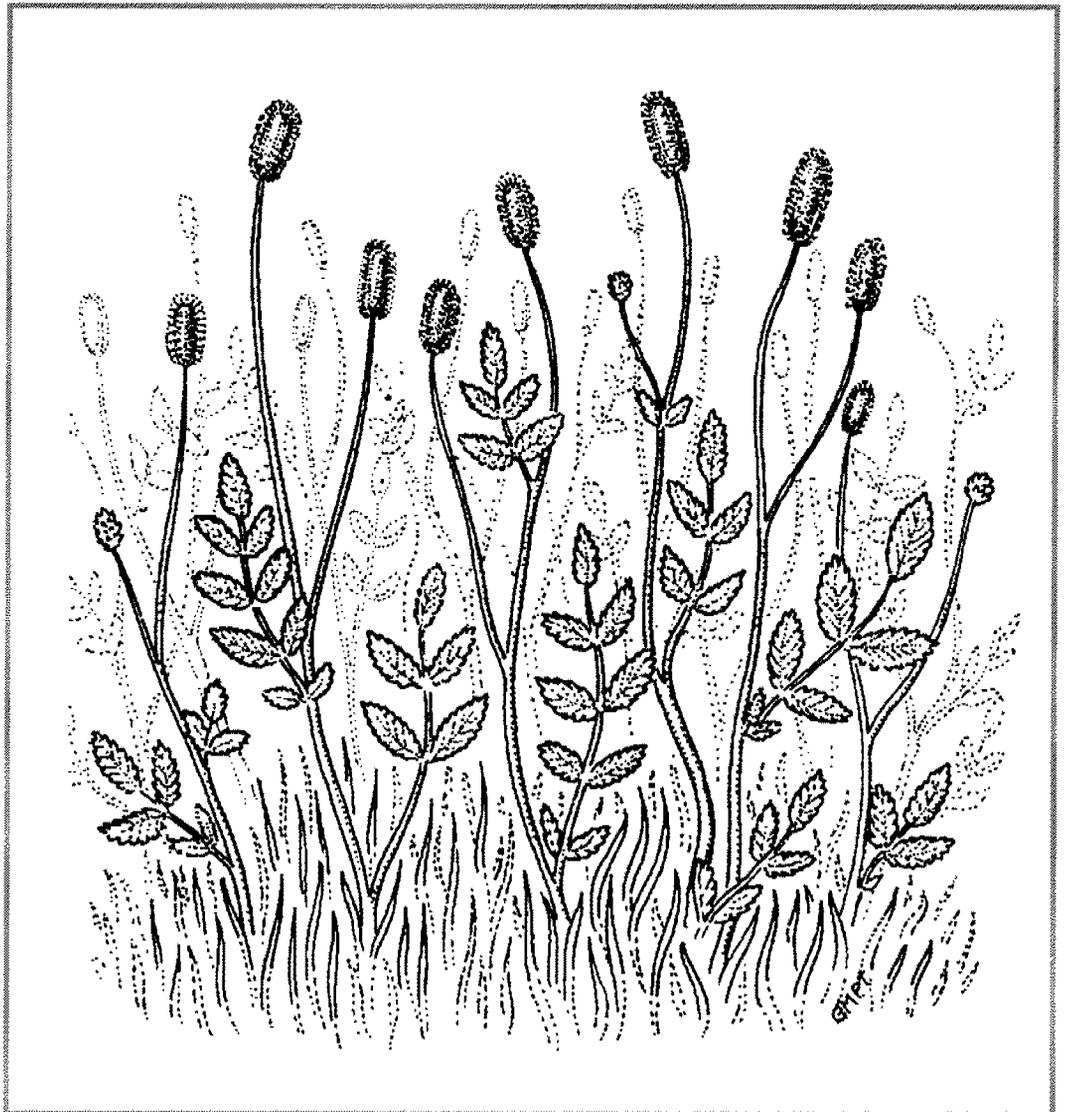


Distribution, status and conservation  
of *Alopecurus pratensis*-*Sanguisorba*  
*officinalis* flood-plain meadows in England

No. 249 - English Nature Research Reports



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English Nature Research Reports

Number 249

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flood-plain meadows in England**

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ISSN 0967-876X  
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## Author's preface

The data contained in this report were originally collated to inform a paper entitled *Biodiversity and sustainable management of English flood meadows* which was presented at a conference on European Floodplain and Coastal Wet Grasslands in the Czech Republic in September 1996.

The conference papers have not been subsequently published as a proceedings and it was felt that the information on MG4 grassland should be published as a Research Report to make it available for practitioners and policy makers to help inform conservation action.

It should be stressed that the information presented in the report has not been verified by recent individual site visits in many cases and represents a 'desk' collation of information from a variety of sources of various ages including personal communication. Additionally, NVC interpretation of survey data and descriptive accounts for some sites was undertaken either by the author or by correspondents and it is possible that other ecologists may not always be in agreement with these determinations for particular sites.

Nonetheless, it represents a first attempt to collate existing data for this grassland type and it is the author's intention to provide periodic updates as further information becomes available.

The author would welcome any comments on the report, including the provision of additional data. This should help to refine knowledge of the distribution, extent and conservation of this important grassland type in England.

## Summary

Data is presented on the distribution, extent, conservation status and management of MG4 flood plain meadows. Ninety two sites have been identified covering a maximum area of 1543.35 ha. Most sites occur south and east of a line from the Tees to the Severn estuaries with 81% of the area occurring in the Severn, Trent, Yorkshire Ouse and Thames catchments. Most sites containing MG4 are small with 62% being less than 10 ha. A high proportion of sites have statutory nature conservation designations or are managed as nature reserves. 77% of sites are currently in favourable management condition in whole or part. The positive conservation of MG4 grassland is discussed in relation to the threats and issues which currently impinge upon the maintenance and enhancement of biodiversity and nature conservation value.

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## 1. Introduction

Semi-natural lowland grassland is a scarce habitat in England as a result of substantial losses sustained particularly over the last fifty years (Fuller 1987, Hopkins & Hopkins 1994, Jefferson & Grice, in press). This decline can be principally attributed to the intensification of agriculture which has resulted in the conversion of semi-natural grasslands to more productive swards. This has taken place through drainage, ploughing and reseeded with high yielding rye-grasses together with the sustained use of inorganic fertilisers and herbicides or conversion to arable land for crop production (Hopkins & Hopkins 1994).

One type of particularly rare and threatened semi-natural grassland community is the flood-plain meadow community conforming to the MG4 *Alopecurus pratensis-Sanguisorba officinalis* grassland of the National Vegetation Classification (NVC) described by Rodwell (1992). This meadow type is restricted to England and Wales and was first described from the Thames Valley in the 1930s by Baker (1937) and Tansley (1939). Only four putative MG4 sites are known from Wales amounting to c7 ha (D P Stevens, pers comm). Jefferson & Robertson (1996) estimated that less than 1500 ha of the community now remains in England.

### 1.1 Community affinities and floristic composition

The community lies within the class *Molinio-Arrhenatheretea* of continental phytosociology. Within this, Rodwell (1996) placed MG4 within the *Cynosurion* alliance while Page (1980) suggested it lies within the *Molinion*. It seems clear that periodically flooded grasslands do not fit existing European grassland classifications very well (Page 1980) and MG4 appears to have affinities with a number of alliances including the *Junco conglomerati-Molinion*, *Cynosurion*, *Arrhenatherion*, *Calthion* and *Filipendulion*.

The floristic composition of this meadow type which has developed under a particular combination of agricultural treatments, hydrological regimes and soils in England, appears to be distinctive from communities described from flood plains elsewhere in continental Europe (Rodwell 1992). Typically the community is species-rich with means of 28 and 29 species per 4m<sup>2</sup> cited by Rodwell (1992) and Page (1980) respectively. It consists of a varied mixture of dicotyledonous herbs and grasses with the former often attaining high percentage cover in the sward (Rodwell 1992). Tall, robust perennials such as *Sanguisorba officinalis*, *Filipendula ulmaria* and/or *Thalictrum flavum* are often characteristically prominent.

### 1.2 Origins

The precursors of MG4 flood meadows were probably flood plain mires or fen meadows of the *Calthion* and *Junco conglomerati-Molinion* which were converted to the former by increased drainage, lowered water tables and the introduction of meadow management of mowing and use of organic manures (Ratcliffe 1977, Ellenberg 1988). This is consistent with the fact that the community has some floristic affinities with fen meadow communities, especially the M22 *Juncus subnodulosus-Cirsium palustre* and M24 *Cirsio-Molinietum* fen meadows described by Rodwell (1991). Nonetheless MG4 meadows are likely to be of some antiquity and Greig (1984) presents evidence that suggests this meadow type has existed since at least the Iron Age although Lambrick & Robinson (1988) suggest that the

community has probably been a feature of the Thames floodplain for less than 2000 years.

### 1.3 Habitat and management

In England, this community is known to occur in lowland river flood-plains or stream sides normally below 125m aod. It is usually situated on free-draining to moderately permeable, neutral to calcareous, clay-rich or silty alluvial loams and occasionally peaty mineral soils ranging from pH 5.8 to 8.3.

Sites are associated with a history of traditional low intensity management of hay cutting and grazing of the re-growth ("aftermath") with no use of herbicides or inorganic fertilisers and limited seasonal flooding or high water tables (Duffey *et al* 1974, Ratcliffe 1977, Rodwell 1992). In addition to the introduction of nutrients from flood water, some stands have had a history of periodic applications of farmyard manure (Page 1980).

The hydrological regime necessary for the maintenance of the community is relatively precise and any increase in the duration of Spring waterlogging can result in a shift from MG4 towards an inundation grassland or swamp community (Gowing & Youngs 1996). *Fritillaria meleagris*, a scarce species largely confined to damp meadows of this type, is also susceptible to changes in the duration of Spring waterlogging (Zhang & Hytteborn 1985).

Conversely, long-term drying out may shift the community towards impoverished drier grassland such as MG6 *Lolium perenne-Cynosurus cristatus* grassland (Rodwell 1992).

A few remaining sites are managed as Lammas or common meadows (for example Portholme, Cambridgeshire and North Meadow, Cricklade, Wiltshire) where the land is divided into strips or doles each mown for hay by different landowners and subsequently the whole meadow is then available for communal grazing on Lammas day (1 August) (Brian 1993).

### 1.4 Nature conservation value

The community is considered to have high nature conservation value (Ratcliffe 1977) and is listed on Annex 1 of EU Habitats & Species Directive (Council of the European Communities 1992). Stands of the community are often species-rich and long-established, and some contain populations of nationally scarce species such as *Fritillaria meleagris* and *Oenanthe silaifolia* (Rodwell 1992, Stewart, Pearman & Preston 1994). Stands of the community, along with other types of semi-natural damp grassland, are known to support a rich dandelion (*Taraxacum* sp) flora (Dudman & Richards 1997). A number of scarce species are known from MG4 grassland including *Taraxacum anglicum*, *T. tamesense* and *T. subundulatum* (Richards 1972, Dudman & Richards 1997).

Larger stands can support populations of breeding wading birds especially *Vanellus vanellus*, *Numenius arquata*, *Tringa totanus* and *Gallinago gallinago* (Ratcliffe 1977, Fuller 1982), and the Derwent Ings flood meadow complex in Yorkshire, supports internationally important populations of wintering wildfowl such as *Cygnus bewickii* and *Anas penelope* (Pritchard *et al* 1992).

The objectives of this report are to provide for MG4, summary data on distribution, extent, management, conservation status and the nature of threats to the maintenance of biodiversity.

The data is required to inform the development and implementation of national habitat action plans and strategies such as the UK Biodiversity Action Plan (The UK Steering Group 1995), local/regional biodiversity action plans and the plans and policies of Non-Governmental Conservation Organisations and statutory authorities. More specifically data could be used to target of Environmental Land Management Schemes such as the Ministry of Agriculture, Fisheries and Food's Countryside Stewardship and Environmentally Sensitive Area Schemes. These aim to ensure that a range of habitats are managed to sustain their nature conservation and landscape value. Data should also assist the selection of sites for statutory designations such as Sites of Special Scientific Interest and Special Areas of Conservation under the EU Habitats and Species Directive . The summary of the key issues affecting the conservation of MG4 should help inform policy development.

## 2. Methodology

The following fields of data were assembled for sites in England containing MG4:

- a. site name
- b. county
- c. six-figure grid reference
- d. river catchment
- e. site area (ha)
- f. area of MG4 (ha)
- g. conservation status
- h. type of vegetation management, and
- I. date of notification of SSSIs.

Site in this report is defined as the parcel or parcels of land named and defined in survey reports, identified by correspondents or notified as Sites of Special Scientific Interest (SSSI). Thus a site can range from a single field to a number of fields which may or may not be contiguous.

Site information was initially compiled on a spreadsheet. English Nature's SSSI database was interrogated for sites containing MG4 and this was subsequently validated by an inspection of the paper-based SSSI citations. Further sites were obtained from an inspection of all lowland grassland Phase 2 survey reports undertaken since 1980 by the former Nature Conservancy Council, English Nature and other organisations. Rowell & Robertson (1994) describe the methodology of Phase 2 grassland survey. The National Trust provided details of data on MG4 sites in their ownership. Other miscellaneous literature sources were also consulted including NGO nature reserve handbooks. The compiled data was then circulated to English Nature staff in Local offices for verification.

This resulted in some changes to data in selected fields and the removal of sites where these were known to have been lost or wrongly classified.

Stands from the Somerset Levels described as “MG4-related” by Cox (1995) were excluded as it was considered that they were sufficiently different floristically from MG4 and occurred in an atypical environment in terms of substrate and hydrological regime.

For some sites it was not possible to derive area figures for the extent of MG4 as these sites had not been mapped using the NVC and in many cases relative areas of different designations and ownerships on sites and how much of these were MG4 were not readily available. This was also often the case with management information. Where MG4 area was not available, total site area was used which means the figure for the total extent of MG4 is likely to be an overestimate.

A number of other factors will affect the accuracy of the data presented. Firstly, Phase 2 grassland surveys of neutral grasslands in England have not been undertaken in all Counties. Secondly, it is possible that a few of the sites listed will have been lost or damaged since survey, particularly if they have not received any statutory protection or been acquired as nature reserves by Voluntary Conservation Organisations (VCO). Similarly, information on management condition was sometimes not recent and it is possible that management condition could have changed in the intervening period.

Also a few sites may have been incorrectly classified by Phase 2 surveys or correspondents. The description and floristic table for MG5 *Cynosurus cristatus*-*Centaurea nigra* does not include *S. officinalis* (Rodwell 1992). The author’s experience is that this species can occur as a constituent of MG5 in the East and West Midlands and Derbyshire and Barfield (1993) supports this contention. This has undoubtedly led to confusion in placing samples in the NVC classification with some surveyors classifying stands with *S. officinalis* as MG4 which should be placed within MG5. In upland valleys, stands of MG3 grassland adjacent to watercourses have also occasionally been mistakenly classified as MG4 in survey reports. This is understandable as the two communities share many of the more abundant species (Rodwell 1992). Stands of semi-improved grassland (MG6 *Lolium perenne*-*Cynosurus cristatus* grassland) derived from MG4 and which support a few MG4 constants and preferential species may also have been incorrectly classified as MG4.

Despite the above limitations this is the most complete dataset on this community currently available. In addition to the data collation, the key issues affecting the community were derived from the literature (Jefferson & Grice, in press; Ratcliffe 1977, Rodwell 1992) and from an analysis of key issues affecting important wildlife feature in Natural Areas in England undertaken by English Nature (English Nature unpublished).

### 3. Results

Data collation identified 92 sites containing MG4 grassland covering a maximum area of 1543.35 ha (see Annex 1).

This estimate is very close to a previous rough estimate of <1500 ha (Jefferson & Robertson 1996). Table 1 provides a breakdown of the area by major catchment as used by the Environment Agency and where appropriate, by major river catchment.

Figure 1 shows the distribution of MG4 sites in England plotted on English Nature’s Natural Areas map. English Nature has divided England into 97 terrestrial Natural Areas which reflect the natural and cultural dimensions of the landscape (Figure 2). These have

Figure 1: Distribution of MG4 Flood Meadow Sites by Natural Area

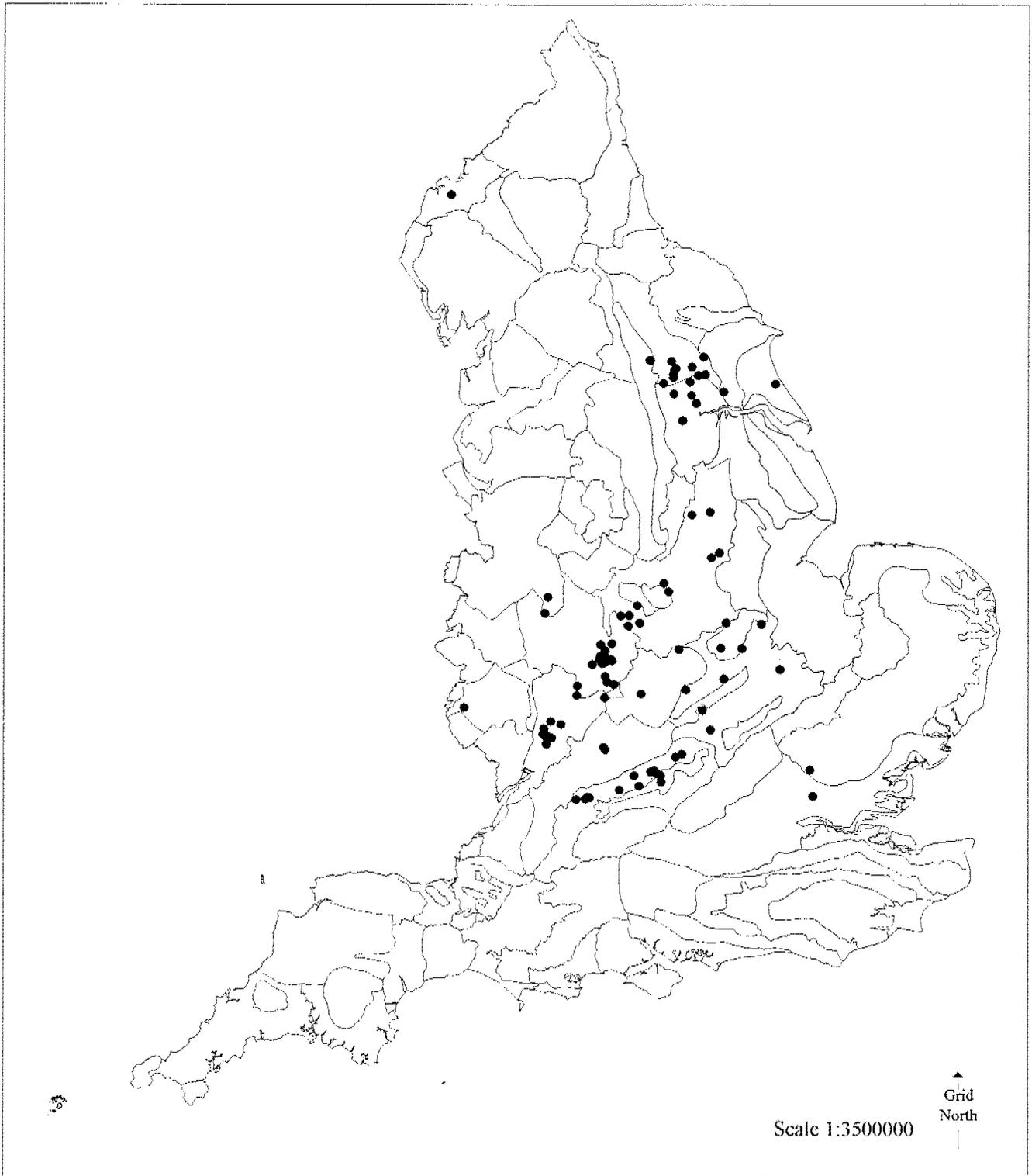
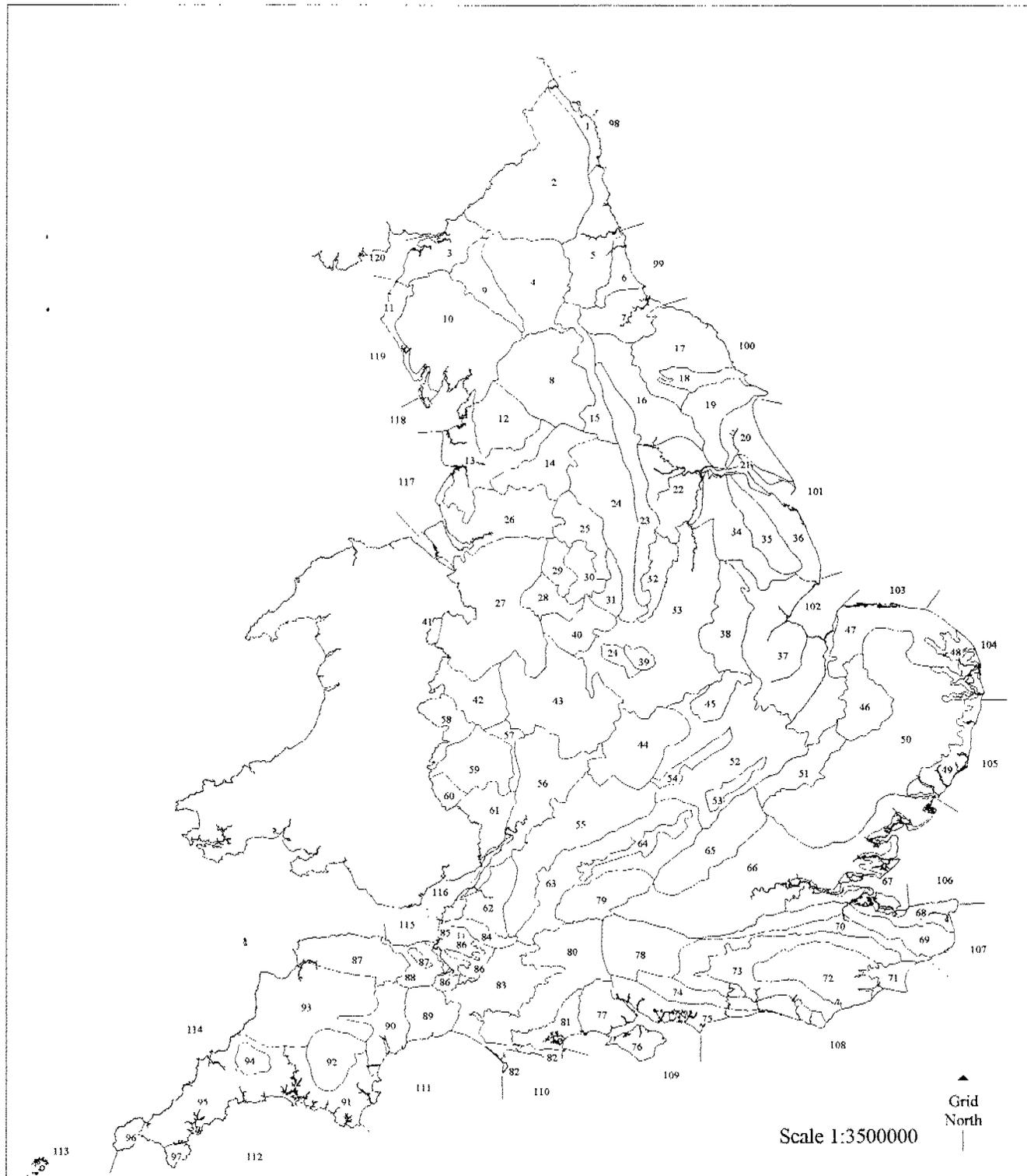


Figure 2

Natural Areas



- |                                       |  |  |  |                                   |   |
|---------------------------------------|--|--|--|-----------------------------------|---|
| 1. North Northumberland Coastal Plain | 11. West Cumbria Coastal Plain               | 21. Humber Estuary                       | 31. Derbyshire Peak Fringe and Lower Derwent     | 41. Owestrey Uplands              | 51. East Anglian Chalk                      |
| 2. Border Uplands                     | 12. Forest of Bowland                        | 22. Humberhead Levels                    | 32. Sherwood                                     | 42. Shropshire Hills              | 52. West Anglian Plain                      |
| 3. Solway Basin                       | 13. Lancashire Plain and Valleys             | 23. Southern Magnesian Limestone         | 33. Trent Valley and Rises                       | 43. Midlands Plateaus             | 53. Bedfordshire Greensand Ridge            |
| 4. North Pennines                     | 14. Southern Pennines                        | 24. Coal Measures                        | 34. North Lincolnshire Coversands and Clay Vales | 44. Midland Clay Pastures         | 54. Yardley-Whittlewood Ridge               |
| 5. Northumbria Coal Measures          | 15. Pennine Dales Fringe                     | 25. Dark Peak                            | 35. Lincolnshire Wolds                           | 45. Rockingham Forest             | 55. Cotswolds                               |
| 6. Durham Magnesian Limestone Plateau | 16. Vale of York and Mowbray                 | 26. Urban Mersey Basin                   | 36. Lincolnshire Coast and Marshes               | 46. Breckland                     | 56. Severn and Avon Vales                   |
| 7. Tees Lowlands                      | 17. North York Moors and Hills               | 27. Mosses and Meres                     | 37. The Fens                                     | 47. North Norfolk                 | 57. Malvern Hills and Teme Valley           |
| 8. Yorkshire Dales                    | 18. Vale of Pickering                        | 28. Potters and Charmet Valley           | 38. Lincolnshire and Rutland Limestone           | 48. The Froads                    | 58. Clun and North West Herefordshire Hills |
| 9. Eden Valley                        | 19. Yorkshire Wolds                          | 29. South West Peak                      | 39. Charnwood                                    | 49. Suffolk Coast and Heaths      | 59. Central Herefordshire                   |
| 10. Cumbria Fells and Dales           | 20. Holderness                               | 30. White Peak                           | 40. Needwood and South Derbyshire Claylands      | 50. East Anglian Plain            | 60. Black Mountains and Golden Valley       |
| 61. Dean Plateau and Wye Valley       | 71. Romney Marshes                           | 81. Dorset Heaths                        | 91. South Devon                                  | 101. Bridlington to Skegness      | 111. Lyme Bay                               |
| 62. Bristol, Avon Valleys and Ridges  | 72. High Weald                               | 82. Isles of Portland and Purbeck        | 92. Dartmoor                                     | 102. The Wash                     | 112. Start Point to Land's End              |
| 63. Thames and Avon Vales             | 73. Low Weald and Pevensey                   | 83. Wessex Vales                         | 93. The Culm                                     | 103. Old Hunstanton to Sberingham | 113. Isles of Scilly                        |
| 64. Midvale Ridge                     | 74. South Downs                              | 84. Mendip Hills                         | 94. Bodmin Moor                                  | 104. Sheringham to Lowestoft      | 114. Land's End to Minehead                 |
| 65. Chilterns                         | 75. South Coast Plain and Hampshire Lowlands | 85. Somerset Levels and Moors            | 95. Cornish Killas and Granites                  | 105. Suffolk Coast                | 115. Bridgwater Bay                         |
| 66. London Basin                      | 76. Isle of Wight                            | 86. Mid Somerset Hills                   | 96. West Penwith                                 | 106. North Kent Coast             | 116. Severn Estuary                         |
| 67. Greater Thames Estuary            | 77. New Forest                               | 87. Exmoor and the Quantocks             | 97. The Lizard                                   | 107. East Kent Coast              | 117. Liverpool Bay                          |
| 68. North Kent Plain                  | 78. Hampshire Downs                          | 88. Vale of Tunstun and Quantock Fringes | 98. Northumberland Coast                         | 108. Folkestone to Selsey Bill    | 118. Morecambe Bay                          |
| 69. North Downs                       | 79. Berkshire and Marlborough Downs          | 89. Blackdowns                           | 99. Tyne to Tees Coast                           | 109. Solent and Poole Bay         | 119. Cumbrian Coast                         |
| 70. Wealden Greensand                 | 80. South Wessex Downs                       | 90. Devon Redlands                       | 100. Saltburn to Bridlington                     | 110. South Dorset Coast           | 120. Solway Firth                           |

been defined using features such as topography, geology, soils and land use. Natural Areas provide a framework which enables decision makers and others to consider habitats, species and natural features in a more relevant context. Figure 3 shows the area of MG4 by Natural Area. The latter presentation has limitations as comparisons between areas are difficult as the Natural Areas are not of the same size. Nonetheless it does highlight the key Natural Areas for the MG4 grassland type.

Figure 1 shows that the majority of MG4 sites occur south and east of a line between the Tees and Severn estuaries and Table 1 indicates that nearly all (98%) of known MG4 grassland occurs in four major catchments (Thames, Midlands, Anglian and North-East). Four river catchments, the Thames, Yorkshire Ouse, Trent and Severn, contribute 81% of the total area of MG4 (Table 1). The key Natural Areas are the Severn and Avon Vales, the Trent Valley and Rises, the Thames and Avon Vales, the Vale of York and Mowbray, the Humberhead Levels and the West Anglian Plain (Figure 3).

Figure 4 shows the distribution by size classes of sites with MG4 and, where information was available, by area of MG4 grassland. The pattern for both is similar with a high proportion of sites (62%) and MG4 area (75%) being less than 10 hectares. This, together with Figure 1, shows that the resource is fragmented and consists of mostly small sites.

Table 2 summarises the conservation status of the MG4 grassland type. This shows that a high proportion of sites are covered by statutory designations and at least one third of the area of sites (21% by number) are being managed as nature reserves by statutory and voluntary organisations. There are no easily available data on the number of sites or parts of sites which have been entered into the Ministry of Agriculture, Fisheries and Food's Countryside Stewardship Scheme and the Upper Thames Tributaries Environmentally Sensitive Area (ESA), the only MG4 grassland in the data set which is within an ESA.

Figure 3: Area of MG4 Flood Meadow by Natural Area

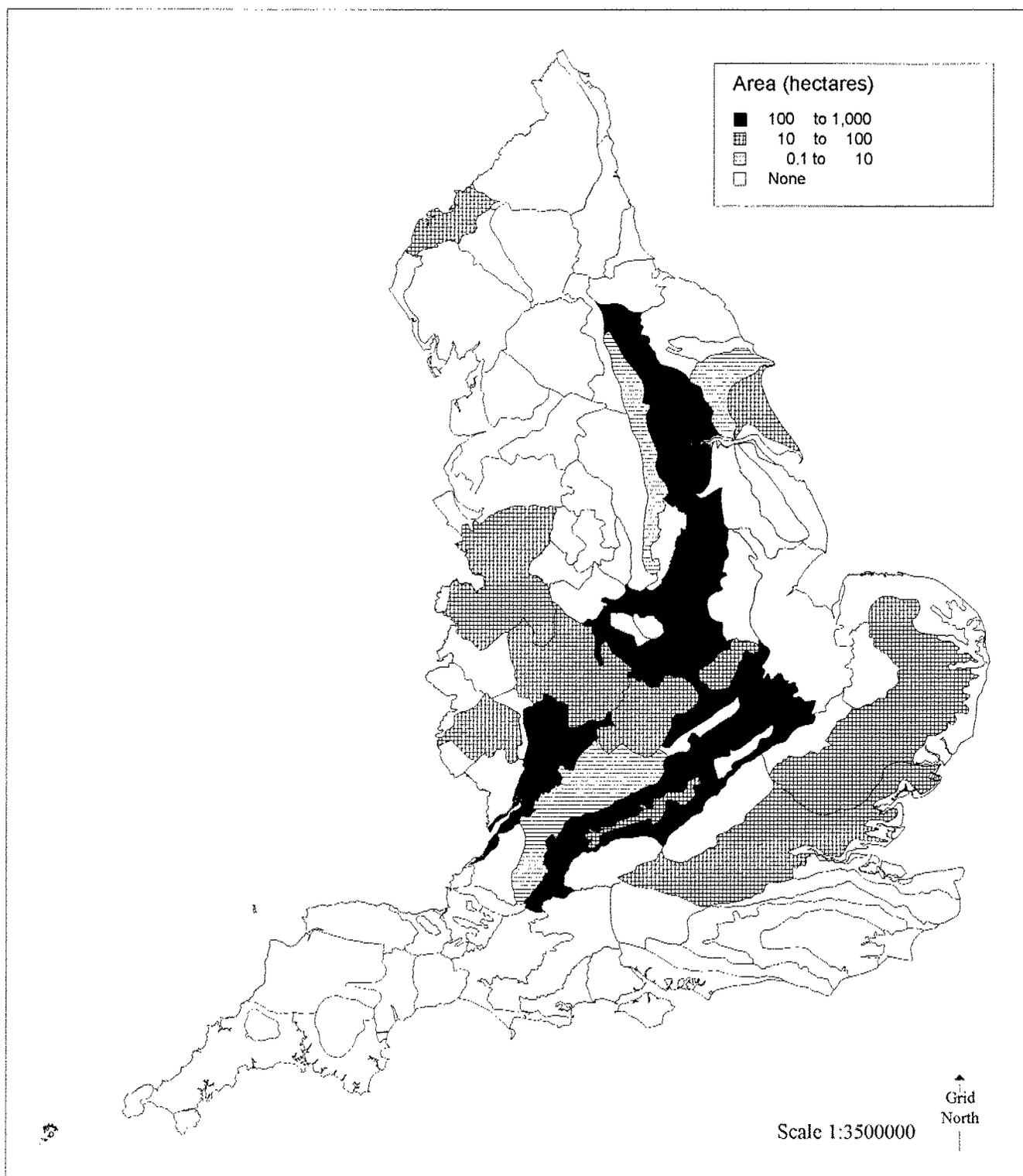
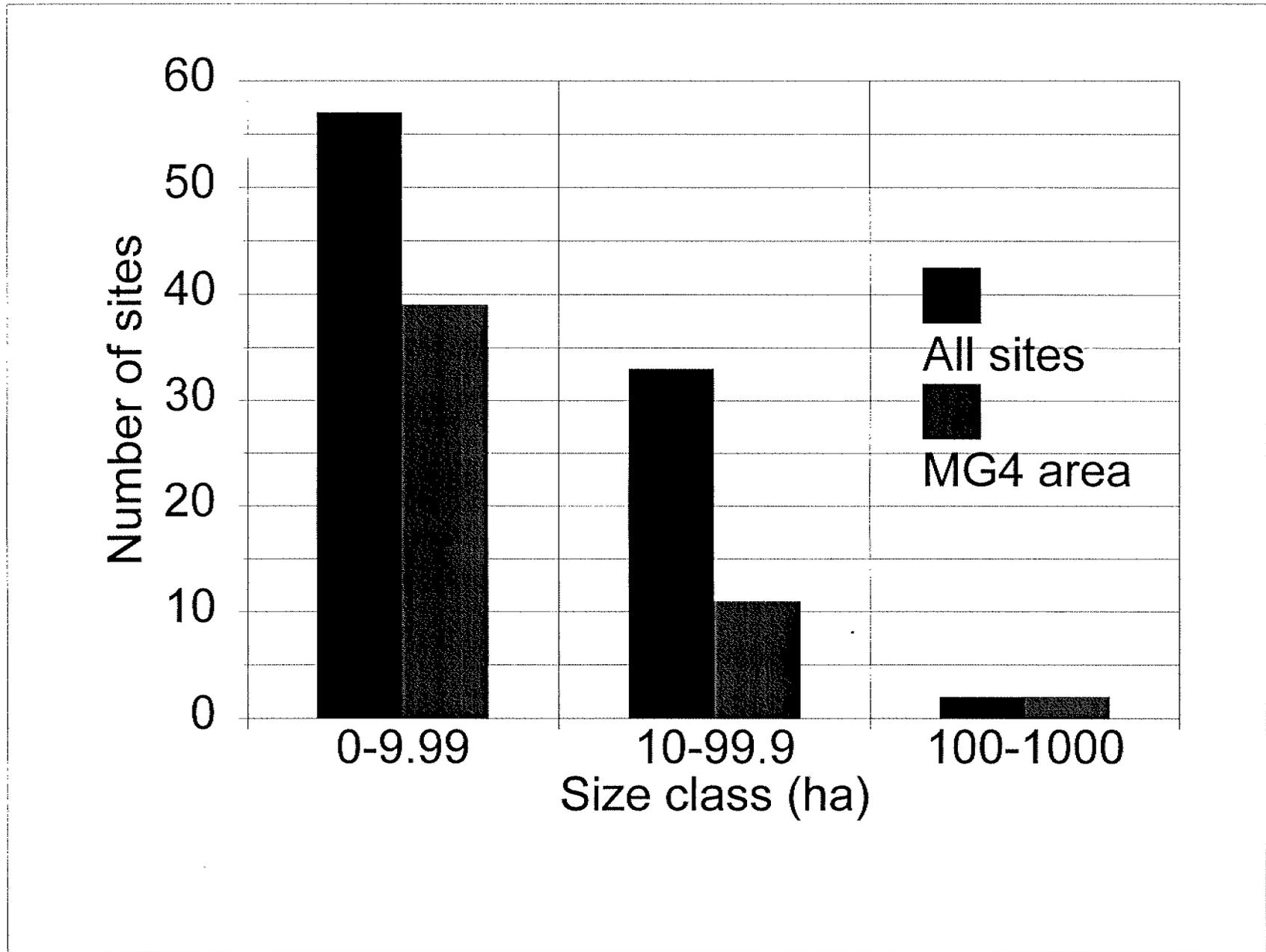


Figure 4 Size distribution of sites containing MG4 grassland



**Table 1. Area of MG4 flood meadow by catchment**

Major catchment/ major river catchment	Area of MG4 (ha)	% of MG4 in selected river catchments as proportion of major catchment	% catchment area <sup>1</sup>
THAMES ( <i>Total</i> )	396.95		0.03
MIDLANDS (SEVERN/TRENT)			0.02
Trent	249.46	57.2%	
Severn	186.52	42.8%	
<i>Total</i>	435.98		
ANGLIAN			0.01
Welland	11.43	4.5%	
Witham	4.1	1.6%	
Great Ouse	113.4	44.2%	
Nene	127.8	49.8%	
<i>Total</i>	256.73		
NORTH-EAST (NORTHUMBRIA/YORKSHIRE)			0.02
Ouse	401.29	95%	
Hull	22	5%	
<i>Total</i>	423.29		
NORTH WEST ( <i>Total</i> )	16.4		0.001
SOUTHERN	NIL		
SOUTH WEST	NIL		
WELSH England area only ( <i>Total</i> )	14		0.007
Wye (England)	14	100%	
			<b>%TOTAL AREA</b>
<b>TOTAL (ha)</b>	<b>1543.35</b>		0.011

<sup>1</sup>Catchment area data from Marsh & Lees (1993)

**Table 2. Conservation status of MG4 grassland in England**

Designation/status	% of sites <sup>1</sup>	% of total area <sup>1</sup>
Site of Special Scientific Interest (SSSI)	72	88
National Nature Reserve (NNR)	8	22*
Special Protection Area(SPA)/ Ramsar site	4	16
Special Area of Conservation (SAC)	12	39
Voluntary Conservation Organisation (VCO) reserve	15	29*
No statutory designation or nature reserve status	27	11

\* An overestimate as accurate data not available

<sup>1</sup> Figures are not mutually exclusive as some sites have >1 designation

Figure 5 shows the distribution of SSSI notification effort by year classes and illustrates that the majority of MG4 sites were notified post-1970. This information was collated to provide historical context to the conservation of this grassland type.

In terms of management, 71 sites (77%), were in whole or part, being managed by an appropriate hay cutting and aftermath grazing regime. 30 sites (33%) were being managed sub-optimally in whole or in part including hay cutting with no aftermath grazing and management as pasture for ruminant livestock or horses. Six sites were receiving no management. All of these three management regimes are likely to result in changes in botanical composition and reduce the nature conservation value of semi-natural flood meadows (Jefferson & Grice, in press). A higher proportion of sites with conservation designations were in favourable management condition in whole or part (83%) compared to those with no designations or protection (60%). The latter figures must be treated with caution as management information may not always be completely up to date.

Table 3 lists the key issues affecting the conservation of MG4 grassland and a summary of the impacts on biodiversity and nature conservation value.

Figure 5 Number of MG4 grassland sites notified as SSSI by year classes

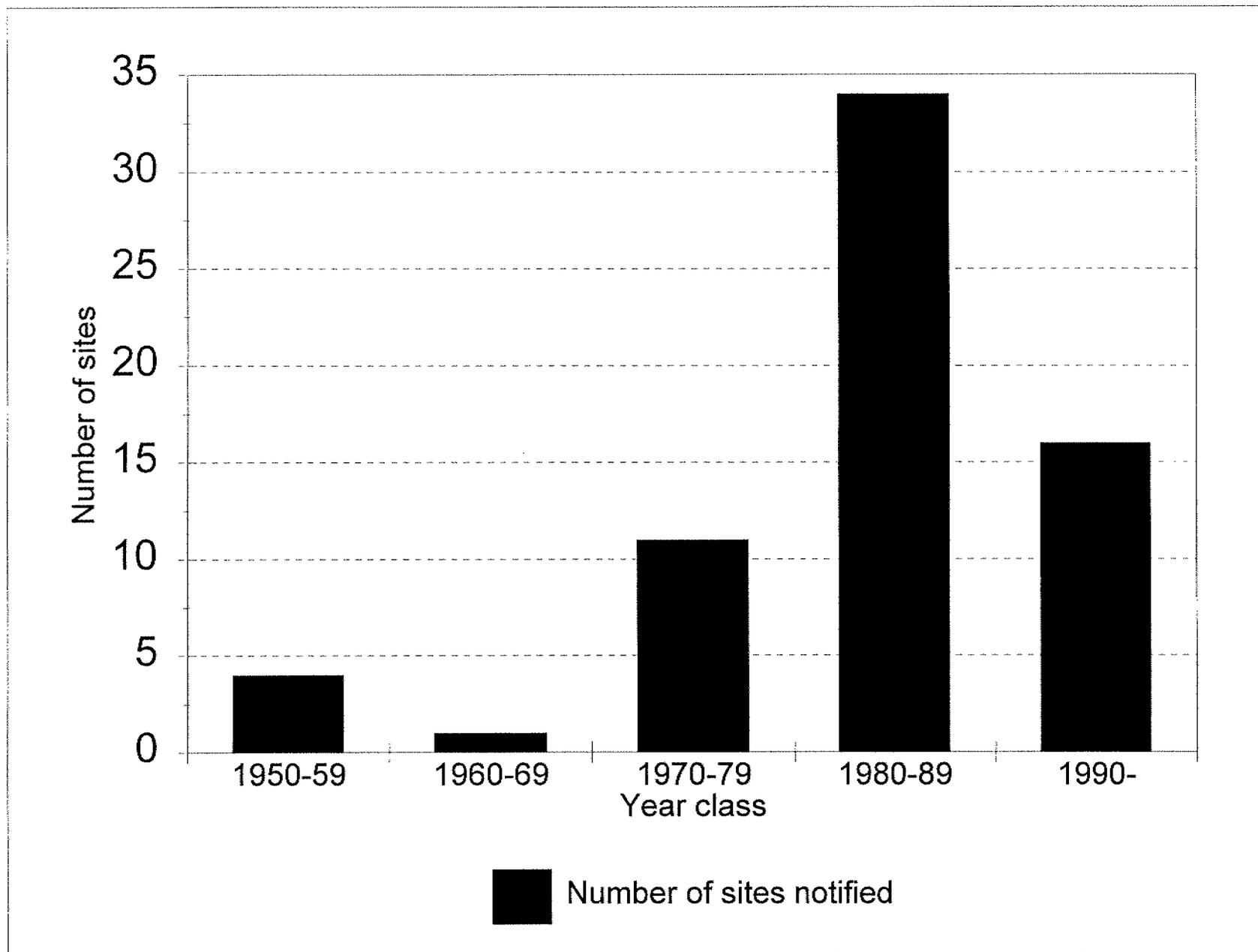


Table 3. Key issues affecting the conservation of MG4 grassland

Key issue	Sub-elements	Impact
Agricultural improvement	<p>i) conversion to arable</p> <p>ii) conversion to intensively managed grassland by ploughing and reseeded with high yielding grasses/legumes</p> <p>iii) conversion to semi-improved (MG6) or improved swards (MG7) by use of inorganic fertilisers</p> <p>i-iii may be accompanied by improved drainage; ii and iii will normally involve change from hay to silage.</p>	Loss /degradation of flood-meadow biodiversity including breeding/wintering avifauna
Changes in agricultural management	<p>i) complete cessation of mowing and grazing</p> <p>ii) cessation of aftermath grazing</p> <p>iii) change from mowing/ aftermath grazing to spring-autumn pasture for livestock including horses</p>	<p>Successional change resulting in replacement by more species-poor communities.</p> <p>Reduction in botanical diversity and change towards more species-poor communities (e.g. MG1)</p> <p>Botanical change including loss of spring-flowering species dependent on seed production for population maintenance (e.g. <i>Fritillaria meleagris</i>) and reduction in the abundance of tall chamaephytes</p>
Hydrological changes	<p>i) lowering of water tables and reduction/cessation of winter flooding caused by water abstraction, mineral extraction, flood alleviation)</p> <p>ii) raised spring water levels (e.g. to benefit breeding wading birds)</p> <p>iii) cessation of ditch/drain maintenance</p>	<p>Conversion to more species-poor grassland communities (e.g. <i>Lolio-Cynosuretum</i>) Reduced use by breeding/wintering birds</p> <p>Conversion to wetter grassland/swamp communities</p>
Restoration /re-creation	<p>i) re-instatement of favourable management on semi-natural sites</p> <p>ii) re-creation of vegetation similar in floristic composition by introduction of seed on ex-arable land/improved grassland</p>	<p>Return of MG4 to favourable condition provided management neglect is short-term</p> <p>Increased biodiversity</p>

## 4. Discussion

### 4.1 Distribution and extent

The distribution map (Figure 1) extends the known range of the MC4 community from the map of NVC samples in Rodwell (1992). It is not known to what extent the distribution of this grassland community might have extended more widely in the past than the current core areas in the Thames, Severn-Trent, Yorkshire Ouse and Anglian catchments. However, the occurrence of suitable substrate, topography and hydrological and management regimes in the past, particularly in lowland England, suggests that it occurred in areas where it is now absent and was more abundant in areas where it is still extant. Rackham (1986) reports that records indicate that by the 13 Century, most flood plains including those of small streams were managed as meadows.

The pre-1950 distribution of *F. meleagris* (Perring & Walters 1982), a species which is characteristic of MC4 in the Midlands and southern England, is also suggestive that the community was formerly more widespread.

Further grassland survey may result in the discovery of additional sites particularly in the few areas which have received little survey effort and are likely to have substantial areas of lowland river flood plain such as in the Herefordshire Plain. However, it is considered unlikely that many new large sites will be discovered due to the past extent of effective flood plain drainage and the use of fertile alluvial soils for intensive grass production and arable cropping.

### 4.2 Historical context

As with all semi-natural lowland grasslands, there are likely to have been large but unquantified losses of neutral grasslands including flood meadows over the last 50 years, principally due to agricultural intensification (Ratcliffe 1984). This has included drainage followed by conversion to arable or reseeded grassland or application of inorganic fertilisers (Table 3). As with other types of neutral grasslands, application of artificial fertilisers to flood meadows results in a decrease in botanical richness (Tallowin 1996, Joyce pers comm) and ultimately conversion to *Lolio-Cynosuretum* semi-improved swards (Jefferson & Grice, in press; Rodwell 1992). There are a number of documented cases of former MC4 sites being agriculturally improved, for example in the Nene and Severn valleys and in the Herefordshire Plain (NCC, English Nature unpublished).

The current sites have survived agricultural intensification due to a combination of factors. Firstly, many have been notified as SSSIs or established as Nature Reserves (Table 2), and secondly the positive attitudes of landowners to nature conservation and the resistance to changes in farming technology by others has also undoubtedly helped to conserve specific sites. The nature of land tenure has also been influential in some cases. For example, Lammas meadows or sites with complex multi-ownership patterns such as the Derwent Ings (Dixon, Jefferson & Woodhouse 1994) in North and East Yorkshire have been more resistant to change due to the difficulties of one or few "progressive" land owners gaining overall control of management.

The historical pattern of SSSI designation shows that few sites were notified prior to 1970 (Figure 5). Marren (1994) postulates that during the 20 years or so following the introduction of the legislation in 1949 which established the Nature

Conservancy and National Nature Reserves and SSSIs, ecologists and conservation scientists paid little attention to the lowland enclosed neutral grasslands in contrast to other habitats which were in contrast perceived as being rare and threatened. The former were part of the farmed landscape and were perhaps considered to be commonplace and widespread and not threatened.

Realisation that such meadows and pastures were rapidly being improved for agriculture and had their own intrinsic nature conservation value led to increased conservation effort in the 1970's culminating in the increase in SSSI notifications following the introduction of the 1981 Wildlife and Countryside Act coupled with the commencement of large-scale grassland survey by the Nature Conservancy Council (Jefferson et al 1997). It appears that large, well-documented flood meadow sites which supported populations of the conspicuous and scarce *F. meleagris* were an exception and this may account for the five sites notified between 1950 and 1969 including Pixey and Yarnton Meads in the Thames Valley described by Baker (1937).

#### 4.3 Protection and conservation

The key issues for conservation of the plant community appear to be the need to stem any further losses or deleterious changes due to agricultural improvement, inappropriate management or altered hydrological regimes and to consider the need for re-creation (Table 3).

The former can be achieved by a combination of mechanisms including statutory designations and land acquisition coupled with provisions for positive management, including Management Agreements and English Nature's Wildlife and Reserve Enhancement Schemes. The use of incentive mechanisms such as Environmentally Sensitive Areas and the Countryside Stewardship Scheme also have a role particularly in conserving sites outwith the statutory site series. The UK Biodiversity Action Plan should provide a catalyst for further action on the conservation and enhancement of habitats and species (The UK Steering Group 1995).

A high proportion of the area of MG4 has some form of conservation protection (Table 2) and favourable management was in place on a high proportion of sites for which data were available.

Impacts on hydrological regimes which might stem from mineral extraction proposals in river flood plains, river engineering and land drainage could be addressed through seeking to ensure appropriate environmental sustainability policies appear in development/structure plans and catchment management plans (now known as Local Environment Agency Plans).

Although it is not possible to re-create semi-natural flood plain meadow, at least in the short term, it would seem desirable from a nature conservation perspective to re-create a similar community to offset, in part, past losses. Re-creation of a community similar to MG4 flood meadow is currently being researched in the floodplains of the Thames and Ray (McDonald 1993, Mountford, Manchester, Treweek, in press) while practical re-creation attempts to re-create a similar community on former arable land are currently underway in the Yorkshire Derwent Valley (T.E. Dixon pers comm.).

It is clear that positive conservation and re-creation of flood meadow vegetation in England needs to be supported by data on the distribution and extent of the community in order that conservation schemes can be properly targeted. This needs to be combined with an understanding of the desired management to achieve nature conservation objectives and of the ecological dynamics of the community, particularly in relation to its response to changes in management and hydrology.

## 5. Acknowledgements

I would like to thank all English Nature Local Team colleagues who provided information on sites. Katherine Hearn of the National Trust also provided data for which I am grateful. Thanks also are due to Marcus Polley and Dr Heather Robertson for help with map production, to Richard Wright (EN) for helpful comments and to Chris Joyce of the Department of Geography, Loughborough University for useful discussion on the ecology of flood meadows and comments on the text.

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ANNEX 1: SELECTED FIELDS OF DATA FOR MG4 SITES IN ENGLAND						
COUNTY	SITE NAME	GRIDREF	CATCHMENT	AREA ha	STATUS	MANAGEMENT
North Yorkshire	Acaster South Ings	SE594437	Ouse	37	SSSI	1
North Yorkshire	Aubert Ings	SE453538	Ouse	9.6	SSSI,NNR	4
North Yorkshire	Bolton Percy Ings	SE534401	Ouse	6.8	SSSI	1
North Yorkshire/Humberside	Brighton Meadows	SE704330	Ouse	26.04	SSSI,NNR pSAC RAM SPA	1,4
North Yorkshire	Burr Closes	SE596340	Ouse	1.2	SSSI	4
North Yorkshire	Church Ings	SE594456	Ouse	4.7	SSSI	1
North Yorkshire/Humberside	Derwent Ings	SE 695410	Ouse	190	SSSI,NNR pSAC RAM SPA WT VCO	1,4
North Yorkshire	Clifton Ings	SE582532	Ouse	61.25*	NS	1
North Yorkshire	Fulford Ings	SE608491	Ouse	3.7	SSSI	3
North Yorkshire	Naburn Marsh	SE600479	Ouse	8	SSSI	1
Oxfordshire	Arcott Bridge Meadows	SP609185	Thames	7.2*	SSSI	3
Oxfordshire	Cassington Meadows	SP463101	Thames	7.03*	SSSI,pSAC	1
Oxfordshire	Ducklington Mead	SP363077	Thames	5.6	SSSI	1
Oxfordshire	Grafton Lock Meadow	SU273991	Thames	11.1	SSSI,NT	1
Oxfordshire	Hook Meadow and the Trap Grounds	SP500089	Thames	11.3*	SSSI	2,3
Oxfordshire	Iffley Meadows	SP524038	Thames	36.2*	SSSI,WT	1
Oxfordshire	Langleys Lane Meadow	SP391015	Thames	3.5*	SSSI	1
Oxfordshire	Wolvercote Meadows	SP484096	Thames	9.2	SSSI,pSAC	3
Oxfordshire	New Marston Meadows	SP520076	Thames	44.42*	SSSI	1
Oxfordshire	Pixey & Yarnton Meads	SP480105	Thames	85.6	SSSI,pSAC, CL	1
Cambridgeshire	Castor Flood Meadows	TL123973	Nene	42*	SSSI	1
Cambridgeshire	Portholme	TL238708	Great Ouse	104	SSSI,pSAC	1
Staffordshire	Motley Meadows	SJ840134	Trent	44.6*	SSSI,NNR pSAC	1
Northamptonshire	Bosworth Mill Meadow	SP628822	Severn	5.2*	SSSI,WT	1
Northamptonshire	Bugbrooke Meadows	SP672586	Nene	9.8*	SSSI,WT	1
Northamptonshire	Mill Crook	SP773464	Great Ouse	5.7*	SSSI,WT	1
Northamptonshire	River Ise and Meadows	SP882832	Nene	14*	SSSI, WT	1
Northamptonshire	Wadenhoe Marsh & Achurch Meadow	TL008828	Nene	47.4*	SSSI	1
Northamptonshire	Wollaston Meadows	SP898650	Nene	14.6	SSSI	1
Humberside	Barn Hill Meadows	SE734285	Ouse	8.5	SSSI	1
Humberside	Bishop Wilton Poorland	SE778558	Ouse	2.1	SSSI	4
Humberside	Hotham Meadow	SE895351	Ouse	0.9	SSSI	1
Humberside	Lambwath Meadows	TA208398	Hull	22	SSSI	1,3
Humberside	Melbourne & Thornton Ings	SE745450	Ouse	17.5*	SSSI,NNR pSAC RAM SPA VCO	1
Humberside	Newton Mask	SE707500	Ouse	16.5*	SSSI,pSAC RAM SPA	1
Humberside	White Carr Meadow	SE787457	Ouse	1.1	SSSI	4
Wiltshire	Clattinger Farm	SU012933	Thames	60.3*	SSSI,p.SAC WT	1
Wiltshire	North Meadow Cricklade	SU094946	Thames	44.4	SSSI,NNR p.SAC	1
Wiltshire	Upper Waterhay Meadow	SU068937	Thames	2.8	SSSI	1
Nottinghamshire	Eakring & Maplebeck Meadows	SK705622	Trent	16.03*	SSSI,WT	1
Nottinghamshire	Besthorpe	SK817641	Trent	7	NS WT	1
Leicestershire	Barrow Gravel Pits	SK568166	Trent	35.9*	SSSI	4

Leicestershire	Loughborough Meadows	SK538218	Trent	63.5	SSSI,WT	1,3
Leicestershire	Newton Burgoland Marshes	SK381084	Trent	8.1*	SSSI	1
Leicestershire	Kendalls Meadow	SP394981	Trent	2.7*	SSSI	1
Leicestershire	Muston Meadows	SK824367	Trent	8.77*	SSSI,NNR	1
Leicestershire	Seaton Meadows	SP915979	Welland	11.43*	SSSI	1
Leicestershire	Sheepy Fields	SK332025	Trent	5.3*	SSSI	1
Lincolnshire	Allington Meadows	SK871398	Witham	4.1*	SSSI	1
Warwickshire	Birches Barn Meadows	SK282021	Trent	10.74	SSSI	1
Warwickshire	Brook Meadow	SP180743	Trent	1.73	SSSI,WT	1
Warwickshire	Avon Meadow	SP186537	Severn	1.5	NS	1
Warwickshire	Packington Meadows	SP228858	Trent	1.04	NS	2
Warwickshire	Manor Farm, Wolverton	SP199632	Severn	0.96	NS	1
Warwickshire	Anker Meadows,Atherstone	SP327961	Trent	3.25	NS	1
Warwickshire	Oak Tree Farm Meadows	SP189666	Severn	2.5	NS	1
Warwickshire	Sherbourne Meadows	SP242618	Severn	21.53*	SSSI	1
Warwickshire	River Itchen Meadows	SP403561	Severn	45.3*	NS	1
Hereford & Worcester	Long Meadow, Thorn	SP015553	Severn	5.1*	SSSI,WT	1
Hereford & Worcester	Marshlands Meadow	SO812324	Severn	1.08	SSSI	1
Hereford & Worcester	Poolhay Meadows	SO829308	Severn	2.75*	SSSI	1
Hereford & Worcester	Rectory Farm Meadows	SO922382	Severn	8	SSSI	1
Hereford & Worcester	Burley Dene	SO814324	Severn	13*	NS	1
Hereford & Worcester	Hooze Meadows	SO820335	Severn	3.2	NS	3
Hereford & Worcester	Shurnock Meadow	SP018609	Severn	1.2*	NS	1
Hereford & Worcester	Marsh End Meadows	SO817356	Severn	1	NS	1,3
Hereford & Worcester	The Sturts	SO338480	Wye	14	SSSI	1,4
Hereford & Worcester	Upton Ham	SO860400	Severn	56.6*	SSSI	1
Hertfordshire/Essex	Hunsdon Mead	TL418110	Thames	34*	SSSI	1
Buckinghamshire	Long Herdon Meadow	SP648202	Thames	4.5	SSSI	1
Buckinghamshire	Oxley Mead	SP819348	Great Ouse	3.7	SSSI	1
South Yorkshire	Went Ings Meadows	SE650183	Ouse	6.4*	SSSI	1,4
Gloucestershire	Ashleworth Ham	SO833263	Severn	10	SSSI	1
Gloucestershire	Chessels Meadow, Dikler Brook	SP187230	Thames	2.6*	NS	1
Gloucestershire	Chaceley b	SO855305	Severn	0.3	NS	4
Gloucestershire	Yew Tree Inn Meadows	SO866301	Severn	3.5	NS	1, 2
Gloucestershire	Chaceley a	SO856303	Severn	1.2	NS	2
Gloucestershire	Hyde Hill Meadows	SP178244	Thames	0.5	NS	3
Gloucestershire	Elmlea Meadows	SU079948	Thames	6.9*	SSSI	1
Essex	Roding Valley Meadows	TQ436953	Thames	19.8*	SSSI	1
West Midlands	Cuttle Brook Meadow	SP202757	Trent	2	NS	1
West Midlands	Fen End Meadows	SP229758	Trent	1.2	NS	5
West Midlands	Parkfield	SP170741	Trent	0.6	NS	5
West Midlands	Sheldon Country Park	SP160851	Trent	1.5	NS	5
West Midlands	Blythe Fields	SP155765	Trent	22*	NS	1
West Midlands	Great Hytail	SP160784	Trent	3	NS	5
West Midlands	Ford Meadow & Pasture	SP222763	Trent	1	NS	1

West Midlands	Henwood Mill Meadow	SP182794	Trent	0.3	NS	5
West Midlands	Bickenhill Meadows	SP188816	Trent	7.2*	SSSI	2
West Midlands	River Blythe Meadows	SP112733	Trent	2	SSSI	5
Cumbria	Broad Dales	NY253524	Wampool	16.4*	SSSI	1
Shropshire	Lord's Meadow, Albrighton	SJ822036	Severn	2.6	NS	1
					KEY	
					SSSI: Site of Special Scientific Interest	1: hay cut/aftermath grazing
					NNR: National Nature Reserve	2: Spring/summer grazing
					pSAC: Special Area of Conservation	: sheep/cattle
					RAM: Ramsar Site	3: Spring/summer grazing
					SPA: Special Protection Area	: horses
					WT: Local Wildlife Trust Reserve	4: hay cutting, no aftermath
					NT: National Trust Reserve	grazing
					VCO: Other Voluntary Conservation Organisation Reserve	5: no management
					CL: Registered Common Land	* Site area includes
					NS: Non-statutory site	habitats in addition to MG4