, is here included for the sake of completeness.

Five NVC communities are included within the habitat, occurring quite often as mosaics in various combinations, and with other vegetation types. Comparable Molinietalia associations of the Molinion, Junco-Molinion, Calthion and Juncion acutiflori alliances occur widely across Europe, though often less extensively than in the UK. Designation for the Natura 2000 habitat 6410 Molinia meadows is narrower than the BAP habitat, generally including the Junco-Molinion and, more exclusively in continental areas, the Molinion. Throughout Europe, these vegetation types are threatened by drainage and reclamation with increasing difficulty in ensuring management on those often fragmented stretches that remain.

6.2 Synonymy


Annex I 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae).

EVS 26F02 Calthion, 26F07 Juncion acutiflori, 26F08 Junco-Molinion, 26F10 Molinion.

EUNIS E3.4 Moist or wet eutrophic and mesotrophic grassland, E3.5 Moist or wet oligotrophic grassland.

6.3 Character and distribution of the NVC constituents

The UK Lowland Grassland HAP Steering Group (1998) defines the habitat as including five NVC communities: M22 Juncus subnodulosus-Cirsium palustre fen-meadow, M23 Juncus acutiflorus-Galium palustre rush pasture, M24 Molinia-Cirsium dissectum fen meadow, M25 Molinia-Potentilla erecta mire and M26 Molinia-Crepis paludosus fen-meadow (Rodwell 1992). It is estimated that there are 21,544 ha of the habitat in England, 32,161 ha in Wales and 6768 ha in Scotland (Lowland Grassland UK HAP Steering Group 2005) and the known distributions of the various communities, together with the total extent of the habitat, are
shown in Figures 29-34. Together with the substantial Northern Ireland total (see 6.4 below),
the UK probably has almost 80,000 ha - more than survives in the whole of the rest of
continental western Europe.

The range of vegetation included here is difficult to classify adequately because of the
complex effects of past agricultural treatments and widespread more recent neglect. This has
favoured the extensive spread throughout of competitive dominants like *Molinia caerulea*
and various *Juncus* spp., many of which, in the Atlantic climate of this country, are more
broadly tolerant anyway of different edaphic conditions than elsewhere in Europe. A further
complexity is that, in less improved landscapes where there has been a diversity of treatments
occurring side by side and often varying through time, several of the communities can occur
in complex intimate mosaics, the constituents of which can now be hard to distinguish. In
this sense, a broader descriptive category like the BAP habitat is useful (or the more
precisely-defined Rhos Pasture originated by the Countryside Council for Wales, eg.
Blackstock *et al.* 1997, and the Culm Grassland of Devon and Cornwall, although the various
vegetation types these categories include are dependent on different soil and ground water
conditions and interventions to sustain them, so a single management prescription might not be
desirable.

The communities are best understood as a pair of climate-related sequences. Among the
vegetation types where *Molinia* is the most common dominant, the M24 *Molinia-Cirsium*
community includes most of the anthropogenic swards on well-aerated peats and peaty
mineral soils in the warmer and drier south-east of Britain, typically in topogenous and
soligenous mires, particularly in East Anglia and the Somerset Levels, and in flushed wet
heaths, especially in the west. The vegetation was often treated as a fen-meadow, yielding an
annual crop of litter, though most often now it is grazing which maintains the vegetation and
this has maybe always been the commoner management in the west where the vegetation
often takes on a distinctly heathy character with the appearance of ericoids and Juncii in a
more oceanic sub-community. Towards the limit of the community in Wales, essentially
similar vegetation extends beyond the range of *Cirsium dissectum* and *Juncus subnodulosus*
(Blackstock *et al.* 1993, 1998), but towards northern Britain a distinctive Continental
Northern or Northern Montane element enters the flora on more distinctly base-rich peats and
peaty mineral soils, usually in isolated topogenous fens, and there the M26 *Molinia-Crepis*
community can be found. It is not so limited in occurrence as Rodwell (1991) implies but
nonetheless scattered and local beyond the North Pennines.

The more substantial shift among *Molinia*-dominated vegetation towards the wetter and
cooler west where well-aerated peats and peaty mineral soils are very widespread on gentler
slopes in the hills, is to the M25 *Molinia-Potentilla* community in which the dominant grass
reaches a peak of vigour in vegetation which is consequently often species-poor. Here, too,
the common occurrence of *Juncus acutiflorus* makes for an especially difficult separation
from the M23 *Juncus-Galium* community, particular where, as is usual, it is grazing which
maintains the vegetation in less-improved enclosures and (beyond the limit of our interest
here) in open hill pastures. Subsequent survey following the NVC has also revealed the
widespread occurrence of swards of the M25 type but with less (sometimes very much less)
*Molinia* and a close sward rich in small sedges and pasture herbs (Cooper 1993, Cooper &
comm).
The 10km grid records from which these maps were prepared date from 1980 onwards and include vegetation recorded as intermediate between NVC communities. The filtering has been inclusive, including all sites where the target community was recorded, even if only part of an intermediate with one or more other communities.
The 10km grid records from which these maps were prepared date from 1980 onwards and include vegetation recorded as intermediate between NVC communities. The filtering has been inclusive, including all sites where the target community was recorded, even if only part of an intermediate with one or more other communities.
Among the more strictly rush-dominated vegetation included in this BAP habitat, the characteristic assemblage of the warmer and drier south-east is the M22 Juncus subnodulosus-Cirsium palustre community. This is a diverse vegetation type in its floristics and structure, with drier and swampier forms, but it is particular associated with fens of springs, seepage lines and topogenous mires where it has developed through mowing or grazing. It is especially concentrated in East Anglia but with numerous scattered localities further west and north. Forms richer in bulkier grasses have been reported since the NVC from Suffolk fens (Harding & Kay 1992, Harding 1993, Rodwell et al. 2000). Towards the wetter and cooler west, its counterpart among the rush-dominated vegetation of this habitat which occurs very widely on ill-drained peaty mineral soils, in flushes and around mire margins, is the M23 Juncus acutiflorus-Galium palustre community, a very common constituent of unimproved or reverted grazings. Forming a hazy transition between the two communities is the MG10 Juncus effusus-Holcus lanatus rush-pasture, a community that is not included in the BAP habitat, though it can have some interest in the milder west, where stands rich in Iris pseudacorus are a distinctive feature of wetter pastures in, for example, south-west England, Pembrokeshire and Anglesey.

6.4 The BAP Habitat and its constituents in Northern Ireland

In Northern Ireland, the main constituents of this Habitat are M23 Juncus-Galium rush-pasture and M24 Molinia-Cirsium fen meadow, though in both cases there are some differences to the published definitions or general understanding of the communities (as noted by Cooper & McCann 1994), some of which have been outlined in Rodwell et al. (2000). This is partly because of the character of the terrain and soils over which these vegetation types occur in the province. Over Carboniferous Limestone and Tertiary Basalts, for example, less pervious soils are often flushed with base-rich waters, and over drift deposits, the substrates vary within a small compass. Species-rich types of M23 Juncus-Galium rush-pasture (as detailed in Rodwell 2004) are therefore widespread. Then, there is the influence of the moist and equable climate, so that the heathier western M24c Juncus-Erica sub-community of Molinia-Cirsium fen meadow is frequently encountered (Rodwell 2004).

It has been recommended in Northern Ireland that more species-poor examples of rush-pasture and fen-meadow are excluded from this habitat so, along with the focus on stands in enclosed landscapes, this means that much M25 Molinia-Potentilla is not considered here. Nonetheless, the current extent of this BAP habitat in Northern Ireland is 18,919 ha, about a fifth of the UK total (Lowland Grassland UK HAP Steering Group 2005). Of this, just over 20% is M24 Molinia-Cirsium fen-meadow. Most is managed as pasture but some is cut for big-bale silage.

6.5 Character and significance of the UK habitat in the wider European context

Within the UK BAP, Purple Moor Grass and Rush Pastures includes vegetation that would be grouped in four alliances of the Molinietalia, the order of meadows and pastures of moister soils, often peaty, through the European lowlands. These vegetation types have sometimes been elevated to a class of their own, the Molinio-Juncetea (Braun-Blanquet 1947, Géhu 1992, Julve 1995), but more traditionally the Molinietalia is treated as part of the Molinio-Arrhenatheretea, a more generous interpretation of which also includes all the anthropogenic
lowland grasslands of circumneutral mesotrophic soils. Dierschke (1995, largely following Tüxen 1937 and Tüxen & Preising 1951) has provided a useful syntaxonomic overview of these plant communities, in which the Molinietalia shares with the drier meadows and pastures of the Arrhenatheretalia frequent records for Festuca pratensis, F. rubra, Holcus lanatus, Poa trivialis, P. pratensis, Anthoxanthum odoratum, Rumunculus acris, R. repens, Trifolium pratense, Plantago lanceolata, Rumex acetosa and Lathyrus pratensis. By contrast with the Arrhenatheretalia, the Molinietalia has more Filipendula ulmaria, Deschampsia cespitosa, Lychnis flos-cuculi, Galium uliginosum, Cirsium palustre, Achillea ptarmica, Equisetum palustre and Sanguisorba officinalis, a group recognisable by us as tall herbs and sprawlers of poor fens. Despite giving its name to the order, Molinia caerulea itself is not frequent throughout.

There has been (somewhat) less argument about the ordering of alliances within the Molinietalia than in the Arrhenatheretalia (Dierschke 1995) and, in Rodwell et al. (2002), eleven are recognised, of which the four represented in the BAP habitat are the most widespread through Europe as a whole (See Table 6). One of the earliest to be defined and most stable is the Molinion (sometimes termed the Eu-Molinion to stress its centrality in the order), the alliance of unmanured wet meadows in the more continental lowlands of central Europe. This is where Molinia itself has its strong peak of occurrence, along with Briza media, Succisa pratensis, Potentilla erecta, Selinum carvifolia, Linum catharticum, Carex flacca, C. nigra and C. panicea occurring very commonly throughout, and Epipactis palustris and Parnassia palustris also preferential. Shared with the sub-Continental flood-plain meadows now usually separated off into the Cnidion (Nowak in Dierschke 1990) are frequent Serratula tinctoria, Galium boreale and Centaurea jacea. Among the vegetation of the BAP habitat, it is the M26 Molinia-Crepis community that most closely approximates to this alliance, though its continental character is a distinctly northern European one, a feature echoed in the floristics of calcareous pastures described from Sweden by Regnéll (1980), in the G12c Våt/fuktig middel naeringsrik described from Norway by Fremstad (1997), in the Molinion of Latvia (Kabucis 2000) and Lithuania (Rašomavičius 2001) and in some of the Põhjamaade taimkattetüübid järgi of Estonia (Paal 2004). The 5.2.3.5 Blåtåtelängs-typ described from Sweden (Pahlsson 1994) also looks somewhat similar.

Further south than this in continental Europe, following the very early work on these vegetation types, a core Molinion association has often been defined as some form of Molinieta caeruleae medicoeuropeaeum Koch 1926, as in Belgium (LeBrun et al. 1949), Germany (Pott 1995), Poland (Matuszkiewicz 1984), Lithuania (Balevičienė et al. 1998), the Czech Republic (Moravec 1995), Romania (Coldea 1991). Beyond this broad level, treatment has varied considerably from country to country: as Ellenberg (1988) remarks, it has been easier to distinguish regional geographic sequences among these Molinia meadows, as in Germany (Philippi 1960, Korneck 1962/3) and Hungary (Kovács 1962) than it is to develop a coherent European overview. However, two associations have been recorded more widely: the Selino-Molinitum Kuhn 1937 from Germany (Pott 1995, Dierßen 1996), Austria (Mucina et al. 1993), Poland (Herbicha 2004) and Slovenia (Kaligari et al. 2003) and the Gentiano-Molinitum Iljanić 1968 from the Czech Republic (Vicherek et al. 2000, Balášová-Tuláčková & Hajek 1998), Slovakia (Balášová-Tuláčková 2000), Austria (Kuyper et al. 1978, Mucina et al. 1993), Slovenia (Zelnik 2005) and maybe also from Switzerland (Klötzli 1969). The Junco-Molinitum Preising 1951 described from Germany (Pott 1995), Austria (Mucina et al. 1993), Poland (Matuszkiewicz 1984) and Lithuania (Balevičienė et al. 1998) is a community of more acidic soils often at higher altitudes. In this vegetation, the prominence of Juncus effusus, J. conglomeratus and J. acutiflorus bring the floristics close to
our own M25 Molinia-Potentilla community which is best not grouped in the Molinion at all (see below).

It was Westhoff (in Westhoff & den Held 1969) who first proposed a separate Junco-Molinion alliance to accommodate what had previously been distinguished from the more continental Molinia communities as a Molinion caeruleae atlanticum Lemée 1937. *Juncus conglomeratus* was regarded as a good character species but *Succisa pratensis*, *Parnassia palustris* and *Plantanthera bifolia* also tend to be preferential here. This is where our M24 Molinia-Cirsium community belongs, as a clear British counterpart to the Cirsio-Molinietum Sissingh & de Vries 1942 described from The Netherlands (Schaminée et al. 1996), Belgium (Duvigneaud & Vanden Bergen 1945, LeBrun et al. 1949), Germany (Ssymank et al. 1998) and Ireland (Brock et al. 1978, White & Doyle 1982).

The other early-recognised alliance of the Molinietalia was the Calthion (or Bromion racemosi as it was known by Braun-Blanquet 1947, Tüxen & Preising 1951, Tüxen 1955 and still by Julve 1993) which includes the wet meadows and pastures of more fertile, often manured soils, in both the Continental and Atlantic zones of Europe. Shared with the Molinion are frequent records for *Carex nigra*, *C. panicea* and *Valeriana dioica* but the character species here are *Caltha palustris*, *Myosotis palustris*, *Scirpus sylvaticus*, *Angelica sylvestris*, *Lotus pedunculatus*, *Agrostis canina* and *Cirsium oleracea*. *Juncus effusus* and *J. conglomeratus* can be common in these kinds of vegetation throughout the range of the alliance but in the UK we have the additional complication that species regarded as more diagnostic of the Calthion in central Europe tend to lose their affinities. Some British Calthion communities are described under the BAP Lowland Meadows habitat (see pp. 49-52 & 58-59), but among the Purple Moor Grass & Rush Pastures, the vegetation which most closely corresponds to the Calthion elsewhere in Europe, is the M22 *Juncus-Cirsium* fen-meadow.

Beyond that, what its precise affinities are, and quite how Calthion communities in different parts of Europe equate, remains somewhat unclear. Among our own Molinietalia communities, *Juncus subnodulosus* has a clear peak of occurrence in the *Juncus-Cirsium* fen-meadow but this contains only a fraction of the variation that was included in the *Juncetum subnodulosi* Koch 1926 characterised in early classifications elsewhere (and still in Poland: Matuszkiewicz 1984) to include more basiphilous rush-pastures. Of those more recently-defined associations for which detailed accounts are available, the most similar Calthion to our (more swampy) M22 *Juncus-Galium* vegetation seems to be the Lychnido-Hypericetum tetraperti Meltzer 1945 emend Van ‘t Veer described from The Netherlands (Schaminée et al. 1993).

Among the most widespread related vegetation types in more continental regions is the Angelico-Cirsietum oleracei Tüxen 1937 which has been recorded from Germany (Pott 1995), Austria (Mucina et al. 1993), the Czech Republic (Balátová-Tuláčková 1981, 1983, 1987, Balátová-Tuláčková & Hajek 1998), Slovakia (Španiková 1983), Hungary (Borhidi 2003) and Croatia (Regula-Bevilaqua 1980). Here, *Cirsium oleraceum*, which is an introduced and locally naturalised plant with us (Stace 1997), can be dominant but the associated flora shows a broad similarity to that of the *Juncus-Cirsium* fen meadow, and there is a similar diversity of floristic and structural variation within the association.

Extending geographically closer among the European Calthion communities is the Crepido-Juncetum acutiflori (Braun 1915) Oberdorfer 1957 which has been described from the Czech
Republic (Moravec 1995), Germany (Pott 1995) and The Netherlands (Schaminée et al. 1993). Again, the abundance here of Juncus acutiflorus, and the sort of associated flora seen in the detailed account from The Netherlands, evoke richer stands of our western Purple Moor Grass and Rush Pastures. In Rodwell (2000), these M23 Juncus-Galium and M25 Molinia-Potentilla communities were both grouped in the Juncion acutiflori, an alliance characterised by Braun-Blanquet in 1947 and included in the Molinietalia by Oberdorfer et al. (1957) to contain the meadows and pastures of moist peaty mineral soils with impeded drainage or flushing in the sub-Atlantic and Atlantic zones. In Dierschke’s (1995) overview, this is the least well-defined part of the Molinietalia but the best preferentials listed there are Anagallis tenella, Carum verticillatum, Oenanthe peucedanifolia, Scutellaria minor and Wahlenbergia hederacea. Most analogous to our own vegetation of this type seems to be the Juncetum acutiflori subatlanticum Jonas which has been recorded from Belgium (LeBrun et al. 1949). White & Doyle (1982) list a Junco acutiflori-Molinietum Tuxen & O’Sullivan 1964 which has been widely described from Ireland (O’Sullivan 1968a, b, 1969, 1976) but this seems to be equivalent to the distinctive western type M24c of the Cirsio-Molinietum.

6.6 Coverage in Natura 2000

The Natura 2000 Habitat 6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) is defined as comprising Molinia meadows of lowland to montane altitudes, on more or less wet soils, poor in the major nutrients nitrogen and phosphorus, stemming from extensive management, sometimes with a mowing late in the year, and also occurring on deteriorating peat bogs which have been drained (CEC 2003). Two sub-types are distinguished, the first being the Eu-Molinion, described as being on neutral to basic and calcareous soils, sometimes peaty and with a fluctuating water table which drops so as to dry out the substrate in summer. These are relatively rich in species and characterised by Molinia caerulea, Dianthus superbus, Selinum carvifolium, Cirsium tuberosum, Colchicum autumnale, Inula salicina, Silaum silaus, Sanguisorba officinalis, Serratula timctoria, Tetragonolobus maritimus. The second sub-type is defined unhelpfully as ‘Junco-Molinion (Juncion acutiflori)’ as if these two alliances were identical, and as being characteristic of more acidic soils. It excludes species-poor meadows on degraded peaty soils and is distinguished by Viola persicifolia, V. palustris, Galium uliginosum, Cirsium dissectum, Crepis paludosa, Luzula multiflora, Juncus conglomeratus, Ophioglossum vulgatum, Inula brittanica, Lotus pedunculatus, Dianthus deltoides, Potentilla erecta, P. anglica and Carex pallescens.

The distribution of the SACs that have been nominated for this habitat is shown in Figure 35 and the proportions of total site numbers in the various countries is: Austria (3%), Belgium (3%), Czech Republic (2%), Germany (27%), Denmark (3%), Estonia (3%), Spain (3%), Finland (>>1%), France (11%), Hungary (5%), Ireland (1%), Italy (5%), Lithuania (1%), Latvia (1%), The Netherlands (1%), Poland (3%), Portugal (1%), Sweden (23%), Slovenia (1%), Slovakia (1%) and the UK (2%).

Among the EU countries, the UK has designated what are the most recognisable vegetation types of the Molinion, the M26 Molinia-Crepis fen-meadow, and of the Junco-Molinion, the M24 Molinia-Cirsium dissectum fen-meadow (Jackson & McLeod 2002). France (Bensettiti et al. 2005) has taken a similar general line in recognising the presence of both more continental and more Atlantic meadows, including a great range of the associations distinguished there, both in the Molinion (9 associations) and especially in the Juncion acutiflori (25 associations). In Portugal (http://www.icn.pt/psrn2000), although no alliance is specified, the emphasis is also on rushy Atlantic Molinietalia meadows with Juncus acutiflorus, J. conglomeratus and J. effusus.
Figure 35  Annex I 6410  *Molinia* meadows

NATURA 2000 data notified to the European Commission by EU Member States and supplied by the European Topic Centre on Biological Diversity, Paris.
In Flanders (http://www.gisvlaanderen 2006) and the Netherlands (Jansen & Schaminée 2003), where more continental meadows do not survive, attention has focused on the Cirsio-Molinietum. In Belgium, however, and in Germany where some sites have also been designated for this kind of Molinia meadow (Ssymank et al. 1998), this association has been located in the Molinion, rather than the Junco-Molinion in the interpretation manuals. Within the Continental zone, it is necessarily the meadows of the Molinion which figure most obviously in the interpretation of the Natura 2000 habitat and many countries have used a generous but precise definition to ensure designation of sites which include the full range of meadows distinguished within their territory: Germany (Ssymank et al.1998), Poland (Herbicha 2004), the Czech Republic (Chytry et al. 2001), Slovenia (Kaligarić et al. 2005) and, outwith the EU, Romania (Donita et al. 2005). Other countries have defined the phytosociological affinities of the meadows less precisely – as in Austria (Ellmauer & Traxler 2000), Slovakia (Vicheníková & Polák 2003), and Latvia (Kabucis et al. 2000) where at most the alliance Molinion is specified. Among non-EU countries Bulgaria (Dimitrov in Kavrukova et al. 2005) and Croatia (http://www.cro-nen.hr) have taken a similar approach in defining their vegetation in relation to the Habitats Directive.

6.7 Key threats to the habitat

In the Common Standards Monitoring of Designated Sites: First Six Year Report (Williams 2006), the Purple Moor Grass and Rush Pasture were included within Lowland Fens and Marshes but separate figures are given for the condition. Of SSSI/ASSI features, only 30% were found to be Favourable, with Scottish examples being in substantially better condition (62%) than those in either England (42%) or Northern Ireland (22%). Of SACs, Favourable examples were only 4% of the total. Unfavourable Recovering stands accounted for 32% of the SSSI/ASSI total and 56% of SACs. In the random sample of English non-statutory sites, mostly M23 Juncus-Galium rush pasture and M25 Molinia-Potentilla mire, 35% of stands were found to be Favourable. Losses in relatively recent times have been enormous: in Devon and Cornwall, for example, only 8% of the 1900 area now remains with 62% of sites and 48% of the extent being lost between 1984 and 1991.

This habitat is dependent on low-input management in an unimproved landscape with soils that are kept moist by a ground water table or high precipitation, so any shifts in this combination of factors pose a threat to sustainability. The various vegetation types are highly susceptible to any kind of intensive agricultural improvement such as the application of fertilisers and drainage, treatments which have been very widespread within the landscapes where this habitat occurs, together with subsequent cultivation and re-seeding to produce improved pastures or silage-leys of some kind. Reversion to something resembling the various vegetation types can occur where such treatments have been skimpy or sporadic but much of the habitat has been irreversibly lost. This has been part of a bigger shift in landscape character in places where the habitat was formerly extensive.

The various community accounts in Rodwell (1991) summarised knowledge at that time about the different environmental factors involved in sustaining each vegetation type and the work of Blackstock et al. (1998) has shown just how subtle and continuous are the relationships between these. When landscapes were more spacious and the habitat more extensive, it mattered less getting the management exactly right in any particular place for the survival of this or that one of the range of communities the habitat includes. Indeed, variation in the interactions between treatments and the varied ground conditions were probably all part of the spatial and temporal dynamic of the habitat within such landscapes. It is one of
the threatening results of **fragmentation** that a precision of management now has to matter much more if the full range of diversity within the overall habitat is to be preserved, particular isolated stands having an character and value that is recognised as more distinctive and vulnerable. The demise of the marsh fritillary butterfly (*Eurodryas aurinia*), which survives by virtue of metapopulations, is a good illustration of the threats to dependent biota when an extensive dispersed patchwork of Purple Moor Grass and Rush Pasture disintegrates.

With the decline of traditional farming, and particularly now with the scarcity of cattle to graze this vegetation, **neglect and abandonment** has become widespread, affecting particularly those fragments left at the margins of viable agricultural improvement. The usual consequence of such treatment is for the vegetation to become more densely rushy or choked with tussocky *Molinia*, with a consequent decline of the less competitive associated flora. Such vegetation, termed basal by phytosociologists because of the difficulty in discerning its precise affinities (or known by the endearing term Rompgemeenschap by the Dutch) was already widespread at the time of the NVC (Rodwell 1992) and has since become more extensive (Rodwell *et al.* 1998) and is difficult to return to its original richer and more varied state. This is partly because of the accumulation of litter and nutrients, particularly among the *Molinia*-rich element of the vegetation. Tussockiness can effectively prevent further succession to scrub but where this is possible, invasion by willows and birch can be rapid. Figure 18 in Rodwell (1991) illustrates the impact of neglect and succession to scrub and woodland on a lowland vegetation sequence that involves the Purple Moor Grass and Rush Pasture.

Recovery of the habitat from more advanced successions is usually well-nigh impossible but more feasible attempts to retrieve the loss in earlier stages can also result in the application of **inappropriate management** such as over-intensive grazing, particularly by sheep which were probably not the usual (or only) stock in times past, or too-frequent burning. The latter is a tempting option when much *Molinia* litter has accumulated but it creates nutrient-rich ash and can effectively regenerate the grass by stimulating a new flush of unhindered growth in the spring.

*Molinia* is a grass that thrives on freshly-aerated and more fertile soils and has often been regarded by foresters as indicative of the best ground for planting. Certainly, in the past, **afforestation**, and usually for coniferous crops, has been a major threat to this habitat, particularly in the upland fringes.

In the lowlands, much land carrying this habitat in the more populous areas has been lost to **housing and road building**.

Maintenance of a high water-table or periodic flushing of soils that are usually neutral to acidic is essential, so in the lowlands **water abstraction** has sometimes contributed to deterioration of the habitat and, with reduced rainfall predicted by some models of **climate change**, this effect is likely to be accentuated in such catchments. Even where supplies remain sufficient, **eutrophication** of ground waters or through atmospheric nitrogen deposition is a threat.
6.8 Conservation initiatives

The total SSSI/ASSI coverage for Purple Moor-grass and Rush Pasture was estimated by the UK Biodiversity Group (1995) as about 3,800 ha with two NNRs but the present extent in designated sites is estimated as 17,000 ha, that is about 80% of the total resource. Extensive tracts of the habitat have been designated in Devon and Cornwall with 27 sites covering 1,100 ha, in Wales with 93 sites totalling 1,172 ha with a further 630 ha occurring on SSSIs notified for other habitats, in Scotland with 5 SSSIs covering 317 ha and in Northern Ireland with 1 ASSI of 375 ha notified mainly for this habitat. Countryside Stewardship and Wildlife Enhancement Schemes have been widely applied to Purple Moor-grass and Rush-pasture, and the habitat occurs extensively within Dartmoor, the Stewartry and the West Fermanagh and Erne Lakeland ESAs and is on many farms within the Welsh Tir Gofal scheme. Hewins et al. (2005) showed that more than twice as many non-statutory English sites with Purple Moor-grass and Rush pasture within agri-environment schemes were in Favourable condition compared with those outside, and that this difference was statistically significant.

The need for a landscape-scale approach to sustaining this habitat, including non-designated and unmanaged land, as well as SSSIs and holdings in agri-environment schemes, is shown by the CCW’s proposal for a South Wales Coalfield project. This area includes about 25% of the Purple Moorgrass & Rush Pasture in Wales and over half of the M24 Molinia-Cirsium fen-meadow and provides strongholds for Carum verticillatum and the marsh fritillary butterfly Eurodryas aurinia. The aim would be to improve the quality of existing sites, many of which have become rank and overgrown through neglect, others of which are over-grazed, to enlarge patch size and establish connectivity, and sustain mosaics with associated habitats.

As part of the above project at Mynydd Mawr in Carmarthenshire (http://www.carmarthenshire.gov.uk) and on the Culm Grasslands in north Devon and north-east Cornwall (www.butterfly-conservation.org/ne.news/culm-grasslands.html), partnerships have been established with Butterfly Conservation focusing on the importance of Purple Moor Grass and Rush Pastures for other biota like the Marsh Fritillary and Narrow-bordered Bee Hawk-moth. These initiatives work with landowners by offering free support and advice on relevant farming and wildlife grants and fostering cooperative working among landowners aimed at encouraging extensive summer grazing by cattle.

6.9 Research needs

There is a need to collate existing data from the Republic of Ireland and across Europe together with information from the UK so as to appreciate the full extent and quality of the Natura 2000 6410 Molinia meadows and the other equivalents of our Purple Moor-grass and Rush Pasture.

Research on the effects of habitat destruction on genetic diversity, sexual reproduction and clonal spread in Cirsium dissectum at Plymouth University highlights a wider need to understand how species such as this, regarded as key indicators of quality, survive and whether they can be successfully re-established in increasingly fragmented habitats.

Understanding community assembly rules and the relationship between edaphic conditions and the establishment of this kind of vegetation need further research, building on work on M24 Molinia-Cirsium fen-meadow at the North Wyke Research Station of the Institute of Grassland and Environmental Research (Tallowin & Smith 2001, Tallowin et al. 1998, 2002).
and on M25 *Molinia-Potentilla* vegetation at Rhos Llawr Cwrt in west Wales (Adams et al. 1999). In particular, more testing is required of methods of nutrient depletion where restoration is targeted on previously productive land (Walker et al. 2004).

It is unlikely that BAP targets for this habitat will be met by the rehabilitation of neglected sites so research is needed on the larger task of how to target the agri-environment funding that will be the main mechanism for delivery, notably the Higher Level Scheme Options HK7 and HK8. This could entail an investigation of the vegetation, environmental features and management of existing sites and those being restored and monitored already, together with predictive modelling using soil, climate and species-distribution data. An expert system could be directed towards HLS advisors.
7 Metallophyte vegetation

7.1 Summary of the habitat type

This vegetation is at present under consideration for designation as a Priority BAP habitat. It comprises sparse swards characteristic of bedrocks and rubble rich in various heavy metals, occurring on mineral veins and mine spoil, on compacted river gravels and serpentine exposures. The vegetation is often poor in vascular plants but comprises a distinctive suite of metal-tolerant taxa and provides a locus for a range of scarce and rare species, including cryptogams, which can be numerous in more exposed situations. Similar Thlaspion calaminariae vegetation occurs in comparable habitats in Ireland, The Netherlands, Belgium and Germany and related forms in more continental and mountainous parts of Poland, Austria and France. Most of these countries have designated sites for Natura 2000 under 6130 Calaminarian grasslands and, as here, they are sometimes threatened by renewed mining activity or a lack of natural dynamism and renewal in the raw substrate.

7.2 Synonymy

NVC OV37 Festuca-Minuartia community.

Annex I 6130 Calaminarian grasslands of the Violetalia calaminariae.

EVS 16K01 Armerion halleri, 16K02 Thlaspion calaminariae.

EUNIS E1.B Metallophyte grassland.

7.3 Character and distribution of the NVC constituent

Rodwell (2000) recognised just a single vegetation type under this head, the OV37 Festuca ovina-Minuartia verna community, first characterized by Shimwell (1968) from rock outcrops and spoil heaps rich in heavy metals on the Carboniferous Limestone exposures of the Mendips, Derbyshire Dales, Yorkshire Dales and North Pennines. Jackson & McLeod (2002) suggested that there were probably several thousand such localities. The NVC account also recognised that similar vegetation had been reported from stable river gravels and redeposited mineral washings in Northumbria (Sellars & Baker 1988), among which the Tyne & Allen and Tyne & Nent gravels are the most extensive and particularly noted for their lichens. Sites along the South Tyne and its tributaries are being investigated in detail by Simkin (1999, 2003a).

In Scotland, Birse (1980, 1982, 1984) had already characterised several related associations from serpentine exposures which do not really surface in the NVC at all: the Sileno-Armerietum maritimae metallicolae (Br.-Bl. & Tx 1952) Ernst 1974 emend., the Cerastium nigrescens- Armeria maritima Association, an assemblage first noted by Spence (1957) and the Lychnis alpina-Armeria maritima Association. Since then, especially striking examples of such serpentine vegetation have been described from Caenlochan, at the Coyles of Muick, the Keen of Hamar, the Green Hill of Strathdon and the Hill of Towanreef (Averis 1991, Lusby & Wright 1996, Jackson & McLeod 2002, Averis et al. 2004). The map of sites (Figure 36) includes stands of all these assemblages, in both lowland and upland localities.
Figure 36  Heavy Metal Grassland (including upland occurrences)
Vegetation characterised just by distinctive cryptogams of metallophyte sites has been described from Elenydd in Wales and in Cornwall, too, there is a metallophyte element among the bryophytes (Holyoak 2000) and lichens (Giavarini 2002) on abandoned mine sites, particularly those with copper-contaminated substrates (Spalding 2005). Further work is needed to understand the relationships between these various vegetation types.

7.4 The habitat and its constituents in Northern Ireland

This habitat has not been described from Northern Ireland.

7.5 Character and significance of the UK habitat in the wider European context

Shimwell (1968) recognised the essential similarity of the British vegetation he described to the Minuartio-Thlaspietum Koch 1932, the core association that has been recognised from western European metallophyte habitats, described from Ireland (Doyle 1982, White & Doyle 1982) and western Germany (Pott 1995). In Belgium (leBrun et al. 1949), The Netherlands (Westhoff & den Held 1969) and Germany (Pott 1995), a very similar Violetum calaminariae Schwickerath 1931, has also been characterised, with Viola calaminaria or V. lutea ssp. calaminaria (Janssen & Schaminée 2003), not a taxon that has been recognised here, although V. lutea is a common plant with us and its occurrence on heavy metal spoil is well recognised (Stace 1997). The Sileno-Armerietum which Birse (1980) reported from Scotland had been first described from copper workings in Killarney by Braun-Blanquet & Tüxen (1952), and later more widely in Ireland (Doyle 1982, see also White & Doyle 1982). From the French Pyrenees and Cevennes, two further related associations have been described, the Thlaspi calaminaris-Armerietum elongatae Ernst (1966) 1974 and the Armerietum muelleri Ernst 1976.

Such vegetation types have generally been placed in the Thlaspion calaminariae - previously and sometimes, as in France (Julve 1993), still known as the Violion calaminariae - the more Atlantic alliance of the Violetalia calaminariae. This is the order which includes all natural and anthropogenic swards in Europe. In more continental parts of northern Europe, the Thlaspion is replaced by the Armerion halleri where ecotypes of Armeria maritima are the distinguishing feature and where Thlaspi caerulescens (previously alpestre) is less obvious, although this plant actually extends in other vegetation types right into Poland. The core association in this second alliance, the Armerietum halleri Libbert 1930, has been reported from France (Julve 1993), Germany (Pott 1995, Schubert et al. 1995) and Poland (Matuszkiewicz 1984), with more local assemblages such as the Armerietum bottendorfiensis Schubert 1953 and Armerietum hornburgiensis Schubert 1974 characterised by endemic forms of Armeria maritima. Pott (1995) also described a grassier Holco-Cardaminopsietum Hülbusch 1980 in the Armerietum halleri from Germany.

In his monograph on these kinds of vegetation, Ernst (1974) distinguished a third alliance, the Galio anisophylli-Minuartion vernae of alpine metallophyte habitats where such montane plants as Galium anisophillum, Poa alpina and Dianthus sylvestris occur along with Minuartia verna and Silene cucubalis var. humilis, in associations like the Violetum dubyanae Ernst 1965 and the Thlaspietum cepaifolii Ernst 1965 from the Bavarian alps. The latter assemblage has also been described from Austria (Grabherr & Mucina 1993) but placed within the Thlaspion rotundifoli.
Originally, the general floristic and structural similarity of metallophyte vegetation to other open swards of drought-prone habitats led to their being grouped within the Brometalia of the Festuco-Brometea (as in leBrun et al. 1949, for example). It was Braun-Blanquet & Tüxen (1943) who elevated these vegetation types into their own class, the Violetea calaminariae, though Ernst (1974) has pointed out that *Minuartia verna* and *Silene vulgaris* are actually better character species than *Viola calaminaria*. Some more recent treatments have returned to the earlier notion of the higher affinities of such vegetation, locating the Violetalia as an order, or associations that would once have been assigned to it, within the class of scree and rubble vegetation, the Thlaspietea rotundifolii (as in Grabherr & Mucina 1993 and Rodwell et al. 2002). Others totally dissolve the traditional order and alliance affinities of the vegetation, as in Schaminée et al. (1995), where Metallophyte swards are treated as a sub-association of the Festuco-Thymetum serpylli Tx 1937, a community within the Plantagini-Festucion of the Koelerio-Corynephoretea. The equivalent treatment for us would be to stress the closeness of the OV37 *Festuca-Minuartia* community to the CG7 *Festuca-Hieracium-Thymus* grassland, a not altogether strange notion.

### 7.6 Coverage in Natura 2000

The Natura 2000 habitat 6130 Calaminarian grasslands of the Violetalia calaminariae is defined as comprising generally open natural or semi-natural swards on rock outcrops, river gravels or shingles and spoil heaps rich in heavy metals like zinc and lead. They are described as having a specialised flora with tolerant subspecies or ecotypes of such plants as *Thlaspi caerulescens*, *Armeria maritima*, *Minuartia verna*, *Silene vulgaris*, *Festuca ophiolitica* and *Cochlearia alpina*. Threatened endemic vascular plants are said to be generally absent from what are called pioneer stages which are not considered a priority in the Habitats Directive; and semi-natural sites are to be taken into account mainly where natural sites are very rare or absent from a region or where these provide a locus for characteristic or distinctive plants. The habitat has been designated in only a few countries (with the proportions of total number of SAC sites in brackets): Austria (5%), Belgium (8%), Germany (45%), Spain (3%), France (4%), Ireland (1%), Italy (8%), The Netherlands (1%), Slovenia (1%) and the UK (29%). The locations of the SACs are shown in Figure 37.

In general, the interpretation of the Natura 2000 habitat has been uncontentious, each country where it occurs including examples of all the Metallophyte communities that have been described from their territories, irrespective of their present syntaxonomic position - that is, whether or not they are actually now classified as within the Violetalia calaminariae, the order that is used to name the Annex I habitat (Ssymank et al. 1998, Bensettiti et al. 2005). Sometimes, as with the UK (Jackson & McLeod 2002) and Austria (Ellmauer & Traxler 2000), a more generous interpretation has included assemblages from serpentine rocks whose floristic relationships are either obviously broader or as yet rather uncertain and vegetation in which cryptogams dominate. Only with Poland, from where Armerion halleri vegetation has certainly been reliably described (Matuszkiewicz 1984), have there been no nominated sites, its representation in the country being considered insufficiently important.
Figure 37  Annex I 6130 Calaminarian grasslands

NATURA 2000 data notified to the European Commission by EU Member States and supplied by the European Topic Centre on Biological Diversity, Paris.
7.7  Key threats to the habitat

Concentrations of heavy metals like zinc, lead and copper are damaging to most plants but for some species which have developed tolerant varieties or ecotypes, habitats where such situations occur are effectively protected against invasion by more competitive plants (Ernst 1974, Kinzel 1982). Natural rock outcrops of this type are geologically scarce within the European lowlands or have been obliterated, but mining of such ores has been occurring since the Bronze Age, leaving a widespread heritage of anthropogenic sites, the earlier ones small and scattered but often richer in the metals because of the inefficiency of extraction in those times (Ellenberg 1988). In addition to the peculiar chemical environment, such habitats are usually very sharply-draining, and therefore drought-prone in drier climates, and poor in nutrients. Any change which ameliorates these harsh conditions therefore poses a threat to the distinctive vegetation able to capitalise on them.

Less rocky sites are vulnerable to reclamation for agriculture, or can be easily affected by operations around, or to the kind of tidying up that is often thought necessary for access and amenity, even (maybe especially) on sites which have a high cultural value because of their mining heritage.

Locally, there has been a reworking of abandoned mineral veins which can destroy existing colonised spoil though such activity also offers the prospect of creating new areas of this habitat. This can be especially important where, in less exposed conditions, succession is a threat to those less competitive vascular plants that are readily overwhelmed by the closure of the sward, the accumulation of a more fertile soil mantle with the prospect of grazing by stock.

Undervaluing the earlier stages in colonisation of debris, forms of this vegetation which are not so highly rated in the Habitats Directive, is therefore itself a threat particularly because of their importance for those cryptogams tolerant of heavy metals (Simkin 2003b). Among the distinctive lichens recorded at British sites, for example, are Vezdaea cobria, V. acicularis, Lecanora handelii, Gyalidea subscutellaris, Thelocarpon impressellum and, on river shingles, Peltigera venosa, P. neckeri and Sarcosagium campestre var. macroporum. Among the bryophytes, the near endemic Ditrichum plumbicola, D cornubicum, D. lineare, Grimmia ungeri, Pohlia andalusica, Scopelophila cataractae (maybe an introduction on imported ore), Marsupella funckii, Gymnomitiron obtusum, Lophozia sudetica, Cephaloziella integerrima, C. stellulifera are noteworthy.

In old workings and in natural situations, the scattered nature of the resource means that populations of scarce and rare vascular plants dependent on them are vulnerable to further fragmentation. Apart from Thlaspi caerulescens, which is nationally scarce with us (Baker in Stewart et al. 1994), though now evaluated in the ‘Least Concern’ category of threat (Cheffings & Farrell 2005), vascular species for which these kinds of habitat offer a congenial locus in the UK include Lychnis alpina, Cerastium fontanum ssp. scoticum, Cochlearia pyrenaica, Arabis petraea, Arenaria norvegica ssp. norvegica, a serpentine form of Asplenium adiantum-nigrum and Epipactis youngiana. Designation and management on a landscape scale offers a more secure prospect of sustaining separate sites for this habitat and the conditions and processes on which they depend.
With climate change, it is also possible that some stands may experience more frequent, extreme or prolonged drought events which could threaten the distinctively Atlantic character of British examples of these swards. Where this causes the periodic demise of perennial vascular plants, it may help keep the swards open. Likewise, on river gravels, more unpredictable flood episodes could increase the prospect of habitat renewal.

7.8 Conservation initiatives

The SSSI and SAC series aim to provide a selection of both natural and anthropogenic sites, the approach to the latter being rather selective within Natura 2000. Simkin (2003a) has argued strongly for a landscape-scale approach to the conservation of the river-gravel examples of this habitat and one which attempts to integrate both the biodiversity and cultural value of the lead-mining heritage.

7.9 Research needs

To understand more fully the research needs for this habitat, it is important to re-examine data for both Metallophyte Vegetation in its stricter sense, similar assemblages from serpentine exposures and those comprising mostly cryptogams so as to gain an integrated overview of the variation represented there, the distribution among the various assemblages of particularly threatened or rare vascular plants and the importance of the bryophytes and lichens. Appreciating the real distinctiveness of the British (and Irish) examples also means setting such data within the wider context of information from other parts of Europe.

Simkin & Smith (2003, 2004, 2006) have undertaken an interesting series of management experiments at three sites on mid-reach river gravels on the South Tyne tributaries aimed at setting back the succession that is overwhelming the more open swards rich in cryptogams and metallophytes by attempting to regenerate the open, contaminated substrate using scrub-clearance, moss-killing, raking and soil-stripping. It is this kind of research which will help understand the balance between establishment and disturbance essential to sustain a habitat that originated through dynamic landscape processes, and the possible role which rabbit grazing can play in keeping swards more open.
8 Conclusions

8.1 The BAP Priority Habitat definitions of Lowland Grasslands and their constituent NVC plant communities

There is no standard format to the descriptions of the UK BAP Lowland Grassland habitats and they vary in the precision and clarity of their definition and the account of their basic floristics and ecology (www.ukbap.org.uk). Sometimes, as with the Purple Moor-grass and Rush-Pastures, subsequent clarification has been provided as to the character of the vegetation types covered (UK Lowland Grassland HAP Steering Group 1998) but some inconsistencies remain as to what should be included or not. With Lowland Dry Acid Grassland, for example, a part of SD12 *Carex-Festuca-Agrostis* grassland that is covered by the relevant Annex I habitat and which ought to be included for ecological reasons, is not covered.

Also, though the published version of the NVC (Rodwell 1991, 1992) has now been used explicitly to define the plant communities covered by all of the BAP lowland grassland habitats, there is no reference to the subsequent overview of coverage of the NVC (Rodwell et al. 2000) whose findings shift our understanding of a number of the habitats and highlight the need for additional survey and review of what should be included within the BAPs. With Lowland Dry Acid Grassland, inland Thero-Airion communities that are rich in threatened ephemeralf calcifuges, need to be sampled and classified and, among Lowland Meadows, rushy MG5 *Centaurea-Cynosurus* grassland, herb-rich MG7c *Lolium-Alopecurus-Festuca* grassland and the sedge-rich relatives of MG8 *Cynosurus-Caltha* flood-pasture all need a thorough examination.

Beyond these possible additions, subsequent work has raised further questions. For example, Simkin (2006) shows that the definition of the OV37 *Festuca-Minuartia* community needs some revision, in particular to take account of the importance there of cryptogams, and we consider that this should be undertaken together with a review of all vegetation types from Serpentine exposures which hardly figured in the NVC. Whatever the precise character of the assemblages included within this habitat, there is clearly a case for considering whether Metallophyte Vegetation deserves provision with the UK BAP. The BAP UK Standing Committee is expected to effect this in 2007.

8.2 The wider phytosociological perspective on Lowland Grasslands

This project, like its forbear for English Nature on woodlands (Rodwell & Dring 2003), attempts to set important groups of vegetation types in a particular European country within a wider framework of understanding. The BAP categories under which the Lowland Grasslands are considered here are peculiarly British and broader than many of the habitats or biotopes defined in other countries, but a phytosociological approach to the plant communities which they comprise enables an overview of their analogues across the Continent to be developed.

However, the phytosociological literature is enormous, mostly written in languages other than English and difficult to access in this country. The Affinities sections of the community descriptions in the published version of the NVC (Rodwell 1991, 1992) outline the
relationships as they were understood then and these were updated and summarised at the level of alliances in the phytosociological conspectus to the NVC provided by Rodwell (2000). This overview was further revised in Rodwell et al. (2000) for existing NVC plant communities and for those provisional assemblages proposed in that review. Since then, the European Vegetation Survey team has published the first European overview of alliances (Rodwell et al. 2002), a robust classification that has cross references to EUNIS, but one which is necessarily subject to further change as new data and analyses become available and understanding deepens. The EVS is expected shortly to make available on its section of the website of the International Association for Vegetation Science (www.iavs.org), a complete synonymy of alliances that should help make sense of the many different perspectives on how the vegetation of Europe should be classified, an often contentious subject with much factional energy.

The challenge of classifying Lowland Grasslands within the alliances at the level of associations is daunting, given the huge amount of information available, its dispersal in many sources, and the complexities of negotiating a complex synonymy. Again, the EVS has pledged to publish the huge bibliography produced by the Unit of Vegetation Science at Lancaster University that lies behind the Overview of Alliances, though extensive libraries containing these sources are few and far between. Those at the Orto Botanico in Rome and the research institutes at Bailleul in France and Rinteln in Germany are among the most extensive. Where such literature sources provide frequency tables, the kind of overviews developed by Dierschke (1981, 1995) can be attempted making more precise comparisons between associations, but here, because of the bigger scale of our task, we have used an essentially bibliographic approach.

The difficulties and benefits of classifying Lowland Grasslands bottom-up, working from actual relevés, are well seen in the study of the Cynosurion by Zuidhoff et al. (1997). To extend such an exercise across all the relevant European alliances, with the tasks of locating, coding and analysing what would be many tens of thousands of data items is not impossible, given the degree of cooperation nowadays among the phytosociologists of the European Vegetation Survey. However, it is difficult to think who would sponsor such an exercise and it is probably most likely to be undertaken piecemeal within an academic context by, say, postgraduate researchers working on particular alliances in PhD programmes. Collaboration between the supervisors involved could then ensure some evenness of coverage and avoid duplication in the accumulating overview.

8.3 The coverage of Lowland Grasslands in Natura 2000

Although not part of the brief, this project can provide the basis of a detailed Interpretation Manual for Lowland Grassland that is much needed to ensure comprehensive coverage within Natura 2000. As a result, we can see that, one way or another, what the UK BAP terms Lowland Grasslands are quite well covered by the Habitats Directive, though Members States can differ in just which Annex I categories they would include in such broad habitats. Sometimes this is because of climatic variations across Europe, such that vegetation types which are with us mostly beyond the limit of enclosure occur more widely within the lowlands elsewhere. With Lowland Dry Acid Grasslands, for example, the UK decision to include only the 2330 Inland dunes with Corynephorus as equivalent to this category would puzzle some other States where it is the 6230 species-rich Nardus grasslands of the Violion that are a more important component of grasslands on lowland sands. Here, this habitat is interpreted as an upland type and equivalent to mildly calcicolous swards of the CG10
**Festuca-Agrostis-Thymus** and CG11 **Festuca-Agrostis-Alchemilla** types. Again, with the equivalents of our Purple Moor-grass and Rush-pastures, the increasingly Continental climate towards the eastern lowlands of northern Europe means that it is true Molinion vegetation that figures more prominently there.

In other cases, some ambiguity in the definition of an Annex I habitat in the Interpretation Manual (CEC 2003) has allowed Member States considerable freedom in designating SACs for Lowland Grasslands which, as one habitat or another, they wish to see protected within the Natura 2000 network. With Lowland Meadows, for example, a more generous interpretation of 6510 grasslands with *Alopecurus* and *Sanguisorba* only partly reflects the wider occurrence of these species in grasslands other than equivalents of our own MG4 *Alopecurus-Sanguisorba* grassland. The narrower UK approach has made it impossible designate SACs for MG5 *Centaurea-Cynosurus* grassland, a mainstream unimproved Cynosurion sward which would readily qualify for inclusion under a more liberal interpretation of the definition. Fortunately, this type is well represented within BAP.

Second, there is the continuing neglect in the UK, even within BAP, of our richer MG1 *Arrhenatherum* grasslands, swards that can be quite diverse, that are the locus of a number of threatened plants and which provide a structure, with rank grasses, taller herbs and sprawlers that is appealing to invertebrates and small passerines. Moreover, these are vegetation types which can thrive in relatively commonplace situations such as suburban wasteland and road verges and which are relatively easy to manage by cutting without grazing. This is perhaps the clearest missed conservation opportunity highlighted by this research.

Then, conversely, the UK interest in Lowland Grasslands sometimes highlights deficiencies in coverage of a habitat within Annex I. Though Metallophyte Grasslands are not yet covered by a BAP Priority Habitat, the attention they have attracted shows up the failure of the Habitats Directive to give sufficient status to early stages in colonisation of heavy metals deposits in which cryptogams, including rare species, are well represented.

### 8.4 Key threats to Lowland Grasslands

Williams (2006) provides an indication of the major reasons for the unfavourable condition of broad habitat types (not quite corresponding with the BAP categories) in the SSSI and SAC networks and Hewins *et al.* 2005 a less formal review of threats to a random sample of sites with the BAP habitats outwith the network of designation. From these sources, research during the preparation of this report and the responses of expert readers of the draft text, it is clear that some generic threats to these vegetation types can be recognised and that certain threats are actually part of current attitudes and approaches to conservation management. As part of the questionnaire exercise with EVS members, we also asked how threatened different alliances were in different countries across Europe and which threats were most important there and we make occasional references to these results below.

It is clear that the eutrophication effects of agricultural improvement, which over the past century and more have been one of the major factors in the disappearance and degradation of most types of Lowland Grassland in the UK, continue to make an impact on surviving stands of these vegetation types where the measure of protection through some sort of designation frame or beneficial influence on management is low. This is of particular importance still with the Lowland and Upland Meadows in the wider countryside of the UK, especially where they occur on more fertile and better-drained soils where the benefits of upgrade are more
immediate and economic. Even where such impacts of intensive farming have greatly lessened, as on Lowland Calcareous Grasslands for example, the undiscriminating impacts of atmospheric nitrogen deposition are likely to take a considerable toll and may already be widely implicated in the eutrophication of other Lowland Grasslands. With those swards which are somehow dependent on a ground water table, as with the alluvial MG4 Alopecurus-Sanguisorba Lowland Meadows or most of the Purple Moor-grass and Rush-pastures, the nutrient enrichment of inundating or flushing waters is likely to increase this burden of threat considerably.

However, much more pervasive now, and widely threatening to designated sites for Lowland Grasslands as well as in the countryside at large, are the impacts of reductions in grazing as low-intensity pastoral farming with its need for traditional stock management and its poorer returns has become uneconomic and unappealing. Such effects are being especially severely felt in Lowland Calcareous Grasslands and Lowland Dry Acid Grasslands which have been important resources in stock rearing, particularly towards the south-east, but also in the Purple Moor-grass and Rush-pasture that is so extensive in the west and which has often been simply abandoned for either grazing or cropping for hay and litter. With the long-time importance of rabbits in the maintenance of some of these systems, particularly the Lowland Calcareous and Lowland Dry Acid Grasslands, both for cropping of the herbage and reducing fertility away from their latrines, reductions in their populations through periodic infestation with myxomatosis or haemorrhagic disease, or the unpredictability of their numbers, have sometimes added severely to these problems. Lack of grazing also clearly has deleterious effects on Metallophyte Vegetation.

Both these threats are part of a widespread disintegration of the cultural and social fabric of kinds of farming that produced habitats with high wildlife value and which are very difficult to replicate within the legislative frameworks of designation and the rules and regulations of the various agri-environment subvention schemes. Many Lowland Grasslands were an integral part of complex and locally distinctive systems of farming so, even approximating to one element of these kinds of treatment, can leave the habitats wanting for some complementary impact. With those Lowland and Upland Meadows cut for hay, for example, a balanced yearly round of spring and autumn grazing with mowing timed in relation to weather, has been crucial for producing the biodiversity and aesthetic appeal we value now. With Lowland Calcareous and Lowland Dry Acid Grasslands, the forage value of the habitat has formed part of farming systems integrated with arable cultivation, or for the latter, with the management of heathlands, themselves a varied resource of grazing and fuel and periodically burned. Particular problems being experienced now like the unavailability of suitable breeds of stock and the shortage of manure, together with the disappearance of practices like the folding of animals, are all part of this complex change.

Unimaginative approaches to designating discrete sites for their wildlife value with long neglect of the quality of the intervening countryside has accentuated the fragmentation and isolation of stretches of habitat with any real character and adds further to the difficulties of managing many Lowland Grasslands in a coherent fashion and to the prospect of recruitment of flora and fauna in areas targeted for restoration. This kind of consideration is the spatial aspect of a failure to conceive sustainability of these habitats on an appropriate scale. These Lowland Grasslands have developed as part of wider landscapes, the habitats themselves at one time more extensive, but also dependent for their character on being integrated spatially with other kinds of vegetation whose own survival is often regarded as a quite separate target. The UK BAP sometimes draws attention to the need to consider
projects directed to one habitat, like Lowland Dry Acid Grasslands, to another, like Lowland Heath, but such awareness ought to apply much more widely.

The integration of one habitat with another was often also often functional in character, so the second kind of scale-related threat has to do with insensitivity to time and processes. Agri-environment schemes, for example, are seen as offering a viable alternative to the management agreements which have been the mainstay for securing appropriate treatment for designated sites and also widely applicable outwith such networks but inflexible application of generalised fixed rules for the timing of operations means that there is often little sensitivity to those seasonal and longer term relationships between the vegetation, the climate and the needs of the farmer for a sustainable crop. Naïve trust in simply decoupling productivity and financial support for farming through new but rigid regulations will not be sufficient to ensure survival of Lowland Grasslands.

But this is just one part of a wider anxiety about managing process as much as pattern in the conservation of Lowland Grasslands. These habitats are dynamic, with patterns of change through each year and, even when climatic variation has been more stable than now, from year to year. For example, in the kind of landscape where Lowland Dry Acid Grassland occurs, a measure of repeated local disturbance is essential to maintaining the more open inland dune vegetation as well as the full range of associated vegetation types, like those rich in ephemerals.

Or again, while the kinds of successions that ensue with relaxation of grazing or abandonment are regarded as threatening to the richness of existing Lowland Grasslands, it may be that, in some situations, dynamic mosaics of such swards, together with ranker grasslands, bracken, sub-scrub and scrub, can bring their own benefits to sites, in terms of second order diversity and an appeal to biota that favour ecotones. Roomier approaches to landscape-scale patterns and processes might enable such phased retreat to be targeted in places where maintenance of grazing is unlikely.

Resistance to new forms of management of Lowland Grasslands is already evident in anxiety about taking a second cut on those Lowland Meadows on flood plains that are in unfavourable condition through eutrophication of ground waters. The benefits of mowing Lowland Calcareous Grasslands, long practiced elsewhere in Europe, are becoming clear and trialling such approaches may be essential where past forms of management are no longer sustainable.

Broader categories such as those like the BAP Priority Habitats can be beneficial if they bring a measure of confidence to sustaining a diversity of Lowland Grasslands, but uncritical acceptance of existing definitions of what is included in each would be unfortunate. For one thing, there are vegetation types that are poorly defined within the NVC, only belatedly recognised in the review of its coverage (Rodwell et al. 2000) or described since then, that need to be properly defined and considered for integration in the definition of the habitats and their Action Plans. In this respect, it is the Lowland Dry Acid Grasslands, the wetter swards among the Lowland Meadows and the Metallophyte Vegetation (including Serpentine assemblages) that we know already need most attention. Sometimes, too, it is the low value attached to well-known vegetation types that has ruled them out for inclusion. For example, there are those richer MG1 *Arrhenatherum* grasslands that are potentially much more interesting than so far thought, and quite readily manageable, and which could be a worthy part of the Lowland Meadows BAP habitat.
It might be thought that most of these threats will pale into insignificance with the prospect of climate change but the impacts of such shifts as reduced summer rainfall, milder winters and more unpredictable storm events and flooding on Lowland Grasslands may be to some extent predictable if there is a sound understanding of the ecology of the existing habitats and their various plant communities; and the effects of these climatic changes will be mediated through the heritage of past and present agricultural practice and wildlife management. Also, the more imaginative approach to existing challenges suggested above should help make response to these future and less manageable threats more positive.

8.5 Conservation initiatives for Lowland Grasslands

We have not undertaken any comprehensive review of conservation initiatives aimed at sustaining Lowland Grasslands in the UK but, though that scene is rapidly changing and widely accessible through the internet, there is indeed something to be said for providing a more comprehensive periodic summary or web-based gazetteer of projects for newcomers. In principle, the Biodiversity Action Reporting System (http://www.ukhap-reporting.org.uk) is supposed to fulfil this function, but it needs more comprehensive population with details of initiatives.

What is clear on even a cursory view is that the capture of the national habitat resources within designated sites, the condition of the habitats and the disposition of initiatives varies greatly between the different habitats, this last influenced by tradition and fashion. Lowland Calcareous Grasslands, for example, remain a favourite habitat and are benefiting greatly from new partnerships between vegetation interests and those concerned with other biota, particularly birds and butterflies, enthusiasts for the former being especially powerful. Lowland and Upland Meadows, too, often attract attention because of their species richness and aesthetic appeal but projects here have tended to be organised on a more fragmentary basis because of the scattered nature of the sites, unless a local authority or a national park provides some framework at a larger scale.

Lowland Dry Acid Grasslands have generally fared much more badly than these habitats and continue to suffer some neglect in favour of the heaths that often accompany them. The poverty of vascular plants in the more closed swards has served them badly and more attention should be given in projects to the richer, open and disturbed vegetation types included in this habitat. The increasing and welcome tendency to consider the importance of cryptogams in various of the Lowland Grasslands should certainly reap some benefits in this particular case.

Champions for Purple Moor-grass and Rush-pasture have also been rarer, though regionally very effective in raising the profile of the vegetation types found in this habitat and their importance for, for example, butterflies. Metallophyte Vegetation, and the related plant communities of the Serpentine rocks of this country, have so far had but a few advocates and need the higher profile that BAP status can afford. A particular appeal here is the possibility of conservation initiatives highlighting the often close relationship between the biodiversity interest and the industrial origin of the habitat. This will therefore be a test case for partnerships between biodiversity and heritage interests, previously very scarce.
Finally, a striking feature of some Lowland Grassland projects is their attempt to foster relationships between habitats and the communities who live in the landscapes and to give a distinctive local flavour to their endeavours. But much more could be done in this respect, strengthening the links between biodiversity interests and organisations such as Common Ground.

8.6 Research needs for Lowland Grasslands

Although the NVC provides a good basis for defining the plant communities included within the Lowland Grasslands, it is clear that, for proper definition and protection of certain of these habitats, further survey and/or data analysis are needed to cover the full range of vegetation types or to complete our knowledge of their extent and distribution. In particular, with Lowland Dry Acid Grasslands, Thero-Airion assemblages of sandy tracks and rock outcrops need extensive sampling and further information is required on the location and character of U1 Festuca-Agrostis-Rumex grassland. Among the Lowland Meadows, the range of wetter grasslands now described from alluvial flood-plains should be integrated within the existing NVC framework, modifying the original definitions of MG4 Alopecurus-Sanguisorba, MG8 Cynosurus-Caltha and MG7c Lolium-Festuca-Alopecurus grasslands and characterising new communities where necessary. With Metallophyte Vegetation, further survey is needed of natural exposures and old mine sites to amend the OV37 Festuca-Minuartia community, together with analysis of vegetation from Serpentine rocks. More generally, it would be very satisfying to integrate an account of UK plant communities with those of both Northern Ireland and Eire, but this is especially pressing for Calcareous Grasslands, Lowland Meadows and Purple Moor-grass and Rush-pastures.

Despite some classic studies and continuing research interest in certain Lowland Grasslands, much still needs to be known about the basic ecology of their plant communities, and their relationships to particular soil and climatic conditions. Many of the vegetation types have developed and been sustained because they were an integral part of agricultural systems. Although the traditional management of some habitats, like Upland Hay Meadows and the wetter Lowland Meadows, has been well researched, not enough is known about the relationships between productivity and biodiversity in Lowland Grasslands and how favourable condition might continue to be maintained in a transformed agricultural situation. Continuing assessment of the effectiveness of agri-environment schemes is vital to see whether they can deliver their goals but new and creative approaches to management also need serious investigation and more than sporadic local experiment.

In particular, there is a continuing need for research into the effectiveness of different kinds of pastoral management – the intensity and periodicity of grazing, the impact of different kinds of stock in pastures and so on – and the way in which grazing can be integrated with mowing in meadows and rush-pasture. Projects such as GAP and PONT are of exemplary value in exchanging information but there is room for further development of networks and for making readier links between academic research and conservation practitioners. The meetings of the British Grassland Society and periodic British Ecological Society symposia provide the kind of varied forum within which such discussion can take place.

Understanding how such management can work on a landscape scale will be essential to sustain the range of different plant communities which make up the Lowland Grassland habitats and to ensure that these are dynamic systems and not static mosaics and ecotones. This is especially pressing for the swards and scrub of Lowland Calcareous Grassland, for the
grasslands, heaths and open assemblages of Lowland Dry Acid Grasslands, for the sequences
of inundation communities and grasslands in wetter Lowland Meadows and for the range of
swards included within the Purple Moor-grass and Rush-pastures. With Lowland and Upland
Meadows which often survive as small and fragmented sites, further research is needed on
the consequences of genetic isolation and how these sites can be sustained within intervening
landscapes that are largely improved.

Particularly for those Lowland Grasslands where more effective management of existing
resources will be insufficient to meet BAP targets, a better understanding of options for
restoration and of the technicalities of particular methods of restoration and aftercare is
needed. Further research is especially required on species recruitment and assembly rules in
vegetation under restoration, on coping with nutrient depletion in intensively farmed soils, on
arable reversion and on mechanisms for disturbing those habitats which require repeated
intervention to maintain dynamic processes. With more ambitious programmes such as are
necessary for Purple Moor-grass and Rush-pasture, there needs to be research into the
feasibility and targetting of restoration.

A European perspective on the Lowland Grasslands of the UK will be vital if this country is
to play its full part in contributing to Natura 2000 and the sustainability of a full range of
these important habitats more widely. This is important not simply from the point of view of
understanding how the plant communities represented here relate to their analogues
elsewhere but also in developing concerted approaches to what are clearly widespread threats
right across the Continent – abandonment and agricultural improvement of these grasslands
and global dangers such as atmospheric nitrogen- and acid-deposition and changes in climate.
Conservation practitioners and those concerned with the development and delivery of policy
need to develop better links with the international science community to set sensible research
agendas and disseminate the results of such enquiries.

8.7  The future for Lowland Grasslands in Europe

The best prospect for developing an integrated overview of the character, extent and ecology
of Lowland Grasslands of Europe, one that would serve the scientific community, policy
makers and practitioners, is SynBioSys. This information system, pioneered in the
Netherlands (Schaminée & Hennekens 2006) and now being developed for European
application, has three tiers of data - on plant species, vegetation types and landscapes.
Structurally, it comprises three classifications - the first integrated species list for the whole
of Europe, the phytosociological alliances according to the EVS overview and a landscape-
scale classification based on the Vegetation Map of Europe (Bohn et al. 2002). It also has a
parameter frame for each set of units that includes data on their distribution, environmental
relationships, conservation status and other values, and a GIS facility to visualise spatial
aspects of the information. Ultimately, it will function as a distributed database with the
prospect of interactive participation by a wide community of users already united by their
common commitment to TURBOVEG (Hennekens & Schaminée 2001), a database platform
which includes popular multivariate analytical software such as TWINSPAN, DECORANA
and CANOCO. After a presentation of the interim results of this Natural England project at
the EVS 15th Symposium in Catania, Sicily, in March 2006, there is the prospect of Lowland
Grasslands serving as the first demonstration for population of SynBioSys Europe with
detailed information.
Such an enterprise is part of the ongoing conversations and developing vision of the EVS network. Particular opportunities have arisen from this project through which our country agencies could continue to strengthen links with their European counterparts. For example, to obtain some interim appreciation of the extent of broad types of Lowland Grassland alliances across Europe, the questionnaire which we circulated to country representatives of the EVS winzipasked for each of the alliances to be scored in their territory with a crude value indicating whether the vegetation types were widespread and common, widespread but uncommon, local, rare, extinct or never recorded – the first time such an enquiry had been made. Replies were received for Bulgaria, the Czech Republic, Germany, Italy, Latvia, The Netherlands, Slovakia, Spain, Slovenia and, too late to include on the maps, Lithuania and Switzerland. Results for two alliances are shown in Figures 38 to 41. Even from modest initiatives such as this, a better international understanding of Lowland Grasslands can be developed.

Meanwhile, in this country, the Lowland Grasslands present one of the best options for developing a pilot project for a SynBioSys UK which could serve as a tool for the BAP user community. A first step in developing this would be to update the UK Vegetation Database with the many relevés collected among Lowland Grasslands since the completion of the NVC, both by the country agencies and through other survey initiatives. This would be best performed within TURBOVEG, as part of a wider shift from VESPAN (Malloch 1988) as the better operating platform for the Database. A second step would be to integrate this relevé data with a UK species database developed from the Biological Records Centre and now incorporated within the National Biodiversity Network. A third step would be to add the landscape-scale information later based on the UK contribution to the Vegetation Map of Europe, but rationalising the legend and polygon boundaries with the compatible but more precise Soilscapes map produced by the National Soil Resources Institute at Cranfield (Thompson & Rodwell 2004). The total cost for such a pilot project would be between £20& 25K.

Within the UK BAP process, there is a growing awareness of the wider landscape scale within which sites designated for particular habitats exist, of the importance of managing process and dynamism in the sustainability of sites and landscapes, and of the relationships between biodiversity and cultural resonances in the distinctiveness of place. Novel partnerships are beginning to recognise the synergies between these various strands but there is a need to focus this momentum in more concerted and explicit way within the BAP process. More widely, international initiatives are beginning to stress the agricultural context for habitats in High Nature Value Farmland (EEA/UNEP 2004), the need to safeguard cultural landscapes (http://ec.europa.eu/culture) and the importance of sharing best practice in conservation management (http://www.eurosite-nature.org). Lowland Grasslands provide a prime example of how such interests might coincide to promote a more integrated and dynamic approach to the sustainability of habitats across Europe.
Figure 38  Extent of Alopecurion grasslands in selected European states
(blank = no data, 1 = never recorded, 2 = rare, 3 = local, 4 = widespread but uncommon, 5 = widespread and common)

Figure 39  State of threat to Alopecurion grasslands in selected European states
(0 = no data, 1 = unthreatened, 2 = locally threatened, 3 = a nationally threatened, 4 = endangered, 5 = critically endangered)
Figure 40  Extent of Calthion grasslands in selected European states
(blank = no data, 1 = never recorded, 2 = rare, 3 = local, 4 = widespread but uncommon, 5 = widespread and common)

Figure 41  State of threat to Calthion grasslands in selected European states
(0 = no data, 1 = unthreatened, 2 = locally threatened, 3 = a nationally threatened, 4 = endangered, 5 = critically endangered)
9 Abbreviations & Glossary

Annex I
The Annex to the Species and Habitats Directive which lists habitats of nature conservation importance in the European Union

ASSI
Area of Special Scientific Interest, the equivalent in Northern Ireland to SSSI

BAP
Biodiversity Action Plan

BSE
Bovine Spongiform Encephalitis, popularly known as ‘Mad Cow Disease’

CEC
Commission of the European Communities

CORINE
A programme ‘Coordination of Information on the environment’, initiated by the European Union in 1985 and since 1994 an integrated part of the European environment Agency programme. Often used as shorthand for the habitat classification that underlies the EU Habitats Directive.

ESA
Environmentally Sensitive Area

EUNIS
European Union Nature Information System, a database on Species, habitats and Sites of significance in the European Union

EVS
European Vegetation Survey, a Working Group of the International Association for Vegetation Science including

GAP
The Grazing Animals Project, a partnership dedicated to optimal grazing of wildlife sites

humic
Organic character of topmost soil horizon

INDITE

‘Least Concern’
The International Union for the Conservation of Nature Red List category including widespread and abundant taxa that do not qualify for more endangered status after evaluation against the criteria

‘Near Threatened’
The IUCN Red List category for taxa that are close to qualifying for categories of greater concern: vulnerable, endangered or critically endangered.

Natura 2000
The network of SACs and SPAs within the European Union

NGO
Non-governmental organisation

NNR
National Nature Reserve

NVC
National Vegetation Classification, the UK standard for defining plant communities.

PONT
The Welsh Grazing Animals Project, Pori, Natur a Threftaedath meaning Grazing, Nature & Heritage, the acronym being the Welsh word for ‘bridge’

Relevé
A phytosociological sample of vegetation comprising complete species lists and cover-abundance values within a homogeneous plot

SAC
Special Area of Conservation, designated under the Habitats Directive

Saum
Vegetation intermediate between grassland and scrub in succession or ecotones

SPA
Special protection Area, designated under the Birds Directive

SSSI
Site of Special Scientific Interest

xeric
Habitat or vegetation with species tolerant of dry conditions
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Appendix 1  UK Lowland Grassland distribution: data sources and quality

The great majority of records on UK Lowland Grasslands come from three main sources, which are defined below. Table 7 summarises their characteristics.

UK lowland grassland database

This is a large and important collection of Lowland Grassland community records for the whole of Great Britain. It is currently being improved and developed as a tool for data storage and reporting of HAP work. It is unusual in that it can store quadrat or rélevée records as well as biotope summary information and can therefore be used to validate community records, to assess change, and for other ecological and phytosociological analysis. So far detailed quadrat records are available for Wales and England and summary community information is available for Scotland.

Priority habitat inventories for England

Each Biodiversity Action Plan priority habitat has an individual inventory which represents English Nature’s best assessment of its distribution, based on existing available datasets, including earlier versions of the two other main sources used in this European project. It was based on the digitised version of the published, paper, lowland grassland inventory (English Nature 1993-; Jefferson 1997), which was refined by reference to aerial photographs and archived field records. In some areas Local Record Centres also helped to up-date the inventory.

To extract community records, the data were filtered using MapInfo software to select the relevant polygons, which were then assigned to the relevant 10km squares.

More detailed metadata for this dataset are available from Nature on the Map (http://www.natureonthemap.org.uk with links below) where the inventories can also be viewed as maps.

Purple moorgrass & rush pasture
http://www.natureonthemap.org.uk/bap/metadata/pdf/M_NBNSYS0000004620_V1_1.pdf

Lowland meadows
http://www.natureonthemap.org.uk/bap/metadata/pdf/M_NBNSYS0000004613_V1_1.pdf

Lowland calcareous grassland
http://www.natureonthemap.org.uk/bap/metadata/pdf/M_NBNSYS0000004615_V1_1.pdf

Lowland dry acid grassland
http://www.natureonthemap.org.uk/bap/metadata/pdf/M_NBNSYS0000004617_V1_1.pdf

Upland hay meadows
http://www.natureonthemap.org.uk/bap/metadata/pdf/M_NBNSYS0000004614_V1_1.pdf
English Nature’s SSSI notified features database

This is an evolving dataset about SSSI being being up-graded in 2006-9. At the time of data collation for this report, data could be attributed to named SSSI, but not to SSSI unit. The level of detail is greater than broad habitat types and often includes NVC community records.

Table 7: Main sources of NVC data from Great Britain

<table>
<thead>
<tr>
<th>Scope and size</th>
<th>UK lowland grassland database</th>
<th>England: priority habitat inventories</th>
<th>England: SSSI notified features database</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Lowland Grassland habitats: <strong>England</strong>: &gt;8000 sites; field data collected between 1981 and 1999 <strong>Wales</strong>: &gt;1000 sites; field data collected between 1987 and 2004 <strong>Scotland</strong>: c650 sites; field data collected between 1983 and 2001</td>
<td>Lowland Calcareous Grassland: &gt;4500 sites Lowland Meadows: &gt;5000 sites Upland Hay Meadows: 250 sites Purple Moorgrass and Rush Pasture: &gt;3000 sites Lowland Dry Acid Grassland: &gt;1500 sites</td>
<td>&gt;4000 Sites of Special Scientific Interest (habitats, species and geology)</td>
</tr>
<tr>
<td>Origin</td>
<td>Phase 2 field survey data</td>
<td>Site habitat maps digitised in the early 1990’s, to broad habitat level.</td>
<td>Part of the information system for Designated Sites.</td>
</tr>
<tr>
<td>Strengths</td>
<td>• Data were quality assured (QA) • Relevee (quadrat) data • NVC communities recorded • Most data backed up by detailed field cards • Reasonable data for extent • Full coverage in Wales</td>
<td>• GIS inventories • Some up-dating</td>
<td>• Linked to SSSI GIS data at level of whole site. • Base-data more stable than those for undesignated areas, as these sites are protected by statute.</td>
</tr>
<tr>
<td>Weaknesses</td>
<td>• Not a GIS inventory, ie no polygons, just grid references • Not fully up-to-date • In England, NVC determinations often cautious, leading to intermediates • English data were collected piecemeal, without consistent data standards • Significant gaps, particularly in England</td>
<td>• QA may have been inconsistent • Extent is not always of a single NVC community • NVC data not consistently recorded</td>
<td>• Imprecise linking to GIS polygons so no useful extent data • QA may be inconsistent as up-grade incomplete.</td>
</tr>
</tbody>
</table>
For two habitats, additional sources were used. These are shown in Table 8.

**Table 8: Additional sources of NVC data from Great Britain**

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Community</th>
<th>Source and notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland Meadows</td>
<td>MG4</td>
<td>Gowing and others (2002). A spreadsheet of site data which were used to compile Appendix 1 of David Gowing’s report formed the basis for most of the English records reported here.</td>
</tr>
<tr>
<td>Calaminarian grassland</td>
<td>OV37 (and others)</td>
<td>Jackson &amp; McLeod (2000). Spreadsheets showing the 10 km square records shown on the maps in the report (also viewable on the JNCC website) were made available from JNCC. Colleagues in the country agencies were consulted to separate squares containing at least some lowland sites from those which are exclusively upland in character. Two additional Welsh squares came from Averis and others (2004). (TBC).</td>
</tr>
</tbody>
</table>

**Data quality in the NVC distribution maps**

The maps of the UK distribution of the NVC communities (Figures 4-13, 16-20, 23-25, 30-34) could easily give a misleading impression to those who are not aware of the sources and limitations of the records. In particular they could give a visual over-estimate of the abundance of habitats which are widely but very thinly distributed, many of which have suffered severe decline and fragmentation and continue to be threatened.

**An example**

As an example, consider the Lowland Meadow community MG5 *Centaurea nigra – Cynosurus cristatus* grassland, the 2005 known distribution map for which is shown below as Figure 40. Each dot on the map means that vegetation matching or related to MG5 has been recorded from that square since 1980. It gives no information about the accuracy of the determination beyond the quality assurance incorporated into the various sources. It gives no information about the extent of the community now or in the past.

**Precision of records**

Many of the English records are of intermediate vegetation types. Intermediates (see Table 9 for examples) are recorded where surveyors feel that vegetation is truly intermediate between two or more communities, or where they wish to denote the affinities of vegetation for more than one community. There is little standardisation between competent, reputable surveyors on this matter. Some value the depth of information which can be recorded using intermediates (which reflects the real complexity of semi-natural vegetation), while others prefer the clarity of recording a ‘best fit’ determination based on expert knowledge (they assume that data users will be aware of the innate breadth of the community types and rely on the quadrat data as a ‘voucher’ of their judgement).
In the English part of the UK database, a large number of intermediates have been recorded. For example 178 intermediates including MG5 are recorded, all of which would be included in our maps. They include the following:

**Table 9** Examples of MG5 intermediates recorded in England

<table>
<thead>
<tr>
<th>Spread of intermediate</th>
<th>Within MG5</th>
<th>Within mesotrophic grasslands</th>
<th>Within grassland</th>
<th>With other vegetation classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>MG5/MG5a</td>
<td>MG6/MG5b</td>
<td>CG10a/MG5b</td>
<td>H8/MG5c</td>
</tr>
<tr>
<td></td>
<td>MG5a/MG5b</td>
<td>MG5a/MG4</td>
<td>CG6a/CG6b/MG5b/C</td>
<td>MG9/MG5/MG6/M27</td>
</tr>
<tr>
<td></td>
<td>MG5a/MG5c</td>
<td>MG6/MG5</td>
<td>MG8/MG5a/M25/</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MG5c/MG5b/MG5a/MG5a/MG6</td>
<td>M10b/M25/MG5a/M10a/M22b</td>
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</tbody>
</table>

Thus although we are reasonably confident that the dots on the map represent the judgement of a competent botanist that MG5-related vegetation has occurred there, we cannot be precise about the nature of the vegetation.
Presence in 2006

We cannot be sure that all sites which contributed records to the maps still contain the plant communities which were recorded. Therefore some of the squares may no longer hold any of the relevant habitat. Surveillance of undesignated sites is inadequate for us to quantify this potential source of error for the whole of the UK. We do however know that losses of semi-natural grasslands have continued throughout the period during which the records were collected, i.e. since 1980. For example Hewins and others (2005) showed that out of a sample of 108 non-SSSI lowland meadow sites from English Nature’s Lowland Meadows Priority Habitats Inventory, 41 are no longer BAP priority grassland.

Alternative approaches to mapping extent

Not all of our sources allow an estimate to be made of extent, for example the priority habitat inventories measure extent at the level of broad habitat rather than NVC community. Of those that do record NVC communities by extent, it is not measured at all sites. This means that it is impossible to make really comprehensive maps which show the extent as well as the distribution of each community. It is for this reason that we chose to map only known distribution in its broadest sense.

Where extent is known, it is possible to produce maps which give a much more realistic impression of a community’s abundance. For example Figure 43 shows 2005 extent data from the UK Lowland Grassland Database, expressed as extent and as the percentage of the total surface area of each ten km square (land and sea) which is recorded as MG5 in the database.

Comparing Figures 42 and 43 shows that a number of occurrences are left out of the latter, most especially in southwest England: this map is therefore not as accurate as the first. It does however give a more realistic impression of the scarcity of the habitat in the UK and is in that sense more precise.
Figure 43  Distribution of MG5 in Great Britain by recorded extent
The Welsh dataset is more complete than the others, so a comparison of two maps just for Wales shows more clearly how the use of data on extent can give a more meaningful map, as shown in Figure 44.

Figure 44  MG5 in Wales: maps of distribution and extent (2005)
**Fragmentation**

Even where we have records of the extent of habitats at particular sites, we do not usually have digitised information about patch sizes. In many surveys, extent figures are summed for each site to give a total for each community or sub-community. Where detailed habitat maps have been digitised into GIS applications, as in Wales, it would be possible to measure and analyse patch size. We have not attempted it in this project.

Different surveys have adopted differing definitions of an individual site: some based on individual fields or management units, some on whole farms or other large units. In the latter case, figures for extent may suggest larger patch sizes than really exist. Conversely, small patches of MG5 vegetation can occur as part of larger patches of semi-natural grassland, in which case extent figures reflect patch size only in the narrowest sense, which may not be key to the conservation and survival of MG5 grassland.

Nonetheless extent can be cautiously accepted as an adequate surrogate for true patch size, and it can be seen from Table 10 that MG5 is highly fragmented in all three countries.

**Table 10** Statistics for extent (ha) of MG5 recorded at each site in the UK lowland grassland database in 2005

<table>
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<th>England</th>
<th>Scotland</th>
<th>Wales</th>
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<tbody>
<tr>
<td>Average (mean) (ha)</td>
<td>2.88</td>
<td>2.87</td>
<td>2.5</td>
</tr>
<tr>
<td>median (ha)</td>
<td>1.41</td>
<td>1.35</td>
<td>1</td>
</tr>
<tr>
<td>maximum (ha)</td>
<td>94</td>
<td>31.9</td>
<td>361.7</td>
</tr>
<tr>
<td>minimum (ha)</td>
<td>0.01</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>Number of records</td>
<td>1751</td>
<td>294</td>
<td>639</td>
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Appendix 2  Habitats Directive interpretation manuals & related sources

**Albania**

**Austria**

**Belgium**
For Flanders: [http://www.gisvlaanderen.be/geo-vlaanderen/3fagrapporter/abstract/abs3675uk.asp](http://www.gisvlaanderen.be/geo-vlaanderen/3fagrapporter/abstract/abs3675uk.asp)

**Bulgaria**

**Croatia**

**Cyprus**
See also Biocyprus CD and Antonio Antonius in the Ministry of the Environment, Cyprus.

**Czech Republic**

**Denmark**

Estonia

Finland

France

Germany

Greece

Hungary

Iceland
Ireland

Italy

Latvia

Lithuania

Malta

Netherlands

Norway

Poland

Portugal
and for the maps http://www.icn.pt/psrn2000/cartog_habitat.htm

Romania

Slovakia
Slovenia

Spain

Sweden

Switzerland

Ukraine

United Kingdom
Joint Nature Conservation Committee: report distribution

Report number: 394
Report title: The European context of British Lowland Grasslands
Contract number: VT0509
Nominated officers: Vicky Morgan and Richard Jefferson
Date received: February 2007
Contract title: The European context of British Lowland Grasslands
Contractors: Professor John Rodwell, 7, Derwent Road Lancaster LA1 3ES
Dorian Ecological Information Ltd, Old Buck House, Buck Yard, Helhoughton, Fakenham, Norfolk NR21 7BW
Comments: This report assesses the significance of British Lowland Grasslands, occurring below the line of enclosure or moorland wall, within a wider European frame.
Restrictions: None

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