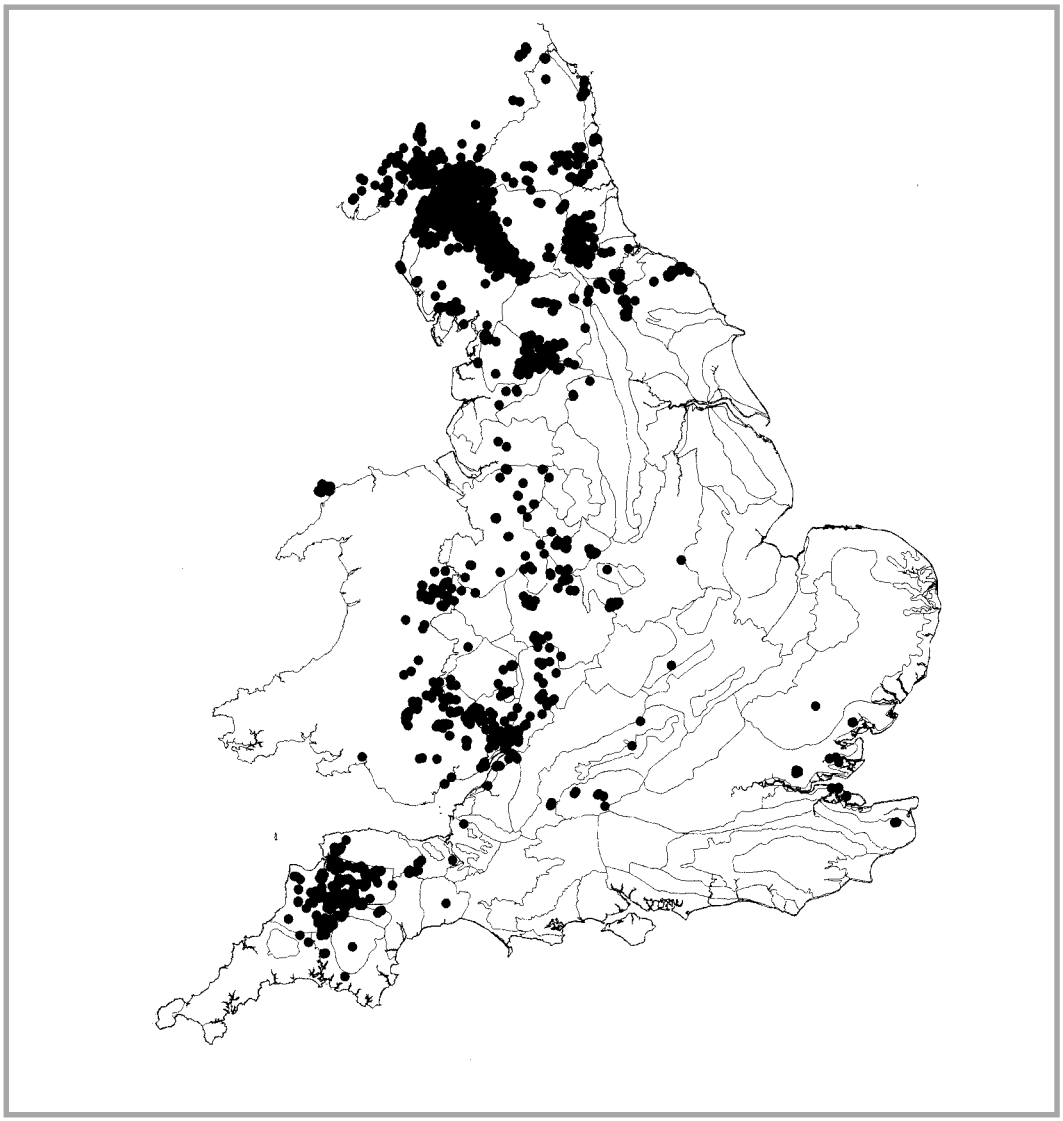
ENGLISH NATURE

Interim assessment of the effects of the Foot and Mouth Disease outbreak on England's biodiversity

No. 430 - English Nature Research Reports



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Cover illustration: Distribution of FMD cases across England's Natural Areas. See text for further information. (Partial data for Wales and Scotland also shown.)

English Nature Research Reports

Number 430

Interim assessment of the effects of the foot and mouth disease outbreak on England's biodiversity

Edited by

H J Robertson
A Crowle
G Hinton

ISSN 0967-876X

Contents

Summary and conclusions

! Livestock farming has an integral role in the conservation of England's biodiversity. This report makes an interim assessment of how the large scale outbreak of Foot and Mouth Disease (FMD) in 2001 may affect that biodiversity. The purpose of the report is to assist English Nature in the urgent task of developing a package of strategic recovery aid, and to inform and assist other organisations, at local, regional and national levels, who are involved in FMD recovery plans and in the wider re-assessment of agricultural policies.

! The implications for biodiversity from the range of impacts generated by the FMD outbreak are complex and at this stage the full extent of the effects on habitats and species is not known. Field work and visits in the countryside have necessarily been limited by stringent precautions imposed by English Nature on its staff and contractors to help prevent the spread of the disease. The effects of the outbreak need to be considered against the background of issues which were relevant to biodiversity conservation before the outbreak, such as the generally poor economic returns from livestock farming. Several possible research and monitoring projects are identified in the report to improve the longer term understanding of the impact of the outbreak on biodiversity.

! There has been a lack of grazing of examples of most habitats of wildlife interest that are normally grazed by livestock, through culling of livestock or movement restrictions. Grazing management has been disrupted in the uplands and the lowlands and inside and outside the infected areas in England. Habitats affected include lowland grassland, lowland heathland, coastal saltmarsh and sand dune, upland meadows and pastures, upland calcareous grassland and limestone pavement, upland heath, blanket bog and montane habitats. Short term lack of grazing over one or two years is unlikely to have a great effect, either positive or negative, on most of the fauna and flora of these habitats. However, species in a precarious state with small, vulnerable and declining populations may be more strongly affected, either negatively, as in the case of the high brown fritillary butterfly (*Argynnis adippe*) on the Malvern Hills, or positively, as in the case of marsh saxifrage (*Saxifraga hirculus*) in Moor House and Upper Teesdale National Nature Reserve.

! Movement restrictions which have resulted in livestock grazing some sites to a greater degree than normal have been noted primarily in lowland habitats, specifically, lowland grassland, lowland heathland, and coastal sand dune, but also in upland meadows, for example in the Yorkshire Dales. As is the case for lack of grazing due to FMD, increases in grazing have affected sites inside and outside the infected areas. Impacts on biodiversity will depend on the severity of the grazing pressure, which can vary in effect from reducing the sward height by a few centimetres to trampled bare ground, over-enriched by livestock dung and remains of supplementary feed given to the animals. Freshwater habitats are also vulnerable to increased sediment loads and organic waste runoff in these situations.

! The risks to wildlife habitats and species from pollution and damage which result from disease control measures such as pyres, burial sites, disinfectants and increased rodenticide use need to be evaluated. These disease control measures have had to be operated widely across the landscape. Examples of potential problems that require investigation are

atmospheric pollution from pyres affecting sensitive lichens growing on old trees, leachate from pyre sites in catchments of wetlands and disinfectant runoff into freshwaters.

- Cessation of countryside management and associated activities may have significant effects, particularly on deer populations in woodlands. Limitations on human movement have lead to reductions in deer culling programmes in the short term, while loss of the export market for venison and sporting revenues are likely to have longer term impacts. Deer populations have been increasing in woodlands in recent years and have been reducing the abundance of grazing intolerant plants like oxlip (*Primula elatior*) as well as inhibiting tree and shrub regeneration. Further increases in deer populations as an indirect result of the FMD outbreak are likely to exacerbate these changes.

- Changes in the structure of livestock farming, for instance changes in stocking levels or type of livestock, and changes in land use where livestock farming ceases as a result of the FMD outbreak are likely to be the major long term and most complex influences on biodiversity. The future direction of rural policies, especially those related to agriculture and environmental support mechanisms, is critical to the outcomes for biodiversity..

- Before the FMD outbreak, intensification of agricultural practices and specialisation into arable enterprises in lowland landscapes had resulted in widespread loss and fragmentation of wildlife habitats dependent on extensive livestock farming to maintain their biodiversity, for example the loss of Culm grasslands in Devon. Further reductions in extensive livestock farming post-FMD will exacerbate existing problems of insufficient grazing. Further intensification of livestock production, for example through increased fertiliser use and frequent re-seeding or a shift to intensive arable production would have consequences for habitats such as freshwaters, which are already threatened by diffuse pollution from these activities in their catchments. The River Wye is an example of a valuable habitat that is already subject to these problems, which are likely to worsen as a result of the FMD outbreak. It is vital that recovery action and future agricultural policies ensure that extensive livestock farming can thrive in the lowlands.

- Prior to the FMD outbreak, many upland habitats were overgrazed, primarily due to the increase in sheep numbers encouraged by subsidy payments. For instance, upland heath, which is the stronghold of species such as red grouse (*Lagopus lagopus*) and merlin (*Falco columbarius*) has been extensively replaced by species-poor grassland. There is a major opportunity to reverse damaging, environmentally unsustainable, livestock farming practices as part of the recovery programme and to make significant progress towards meeting the government's Public Service Agreement target of achieving favourable condition for 95% of Sites of Special Scientific Interest by 2010. Upland farming needs to be both environmentally and economically sustainable if upland habitats which depend on a livestock grazing regime, such as upland meadows and upland calcareous grasslands, are to be maintained and managed over the long term. At the same time there is scope for incentives to encourage enhancement of habitats such as woodland and montane heath where livestock grazing is not critical for their conservation.

- **!** Overall, the outbreak has reinforced the urgent need to consider how agricultural policies can be structured so that economically and environmentally sustainable livestock farming can prosper in England in the future.

1. Introduction

Farming and the biodiversity of the English countryside have an interwoven history extending back in time at least 3,000 years. Livestock farming in particular has played a crucial role in the development and maintenance of important wildlife habitats such as chalk downland, fen meadow, heathland, wood-pasture and moorland. More recently, however, intensification and specialisation of livestock production both in the lowlands and the uplands has caused environmental degradation. The outbreak of Foot and Mouth Disease (FMD) in 2001 happened at a time of great economic uncertainty in Britain's farming sector. Before the FMD outbreak, livestock producers were facing increasingly poor returns, together with the loss of infrastructure to support the industry, such as local abattoirs. This situation, coupled with the large scale of the outbreak, means that the disease and its aftermath could have significant negative consequences for England's livestock farming and the biodiversity which depends on it. Equally, support for economically and environmentally sustainable farming post-FMD could provide positive opportunities for the conservation and enhancement of England's biodiversity.

The current report aims to provide an interim overview of likely effects of the outbreak on biodiversity and identifies the existing issues which provide the context for these impacts. The purpose of the report is to assist English Nature in the urgent task of developing a package of strategic recovery aid, and to inform and assist other organisations, at local, regional and national levels, who are involved in FMD recovery plans and in the wider re-assessment of agricultural policies. The report also provides an outline of possible research and monitoring studies to assess the impacts of the outbreak on biodiversity over the longer term.

2. Overview

2.1 Scope and structure of the report

The scale of the foot and mouth disease (FMD) outbreak in relation to biodiversity interests is summarised in the overview section and the main strands making up the pattern of its impact are described. At the time of writing the outbreak is not yet over and 'on the ground' assessments of its impact have necessarily been limited by English Nature's stringent procedures minimising field work and visits. These precautions were imposed to help prevent the spread of the disease. In addition, particular consequences of the outbreak for biodiversity may not be evident for some time and the future direction of rural policies will be a major influence on the outcomes for biodiversity. There is, therefore, a degree of uncertainty attached to the various predictions of effects, but these are made using the best judgement of national and local science and conservation staff, aided by the information provided by actual examples.

Following the overview section, the two categories of lowland and upland landscapes are used to structure the more detailed assessments made in the habitat accounts. Slightly different approaches have been taken in the lowland and upland sections, with lowland examples generally concentrating on single habitats, reflecting the greater degree of habitat fragmentation in the lowlands compared to the uplands. Remaining habitats of high biodiversity value in the lowlands are often isolated by intensively farmed land or urban development. There is greater emphasis on habitat mosaics in the uplands section, because extensive tracts of less-modified (semi-natural) habitats are more characteristic of the uplands.

The lowlands and uplands sections (3 and 4) outline the significance of livestock grazing to particular habitats and their component species, in the context of existing issues affecting these elements of England's biodiversity. Identification of impacts such as loss of livestock in particular areas and from designated sites is followed by an evaluation of the likely effects of the FMD outbreak on biodiversity, both short and long term. These effects are illustrated by more detailed examples from individual sites and geographical areas across England. The report is concluded by a summary of monitoring and research topics for consideration (section 5). These topics include projects that relate to existing programmes and to work that might be carried out by other organisations as well as English Nature. The aim of such projects would be to gain a fuller understanding of the actual impacts of the FMD outbreak on biodiversity, particularly in the longer term. A glossary of terms used in the report, such as Biodiversity Action Plan and Special Protection Area, is provided in Appendix 1.

2.2 How the FMD outbreak affects biodiversity

The direct effect of FMD on wild animals does not appear to be significant, although it is known that deer, other wild ungulates and wild boar are susceptible to it. The main consequences for biodiversity stem from the disease control measures and the impact of the disease on farm businesses and countryside management. These effects of the FMD outbreak are not confined to the loss of livestock that grazed conservation sites. The main impacts generated by the outbreak can be grouped as follows:

- Loss of livestock grazing due to culling or movement restrictions.

- Increase in grazing levels because of movement restrictions.

- Pollution and damage from disease control measures eg pyres, burial sites, disinfectants and rodenticides.

- Cessation of other countryside management and associated activities, such as deer control and public access, because of limitations on human movements. Related impacts such as loss of export markets for venison are also included.

- Changes in the structure of livestock farming, eg stocking levels and livestock type (cattle, sheep, pony), after the outbreak is over.

- Changes in land use where livestock farming ceases after the outbreak.

The implications that these impacts have for biodiversity are examined in more detail in relation to particular habitats and species found in sections 3 and 4. The issues and impacts illustrated in the lowland and upland examples in sections 3 and 4 are summarised in Table 1. Themes that are shared across habitats are discussed in the remainder of section 2. Overall, the main impacts affecting particular habitat groups, based on reports received to date, and most likely long term outcomes are as follows:

Habitats/Main impacts	Loss of livestock	Increase in grazing	Pollution and damage from disease control	Cessation of countryside activities	Change in livestock farming post-FMD	Change in land use where livestock farming ceases post-FMD
Lowland grassland	**U**	**U**	**U**	**U**	**U**	**U**
Lowland heathland	**U**	**U**			**U**	**U**
Lowland wetlands and freshwaters			**U**		**U**	**U**
Coastal habitats	**U**	**U**	**U**		**U**	**U**
Lowland woods, wood pastures and scrub			**U**	**U**		**U**
Grasslands in upland dales	**U**	**U**	**U**		**U**	**U**
Upland woods and scrub	**U**		**U**	**U**	**U**	**U**
Upland calcareous habitats	**U**		**U**		**U**	**U**
Upland moorland, blanket bog and freshwaters	**U**				**U**	**U**
Montane habitats	**U**				**U**	**U**

The effects on biodiversity will need quantifying when field work is resumed and more detailed studies are carried out. Short term impacts such as reduced grazing for one or two years are relatively straightforward to assess. The scope and type of recovery action and implementation of emergency habitat management measures will also affect the overall impact of the outbreak on biodiversity. The long term outcomes for habitats and species from possible changes in land use or structure of livestock farming are more difficult to predict and critically depend on the future direction of rural policies and incentives to encourage environmentally sustainable farming.

2.3 The scale of the FMD outbreak

In the period from the date of confirmation of the first case of FMD on 20 February 2001 to 21 August 2001, 1963 cases were identified in the United Kingdom. The number of cases in England at that date was 1659. By the end of week 26 (20 August 2001) after the start of the outbreak the rate of appearance of new cases had dropped below 25 a week as shown in Figure 1. By 21 August 2001, the number of livestock slaughtered on infected premises, contiguous farms, dangerous contact premises and through welfare culls totalled 5.2 million in the UK as a whole. This total represents loss of livestock from over 9,000 premises.

Sheep and cattle are the two livestock types which comprise the bulk of grazing animals on areas of biodiversity value. A recent survey of 122 such areas in the UK, both upland and lowland, which were grazed for conservation purposes, showed that 79% were grazed by sheep and/or cattle, while 16% were grazed by horses and ponies, 4% by goats and 1% by pigs (Small et al 1999).

The FMD cull total for the UK, reported on 21 August 2001, included 0.7 million cattle and 4 million sheep. Excluding welfare culls, for which no information is available on a country basis, in England, out of a total of 2.7 million animals slaughtered, 0.4 million were cattle and 2.1 million were sheep. These totals represent 7.5% of England's cattle and 11 % of the country's sheep, compared to the overall numbers of cattle and sheep given in the agricultural census digest for 2000. This census was compiled by the former Ministry of Agriculture, Fisheries and Food (now the Department of Environment, Food and Rural Affairs: DEFRA).

The distribution of cases has been widespread across England but the frequency of cases has been highest in the western areas of the country, particularly Cumbria, Gloucestershire and Devon. Information on locations of all culls across the country is not yet available to English Nature. In the absence of a full analysis English Nature has used a spatial index to gain an approximate idea of the extent of culling in relation to sites and geographical areas of nature conservation importance. The index is based on the summed area of 3 kilometre radius circles around the location of each infected premises, on the assumption that culling in this zone is likely to have occurred. This will not always have been the case, while some culling due to dangerous contacts could have occurred outside the 3 km zones. Welfare culls do not feature in the index and could change the picture quite considerably as they have occurred outside, as well as inside, the infected areas of the country. By 21 August, numbers of animals slaughtered under the welfare scheme represented 27.7% of the total culled in the UK. The spatial index, as of 9 August 2001, is shown by the grey shading on Figure 2. Partial data for Wales and Scotland is also shown. The strong western distribution of the outbreak in England and the regional concentration of cases stand out strongly on this map.

2.4 Extent of the outbreak in relation to the nature conservation significance of Natural Areas

In the mid 1990s, English Nature developed the concept of Natural Areas. These represent sub-divisions of the English countryside into geographical areas that have ecological meaning at a landscape scale in terms of the distribution of wildlife habitats and species. An example is the South Downs Natural Area, which is focussed on the chalk downland of East and West Sussex. These Natural Areas provide the framework for nature conservation objectives for the wider countryside and for turning the priorities in the UK government's Biodiversity Action Plan into action on the ground. The definitive map of Natural Areas was published in 1996 and is shown in Figure 3. Those Natural Areas where upland landscapes predominate are picked out by grey shading in this Figure. Habitats which are mainly found in lowland Natural Areas are discussed in section 3, while those habitats characteristic of upland Natural Areas are covered in section 4 of the current report.

During the development of the Natural Areas concept, the significance of individual Natural Areas for particular habitats and species groups was assessed (eg Grice et al 1994, Reid et al 1996). These assessments have been used to give an indication of the likely impacts of FMD on biodiversity, not just on designated sites, but also across the wider countryside. Figure 2 shows the Natural Areas boundaries overlaid on the spatial index of FMD extent. Table 2 lists the proportion of each Natural Area covered by the index, the number of animals culled (excluding welfare culls) and the number of infected premises in each Natural Area, as at 9 August 2001.

Pre-FMD livestock numbers are not, as yet, available on a Natural Area basis. To indicate relative proportions of livestock culled in different parts on the country, excluding welfare culls, Table 3 shows a breakdown of DEFRA data for pre-FMD livestock numbers, from the agricultural census data for 2000, and FMD culls, on a 'county' basis. The proportions of livestock culled by county are illustrated for sheep and cattle in Figures 4 and 5. These maps show that some south-eastern counties of England have lost proportionally almost as much livestock as western counties, for example, compare Essex (11%) and Devon (15%), even though the numbers involved are very different (7,319 in Essex, 273,499 in Devon). These patterns reflect the general distribution of livestock across England prior to FMD, with the north and west having the bulk of the country's livestock.

The county boundaries used in these Figures are the same as those used by DEFRA in census and cull data, with the exception of County Durham. This boundary includes Darlington Unitary Authority on the maps but the cull figures and pre-FMD livestock numbers for the Authority are included in DEFRA's data for Cleveland.

The assessments of the nature conservation significance of particular habitats and species in Natural Areas in relation to the spatial index and cull data appear in two tables, one for habitats (Table 4) and one for species (Table 5). These tables enable comparisons to be made in relation to the impact of FMD on individual habitats and species groups. The tables also indicate the relative importance of particular geographical areas, which are heavily affected by FMD, for a range of habitats and species. For example, the importance of Cumbria, which includes Natural Areas such as the Cumbrian Fells and Dales, the Solway Basin and the Eden valley, is readily apparent.

Within the broad habitat groupings used for the Natural Area assessments are priority Biodiversity Action Plan (BAP) habitats. At present, the extent and degree to which these habitats may have been affected is not clear, but a list of those reported as most likely to be impacted is given in Table 6 and is broadly cross-referenced to the habitat groups discussed in sections 3 and 4. The detailed examples given in these sections also refer to priority BAP habitats and species.

2.5 Extent of the outbreak in relation to designated sites

A comparison of the spatial index and the boundaries of Sites of Special Scientific Interest (SSSI) showed that 440 SSSIs intersected with the 3 km buffer areas around infected premises on 9 August 2001. However, the uncertainties surrounding the extent of culling in relation to particular SSSIs mean that this estimate of number of SSSIs that may have been affected directly by culling or other disease control measures is very approximate. Conservation officers in English Nature Local Teams are currently gathering more accurate information.

Preliminary information on the National Nature Reserve (NNR) series has been collected and while this information is not strictly statistically representative of the habitats and management regimes in the SSSI series of over 4,000 sites, it does give another indication of the likely scale of the issue. Of 190 NNRs with information, 26% have suffered disruption of livestock management. Stock have been culled from 5% of Reserves, 11% have been affected by movement restrictions preventing animals grazing Reserves, while 13% have had to retain stock on Reserves outside the normal grazing period. A few sites which contribute to this breakdown of percentages have experienced more than one of these livestock management problems. If this pattern is repeated across the SSSI series, perhaps 500 to 1000 SSSIs could be affected, including large sections of extensive upland SSSIs in Northern England.

Some NNRs and SSSIs affected are within candidate Special Areas of Conservation (cSAC), designated under the European Union Habitats and Species Directive. Some are within Special Protection Areas (SPA) designated under the European Union Birds Directive, while others are designated under the Ramsar Convention on Wetlands of International Importance. Examples are given in the sections 3 and 4 (see Table 1 for a summary of designations in the detailed examples). Therefore there is an international dimension to the impacts of FMD on biodiversity, which may be positive or negative, depending on the type of impact, recovery action and the direction of future agricultural and environmental policies.

2.6 Short term and long term impacts

Factors such as loss of grazing animals or pollution from disease control measures may result in short or long term impacts on biodiversity. While some factors such as temporary increases in grazing could be predicted to have short term effects and others, such as changes in land use, to have long term effects, the actual outcome in particular cases will depend on the severity of the impact. The same is true for pollution and damage resulting from disease control measures. For example, a grassland sward on a site where stock are marooned could be largely destroyed by stock trampling and overgrazing or merely reduced in height by a few centimetres, depending on numbers of animals, the length of time they are on the site and the vulnerability of the particular grassland type. Similarly, loss of livestock grazing for a season may not have a long term impact on

a lowland heathland, whereas no grazing for several years would result in increased scrub invasion and long term loss of open heathland.

Historically, the fortunes of agriculture have fluctuated, in turn affecting wild plants and animals and their habitats. The potential impacts of FMD on livestock farming and biodiversity need to be seen in the context of existing threats and opportunities which influence nature conservation in England. As a general background to assessing effects of FMD, the significance of livestock grazing to wildlife habitats and species, current trends and other relevant issues are described in each habitat overview. Long term effects due to changes in farming enterprises are discussed further in the rest of section 2 and in the habitat accounts. Again, the scale of these effects is very uncertain at present. One of the main factors which will determine the scale of impacts is the extent to which the livestock industry in particular areas recovers, and where it does survive, the direction it takes. Preliminary information is mixed, suggesting that some farmers are planning to re-stock while others are considering changing or ending their livestock enterprises.

2.7 Uplands versus lowlands

Before the FMD outbreak there was a marked imbalance in stocking levels on wildlife habitats between upland and lowland parts of the country. In the lowland Natural Areas, intensification of agricultural practices in the landscape and specialisation, particularly into arable enterprises, had resulted in loss and fragmentation of the wildlife habitats that depended on extensive livestock management to maintain their conservation value, such as chalk downland or fen meadow. Where such sites remained, they were often marginal to the farm business and as a result undergrazed or not grazed at all.

In upland Natural Areas, livestock subsidy payments encouraged a large increase in livestock numbers, especially sheep. For example, the number of breeding ewes in the Less Favoured Areas in England increased by around 35% between 1980 and 2000, with resultant overgrazing of wildlife habitats. For instance, heather moorland, which is the stronghold of species such as merlin (*Falco columbarius*) and red grouse (*Lagopus lagopus*), has been converted to species-poor grassland by overgrazing. Many upland habitats are in unfavourable condition for biodiversity, illustrated by the condition assessment figures for SSSIs given in section 4. For example, among upland heath SSSI units in England, 72% of the area assessed is in unfavourable condition (English Nature 2001).

The possible lack of replacement of culled livestock in lowland areas after the outbreak is over, or specialisation into more intensive production systems, especially dairy, are very likely to exacerbate the existing problems of insufficient grazing of high biodiversity areas in lowland landscapes. Culling of stock in the uplands could be the signal for a major change to more support for environmentally sustainable stocking levels, alongside development of economically sustainable livestock farming. Such a change would make a large contribution to the achievement of the government's Public Service Agreement target of getting 95% of SSSIs into favourable condition by 2010. There could also be opportunities for other biodiversity gains, such as expansion of native broadleaved woodland, if appropriate incentives are in place. However, complete abandonment of upland farming in the face of unviable economic returns would have deleterious consequences for habitats,

such as upland hay meadows and upland calcareous grassland, which depend on extensive livestock farming for their maintenance and management.

2.8 Landscape scale effects

The FMD outbreak is likely to have landscape scale impacts as well as affecting individual sites. There are four main landscape scale effects.

- Disease control measures have had to be operated widely. Culls have removed animals from large sections of the countryside. Pyres and burial sites have the potential to pollute the atmosphere, ground or surface waters with substances such as sulphur dioxide, nitrogen oxides, unburnt accelerants (usually diesel), ammonia and organic compounds. The extensive use of disinfectants may have impacts through runoff into freshwaters and wetlands across the landscape. Any habitat is potentially at risk. Those judged to be most vulnerable to date are discussed in the habitat accounts. Species that range widely over the landscape may be affected by disease control measures through the disinfection of farm buildings and the increased use of rodenticides to minimize risk of spread of FMD by rats. Farm buildings are used as roosts and nesting locations of wide-ranging species such as barn owls and bats, while rodents form part of the diet of mammals like the polecat as well as birds such as barn owls.

- The geographical complexity of livestock rearing regimes and the inter-relationships between the beef, dairy and sheep sectors mean that impacts are likely to be felt across the landscape, extending into areas beyond those most directly affected by FMD. The details of these geographic and economic inter-relationships are not well documented but some examples can be given. For instance, in Cumbria many hill sheep are wintered in the lowlands, often on dairy farms, as shown by the case of Moor House NNR. Sheep on the Reserve are normally wintered in the Eden valley, where they were culled in 2001. On areas managed for conservation in the UK, the sustainable grazing survey (Small et al 1999) showed that 34% of sheep flocks were hill or moor breeds even though 78% of sites were lowland. A more specific example of a conservation site in the lowlands which is managed by hill sheep is Ainsdale NNR, which on the coast near Liverpool. Herdwick sheep from the Lake District are wintered on the Reserve and have been unable to return to the Lake District because of movement restrictions. Beef store cattle are often finished away from their place of birth and are sometimes grazed on conservation sites during part of this process. Some indication is given by the 1999 survey (Small et al 1999). In this survey, of 92 cattle grazed sites, 54% had cattle which were 1 to 5 years old and 12% had cattle less than one year old.

- The consequent land use changes from possible cessation of livestock grazing or changes to stocking levels or livestock systems act at a landscape scale, especially on the more extensive habitat mosaics of the uplands. Further extension of specialist arable farms in the lowlands could have impacts on wide-ranging species, such as bats, which depend on an inter-connected network of habitats, including hedges and grassland. Neither of these habitats are required on arable farms. Arable cultivation of erosion-prone soils can also have implications for water quality in river catchments, especially nutrient and sediment

loads. European Union subsidy rules, which prevent arable subsidy payment on land not registered as arable by 1991, are likely to put a brake on arable extension, though unsubsidised crops, particularly potatoes, are being increasingly grown in some areas, for example in Herefordshire. Post-FMD, further intensification of livestock farming to achieve better returns, through activities like increased use of fertilisers and frequent re-seeding, could also increase pollution loads in river catchments and affect wide-ranging species, such as farmland birds, which depend on less-intensive grassland management in the farmed landscape.

! The restrictions on human movement during the outbreak have been accompanied by observations, made across a range of habitats in the landscape, that wildlife, especially ground-nesting birds, have changed behaviour. Typical reports refer to birds nesting close to paths normally used for recreational access but which have been closed due to FMD restrictions. Because of these restrictions, monitoring of these changes in relation to bird breeding populations and nesting success as a whole in the countryside has not been possible, indeed, the annual, national, breeding bird survey has had to be cancelled. Thus it is difficult to determine if the records are due to local re-distribution of birds, or to an actual increase in numbers of nests through some birds nesting that would usually be deterred from breeding by disturbance. Overall, any effects are likely to be transitory once normal access to the countryside is resumed.

2.9 Long term sustainabilty

Linked to the theme of landscape scale effects is the theme of sustainability. Livestock farming has the capacity to sustain a multi-functional landscape capable of producing high quality food, rich biodiversity, conservation of scenic and archeological features and recreational opportunities. The agri-environment schemes and rural enterprise programmes run by DEFRA aim to encourage this multi-functional approach. There is a strong biodiversity element to the case for recovery of a livestock industry which can deliver this range of benefits.

In the lowlands, habitats of high biodiversity interest that need extensive livestock farming for their maintenance often occupy only a small proportion of a farm. Consideration of post-FMD agricultural policies and support needs to include ways in which extensive livestock farming can be economically sustained, or indeed return to areas now devoid of livestock farms. The FMD outbreak and its aftermath may act as a disincentive for the continuation or re-introduction of livestock farming across the country, not just in areas directly affected by the outbreak.

In addition to the livestock already needed to graze existing high value wildlife habitats in the lowlands, the expansion of these habitats in future will increase the area requiring grazing. Restoration and creation of habitats such as heathland and chalk grassland are being vigorously pursued to meet the targets in the United Kingdom's Biodiversity Action Plan, for example, there is a target of 6,000 hectares of lowland heathland to be re-created by 2005.

One possible solution to the problem of achieving economically and environmentally sustainable grazing is being pursued by the Grazing Animals Project (GAP). The project aims to overcome the dislocation of conservation sites from current farming systems, at least until such time as agricultural

policies ensure a long term future for integrated management of biodiversity within individual farms. The project is supported by a range of partners including the National Trust, the National Farmers Union and the Rare Breeds Survival Trust and is funded by English Nature. It is in an early stage of development but included amongst GAP's many co-operative objectives is one to foster the implementation of regional grazing schemes. Under these schemes, graziers operate sustainable grazing across a series of sites that would be hard to manage as isolated fragments. This model is illustrated by Bill Grayson's farm in Silverdale, Cumbria (Figure 6). He manages a range of different habitats, widely separated from each other, with his sheep and cattle. This type of arrangement is particularly vulnerable both to movement restrictions during the FMD outbreak, even in parts of the country outside infected areas, and to any post-FMD restrictions on movement of stock, such as a required 20 day gap between stock relocations. Many conservation sites are small and thus provide limited forage. Flocks would have to be fragmented, with consequent increases in management costs, to enable sustainable grazing to occur in 20 day periods.

Elsewhere in the lowlands, intensive livestock farming has negative impacts on habitats such as freshwaters through runoff of fertilisers and sediments and provides a low value habitat for wide-ranging species such as farmland birds. Support for the extension and development of environmentally and economically sustainable livestock farming in the lowlands would not only benefit high biodiversity sites but also biodiversity in the wider countryside.

In the uplands, long term environmental sustainability should also apply across the whole landscape. Reductions in stocking on land above the moor wall to solve overgrazing problems should not result in increases in stocking on enclosed (in-bye) land below the moor wall. Equally, environmentally sustainable stocking rates need to be part of economically sustainable farm businesses. The ways in which these aims can be achieved need urgent attention in the recovery period after the outbreak is over.

In designing recovery packages and support schemes in relation to sustainable stocking levels, there is a natural desire to link stock numbers on individual sites to biodiversity outcomes, especially because stock numbers and rates can readily be used in financial calculations. However, in practice, stocking rates need to vary from site to site and year to year depending on the agricultural productivity of individual sites and weather effects on the amount of forage available (Peel and Jefferson 2000). Agri-environment schemes and English Nature's Wildlife Enhancement Scheme generally try to specify desired biodiversity outcomes in terms of sward condition rather than rigid stocking rates and encourage site managers to use their skills and experience to deliver wildlife conservation. Thus, while indicative stocking rates can provide the broad framework, flexibility needs to be built into recovery action and into the implementation of stocking levels which are sustainable over the long term.

3. Lowland landscapes

3.1 Lowland grassland landscapes

3.1.1 Overview

Significance of livestock grazing

The continued existence of lowland grassland in the English countryside after forest clearance in prehistoric times is due very largely to the grazing activities of livestock and the production of winter forage from grassland. Without grazing, these grasslands would eventually revert to forest. England's great variety of soils, climate and topography, in combination with traditional livestock management, have produced a wide range of different grassland types, from chalk downland in the Yorkshire Wolds to fen meadows and rush pastures in the south west. In turn, these grasslands support a very diverse flora and fauna. For example, 20% of nationally rare and scarce plants occur in lowland grassland.

Since the Second World War, agricultural intensification of grass production through use of inorganic fertilisers, herbicides and re-seeding and the increased ploughing of grassland for arable production have greatly reduced the extent of grasslands rich in wildlife. The diverse flora and fauna of unimproved grasslands depend on traditional, low intensity management without recourse to inorganic fertilisers, herbicides and re-seeding. Unimproved grasslands are now frequently marginal to farming, especially in predominantly arable areas. Insufficient grazing is a pervasive problem, leading to extension of scrub cover and further loss of grassland. Unimproved lowland grassland has been a particular focus for agri-environment schemes in recognition of their high wildlife value and threatened status.

Apart from the value of individual sites, permanent grassland, particularly when managed in an extensive way, plays an important role in reducing erosion risk in river catchments. This aspect is discussed further in the wetland and freshwater section (3.3). Grassland is also an integral part of landscapes which support more wide-ranging species. Unimproved grassland is of particular value but more agriculturally improved grasslands can also contribute, for example to foraging habitat for bats. Hedges traditionally provided the stock-proof boundaries to pastures and are themselves, when well-managed, a significant component of the biodiversity of pastoral landscapes. They shelter song birds and small mammals such as the dormouse (*Muscardinus avellanarius*) and act as corridors linking other habitats that would otherwise be isolated, for example small woods which occur in predominantly grassland and arable landscapes.

Impacts of the FMD outbreak: Natural Areas and designated sites

The significance of Natural Areas for unimproved grassland habitats in relation to the FMD outbreak is shown in Table 4. Several Natural Areas heavily affected by FMD are very important for unimproved grassland. The Culm Natural Area is one of these and is discussed in more detail in section 3.1.2 below.

Lowland grasslands of biodiversity value have been affected by the disruption to livestock farming caused by FMD. Some SSSIs have had stock marooned on them or stock have been unable to graze sites because of movement restrictions. These effects have been felt not just in infected areas. For example, sheep have had to be kept on Knocking Hoe, a small chalk grassland NNR in the Chilterns beyond the end of the desired grazing period. The grazier manages a series of small sites in a similar way to the regional grazing scheme model discussed in section 2.9 and has had particular difficulties because of movement restrictions. In another example, in North Yorkshire, sheep have been stranded on a small species-rich grassland SSSI which is one of the most northerly locations for the nationally scarce burnt tip orchid (*Orchis ustulata*). On the South Downs the opposite has occurred. Stock have been unable to move onto Mount Caburn NNR, another chalk grassland NNR. Delays in grazing also occurred in the Fens, on wet grassland in the Nene and Ouse Washes SSSIs, which are important for breeding waders. Other grassland SSSIs have lost stock directly through culling, for instance those in the Culm Natural Area, discussed in more detail in section 3.1.2.

Pollution from disposal sites in infected areas may have impacts on unimproved grasslands, for instance the wet grasslands that provide habitat for the marsh fritillary butterfly (*Euphydryas aurina*) in the Eden Valley Natural Area. Disease control measures such as disinfecting farm buildings and rodenticide use have had to be operated widely in the general pastoral landscape. Cessation of countryside management due to restrictions on human movements, such as rabbit control, has occurred both inside and outside infected areas in lowland grassland landscapes.

Short and long term effects

Overgrazing due to movement restrictions are likely to have impacts that vary in severity and duration. Effects are likely to range from short term reductions in sward height of a few centimetres to heavily disturbed and enriched ground. Flowering and seed set of plants can be suppressed by overgrazing. Lack of flowering can be a particular problem, even in the short term, for annual species with short-lived seed banks, notably yellow rattle (*Rhinanthus minor*). Severe trampling damage which creates bare ground allows invasion of noxious weeds, such as creeping thistle (*Cirsium arvense*) and ragwort (*Senecio jacobaea*). Over-enrichment of the soil occurs where high numbers of animals congregate, especially around supplementary feeding areas. Weeds such as creeping thistle could be troublesome for some time and over-enrichment may be hard to reverse. There may be increased need for weed control on sites of high biodiversity value, using machines such as the eco-puller or spot treatment with herbicides, thus increasing management costs. There is a danger that weed problems could spark blanket spraying of herbicide or ploughing and re-seeding on unprotected, unimproved, grasslands. Increased use of fertilisers to boost grassland productivity on overgrazed grasslands another risk affecting these sites.

High populations of rabbits, resulting from disruption of control due to human movement restrictions, can create overgrazing problems. For instance, in the South Downs large rabbit populations have produced tracts of heavily disturbed ground around their warrens. However, rabbit grazing can substitute to some extent for loss of livestock grazing and provides patches of bare ground for plants preferring very open conditions, such as the nationally scarce wild candytuft (*Iberis amara*).

Most grassland plants and grassland fauna can probably recover from short periods of reduced grazing if appropriate management is then re-instated. For instance, grazing of the Nene and Ouse Washes SSSIs has now been re-established and there are not thought to have been significant effects from the delay in grazing on the grassland sward structure required for breeding birds. Where grassland plants and animals are already in a precarious situation, even short term disruption to grazing management of a year or so is likely to exacerbate existing problems, as described in section 3.1.3 below in relation to the high brown fritillary butterfly (*Argynnis adippe*). As an emergency measure, mowing can be used as a substitute for grazing, although in the long term, mowing alone is usually less effective in conserving a diverse flora. It is also not ideal for invertebrates that need a continuous nectar and pollen supply, nor for breeding birds that require a tussocky sward. The more productive grasslands on neutral soils would probably benefit most from mowing, especially to prevent build up of dead plant litter, which would hamper the growth of small plant species and seedling regeneration, providing the cuttings are removed. Equines, especially hardy pony breeds, can be substitute grazers instead of sheep or cattle though care is needed to avoid problems such as over-grazing and over-enriched dung areas.

In the long term, lack of grazing allows competitive grasses, such as tor-grass (*Brachypodium pinnatum*), to spread and dead plant litter to build up, to the detriment of smaller herbs and the invertebrates that depend on them, and enables woody plants to take over the grassland. Spread of woody species may occur more rapidly where they are already abundant in the sward prior to FMD but were suppressed and controlled by grazing. Release from grazing in these situations can result in rapid growth of scrub above browsing levels and it is then difficult and expensive to control.

Assessment of possible impacts of disposal sites in the vicinity of vulnerable grassland habitats is needed, for example, atmospheric deposition of nitrogen compounds on species-rich, wet grasslands that require low-nutrient conditions to maintain their species interest.
In the wider pastoral landscape, there may be impacts of disease control measures on wide-ranging species. These impacts include disinfection of farm buildings used as roosts by protected species such as bats or barn owls. For instance, there was a relatively large population of barn owls (*Tyto alba*) in Devon, one of the counties most affected by FMD (Ogilvie and the Rare Breeding Birds Panel 1999). Increased use of rodenticides to minimise risk of spread of FMD by rats could add to the risks, identified before FMD (Carter and Burn 2000), of secondary poisoning of predators such as polecats (*Mustela putorius*) and barn owls. Repeat monitoring of breeding barn owls, which was first carried out in the mid-1990s (Toms et al 2001), could provide useful information on impacts. The Joint Nature Conservation Committee already has a long term programme for monitoring levels of pollution in selected wildlife species in Britain and this includes analysing rodenticide residues in barn owls (Newton et al 2000).

In the longer term, if FMD threatens the future of extensive livestock farming in areas with grasslands of high biodiversity value, this would make existing problems of obtaining grazing animals for unimproved grasslands worse and lead to losses of grassland to scrub where grazing ceases. Horses and ponies may increasingly be used where suitable sheep or cattle are difficult to obtain, and will require careful management to avoid problems such as weed invasion. At a landscape scale, cessation of livestock farming could lead to further losses of grassland to arable cultivation and removal of agriculturally redundant hedges of value to wildlife. Although the European Union subsidy rules, which prevent arable subsidy payment on land not registered as arable by 1991, are likely to put a brake on arable extension, unsubsidised crops, particularly potatoes, are being

increasingly grown in some areas, for example in Herefordshire. This extension of arable cultivation could impact on wide-ranging species as described below in the greater horseshoe bat example (section 3.1.4), and on river catchments as discussed in the wetlands and freshwaters section (3.3). Further intensification of livestock farming to achieve better returns, through activities like increased use of fertilisers and frequent re-seeding, could affect wide-ranging species such as farmland birds, which depend on less intensive grassland management in the farmed landscape (Vickery et al 2001). There are positive opportunities for extensifying grassland management after FMD, for instance through entry into agri-environment schemes, to benefit such species.

3.1.2 Example: Culm grassland and the marsh fritillary

Context

Culm grassland is the popular name for a series of grassland and mire habitats that are the principal wildlife features in the Culm Natural Area. The Natural Area is mainly within the county of Devon but also includes parts of Cornwall and Somerset. It has suffered one of the most extensive outbreaks of FMD in England (Table 2, Figure 2).

Nature conservation value and farming pattern

The importance of the Culm grasslands for wildlife has been recognised through the designation of the Culm candidate Special Area of Conservation under the European Habitats and Species Directive, the notification of 34 SSSIs and the identification of the priority habitat of purple moor grass and rush pasture in the Biodiversity Action Plan. The varied plant and animal life of these grasslands includes the marsh fritillary butterfly (*Euphydryas aurinia*), which is afforded special protection under the Habitats and Species Directive, and the nationally scarce wavy St John's-wort (*Hypericum undulatum*).

The Culm grasslands harbour 60% of the marsh fritillary populations in England. The butterfly's food plant is devil's-bit scabious (*Succisa pratensis*). Eggs are laid on the underside of large plants and the caterpillars feed together on scabious leaves inside a silken white web. Populations of the butterfly fluctuate widely, making it prone to local extinction. However, in good years it can disperse to re-colonise other sites. It is therefore thought to sustain its presence in the landscape as a group of local populations connected by occasional dispersal.

The Culm grasslands are set within a landscape of drier pasture, which is sub-divided by species-rich hedges. These hedges support species such as the dormouse (*Muscardinus avellanarius*) which is a priority species in the Biodiversity Action Plan. Table 5 shows that the Culm Natural Area is among those of highest significance for dormouse. The predominant farming enterprise which sustains the wildlife of the Culm grasslands is beef rearing. Cattle, generally stores and sucklers, are grazed in spring and summer, sometimes supplemented by ponies and, very occasionally, by hill sheep. Traditional cattle breeds such as Devon Reds and Welsh Blacks are particularly suited to the forage provided by Culm grasslands. Cattle or pony grazing is best for maintaining a sward structure and composition ideal for marsh fritillaries. Swards over 8 centimetres (3 inches) in height are preferred as breeding habitat by the butterflies.

Current conservation action and threats

Severe habitat losses of around 10% by area annually in the 1980s, largely due to agricultural intensification, were tackled in the pilot of English Nature's Wildlife Enhancement Scheme and the pilot of the Countryside Stewardship Scheme. The latter was originally administered by the Countryside Commission and is now run by DEFRA. Devon County Council also offered environmental land management agreements. By 1997, about two-thirds of the estimated resource area of 4318 hectares (ha) was within some kind of conservation agreement, though this area comprised only about 40% of the known sites (546 in total). Despite these efforts some losses still occurred in the 1990s, particularly through damage and destruction from fibre flax cultivation, while insufficient grazing means that some sites are in unfavourable condition. The marsh fritillary has declined sharply in England since the Second World War and the rate of decline appears to be increasing. In Devon, 67% of known 1990 populations were extinct in 1999/2000 (66% in England as a whole). Even sites found since 1990 have declined by 30% in Devon and 37% in England as a whole (unpublished data from Butterfly Conservation).

The impact of FMD

The FMD outbreak has caused loss of stock from Culm grasslands although the full impact is not yet known. Nine SSSIs have lost stock over at least part of the sites. Sections of three of these SSSIs have been affected by movement restrictions which have meant that farmers have been unable to be put stock on to them. The sites affected are the larger SSSIs and in area terms comprise over 60% of the Culm grassland SSSI resource.

Potential longer term impacts of FMD if the viability of livestock farming is threatened are:

- lack of stock replacement on sites well-grazed prior to the outbreak;
- difficulties in getting stock to graze previously under-grazed sites;
- changes in land use such as increase in arable farming. A switch from improved grassland to arable has been noted is a few areas since the start of the outbreak;
- loss or deterioration of redundant hedges.

Long term sustainability

Stocking of Culm grasslands to deliver nature conservation is adjusted on a site by site and seasonal basis. For example, a site requiring restoration grazing after a period of undergrazing might be more heavily stocked initially than a site in favourable condition, although care is needed to avoid over-grazing marsh fritillary sites. An approximate average stocking rate is 1 Livestock Unit (LU)/ha for the 20 week grazing season. For comparative purposes with annual stocking rates for other habitats, this translates to 0.5 LU/ha over a year but rates would be lower on some sites, for example, 0.2 LU on marsh fritillary sites with very low agricultural productivity. To manage the 'on-site' resource as a whole (4318 ha) would require up to 8,600 cattle in the 20 week summer grazing season (assuming beef stores at 0.5 LU). However the problem needs to be addressed at a

landscape scale if the solution is to be sustainable. In particular, the marsh fritillary needs a network of suitable sites in the landscape for its long term survival.

The following estimates give an idea of the relative scale of this solution. It is estimated that Culm grassland usually occupies less than 10% of a farm holding. Thus viable livestock farms to support the sustainable management of Culm grassland are likely to extend over some 43,000 ha. Stocking rates on this more productive grassland may be around 1 to 1.5 LU/ha. Therefore around 40,000 to 70,000 cattle may be required in the landscape of the Culm Natural Area to sustain these special Culm grasslands, within the context of necessary markets, infrastructure and incentives for viable livestock farming.

3.1.3 Example: The Malvern Hills and the high brown fritillary

Context

The Malvern Hills lie along the border between the counties of Herefordshire and Worcestershire and form the main ecological feature of the Malvern Hills and Teme Valley Natural Area. While no cases of FMD have occurred in the Natural Area at the time of writing, the Natural Area is adjacent to the Severn and Avon Vales and Dean Plateau and Wye Valley Natural Areas which have been heavily affected. There has been some culling of sheep in the Malvern Hills Natural Area (Table 2).

Nature conservation value and farming pattern

The Malvern Hills are notified as an SSSI for their mosaic of wildlife habitats and the diverse and scarce flora and fauna they support. The Hills are between upland and lowland in ecological character. The tops of the Hills are covered by acid grassland, with patches of heath and more base-rich grassland in places. These habitats are priority habitats in the Biodiversity Action Plan. The lower slopes of the Hills are dominated by bracken. Woodland fringes the Hills and occurs in more extensive blocks at the southern end of the SSSI.

The site is notable for its butterflies, including the nationally rare high brown fritillary (*Argynnis adippe*). This priority Biodiversity Action Plan species breeds in the bracken areas. Traditionally, cattle and sheep grazed the Hills, which are largely common land with public access. This grazing management suited the high brown fritillary. The butterfly lays its eggs on dense mats of dead bracken. The caterpillars, which resemble the leaflets of dead bracken fronds, bask on the dead bracken in spring and feed on nearby violets. If the bracken cover becomes very dense, the violets cannot survive, so the ideal habitat is a mixture of patches of dense bracken interspersed with more open grassy areas. Cattle and ponies are particularly good at breaking up dense bracken and creating open areas.

Current conservation action and threats

Since the Second World War, grazing levels have declined sharply, due to three main factors: transfer of properties with common rights to non-agricultural families, a decline in the profitability of grazing enterprises and problems of stock losses, both in vehicle accidents on the unfenced roads which cross the Hills and from worrying by dogs. As a result, the bracken areas have become very dense and have few violets, while species-poor scrub and woodland have spread up the slopes.

Numbers of high brown fritillary have been declining, particularly over the last two years which had wet and cold spring weather. This decline parallels the overall national decline, which shows an 85% reduction in range of the butterfly since the 1950s (Asher et al 2001).

In 1998, English Nature and a partnership of major landowners including the Malvern Hills Conservators formed the "High Brown Hills Project" to reverse these deleterious changes. The aim is to control scrub invasion and re-introduce grazing, initially by employing a shepherd to graze a flock of hardy sheep on the Hills, followed by re-introduction of cattle. The long term aim is to re-establish grazing by commoners. Bracken cutting is used to supplement this management.

The impact of FMD

Grazing began on the Hills in January 2001 but in February the sheep were withdrawn because of the FMD outbreak. If grazing can resume this year or next there will probably be only a short term deleterious effect on the flora of the grasslands. However, the high brown fritillary is in a precarious state and could be deleteriously affected by lack of grazing and by delays to management work, such as bracken cutting, because of restrictions on human movement. The cold, wet, spring of 2001 has been an additional negative factor affecting the butterfly.

Long term sustainability

In the longer term, the sustainablity of grazing on the site could be harder to achieve after FMD if the livestock grazing systems which include agriculturally marginal land such as the Hills, themselves become more difficult to maintain. This long term problem also applies to other important localities for high brown fritillary in south Cumbria and on the fringes of Dartmoor and Exmoor.

If integration with local livestock enterprises proves impossible then the Hills may need to be part of a regional grazing scheme covering a number of conservation sites. Bracken and acid grassland on the Hills covers around 340 hectares, located in several separate blocks, while nearby unimproved grassland on other sites totals about 400 hectares. By using an indicative stocking level of 0.2 Livestock Units per hectare, this translates as about 540 sheep (0.125 LU each) or 140 cattle (0.5 LU each) for the Malvern Hills and 640 sheep or 160 cattle on nearby grassland. This amount of livestock could form the nucleus of a regional grazing scheme.

3.1.4 Example: Greater horseshoe bats in the Dean Plateau and Wye Valley Natural Area

Context

The Dean Plateau Natural Area in Gloucestershire contains one of the last remaining colonies of greater horseshoe bat in the United Kingdom. The Natural Area has suffered one of the most extensive outbreaks of FMD in England (Table 2, Figure 2).

Nature conservation value and farming pattern

The greater horseshoe bat (*Rhinolophus ferrumequinum*) is one of Britain's rarest bats. It is listed on Annex 2 of the European Habitats and Species Directive and is a priority species in the

Biodiversity Action Plan. The UK's population is centred around summer maternity roosts in south-west England and south Wales. The landscape around the roost at Dean Hall in the Dean Plateau Natural Area is a mix of permanent pasture and ancient woodland, linked by an abundance of tall, bushy, hedges. This landscape is ideal for greater horseshoe bats (English Nature 2000).

Grazed permanent pasture with a high population of dung beetles is a vital foraging habitat for young bats and adults. Pastures within 1 km of maternity roosts have a particularly high value for young bats, which are very dependent on dung beetles as they learn to forage. However, any pasture within foraging range (normally 4 km, exceptionally up to 15 km) may be used by adults at some times of year. Cattle provide the best dung although sheep dung can also be useful. The use of rotational mixed grazing and the careful choice of anthelmintic compounds for parasite control, to minimise risk to non-target dung fauna, are important to ensure that the normal dung fauna can develop.

Permanent unimproved pasture is most valuable but more improved grasslands also make a contribution. It is important that grasslands are not ploughed every few years as this destroys cockchafer beetles, which are another important food source for the bats.

Current conservation action and threats

Numbers of greater horseshoe bats in northern Europe have declined significantly in the face of changing land use and loss of roost sites. In Britain only 14 populations survive. The roost sites are notified as SSSI but the surrounding landscape is generally not notified and wider countryside conservation measures are of primary importance. Around Dean Hall entry into the Countryside Stewardship Scheme has been encouraged but take-up has been low, probably because the payments levels are not sufficient. Land use change has continued, with an estimated 30% loss of grassland to arable around Dean Hall over the last 10 years.

The impact of FMD

The FMD outbreak has caused loss of stock from the farmland around Dean Hall including cattle from the vital 1 km zone around the roost. However, it appears that most of the farms close to the roost have not been affected. In the short term there may be a reduction in survival of young bats and therefore recruitment to the population, although the effects will probably be minor. In the longer term deleterious impacts on the survival of the population could arise from a move away from extensive beef cattle systems toward more intensive dairy systems where grassland productivity is enhanced by frequent re-seeding of pastures, as part of efforts to improve the profitability of livestock farming. A continuation of the trend towards arable cultivation that was apparent before FMD would also be damaging, not only through reducing livestock grazing but also if agriculturally redundant hedges were removed. A major switch to horse grazing rather than cattle sheep grazing could have an impact on the dung fauna available to bats, because of the generally higher levels of anti-parasitic treatment of equines.

Long term sustainability

Different pasture types require different stocking rates, with unimproved pasture supporting fewer stock. Higher stocking densities during the time young bats are dependent on dung beetles are

advantageous. An overall average would be 1 LU/ha, with 2-3 LU/ha from July to September. It is estimated that there is 875 ha of grassland remaining within a 4 km radius of Dean Hall, about 100 ha of which is unimproved grassland. Thus, to continue to manage this grassland, 875 cattle would be required (assuming individuals are 1 LU each), although in the summer up to 2625 cattle would be needed. Stocking could include a proportion of sheep depending on farm business objectives and the need to control parasites but cattle are the preferred stock type for nature conservation objectives. There is a need for tailored support for extensive livestock grazing systems within the Dean Hall area, incorporating differential stocking levels for optimal bat feeding habitat. English Nature is investigating what type of support would best deliver environmentally and economically sustainable farming in the area.

3.2 Lowland heathland landscapes

3.2.1 Overview

Significance of livestock grazing

Lowland heathland is found in landscapes underlain by very nutrient-poor soils. The habitat originated in prehistoric times through forest clearance by humans for their grazing animals. Historically, livestock grazing was accompanied by other activities such as cutting of bracken for animal bedding and gorse for fuel. These ecological and management conditions favour a very distinctive flora dominated by ericaceous dwarf shrubs such as ling and bell heather. The fauna of heathland is rich. As well as a great diversity of invertebrates, it includes rare reptiles such as smooth snake (*Coronella austriaca*) and sand lizard (*Lacerta agilis*). Characteristic heathland birds are nightjar (*Caprimulgus europaeus*), woodlark (*Lullula arborea*) and Dartford warbler (*Sylvia undata*). The variable structure of heathland, with its mix of open sandy patches, short grassy areas, taller heather and scattered scrub, is particularly important in providing the range of habitats required by the diverse fauna. Grazing contributes to these maintenance of these habitats, though where it is heavy it can adversely affect some species such as reptiles. Uniformly short swards provide no cover from predators or sheltered places where reptiles can regulate their body temperatures. Conversely, some heathland plants favour short turf, for example, the nationally rare pennyroyal (*Mentha pulegium*) and lesser fleabane (*Pulicaria vulgaris*).

The agricultural productivity of heathlands is low and in the twentieth century large stretches were ploughed, fertilised and sown with crops, or planted with conifers. Where heathlands survived they largely fell outside the farming system, especially in the east and south of England. As a consequence of the lack of farming management, many remaining patches of open heathland disappeared under invading scrub and woodland. The New Forest is an important exception and is discussed in section 3.2.3 below. However, in the 1980s and 1990s, restoration of open heathland gathered pace, particularly through the implementation of agri-environment schemes and a multi-million pound Heritage Lottery project called “Tomorrow’s Heathland Heritage”. Re-introduction of grazing has been a key part of these efforts.

Impacts of the FMD outbreak: Natural Areas and designated sites

The Natural Areas judged to be of greatest significance for lowland heathland are generally outside the infected areas, with the exception of the Midlands Plateau Natural Area (Table 4). However, as described in the two examples below (3.2.2 and 3.2.3), the effects of the outbreak have been felt beyond the Natural Areas that have the most cases of FMD. Loss of livestock has affected some heathland SSSIs. It is not yet clear what will be the scale of the other impacts such as movement restrictions. Stock were trapped on Cavenham Heath NNR in Suffolk for several weeks in the early spring 2001 and required supplementary feeding because forage had run out.

Short and long term effects

Lack of grazing for one or two years will probably not have a great impact on heathland vegetation, although could have more effect on the fauna, as described for the East Devon Pebblebed Heaths (section 3.2.2). Species such as reptiles, which prefer lightly grazed conditions, may benefit, although open, bare ground habitat, which is favoured by invertebrates such as bees and wasps and by birds such as foraging woodlark, may be reduced in extent. Emergency management measures would include cutting and carefully controlled winter burning but both produce more homogenous, less ideal, vegetation structure and composition compared to grazing, as well as adding to management costs. Movement restrictions which lead to trampling damage and nutrient enrichment, as happened around supplementary feeding areas on Cavenham Heath NNR, might have long term effects, particularly as the flora of heathlands requires low-nutrient conditions.

Long term disruption of livestock farming in the lowlands could have serious consequences for heathland conservation by making the already difficult task of finding graziers willing to manage heathlands even more problematic. Newly restored and created heathlands also require grazing. For instance, an area of 1800 hectares is under management agreements and progressing towards the target in the Biodiversity Action Plan of 6000 hectares of heathland to be re-created by 2005. This is in addition to the estimated 30,000 to 40,000 hectares of existing lowland heathland which are grazed or which are being considered for re-introduction of grazing in England. Where existing livestock systems which utilise heathland cease after FMD, land use change to conifer plantation or ploughing for arable or grass production are possibilities on unprotected sites.

3.2.2 Example: The East Devon Pebblebed Heaths

Context

The East Devon Pebblebed Heaths form the largest block of lowland heathland in Devon. The site is within the Devon Redlands Natural Area which has had a low incidence of FMD cases (Table 2).

Nature conservation value and farming pattern

The site comprises a mixture of dry heath, wet heath and valley mires. It is a candidate Special Area of Conservation and Special Protection Area as well as an SSSI. The fauna is diverse and includes 21 breeding species of dragonfly. Among these is the southern damselfly (*Coenagrion mercuriale*). This species is listed under Annex 2 of the European Habitats and Species Directive and the south west of Britain is a European stronghold for it. It is also a priority BAP species. The

southern damselfly has very specialised habitat requirements. Eggs are laid in wet flushes and shallow runnels with slow flowing water, generally less than 10 centimetres deep.

The East Devon Pebblebed Heaths are largely common land and cattle grazing had been re-introduced a few years ago for the summer period. Traditional Devon Red cattle were used as they were particularly suited to the available forage. The southern damselfly has benefited from this management as its larvae require exposed runnels with a dense growth of aquatic plants, notably pondweed (*Potamogeton polygonifolius*) and marsh St. John's-wort (*Hypericum elodes*), which are excluded if heathland plants grow too tall.

Impact of FMD

The cattle were wintered in North Devon in 2000/20001 and all were lost to culling in that area so grazing of the East Devon Pebblebed Heaths in 2001 has not been possible to date. The area is too wet for emergency cutting by machine. The grazier plans to re-stock as soon as this is feasible so it is hoped that there will be no long term deleterious effects on the flora and fauna of the site.

3.2.3 Example: The New Forest

The New Forest SSSI is one of the largest areas of semi-natural habitat in lowland England and is the primary feature of the New Forest Natural Area. The SSSI covers nearly 30,000 hectares and is of outstanding importance for a range of habitats and species. Thirteen habitats and two species are also listed in the New Forest candidate Special Area of Conservation under the European Habitats and Species Directive. It is designated as a Special Protection Area under the Birds Directive and as a Ramsar site for its wetland habitats. Heathland, associated acid grassland and valley mire form a large component of the Forest SSSI. The heathland significance of the Natural Area is rated as outstanding (Table 4).

The open habitats of the Forest are maintained by a pastoral economy based on the exercise of common rights of grazing by a local community of commoners. Cattle and ponies are the main grazing animals in the Forest. When the FMD outbreak began, the cattle were moved off the Forest, although the ponies remained as they were not susceptible to FMD. Unfortunately, the wet conditions at the time and the shortage of alternative grazing meant that welfare culls of cattle were needed. It is estimated that around one-third of the current total of about 3,000 cattle that grazed the Forest were culled.

While the short term effects on habitats of a reduction in grazing levels will probably not be great, the long term future of the grazing system is threatened. The commoning economy was already fragile before FMD in that cattle and pony rearing, especially the latter, had low returns. In contrast to other areas of England the nature conservation and landscape benefits derived from the system have not been rewarded by entry into environmental land management schemes such as the Countryside Stewardship Scheme. There is now an urgent need to consider how long term economically and environmentally sustainable grazing can be supported to conserve this outstanding area.

3.3 Lowland wetlands and freshwater habitats

3.4.1 Overview

Significance of livestock grazing: wetlands

The raised peat bogs of lowland England are formed by the accumulation of peat, which raises them above the general ground level and means that the main nutrient supply is derived from rainwater. Plants adapted to these low nutrient levels are an important part of the interesting flora of raised bogs, for instance bog mosses (*Sphagnum* species) and the carnivorous sundews. Historically, the wet, low nutrient, conditions limited tree and scrub growth. Raised bogs have not generally been integral to the farming system in recent times but drainage of agricultural land around raised bogs and attempts at drainage of the bogs themselves have led to drying out of the bogs and increased tree colonisation. Restoration of wet conditions through actions such as blocking ditches is now being pursued as essential management, for instance as part of the Biodiversity Action Plan for the habitat.

Wetlands in low-lying, swampy areas are generally somewhat more agriculturally productive and were traditionally grazed, for example the fens in the Broads area, or the New Forest, where valley mires grade into heathland. Scrub invasion by willows and other wetland trees and shrubs was thus kept in check and a wide variety of plants and animals suited to open conditions could flourish. For instance, over 500 flowering plant species and over half of Britain's dragonflies can occur in fen sites. Grazing of these wetlands declined in the twentieth century, with some exceptions such as the New Forest. Drainage and agricultural intensification around wetlands also led to drying out and increased nutrient inputs. Grazing is now being restored at some sites as part of the Biodiversity Action Plan for fen habitats.

Significance of livestock grazing: freshwater habitats

Extensively managed permanent pasture and well-managed permanent pasture with higher stocking densities are significant in protecting the catchments of freshwater habitats including rivers, lakes, ditch systems and ponds. Sediment and nutrient loads in freshwaters have increased in recent decades as agricultural methods have intensified. High losses of nutrients (phosphorus and nitrogen) and silt to freshwater are generated by heavy applications of inorganic fertilisers and increased arable cultivation of erosion-sensitive soils. The diffuse pollution arising from these losses causes a range of deleterious effects on wildlife. These include changes to aquatic plant communities from eutrophication, particularly phosphorus enrichment, and the silting-up of coarse substrates in rivers and lakes. These substrates provide habitats for many fish, including salmon (*Salmo salar*), and invertebrates such as the pearl mussel (*Margaritifera margaritifera*).

Excessive stock densities associated with intensive livestock rearing can also cause problems of sward damage and bank erosion, further adding to silt loads. In some situations, the large amounts of dung and slurry produced by intensive livestock rearing can lead to organic pollution of freshwaters. Where stock have access to exposed gravel beds in the river channel they can cause trampling damage to these important invertebrate habitats. However, some low-level disturbance by trampling livestock is vital for some plant species which are 'mud pioneers' around the edges of

ponds and ditches, for example pillwort (*Pilularia globulifera*) and yellow centaury (*Cicendia filiformis*) and for some invertebrate species.

Impacts of the FMD outbreak: Natural Areas and designated sites

Some of the Natural Areas most heavily affected by FMD are outstanding for freshwater and wetland habitats and species (Tables 4 and 5), for instance the Eden Valley and Solway Basin Natural Areas. Livestock have been lost in high numbers from catchments of important rivers in these areas, notably the River Wye (see section 3.3.2) in the Welsh borders and Herefordshire and Gloucestershire and the River Eden in Cumbria. Both river systems are candidate Special Areas of Conservation. Potential pollution from FMD disposal sites and disinfectant use is an issue for freshwaters and wetlands in the FMD infected areas. Disinfectants have also been used more widely, beyond the infected areas.

Reduction of grazing levels through welfare culling of livestock in the New Forest SSSI, important for its grazed wetland habitats, has been discussed in the lowland heathland section. Most fen habitats are in the east and south of England and thus are away from the main FMD infected areas and likely impacts from loss of livestock, apart from sites affected by welfare culls.

Short and long term effects

Short term loss of grazing is not likely to have significant effects on the flora and fauna of wetlands or adjacent freshwaters. However, widespread re-seeding of grassland on de-stocked farms could impact on erosion levels in river catchments. Increased fertiliser use to enhance grassland productivity on farms where animals have been unable to be moved could have impacts, as could erosion from bare ground created by livestock or runoff of organic wastes from animals restricted to limited areas.

Possible pollution impacts from disease control measures are as yet unquantified. For example, atmospheric pollution from the many pyres lit on the Solway Plain in Cumbria could have impacted on the internationally important raised bogs here, which form the Solway Mosses candidate Special Area of Conservation. The *Sphagnum* mosses that predominate in raised bogs can be deleteriously affected by increased deposition of sulphur and nitrogen compounds from smoke. Examination of existing monitoring plots on the Solway Mosses would aid an assessment of these impacts.

Pollution of freshwaters and wetlands from burial sites also needs to be assessed, for instance, the impact of leachate on habitats downstream, including important estuarine habitats. The extended housing of livestock to minimise the spread of the disease may have led to waste management problems such as slurry store overflows, while the widespread use of disinfectants could also have had impacts on the flora and fauna of freshwater habitats and wetlands.

Long term declines in livestock farming, and consequent shifts to arable cultivation, could have serious consequences for river catchments, through increased ploughing of erosion sensitive soils. Further specialisation of livestock systems, for instance a shift to all dairy rather than a mix of dairy and sheep, could lead to a greater intensification of grassland management, through increased fertiliser use and frequent re-seeding, with consequences for nutrient and sediment loads in

freshwaters. Lack of suitable livestock due to any general declines in extensive livestock farming in England post-FMD could also jeopardise fenland restoration which involves grazing management. In recent years, there has been a marked shift in fen management from mowing, which is expensive and lacks markets for products, to extensive grazing, especially in the Norfolk fens.

On the positive side, if restocking is carried out, with appropriate incentives, at environmentally sustainable levels both in upland and lowland parts of river catchments, this could benefit rivers and streams by reducing diffuse pollution. More extensive systems of livestock production around basin mires and raised bogs in the lowlands could also be beneficial in reducing nutrient inputs and drainage impacts. Some protection of river banks and gravel beds from grazing as part of recovery plans would also be helpful, for instance as part of agreements under English Nature's Wildlife Enhancement Scheme.

3.3.2 Example: The River Wye candidate Special Area of Conservation

Context

The River Wye rises in the mountains of Wales and flows through the counties of Herefordshire and Gloucestershire. The catchment of the river includes the Black Mountains and Golden Valley Natural Area and the Dean Plateau and Wye Valley Natural Area, both of which have been heavily affected by the FMD outbreak (Figure 2, Table 2).

Nature conservation value and farming patterns

The River Wye is a Site of Special Scientific Interest for its characteristic and diverse plant and animal assemblages, and is a candidate Special Area of Conservation for a number of specific features of European importance, including its beds of water-crowfoot (*Ranunculus* species), salmon population (*Salmo salar*), lamprey species (*Lampetra* species) white-clawed crayfish (*Austropota mobius pallipes*) and pearl mussel (*Margaritifera margaritifera*). The latter two species are also priority BAP species. A tributary of the River Wye, the River Lugg, has also been designated as an SSSI and forms part of the River Wye candidate SAC.

The River Wye has its headwaters in upland moorland and rough pasture, descends through a more productive pastoral landscape and finally into a more mixed arable and grassland landscape before joining the Severn Estuary. Much of the catchment has soils that are highly susceptible to erosion, and so the dominance of the landscape by permanent pasture is important in controlling the loads of silt and associated nutrients reaching the river.

The general character of the river is fast-flowing with gravel-cobble substrates, and salmonid populations dominate the fish community. The upper reaches of the river network form the main salmon spawning grounds, whilst the slower flowing sections downstream support the largest beds of submerged plants.

Current conservation action and threats

In the middle and lower parts of the Wye catchment and other similar areas of the west of England, traditional pastoral landscapes are increasingly coming under the plough, with potatoes being

particularly popular due to the de-regulation of the potato industry in the early 1990s. The area under potatoes in Herefordshire has increased by around 80% since 1987 and the trend is likely to continue for the foreseeable future.

It has recently been estimated that the amount of soil currently eroded in the catchment of the River Lugg may reach up to 1.2 million tonnes a year. This is about 14 times greater than would be the case if the catchment was covered with natural forest vegetation. In terms of phosphorus loads entering the river system, these could be as much as 79 times higher than under natural forest vegetation, due to high volumes of animal excreta from livestock and heavy use of inorganic fertilisers on grassland and arable land. Neither of these estimates include the additional pollution loads originating from nutrients and silt picked up when floodwaters cover arable land in the floodplain.

Ploughing and heavy fertiliser use within the catchment is a grave threat to the ecology of the river, generating enhanced loads of sediment and nutrients that are highly damaging to many of the characteristic plants and animals. The important wildlife of the Rivers Wye and Lugg need clean and well-oxygenated gravels and suffer badly when these are clogged up with silt. For instance, salmon lay their eggs in gravels and suffer high egg mortalities when silt levels are high. Salmon runs on the Wye have declined dramatically in recent years, down to around 30% of what is considered to be the minimum size required to utilise the available spawning habitat. Nutrient enrichment generates excessive algal growths and reduces beds of floating flowering plants and the animals dependent on these plants for food, breeding localities and shelter. The pearl mussel, another species highly sensitive to siltation and nutrient enrichment, and dependent on salmonids for part of its life cycle, has declined in the River Wye close to extinction in recent years.

The impact of FMD

The FMD outbreak is likely to bring even greater pressure to bear on the viability of livestock enterprises, exacerbating what was already a critical situation. Whilst short-term loss of livestock from the catchment is not a problem for the ecology of the river, there are risks of further arable conversion as farmers turn away from an increasingly troubled livestock industry. There are also short-term risks that widespread re-seeding operations prior to re-stocking may make significant areas of the catchment vulnerable to erosion. There could also be a switch from grass to fodder maize or short term cash crops, thus increasing erosion risks.

Long term sustainability

There are two main requirements:

- The economic returns from livestock farming needs to be improved to prevent further decline in livestock numbers in the catchment.

- Targeted incentives are needed to revert land in sensitive locations back to extensive permanent pasture. Reversion to broadleaved woodland would be another option. Sensitive land includes arable land in the immediate floodplain of the cSAC and other arable land on high erosion-risk soils which pose significant threats to sediment levels in the river.

Proper soil erosion planning and nutrient budgeting is needed to enable land to be farmed in an environmentally sustainable way without loss of excessive amounts of sediment and nutrients to the river network. This approach would fit into holistic floodplain management where grassland, woodland and wetland habitats form part of a system of flood control and water quality safeguards.

3.4 Coastal habitats: sand dune, salt marsh, grazing marsh and cliffs

3.4.1 Overview

Significance of livestock grazing

Saltmarshes

Saltmarshes around the coasts of England are used as grazing land, especially in the west. They are composed of salt-tolerant plants that are able to survive periodic inundation by sea water. Saltmarshes are found in the upper parts of intertidal mudflats and provide an important natural sea defence. In grazed marshes, grasses predominate, while historically ungrazed marshes have a wider range of herbs such as sea purslane (*Atriplex portulacoides*), sea lavender (*Limonium* species) and sea aster (*Aster tripolium*). Saltmarshes are important habitats for wading birds and wildfowl. In winter, grazed marshes are used as feeding grounds by large flocks of wild ducks and geese. High levels of grazing which produce short swards of 2 to 4 centimetres are attractive to these birds. In contrast, breeding waders such as redshank prefer less intensively grazed swards with a tussocky structure. Pools in upper parts of grazed saltmarshes where there is some fresh water influence are used as spawning sites by the scarce natterjack toad (*Bufo calamita*). Short, grazed, grassland is preferred by natterjacks hunting for invertebrate prey. Grazing also favours a number of plants found in salt and brackish conditions on saltmarshes and sea walls behind saltmarshes, for instance, the nationally scarce slender hare's-ear (*Bupleurum tenuissimum*) and stiff saltmarsh-grass (*Puccinellia rupestris*).

Grazing marshes

Grazing marshes are frequently found on the landward side of sea walls behind saltmarshes. Grazing marshes here were often created by embankment of saltmarsh and the networks of ditches which drain them are sometimes brackish in character. The ditches can have a particularly rich aquatic flora and invertebrate fauna. Grazing marshes are also valuable as breeding habitats for wading birds and wintering locations for wildfowl. Historically, grazing marshes were managed by livestock grazing or hay cutting, but in the twentieth century there was much conversion to arable or loss to urban and industrial development. For example, there was a 48% loss of grazing marsh on the North Kent coast between 1935 and 1982 (Royal Society for the Protection of Birds el al 1997).

Sand dunes

Sand dunes are another coastal habitat that has traditionally been grazed by livestock. Sand dunes are formed by sand blown inland from sandy beaches when these dry out between high tides. The sand is trapped by specialist dune-building grasses such as marram (*Ammophila arenaria*). Over

time, other plants colonise and create dune grassland, heathland and low-growing willow scrub. Dunes have a rich flora and fauna, especially in damp hollows called slacks which lie between dune ridges. Orchids such as marsh helleborine (*Epipactis palustris*) and coralroot orchid (*Corallorhiza trifida*) and found in dune slacks as is the nationally rare round-headed club-rush (*Scirpoides holoschoenus*). Natterjack toads use pools in the wettest slacks as breeding sites. Without grazing, these open dune habitats would be invaded by scrub.

Cliff tops and slopes

The vegetation of maritime cliff tops and slopes was traditionally grazed by livestock, which maintained grassland and heathland floras. These included maritime species such as thrift (*Armeria maritima*) in exposed zones receiving salt spray as well as plants preferring more sheltered conditions, such as the nationally scarce hairy bird's foot trefoil (*Lotus subbiflorus*). Arable conversion and decline in grazing on cliff tops leading to scrub invasion, have both reduced maritime heathland and grassland habitats.

The impact of the FMD outbreak: Natural Areas and designated sites

Table 4 shows the relative significance of different Natural Areas for coastal habitats. Coastal grazing marsh is included in the wider grazing marsh area category. The table shows that very important coastal Natural Areas adjoin inland Natural Areas that have been heavily affected by FMD. That these coastal Areas can be affected by culling of stock from inland farms is illustrated by the Solway example below (section 3.4.2).

Coastal SSSIs have been affected by the FMD outbreak. Grazing animals have been lost from saltmarshes, grazing marsh and dune sites. Elsewhere, movement restrictions have resulted in livestock remaining on coastal habitats longer than normal. Examples of the disruption to livestock farming and the biodiversity implications on saltmarsh, sand dune and cliff tops are given in sections 3.4.2, 3.4.3 and 3.4.4 below. Livestock from grazing marsh and saltmarshes around the Thames Estuary in Essex and Kent, including Elmley NNR, have been culled. Pyres for disposal of carcases have been located in coastal areas, for example, in dune heath adjacent to the North Northumberland Shore SSSI and in the catchment of the saline lagoon and reedbed habitats of Benacre NNR in Suffolk.

Short and long term effects

Lack of grazing for one or two years is unlikely to have much impact on coastal plants, although species with a short-lived or limited seed-bank, such as the nationally scarce slender hare's-ear could decline. Slender hare's-ear grows in short turf of saltmarshes and grazing marshes and could suffer where there are no livestock to create the bare ground that this annual plant needs for seedling regeneration. The Thames Estuary marshes are a particular stronghold for this species. Short term lack of grazing could temporarily result in increases in vegetation height, and thus habitat suitability, of marshes and dune slacks used by natterjack toads. Natterjack toads prefer to forage in short, rather than tall, vegetation.

There is a possibility that wintering wildfowl will find swards that have been ungrazed in the preceding months are too long for feeding and they could disperse to surrounding arable land, which

may lead to conflict with farmers. Ungrazed saltmarshes might be more attractive this year to breeding waders but by next season could be too rank. More productive grazing marshes may have become less attractive to waders this year where grazing has not been possible. Emergency mowing management in the autumn of accessible saltmarshes and grazing marshes would be worth considering, as described in section 3.4.2 below, to limit short term deleterious effects on birds and surrounding farmland.

In severe cases, overgrazing on dunes, resulting from movement restrictions, may have similar long term effects to those in lowland grassland sites, such as trampling and over-enrichment of the soil. Potential pollution impacts of disposal sites on coastal habitats, either atmospheric pollution, or leachate via groundwater of surface freshwater, need investigation before the scale and degree of any effects on biodiversity can be assessed.

In the longer term, the future of livestock grazing of coastal habitats could be an issue. Achieving grazing on some cliff tops and dunes is already difficult, a situation that could become worse if livestock farming declines. However, lower density re-stocking of some saltmarshes that were very heavily grazed before FMD could be a benefit to breeding waders. Previously-grazed salt marshes that remain completely ungrazed are likely to become dominated by rank grassland that supports only a limited range of wildlife. Evidence from continental Europe suggests that it would be a long time before removal of grazing led to the development of a richer flora and fauna which was equivalent to that of saltmarshes that have never had a history of grazing. Extension of arable cultivation on non-designated grazing marshes where livestock grazing ceases post-FMD would be another negative, long term, impact of the FMD outbreak.

3.4.2 Example: The Solway Firth saltmarshes

Context

The Solway Firth Natural Area is a large estuary separating the north west coast of England from the south west coast of Scotland. The Solway Basin Natural Area in the county of Cumbria fringes the estuary and has been one of the most hard hit Areas during the FMD outbreak (Table 2, Figure 2).

Nature conservation value and farming pattern

The Solway Firth is one of the largest, least industrialised and most natural, sandy, estuaries in Europe. It is internationally important for wintering and migrating birds and for the saltmarshes, which cover around 3,800 hectares. It is designated as a Special Protection Area under the European Union Birds Directive and as a candidate Special Area of Conservation under the European Union Habitats and Species Directive. Together these two sites are known as the Solway European Marine Site. It is also designated as a Ramsar site. Additional nature conservation interests include breeding birds and natterjack toad populations. The natterjack is a priority BAP species.

The whole population of barnacle geese (*Branta leucopsis*) from the island of Svalbard, north of Norway, overwinter on the Solway Firth. Several thousand birds arrive in the autumn from their arctic breeding grounds and spend the first part of the winter period on the northern shores,

particularly around Caerlaverock. From around late December the geese move into the English half of the estuary to areas such as Rockcliffe, Drumbrugh and Brugh.

Typically, the marshes are grazed by sheep in winter and cattle in summer. Different grazing levels result in different sward structures that support different wildlife. Short, sheep-grazed swards are ideal as feeding grounds for wintering geese and ducks. Longer, more tussocky swards created by cattle are suitable for breeding waders. Natterjacks prosper where grazing keeps the vegetation short and the spawning pools clear of tall, emergent plants.

Current conservation action and threats

There has been some over-grazing of parts of the English saltmarshes on the Solway Firth but now they are largely within Countryside Stewardship Scheme management agreements with the aim of implementing grazing regimes which will conserve the varied wildlife of the marshes.

The impact of FMD

All the livestock on the south Solway marshes have been lost to FMD. If there is no grazing for one or two years there should not be a significant negative effect on the natterjack populations or breeding waders. There could be more of an effect on the wintering geese if they find that the rank dead grass that would result from lack of grazing is less attractive as feeding areas. The need for emergency mowing and its feasibility are currently being assessed by English Nature. In the long term, if grazing is not re-instated, it is likely that the nature conservation interest of the site will be severely reduced by the change to a tall, dense, rank sward of grass.

Long term sustainability

The level of grazing required to conserve the range of ecological interests on the Solway saltmarshes needs to vary in intensity in different sections of the site, depending on the particular interest of that area. Broad, indicative, levels would be 0.5-2 cows per hectare (0.3 LU to 1.2 LU, assuming 0.6 LU per cow) in summer and 1.6-2.4 ewes per hectare (0.2 LU to 0.3 LU, assuming 0.125 LU per ewe) in winter. Given the size of the marshes, environmentally and economically sustainable livestock farming in the area would need to be on a sufficient scale to include several thousand sheep and cattle to graze the saltmarshes.

3.4.3 Example: Ainsdale sand dunes

Context

Ainsdale Sand Dunes National Nature Reserve covers 508 hectares of the Sefton Coast, north of Liverpool. It is part of a large dune complex which runs along the boundary of the Urban Mersey Basin Natural Area and the Liverpool Bay maritime Natural Area. There have been no cases of FMD in these Areas, although some animals have been culled (Figures 2, Table 2).

Nature conservation value and farming pattern

The Reserve contains the complete coastal succession from strandline through embryo dunes, yellow dunes to grey fixed dunes and low-growing willow scrub in dune slacks. It is part of the Sefton Coast candidate Special Area of Conservation which has been designated for dune features. Associated with these habitats are rare plants such as dune helleborine (*Epipactis leptochila* var *dunensis*) and rare animals including sand lizard (*Lacerta agilis*) and natterjack toad (*Bufo calamita*). Both of these animals are protected under Schedule 5 of the Wildlife & Countryside Act 1981 and are priority Biodiversity Action Plan species.

The grazing system on the Reserve has developed through a long-term relationship with the farming community, built up over the last ten years. Livestock are winter-grazed rather than summer-grazed. The system works well both for the management of the Reserve and for the farmers who rent the winter grazing for their sheep. Grazing is done by approximately 250 Herdwick ewes which graze the Cumbrian fells in summer. The Herdwick is a hardy hill sheep well suited to the forage available on the Reserve. It is largely restricted to the Cumbrian fells and has the advantage of a strong 'hefting', or home range, instinct which makes shepherding easy.

Current conservation action and threats

Much of the work on the Reserve involves dune restoration and subsequent management by sheep grazing and mowing. The biggest problems relate to some of the areas of conifers planted on the landward part of the dune system in the early twentieth century. Hydrological monitoring shows that the trees contribute to the drying out of the dune slacks. In addition, the shelter they provide enhances invasion of tall scrub which replaces dune slack grassland and willow scrub. The increase in tall scrub makes grazing more difficult, which in turn leads to further increases in scrub area.

The impact of FMD

The restrictions on the movement of livestock has meant that the Herdwick sheep have remained on the site after the time that they would normally be returned to the fells in Cumbria. In the face of the extensive slaughter of Herdwicks in Cumbria it was felt that every effort should be made to save the flock at Ainsdale to contribute to recovery of the breed. The sheep have not been grazing all the compartments in the Reserve and are not likely to have had an impact on the site, although there will probably be rather fewer flowers this year of species like the dune helleborine. Populations of perennial plants, such as this species, are generally able to survive without flowering for several years. Areas with the nationally scarce annual yellow bartsia (*Parentucellia viscosa*) have not been grazed as this plant probably needs to set seed every year to maintain a healthy population on the Reserve.

Much dune management and scientific work, such as on-going survey of the plant and animal communities and water table monitoring, has not been carried out since the outbreak of FMD because of restrictions on movement of people. For example, water levels in dune slacks have been monitored in an unbroken sequence since 1972, until 2001. Work by contractors and volunteers on dune restoration tasks such as tree stump removal, brash clearance and planting of marram grass has been put on hold at least until autumn 2001. The Reserve is important part of the local community and has a community officer who provides information about the management of

the Reserve to local people and involves them in its management. As with the site management and monitoring programme, this community work has been severely curtailed.

3.4.4 Example: Silloth Dunes and Mawbray Bank

Context

Silloth Dunes and Mawbray Bank SSSI is on the border of the Solway Basin Natural Area and the Solway Firth maritime Natural Area on the north west coast of Cumbria. The Solway Basin is one of the most heavily affected Natural Areas in terms of FMD (Table 2, Figure 2).

Nature conservation value and farming pattern

The site is notified as an SSSI for its extensive coastal habitats ranging from vegetated shingle through to dune grassland and maritime heath. Natterjack toads (*Bufo calamita*) and great crested newts (*Triturus cristatus*) are found on the site. Both species are priority BAP species. The site was traditionally grazed by a mixture of sheep and cattle.

Current conservation action and threats

Most of the site has not been grazed in the recent past. At the time of the FMD outbreak negotiations were being undertaken to re-introduce grazing on to part of the site, in particular in the dune slacks where the natterjacks spawn and in surrounding rank grassland where a reduction in sward height is required to provide natterjack foraging terrain. The biggest threat to the site comes from scrub invasion of the open dune habitats, particularly by gorse.

The impact of FMD

The existing livestock on the site have been removed as a result of FMD. The area which was under negotiation for introducing livestock, in this case, a conservation flock of Hebridean sheep, is a golf course. The proposals have run into difficulties over concern that, in the event of a future outbreak of FMD, access by people would not be possible, thereby affecting the viability of the golf course. There are unlikely to be effects from short term lack of grazing but over a longer period lack of grazing would be a problem for the nature conservation interests of the site.

Long term sustainability

Grazing provides a more economically sustainable way of managing the site than scrub clearance by hand or machine. Management as part of a network of conservation sites in a regional grazing scheme is one possible sustainable solution.

3.4.5 Example: Lundy cabbage on the cliffs of Lundy Island

Lundy Island is the only place in the world where Lundy cabbage (*Coicya wrightii*) grows. This endemic species has a unique endemic insect fauna including the bronze Lundy cabbage flea beetle (*Psylliodes luridipennis*). Both the cabbage and the beetle are Biodiversity Action Plan priority species. Much of the island is an SSSI, which includes most of the cabbage populations. The

habitat of the plant includes the 'Sidelands', which are the steep slopes above the sheer cliffs of the Island. The Sidelands are a mixture of open, ruderal, vegetation on landslips, gorse, bramble and blackthorn scrub, coastal grassland and heathland. Numbers of cabbage plants have declined in recent years due to high numbers of grazing livestock and rabbits on the Sidelands. On cliffs inaccessible to grazing animals, wet summers have led to growth of closed vegetation and a reduction in the bare ground that the cabbage needs for seedling regeneration. Increases in cover of introduced rhododendrons have also reduced cabbage populations on the Sidelands and the cliffs.

The populations of Lundy cabbage have been monitored annually since 1993. The results for 2001 show that, compared to the previous year, there were 84% fewer plants in areas accessible to grazing animals. This compares with a decline of 35% between 1999 and 2000. Plant population change in inaccessible areas varied. The maximum decline was 48% but elsewhere on the cliffs the population increased by 17%.

The overall decline of cabbage populations on the Sidelands in recent years, prior to FMD, has probably been compounded by the impact of FMD restrictions in 2001. Sheep are normally grazed on the Sidelands and movement restrictions prevented the usual removal of the lambs from the Island, leading to increased grazing pressure. There may have been increased grazing by feral animals (goats, Soay sheep and Sika deer) as well. There were no human visitors to the Island for two months, due to the restrictions on movement of people, which meant that there was probably less disturbance and thus less interruption of cabbage grazing by these feral animals. As a result of all these grazing pressures, invertebrates that developed on cabbage plants last year are now concentrated on a much smaller number of plants and may also have an impact on plant survival and reproduction. Reduction in sheep and rabbit numbers grazing the Sidelands, along with on-going control of rhododendron, would be a long term means of conserving Lundy Cabbage populations.

3.5 Lowland woodland, wood pasture and scrub

3.5.1 Overview

Significance of livestock grazing

Lowland woods

Lowland woods of high nature conservation value are not generally used for livestock grazing. Their rich flora includes species that prefer low grazing levels, for example oxlip (*Primula elatior*) and wood rush (*Luzula sylvatica*), while regeneration of trees and shrubs, including coppice, can only occur where young saplings or coppice regrowth are not grazed off. Mammals such as the dormouse (*Muscardinus avellanarius*) need the cover and food supplied by coppice or shrubs below the woodland canopy.

Wood pasture

Livestock grazing is important for the maintenance of active wood pasture. This historic land use involved grazing livestock on grassland or heathland among scattered trees. Timber products were obtained by pollarding the trees above the height grazing animals could reach. Under this

management regime, the trees often survived to a great age. Today these remaining veteran trees support a unique assemblage of lichens and fungi and an extremely rich invertebrate fauna, including rare species such as the violet click beetle (*Limoniscus violaceus*). Parklands are an important type of wood pasture, sometimes maintaining deer herds as well as cattle and sheep. The presence of grazing animals is of direct value to invertebrate fauna dependent on dung, for example the beetle *Aphodius zenkeri* which lives on deer dung. Ancient hedgerow trees are a kind of linear wood pasture and also support rich faunas and floras.

In the twentieth century the decline in livestock grazing in some wood pastures has led to the growth of dense scrub and secondary woodland which has changed the microclimate around the veteran trees. Lichens which need high light conditions can be shaded out, while mycorrhizal fungi which grow on the roots of trees and fruit in the surrounding grassland may be reduced. The veteran trees themselves may succumb to competition from young trees, which rapidly overtop them.

Other wood pastures have suffered from agricultural intensification through use of inorganic fertilisers and herbicides on grassland or ploughing up of grassland and heathland for arable production. These changes have had deleterious effects on the veteran trees and their inhabitants, for instance by removing pollen and nectar sources for invertebrates and locally increasing atmospheric and soil levels of nitrogen. Lichens are particularly vulnerable to increased atmospheric nitrogen while the symbiosis between host trees and fungi can be upset by high inputs of nutrients. In recent years restoration of wood pastures and their system of extensive grazing has been vigorously pursued in line with the Biodiversity Action Plan for the habitat.

Scrub

Where grazing is reduced on open habitats in the lowlands, scrub development is the first stage of forest re-establishment. Scrub has conservation value in its own right in mosaics with open habitats like chalk downland and heathland (Mortimer et al 2000), although it can completely take over these habitats where there is no management. Scrub edges in lightly grazed unimproved grassland are important habitats for rare and local plants including fly orchid (*Ophrys insectifera*), Jacob's-ladder (*Polemonium caeruleum*) and wood bitter-vetch (*Vicia orubus*). Continuous heavy grazing can deleteriously affect the long term survival of existing scrub including scarce species such as juniper, which is a priority Biodiversity Action Plan species, and the fauna dependent on scrub, including a number of priority BAP species of leaf beetle weevils, and a range of birds that use scrub as breeding, wintering and roosting habitat.

Impacts of the FMD outbreak: Natural Areas and designated sites

The Natural Areas with the highest incidence of FMD include ones with high or outstanding significance for woodland (Table 4). In addition, the Border Uplands, Cumbria Fells and Dales, Dean Plateau and Wye Valley and Severn and Avon Vales are of national significance for parklands and the Black Mountains and Golden Valley is of international importance (Reid et al 1996).

Several wood pastures lie within infected areas and livestock has been lost from at least one, as described in the example in section 3.5.2 below. Air pollution from disease control measures could also be an issue, as described in this example and in other areas.

The main impact of FMD on lowland woods is likely to be the indirect effect of the curtailing of the annual deer control programme due to restriction on human movement during the outbreak. The indirect effects of deer increases are likely to be felt across England, both inside and outside infected areas, but particularly in the lowlands where deer pressures are currently highest.

Short and long term effects

Loss of livestock grazing in wood pastures is not likely to have significant long term impacts, such as secondary woodland development, if grazing is re-established within a year or two. Emergency measures such as mowing are not therefore a high priority. Temporary relaxation of grazing may even be a benefit in allowing a slight increase in flowering shrubs for nectar and pollen. If livestock grazing is not re-established this may pose more serious problems, either through growth of secondary woodland or further ploughing of non-designated sites. Replacement of extensive livestock farming by intensive arable production more widely in the countryside, leading to high fertiliser, herbicide and pesticide use, could also damage the nature conservation interest of adjacent hedgerow trees.

The significance of air pollution is not yet known and monitoring of susceptible groups such as lichens in areas where pyres were widespread is needed to understand the extent of the impacts, for instance, in North Devon, where FMD has been widespread, and where there is a particularly rich flora of epiphytic lichens on old trees.

Deer numbers have been increasing in woodlands in recent years and are having discernable effects, such as increasing the abundance of grazing tolerant plants, especially grasses, and reducing the abundance of grazing intolerant plants like oxlip, as well as inhibiting tree regeneration and coppice regrowth (Kirby 2001). Reduced deer control due to FMD is likely to exacerbate these changes, although most of the annual deer culling had been completed before movement restrictions were put in place. However, the reduction in deer control and consequent increases in deer populations may not be just a short term issue. Income from deer culling is made from sporting rights and the venison market. Both of these have strong involvement from continental Europe. Lack of visiting sportsmen and loss of disease-free status of British venison could have long term implications for the profitability of deer control and thus the ecology of lowland woods. The loss of the export market due to FMD has been reported as a major current problem by the Deer Initiative, a partnership of governmental and non-governmental organisations which aims to promote deer management.

On the positive side, re-evaluation of farm businesses after FMD might include, with appropriate incentives, increased cover of broad-leaved woodlands, either planted or natural regenerated. This long term expansion of woodland and also any increase of naturally regenerated scrub could benefit wildlife if they were targeted on farmland currently of low value for wildlife.

3.5.2 Example: Moccas Park National Nature Reserve, Herefordshire

Context

Moccas Park lies within the Black Mountains and Golden Valley Natural Area, close to the boundary with the Dean Plateau and Wye Valley Natural Area. This region has been heavily affected by FMD (Figure 2).

Nature conservation value and farming pattern

Moccas Park is an ancient deer park famous for its rich fauna and flora, which is associated with the veteran parkland trees. Over 100 species of lichens have been found growing on the trees which also harbour over 200 species of beetles, including priority BAP species such as the Moccas beetle (*Hypebaeus flavipes*). Many of these depend on mature or dead timber. The flora, fauna, history and management of the Park is described in detail in Harding and Wall (1999). The site is an SSSI and has been designated as an NNR. A fallow deer herd grazes the Park year round, supplemented by beef cattle in summer and sheep in winter from nearby farms.

Current conservation action and threats

A programme of tree planting aims to ensure continuity of mature timber for dependent fauna and flora. After some intensification of grassland management in the 1960s and 1970s, management is now low-intensity, with minimal inputs of fertilisers to safeguard the nature conservation interests, especially the lichens. A monitoring programme has been set up to assess the recovery of the lichen flora.

The impact of FMD

Livestock on farms around the Park were culled during the outbreak, including those which grazed the Park. At the time of writing the deer remain in the Park. Effects of reduced grazing are likely to be small if grazing levels are re-established soon. Of more immediate concern is the impact of disposal pyres which were located within 500 metres of the boundary of the Park. Pollution from the pyres, especially sulphur and nitrogen compounds, could have had an impact if these pollutants were carried by the wind into the Park. It is not yet known what the consequences have been and repeat of the lichen monitoring as soon as possible is recommended.

4. Upland landscapes

4.1 Grassland landscapes in upland dales and valleys

4.1.1 Overview

Significance of livestock grazing

Grassland in the dales and valleys of upland England comprises in-bye land and allotments. In-bye land is the meadow and permanent pasture, usually enclosed by stone walls, and occupying the lowest ground. Larger enclosures or 'allotments' of permanent pasture frequently form a transition between the in-bye land and the rough grazing land on higher ground above the moor wall. In-bye land is the most agriculturally productive land in the uplands and is a key component of upland livestock farming. Sheep are put on the in-bye for lambing in spring and then moved on to the open moorland over the summer. Some grazing regimes may move sheep back onto the in-bye over the winter, using bought-in fodder to supplement the grass or hay grown on in-bye land. Cattle are grazed on permanent pastures, including allotments, over the summer and are generally over-wintered in barns. Hay or silage provide winter feed.

Hay meadows in the in-bye fields play an important role in providing spring and autumn grazing pasture and are closed up over the summer to produce hay. Traditionally they were fertilised with farmyard manure from cattle. Upland meadows managed in this way have a rich and colourful flora, including species such as wood crane's-bill (*Geranium sylvaticum*) and great burnet (*Sanguisorba officinalis*). Rare lady's mantle species (*Alchemilla* species) and eyebrights (*Euphrasia* species) are found in some meadows. Wetter areas support plants like globeflower (*Trollius europaeus*) and devil's-bit scabious *(Succisa pratensis*). Permanent pastures managed with little or no fertiliser application and light stocking also have a diverse flora and are particularly important for breeding waders such as lapwing (*Vanellus vanellus*), redshank (*Tringa totanus*) and curlew (*Numenius arquata*).

Agricultural intensification in recent decades, through the use of inorganic fertilisers, re-seeding, conversion from hay to silage cutting and increasing stock numbers, has greatly reduced the extent of dales grasslands of value for wildlife. In contrast, other upland fringe areas, such as in the southern Lake District, are under-managed, allowing dense bracken to spread and reducing value of these areas for species such as the high brown fritillary (*Argynnis adippe*). These changes appear to be related to a decline in traditional management activities, such as bracken cutting, a reduction in cattle grazing and less intensive shepherding.

Impacts of the FMD outbreak: Natural Areas and designated sites

The Natural Areas which together contain most of the upland hay meadows, namely the North Pennines, Cumbria Fells and Dales and Yorkshire Dales are among the most heavily affected by FMD (Figure 2, Table 2). All these Natural Areas are also of outstanding or considerable significance for birds (Table 5). The North Pennines is particularly important for breeding waders. For example, curlew is one of the species listed in the reasons for designation of the North Pennines Special Protection Area.

The loss of stock has affected designated upland meadows, for instance, Gowk Bank NNR in the Border Uplands Natural Area. This outstanding hay meadow is within the North Pennine Dales Meadows candidate Special Area of Conservation. Geltdale and Glendue Fells SSSI, important for breeding waders, is another example where stock has been lost and is discussed in more detail in section 4.1.3 below. Meadows have also been affected by movement restrictions, as described in section 4.1.2. Most farm buildings are located in the dales and valleys, which have inevitably been the focus for disease control measures, for example disinfection of farm premises. It is in dales and valleys that there is scope for re-seeding of grasslands, for example if livestock production is going to be intensified after FMD. To date there have some reports of re-seeding of grasslands in the Yorkshire Dales.

Short and long term effects

If mowing is continued as normal in hay meadows, effects on the flora should be small in the short term. However, long term lack of grazing in the aftermath period would reduce the diversity of the sward because the hooves of grazing animals make openings in the sward for seedling regeneration. On permanent pastures, in the short to medium term, the removal of livestock may lead to greater numbers of fledglings being raised by nesting waders because of reduced trampling of nests. In the long term, grazing will be required, preferably by cattle, to maintain the sward structure that these wading birds require. Non-designated grasslands with diverse fauna and flora could lose their rich wildlife if farmers take the opportunity to plough and re-seed after stock have been culled. Widespread re-seeding of grasslands in erosion-sensitive parts of dales and valleys could also affect sediment loads in rivers and streams.

Both permanent pasture and hay meadows may suffer if animals have had to be kept on them for longer than normal due to movement restrictions. Similar problems as those described for lowland grassland could result. On non-designated sites, farmers may be tempted to introduce or increase fertiliser applications to increase grass productivity, or blanket spray with herbicide to control troublesome weeds that spread as a result of overgrazing and supplementary feeding of livestock. These activities could have devastating effects upon nature conservation interests.

In the wider landscape, disinfection of farm buildings and increased use of rodenticides could affect wide-ranging species such as barn owls. Run off of disinfectant or leachates from disposal sites may affect freshwater habitats.

It is essential that the introduction of environmentally sustainable stocking levels on open moorland after FMD does not simply result in shifting the problem of overgrazing down the hill. Environmentally sustainable stocking needs to be implemented across the upland landscape, including in dales and valleys. In fringing areas which are currently under-managed, recovery action to re-establish cattle rearing, along with support for management practices such as bracken control and shepherding, would benefit species such as high brown fritillary.

4.1.2 Example: Hay meadows in the Yorkshire Dales

Context

The North Pennine Dales Meadows candidate Special Area of Conservation comprises a suite of 59 SSSIs (totalling 497 hectares) within the Yorkshire Dales, North Pennines, Border Uplands and Cumbrian Fells and Dales Natural Areas. These Natural Areas have been some of the hardest hit during the FMD outbreak (Fig 2, Table 2). Some of the SSSIs have been affected through loss of livestock, however, two meadow SSSIs in the Yorkshire Dales Natural Area have been directly impacted through livestock movement restrictions. The sites are Deepdale Meadows SSSI in Langstrothdale and Arkle Beck Meadows SSSI in Arkengarthdale.

Nature conservation value and farming pattern

Deepdale and Arkle Beck Meadows are typical examples of England's 'mountain meadows', recognised as internationally important under the European Union Habitats and Species Directive. The two SSSIs have a rich flora which reflects the variety of soil types and moisture levels in the meadows. Species present include wood crane's-bill (*Geranium sylvaticum*), globeflower (*Trollius europaeus*), melancholy thistle (*Cirsium helenioides*), great burnet (*Sanguisorba officinalis*), frog orchid (*Coeloglossum viride*) and marsh valerian (*Valeriana dioica*).

These meadows are integral to the management of the upland farming system in the area. Hay produced from the fields is essential to provide winter feed for the farm livestock. The meadows are used in April/early May to lamb sheep and then livestock are excluded until mid-July when a hay cut is taken. Any summer/early autumn regrowth (the 'fog) is grazed by sheep and cattle. In the traditional manner, farmyard manure produced on the farms by cattle is utilised as an organic fertiliser to replace nutrients removed in the hay crop.

Current conservation action and threats

The sites are managed under English Nature Wildlife Enhancement Scheme agreements designed to conserve their flora through traditional meadow management.

The impact of FMD

Restrictions on the movement of livestock has resulted in farmers being unable to move animals onto higher summer pastures. This restriction, combined with slow grass growth in the cold spring/early summer, has led to increased grazing of inbye pastures and resulted in livestock being short of grass. As a last resort stock have had to be moved onto valuable meadow land. This will have serious consequences from the farming perspective in that the farms will be left with a greatly reduced volume of home-grown winter feed for the livestock.

Farmers are working with English Nature to minimize damage to the meadows, but this additional grazing during the normal 'shutting up period' (mid May-mid July) could lead to suppression of meadow plants susceptible to grazing during this period. This is particularly true for some of the larger species such as globeflower and wood crane's-bill, which are already known to have been lost from some grasslands in the Yorkshire Dales as a result of heavy grazing. Depending on the

duration and intensity of this grazing it is hoped that suppression of these plants will be short term. If movement restrictions are lifted soon, the overall effects should be short term though recovery would be aided by reduced grazing next year, where possible. If grazing were to continue through the autumn and next year effects may be more long-term with some species being lost from the sward.

Long term sustainablility

These meadows and others like them require the continuation of an extensive, rather than an intensive, farming system, and one that includes cattle as well as sheep. The economic difficulties facing upland livestock farming mean that targeted incentive schemes and changes to agricultural support are required to ensure the long term survival of England's 'mountain meadows'.

4.1.3 Example: Wading birds in Geltsdale and Glendue Fells SSSI, North Pennines Natural Area

Context

The Geltsdale and Glendue Fells SSSI lies at the northern end of the North Pennines Natural Area. Two-thirds of this 8,000 hectare upland SSSI is within Cumbria, the remainder is in Northumberland. The North Pennines Natural Area has been hard hit by the FMD outbreak (Table 2).

Nature conservation value and farming pattern

The Geltsdale and Glendue Fells are within the North Pennines Special Protection Area, designated under the European Union Birds Directive and are part of the North Pennines candidate Special Area of Conservation as well as being an SSSI. Part of the SSSI is a reserve managed by the Royal Society for the Protection of Birds (RSPB). The SSSI is notified for a range of upland habitats extending from high altitude blanket bog to fell-bottom grassland in enclosed land around the fringes of the open moorland. These grasslands contain areas of marshy pasture and rough acid grassland as well as pastures partially improved by the use of inorganic fertilisers. Traditionally, some of them will have been managed as hay meadows but are now used for silage production. The fringing grasslands and lower moorlands are particularly important for wading birds including lapwing (*Vanellus vanellus*), snipe (*Gallinago gallinago*), curlew (*Numenius arquata)* and redshank (*Tringa totanus*).

Typically, the majority of pastures and rough grazing are grazed by sheep all year in conjunction with moorland grazing. Historically, the in-bye would have been split into areas for lambing and hay production. In more recent times, as a result of the increases in stock numbers the whole in-bye may be used during lambing with the ground being heavily fertilised and mown for silage once the sheep have been returned to the fells.

Current conservation action and threats

Over the last 25 years the numbers of livestock in this part of the North Pennines and elsewhere have been increased, encouraged by the available subsidies. Grazing levels have increased on

enclosed grasslands as well as open moorland. The result in the enclosed pastures has been the replacement of tussocky swards with uniform, close cropped, grassland. This change in grassland structure has reduced the extent of suitable nesting habitat for breeding waders. Also, increased stock numbers have resulted in more trampling of nests. For example, one area of 129 hectares on the northern edge of the Fells shows the following decline in pairs of breeding waders (unpublished surveys by the RSPB, 1975 and 1995):

Bird species	**1975**	**1995**
Redshank	5	1
Snipe	8	0
Lapwing	53	16
Curlew	16	12

This overall decline of 65% is part of a pattern of decline. For example, breeding waders declined by 38% on the North Staffordshire Moors between 1992 and 1996 (data in RSPB Land for Life technical document 1998). A national survey of lapwings found a 49% decline in breeding pairs between 1989 and 1998 (Wilson et al 2001), due to agricultural intensification in both upland and lowland farming systems.

The impact of FMD

The FMD outbreak has resulted in loss of some stock from the moorlands and fringing grasslands in the SSSI.

Likely short term impacts on fringing grasslands, if there is no grazing for one or two years, are:

- a sward structure more suitable for all wader species in the first year. Sward structure after a longer period of no grazing would be satisfactory for breeding curlew and snipe but less so for redshank and lapwing.

- less disturbance to nesting birds and trampling of nests.

Likely long term impacts if grazing is not re-instated on fringing grasslands:

- Grasslands will become tall and rank and less suitable for nesting waders, although some species such as curlew could utilise relatively tall swards where these are not too dense for foraging chicks. Eventually, grasslands would give way to scrub and trees without some grazing by livestock. Areas that have been severely over-grazed could be left un-stocked for up to three years to allow recovery of vegetation without negative effects on breeding waders.

Long term sustainability

Significant reductions of densities of grazing sheep will be essential if the breeding wading bird populations in the enclosed grasslands of the SSSI are to be restored. Waders would also benefit

from the introduction of cattle grazing to encourage the development of more tussocky swards. Sustainable stocking regimes will need to be flexible so that land managers can manipulate the livestock density on grasslands of different agricultural productivity to produce swards with tussocks in the early part of the breeding season. However, indicative stock densities are 0.15 LU per hectare during the breeding season of 15 March - 15 July. Targeted incentives such as English Nature's Wildlife Enhancement Scheme are needed to ensure environmental and economic sustainablity of these grasslands within upland farming systems.

4.2 Upland woodlands and scrub

4.2.1 Overview

Significance of livestock grazing

Livestock grazing is a feature of many native, wildlife-rich, upland woods in England, in contrast to the situation in lowland woodlands of importance for nature conservation. Upland woods are often rich in mosses and liverworts (bryophytes) because of the high rainfall in upland areas and some suppression of herbs, shrubs and trees by grazing. Lichens also benefit from high light levels below the canopy and from the clean air. However, over the past 60 years, upland woodland has declined in extent by some 30 to 40%, through overgrazing, clearance and conversion to conifer plantation. High livestock numbers have eliminated tree regeneration and eroded the delicate ground cover of lichens and bryophytes.

Juniper (*Juniperus communis*) is a priority BAP species and juniper scrub has shown a marked decline in extent in the English uplands. Overgrazing prevents regeneration of juniper and is a contributory factor in its decline. As in lowland areas, in the uplands scrub species form mosaics with open habitats, such as upland heath, under suitable grazing management. These areas provide valuable habitat for species such as the black grouse (*Tetrao tetrix*), itself a priority BAP species.

Impacts of the FMD outbreak: Natural Areas and designated sites

Several of the upland Natural Areas (Figure 3) that are of outstanding or high interest for woodland (Table 4) have had many animals culled, including the North Pennines, Cumbria Fells and Dales and Yorkshire Dales. The latter two Natural Areas are also in the highest group of upland Natural Areas for numbers of woodland SSSI units (English Nature 2001).

The extensive livestock losses in the upland areas of England have affected SSSIs containing grazed woodland, for example Mollen Woods in Cumbria. Further examples are discussed in sections 4.6.1 and 4.6.2. Atmospheric pollution from pyres in upland areas may affect upland woods, while increases in deer numbers could be occurring because of reduced deer control.

Short and long term effects

The impact of atmospheric pollution on upland woods from pyres needs further examination. More information is needed on location and distance of disposal sites in relation to important woodlands to begin to assess impacts on sensitive species such as lichens. Short term lack of livestock grazing

is unlikely to have a great impact on the biodiversity of upland woods. If there is a long term reduction in stock numbers in woods currently being overgrazed, this could be beneficial both for tree regeneration, scarce scrub species such as juniper and for lower plants. In contrast, some species may fare less well under reduced grazing, such as the priority Biodiversity Action Plan species *Carabus intricatus*, the blue ground beetle, and some fungi. Complete lack of any grazing over the long term would be undesirable for nature conservation interests but is unlikely to happen because of increases in deer numbers. Indeed, long term increases in deer numbers could pose similar problems to those in lowland woods (section 3.5). Expansion of native woodland and scrub in the uplands, encouraged by appropriate incentives, would have long term positive benefits, where it was targeted on land currently of low nature conservation value.

4.3 Upland calcareous grassland, limestone pavement, wetland and freshwater habitats

4.3.1 Overview

Significance of livestock grazing

Upland calcareous grassland is found on thin, infertile soils over Carboniferous Limestone and other calcareous rocks in Northern England. These low nutrient soils, in combination with a history of livestock grazing, have resulted in grasslands containing a rich diversity of lime-loving grasses and herbs. Typical species are fairy flax (*Linum catharticum*), wild thyme (*Thymus polytrichus*) and common rock-rose (*Helianthemum nummularium*). Wetter areas support species such as bird's-eye primrose (*Primula farinosa*) and alpine bartsia (*Bartsia alpina*). At high altitudes in the Pennines, species such as alpine forget-me-not (*Myosotis alpestris*) and spring gentian (*Gentiana verna*) are found. Without grazing, upland calcareous grassland would become woodland except at altitudes above the tree line (about 600 metres).

Traditionally, mixed cattle and sheep grazing occurred on upland calcareous grassland but over the last 40 years mixed systems have declined, and the trend has been towards sheep production. Sheep are more selective grazers and higher numbers in recent years have reduced the diversity and abundance of herbs and grasses. These problems have led to about 67% by area of the upland calcareous SSSI units assessed in England being in unfavourable condition (English Nature 2001).

Limestone pavements are often found within larger expanses of upland calcareous grassland, particularly in the Yorkshire Dales, which has 50% of the UK's limestone pavements. These expanses of exposed rock, deeply fissured by cracks known as grykes, provide a habitat for a wide range of plants including scarce species such as dark-red helleborine (*Epipactis atrorubens*) and rigid buckler-fern (*Dryopteris submontana*). Under traditional livestock grazing systems pavement floras were not heavily grazed, but increases in numbers of sheep, which are agile grazers of these rocky areas, has confined vulnerable plants to the grikes. In 1999, 40% of all pavements were in unfavourable condition due to overgrazing (English Nature 2001).

Floristically-rich calcareous fens and flushes are a feature of upland calcareous landscapes. At lower altitudes they generally depend on grazing to keep them open. Their fauna includes rare species such as the snails *Vertigo genesii* and *V. geyeri*, which are listed on Annex 2 of the

European Union Habitats and Species Directive. Freshwater habitats in these areas have their own diverse flora and fauna, for example stoneworts (*Chara* species) and white-clawed crayfish (*Austropota mobius pallipes*).

Impact of the FMD outbreak: Natural Areas and designated sites

Table 4 shows that the Yorkshire Dales, North Pennines and Cumbria Fells and Dales are outstanding for their upland habitats, which include calcareous grasslands. These Natural Areas have also suffered heavily in the FMD outbreak (Table 2).

Stock have been culled from large areas of upland calcareous grassland and associated limestone pavement in Northern England. Particularly heavy losses have occurred in the Craven area of the Yorkshire Dales. For example, at the time of writing, the Malham-Arncliffe SSSI within the Craven Limestone Complex candidate Special Area of Conservation had lost about one half of the livestock that used to graze it. Runoff of disinfectant into freshwaters and wetlands is another potential impact. Vulnerable sites include Malham Tarn and its associated wetlands and tributary streams in the Craven Limestone Complex. The Tarn is a Ramsar site as well as being part of the candidate Special Area of Conservation. The Moor House and Upper Teesdale example in section 4.6.1 includes further discussion of impacts on upland calcareous habitats.

Short and long term effects

There will probably not be a major effect on the grassland and pavement flora if there is no grazing for a year or two, apart from increased flowering of plants such as common rock-rose which are normally suppressed by high levels of grazing. Some invertebrates may also benefit in the short term such as the northern brown argus (*Aricia ataxerxes*), a priority Biodiversity Action Plan butterfly, which feeds on rock-rose. However, long term absence of grazing would result in rank, less diverse, grassland and replacement of grassland by scrub and woodland. Change in the flora of pavements would most likely be very slow though eventually trees would begin to dominate. Fauna and flora of open flushes and wetlands at lower altitudes would suffer if there was long term lack of grazing but at high altitudes they would be kept open by the harsh climate.

Runoff of disinfectants is a particular hazard in limestone areas because of the fissured character of the underlying rock. Freshwater and wetland habitats such as those in the Malham Tarn area need monitoring to ascertain if they have been affected. Although the current report is concerned with biodiversity it is worth noting that pollution disease control measures such as use disinfectants could have impacts on underground limestone features of geological interest. These risks need further examination.

If environmentally sustainable grazing is instituted as part of re-stocking after FMD, this would be a great benefit for both upland calcareous grassland and limestone pavement. In particular, a return to more mixed livestock systems and lower sheep numbers would be crucial. Agri-environment schemes and agreements under English Nature's Wildlife Enhancement Scheme have an important role to play in ensuring that the limestone country of Northern England can be farmed in an economically and environmentally sustainable way.

4.4. Upland moorland, blanket bog, flushes and freshwater habitats

4.4.1 Overview

Significance of livestock grazing

Upland moorland and blanket bog habitats comprise much of the rough grazing land above the moor wall in the uplands of England. This rough grazing land is a key part of upland livestock farming systems, which are primarily sheep meat production enterprises. Upland heath and acid grassland are extensive moorland vegetation types, both resulting from forest clearance and a history of livestock grazing. Upland heath is dominated by heather (*Calluna vulgaris*) and grazing management has included burning to produce younger, more palatable shoots of heather for livestock and for red grouse (*Lagopus lagopus*), the latter being managed for sporting purposes. Red grouse and merlin (*Falco columbarius*) have their English strongholds on upland heath, along with rare and local invertebrates, such as the ground beetle *Carabus nitens*. Species-poor acid grassland has replaced upland heath in overgrazed uplands, a trend that has increased in recent decades with the great increases in sheep numbers in the uplands. Between 1980 and 2000 the number of breeding ewes in the Less Favoured Areas, which are primarily uplands, increased by 35% in England. Among upland heath SSSI units in England, 72% of the area assessed is in unfavourable condition (English Nature 2001).

Blanket bog is another extensive habitat in the uplands. It is formed in cool, wet climates where waterlogged plant material decomposes very slowly. As a result a blanket of peat builds up. Bog mosses (*Sphagnum* species) are a vital part of bog vegetation because they retain water like a sponge. As is the case on lowland raised bogs, wetness and low nutrient levels inhibit tree and shrub colonisation. Other characteristic plants of blanket bog are cottongrasses (*Eriophorum* species), cross-leaved heath (*Erica tetralix*) and heather. Blanket bogs are important habitats for a wide range of species including internationally significant populations of golden plover (*Pluvialis apricaria*) and dunlin (*Calidris alpina*). More nutrient rich flushes and fens are often found in a blanket bog landscape and support their own characteristic species such as butterwort (*Pinguicula vulgaris*) and yellow saxifrage (*Saxifraga aizoides*). Historically, blanket bog was lightly grazed by livestock though it has very low agricultural productivity. Overgrazing, poorly managed burning, drainage attempts and conifer afforestation have all reduced and degraded blanket bog. Overall in England, 60% of blanket bog SSSI units assessed are in unfavourable condition (English Nature 2001).

The headwaters of many important river and lake systems lie in upland moorland areas, for example the River Derwent and Bassenthwaite Lake candidate Special Area of Conservation in the northern Lake District. Overgrazing of moorlands can lead to reductions in the soil-binding capacity of upland vegetation and cause increased soil erosion into freshwater habitats.

Impact of the FMD outbreak: Natural Areas and designated sites

Three of the upland Natural Areas that have been most heavily affected by FMD, namely the Yorkshire Dales, North Pennines and Cumbria Fells and Dales are outstanding for moorland habitats, including blanket bog (Table 4). Livestock has been lost from extensive stretches of the

uplands in the Pennines and the Cumbrian fells. Several large upland SSSIs in these areas, containing a range of upland habitats, have lost stock, including Moor House and Cross Fell, the Skiddaw Group and Appleby Fells. Blanket bogs in these areas have been affected, and in other sites, for example Butterburn Flow SSSI in the Border Uplands Natural Area. Many losses have been due to culling of stock away-wintered in lowland areas. For example, sheep on Moor House SSSI are usually wintered in the Eden Valley and in 2001 were culled there. Impacts are discussed further in the upland landscape examples in sections 4.6.1 and 4.6.2.

Short and long term effects

Given the pre-existing problems of overgrazing in many areas, short-term lack of grazing is unlikely to have negative impacts. Long term lack of grazing would deleteriously affect dry and wet upland heath and drier blanket bogs as well as small flushes which require a degree of grazing to maintain their characteristic plants and animals which depend on open conditions. On wetter blanket bogs, tree and shrub growth would probably be limited in the absence of livestock grazing. Some uplands are managed as grouse moor by rotational burning and are either not grazed by livestock, or are grazed by very low numbers of livestock, and would therefore be unaffected by long term lack of livestock.

If environmentally sustainable levels of grazing can be implemented after the outbreak, upland habitats would benefit and risks of soil erosion into freshwater habitats reduced. Stocking levels would need to vary, for example very low levels (around 0.015 LU/ha) on unproductive blanket bog would help these habitats to recover to a favourable condition.

Re-stocking may not be an easy task because of the loss of hefted flocks which had their own territories on the hill. Extra shepherding effort is therefore likely to be needed. For example, hefted flocks have been lost from Hexhamshire Moors SSSI (Northumberland) and Cotherstone Moor SSSI (Durham). English Nature is in discussion with commoners here about how to reinstate hefts by using traditional shepherding methods. The other alternative to re-establishing hefts would appear to be dividing up unenclosed moorland by fencing. As well as having access and landscape implications, fencing would impact on moorland nesting birds both in terms of increasing bird collisions with wire fencing (black grouse are especially vulnerable) and providing perches for crows and other corvids, thus increasing predation risks for eggs and young of wading birds. Another major advantage of shepherding management is that it enables effective and sustainable utilisation of available forage, whilst preventing problems such as localised overgrazing on dwarf shrub heaths.

Development of agri-environment schemes and English Nature's Wildlife Enhancement agreements are key elements in recovery action to ensure that there is a future for economically and environmentally sustainable livestock farming in the uplands.

4.5 Montane habitats

4.5.1 Overview

Significance of livestock grazing

Within England, montane heathland and grassland is confined to the upper slopes and summits of some of the highest fells in the Lake District and North Pennines. Plants and animals of the montane zone are adapted to wind-exposed summits, cliff ledges, screes, springs and flushes. Abundant lichens are found along with bilberry (*Vaccinium myrtillus*) and heather (*Calluna vulgaris*), while other heath areas have mats of woolly hair-moss (*Racomitrium lanuginosum*). More sheltered slopes with higher-nutrient soils have tall herb and grassland vegetation containing species such as mountain sorrel, (*Oxyria digyna*), alpine saw-wort (*Saussurea alpina*) and rare plants like alpine catchfly (*Lychnis alpina*).

Montane habitats are above the altitude at which trees can survive (about 600 metres) and so do not depend on grazing to keep them open. However, they have traditionally been grazed as part of unenclosed rough grazing land, although their agricultural productivity is very low. Increases in sheep numbers in recent years have eroded the montane heath habitats, which are particularly vulnerable because the plants grow very slowly and cannot recover quickly from trampling and over-grazing. Tall herb communities are now restricted to ledges inaccessible to sheep but would once have been found more widely. Of the area of montane SSSI units assessed, 64% are in unfavourable condition (English Nature 2001).

Impact of the FMD outbreak: Natural Areas and designated sites

Montane habitats are restricted to four Natural Areas, the Yorkshire Dales, Cumbria Fells and Dales, North Pennines and Border Uplands. All these Natural Areas have been heavily affected by FMD (Table 2).

Livestock has been lost from large sections of upland SSSIs containing montane habitats and species. The Skiddaw Group and Moor House and Cross Fell are examples which have moss heath on their highest summits and which have lost stock. Impacts on montane habitats and species are discussed further in sections 4.6.1 and 4.6.2.

Short and long term effects

Removal of livestock is likely to aid the recovery of overgrazed areas, especially in the longer term. Re-stocking at levels that are environmentally sustainable for adjacent moorland habitats below the montane zone may also benefit montane habitats, as would reductions in local overgrazing through more intensive shepherding during re-establishment of hefted flocks. If a long-term wilderness option of no livestock grazing in some montane areas were to be pursued, through mechanisms such as English Nature's Wildlife Enhancement Scheme, recovery of montane heath and spread of alpine flowers from their refuges on crags and screes would be the likely long term result. Invertebrates dependent on montane habitats, such as the ground beetles *Nedria nivalis*, *Leistus montanus* and *Elaphrus lapponicus*, may also benefit.

4.6 Upland landscape examples

4.6.1 Moor House and Upper Teesdale National Nature Reserve

Context

Moor House and Upper Teesdale NNR is one of the largest NNRs in England, extending over 7,400 hectares of the North Pennines Natural Area. This Natural Area has been hard hit by the FMD outbreak (Table 2).

Nature conservation value and farming pattern

The North Pennines is one of the few remaining wild areas in England. The Reserve contains an outstanding series of upland habitats comprising upland heath, blanket bog, montane heath, upland calcareous grassland and upland hay meadows. Blanket bog is particularly extensive in the Moor House section of the Reserve. Characteristic species are heather (*Calluna vulgaris*), hare's tail cottongrass (*Eriophorum vaginatum*) and bog mosses (*Sphagnum* species) and, more locally, cloudberry (*Rubus chamaemorus*). Sedges (*Carex* species) are abundant in flushes at the edges of the blanket bog and elsewhere. Other species occurring in flushes include bird's eye primrose (*Primula farinosa*) and grass-of-Parnassus (*Parnassia palustris*).

The flora of the Reserve is exceptionally rich in rare, arctic-alpine, plants including the marsh saxifrage (*Saxifraga hirculus*). This plant is found in base-rich flushes. It is listed in Annex 2 of the European Habitats and Species Directive and is a priority Biodiversity Action Plan species. Other nationally rare species also occur in calcareous flushes on the limestone outcrops, such as Teesdale sandwort (*Minuartia stricta*). In addition, these flushes are the habitat of an arctic snail species, *Vertigo genesii,* which needs permanently wet, open conditions with low growing vegetation. As mentioned in the upland calcareous habitats overview (section 4.3.1), *Vertigo genesii* is listed in Annex 2 of the European Union Habitats and Species Directive.

Dry upland calcareous grassland on the Reserve supports nationally rare and scarce species like spring gentian (*Gentiana verna*) mountain avens (*Dryas octopetala*) and alpine forget-me not (*Myosotis alpestris*). Juniper and sub-alpine birchwood occurs on crags and riversides and there are also substantial patches of juniper scrub in places, for example, on Cronkley Fell. The hay meadows have a diverse flora including melancholy thistle (*Cirsium heterophyllum*) and globe flower (*Trollius europaeus*). There is a very rich assemblage of birds on the Reserve including golden plover, dunlin, redshank, curlew, merlin, yellow wagtail (*Motacilla flava*), red grouse and black grouse. Black grouse is an example of a bird species that has declined sharply in the uplands of Britain in recent years.

The international importance of the site for nature conservation has been recognised by its inclusion within the North Pennines Special Protection Area under the European Birds Directive and the Moor House-Upper Teesdale candidate Special Area of Conservation under the European Habitats and Species Directive.

The Reserve ranges in altitude from 290 metres (940 feet) at Holwick Head to 847 metres (2,750 feet) at Great Dun Fell. The difficulties of farming in such harsh environmental conditions are recognised by the inclusion of the Reserve in a Severely Disadvantaged Area within the Pennine Less Favoured Area. The unenclosed land is predominantly used for grazing by hardy hill sheep, most of which are wintered off this land. Over half of the unenclosed land in the Reserve is common land. Suckler cattle are reared on the lower pastures and allotments. The enclosed hay meadows on the lower ground form a key part of the upland farming system practised on the Reserve, providing winter feed for cattle and sheep.

Current conservation action and threats

Despite the NNR status of the site, management has been problematical. Difficulties have arisen because of a combination of a subsidy system, which over the last forty years or so has encouraged high stocking levels, and rights of common which means that little or no control can be exercised over the levels of grazing. Overgrazing of blanket bog, montane and upland heath has been a particularly significant result. The vegetation of upland calcareous grassland and flushes is highly palatable compared to the moorland and is heavily grazed. As a consequence, the rare and scarce flora in these habitats have rarely flowered and set seed in recent years.

Other factors which mitigate against ideal management are a general trend towards rearing of sheep rather than cattle, past use of inorganic fertiliser to boost productivity of grass swards (in order to carry higher numbers of livestock) and change to higher productivity cattle breeds. One effect of these factors has been to eliminate marginal 'rough' areas of critical importance to birds such as black grouse, yellow wagtail and grey partridge (*Perdix perdix*). Species- rich grasslands, which include limestone grasslands and the upland hay meadows, have been degraded at the same time. The current agricultural regime has therefore led to the decline in quantity and quality of the key upland habitats. The main conservation work in recent years has been centred around trying to prevent losses of the most vulnerable features in the absence of a wider sustainable grazing regime.

The impact of FMD

The FMD outbreak has resulted in the almost complete removal of livestock from the Moor House (Cumbria) section of the Reserve. Some away-wintered stock from the Upper Teesdale (Durham) section have been slaughtered as well.

Likely short term impacts of reduced grazing are:

- enhanced flowering and seeding of herbs and grasses, such as cottongrass, which has flowered prolifically for the first time in many years. An example of fauna that could also benefit is black grouse. Cottongrass flowers are an important spring food source for them. Nationally rare and scarce plants have flowered and set seed this year, including marsh saxifrage, hairy stonecrop (*Sedum villosum*) and alpine forget-me -not (*Myosotis alpestris*).

- enhanced growth as well as flowering and seeding of dwarf shrubs such as heather.

- ground nesting birds may have suffered less from losses due to trampling and disturbance by livestock.

Likely impacts if there is no livestock grazing in the long term:

- Some species found within flushes, for example, *Vertigo genesii*, may decline with the removal of livestock, which keep lower altitude flushes open through grazing and trampling. In contrast, other species, especially marsh saxifrage could benefit from reduced grazing. Research is already underway to establish the effect of different grazing levels on flowering, seed set and vegetative reproduction of marsh saxifrage. Increased seed set may have beneficial consequences for genetic variation in the populations of the plant and their relative adaptability to climate change.

- Open grassland that is used for nesting by wading birds such as lapwing and curlew may become invaded by scrub and woodland.

- The conservation of the hay meadows would be at risk as these grasslands are dependant upon the continuance of a livestock farming regime.

- Increased 'naturalness' and improved condition of areas with no livestock grazing. For example, there are habitat restoration possibilities for montane heath communities, blanket bog, upland heath, juniper, willow scrub, and woodland. Species such as black grouse would also benefit from having access to a range of less heavily grazed habitats.

- Enhanced viability of rare plant populations in high altitude calcareous grasslands due to increased flowering and seed set.

Long term sustainability

The range of habitats and management practices in the Reserve broadly divide along the boundary between Cumbria and Durham. The Moor House (Cumbria) section is largely blanket bog, upland heath and montane communities. In order to secure favourable condition of these habitats, significant, long term, reductions in stocking levels are required. Enhancement of scrub and woodland habitat, particularly on the western flanks of Moor House, would benefit the recovery of black grouse in this part of the Pennines.

On the Upper Teesdale (Durham) section of the site continuation of livestock grazing at sustainable levels is necessary to maintain the nature conservation interest of the enclosed land. It is here that pastures, large allotments and hay meadows form an important component of the Reserve. Grazing of pastures and allotments which results in a tussocky sward meets the requirements of ground nesting birds (ie shelter and invertebrate food). This structure is best achieved by grazing with a combination of sheep and cattle. A more environmentally sustainable approach to stocking would be to reduce sheep numbers whilst maintaining cattle numbers. A switch to cattle breeds better suited to the local environment would also be beneficial, as long as this is feasible in production terms, for instance, to satisfy the need to finish animals within 30 months. Hardy breeds, such as Galloways, that are lighter than high productivity breeds, cause less ground damage when the land is wet and are able to thrive on naturally occurring forage. To maintain the upland meadows,

continuation of hay making, along with grazing outside of the period the meadows are shut up for hay, are both needed.

At lower altitudes, upland calcareous grassland and flushes are more productive and require grazing to keep them open whilst at high altitudes they remain open because of the harsh climate and low nutrient soils. Both types can suffer local overgrazing as they are usually composed of relatively palatable plants. Hence it is difficult to specify broad stocking levels unless a greater degree of shepherding management is deployed in order to conserve the more sensitive areas. Increased levels of shepherding would allow more sustainable grazing across the range of upland habitats in the Reserve and would also be a preferable alternative to fencing to re-establish hefts. Localised over-grazing could be avoided as would other effects such as the increased collision hazard to black grouse that would be posed by fences.

4.6.2 Northern fells of the Lake District

Context

The northern part of the Cumbrian Fells and Dales Natural Area contains two large SSSIs, Buttermere Fells and Skiddaw Group. Together, the two sites cover over 16,000 hectares. This northern section of the Natural Area has been heavily affected by FMD (Fig 2).

Nature conservation value and farming pattern

The SSSIs are within the Lake District High Fells candidate Special Area of Conservation and form part of the upland catchment of the River Derwent and Bassenthwaite Lake candidate Special Area of Conservation. Skiddaw Group also contains upland tributaries of the River Eden candidate Special Area of Conservation. Both SSSIs are of particular interest for their upland heath and montane heath and Skiddaw also has extensive blanket bog. Fragments of upland oak woodland, a priority BAP habitat, occur in both sites and Skiddaw has a notable stand of juniper. Crags in the Buttermere Fells SSSI are refuges for one of only two populations in Britain of alpine catchfly (*Lychnis alpina*). Montane invertebrate species in the Skiddaw SSSI include the rare ground beetle *Leistus montanus*. The breeding bird community is outstanding and includes peregrine (*Falco peregrinus*), merlin (*Falco columbarius*), golden plover (*Pluvialis apricaria*), ring ouzel (*Turdus torquatus*) and curlew (*Numenius arquata*).

The fells form an integral part of upland livestock farms. Hardy hill sheep are the main type of stock grazed on the fells, most of which are designated as common land. Some farms also have cattle but these generally graze lower ground. Sheep are normally present on the fells all year round but part of each flock usually spends the winter either on in-bye land near the farm or away-wintered, particularly in the Solway Basin. Controlled burning of upland heath forms part of the management regime in some areas, to produce more palatable, young, shoots of heather for the livestock.

Current conservation action and threats

Increases in numbers of sheep on the fells in recent decades have led to over-grazing of upland heath, blanket bog and montane heath, resulting in the expansion of species-poor grassland and bare ground, while grazing of the upland oakwoods and juniper has curtailed tree and shrub

regeneration. However both SSSIs are now in the Lake District Environmentally Sensitive Area. Agreements reached under this scheme have resulted in large reductions in livestock on the fells, although there are still overgrazing problems and some large common units are not under any agreement.

The Lake District National Park Authority own two of the large commons on Skiddaw. They have been working with commoners to restore blanket bog by blocking drains and have set up an appropriate programme of controlled burning of some areas of upland heath on drier slopes. The National Trust, who own much of the Buttermere Fells, are working with their tenants here and elsewhere in the Lake District to achieve environmentally sustainable management of upland habitats.

The impact of FMD

Many flocks have been culled due to the outbreak. Whole flocks of sheep have been lost from Skiddaw, including an estimated 60% of all the flocks grazing common land. Buttermere Fells SSSI has suffered losses of sheep away-wintered in the lowlands. These animals were mainly one and two year old sheep which represented the replacement generations for older ewes left on the fells over the winter.

The lack of grazing animals is not likely to have a major effect on the fauna and flora of the SSSIs if it is short term. Areas currently over-grazed would benefit from a temporary respite from grazing and a flush of tree and shrub regeneration might occur around the oakwood and juniper areas. In the longer term, upland heath habitats and drier blanket bogs would be likely to be replaced, eventually, by woodland if there continues to be no livestock grazing, thus affecting wildlife which needs open habitats, such as breeding waders.

The system of away-wintering has been disrupted by FMD and in the future farmers may wish to retain more stock on the fell or in-bye land in winter as this arrangement could be less vulnerable to future movement restrictions and disease outbreaks. Thus further over-grazing may occur in the long term on both in-bye and fell. The problems created by FMD, added to existing difficulties of hill farming, may result in more farmers giving up farming all together. As a result, there could be a reduction in sheep numbers on the fells, or the shortage of farmers willing to look after fell flocks might lead to fewer, larger, flocks and less shepherding. Especially where hefted flocks have been lost, lack of shepherding can lead to uneven grazing pressure across the hill, with some areas being over-grazed.

Long term sustainability

Environmentally sustainable grazing to conserve the range of habitats and species on the fells needs to vary in intensity, depending on the particular interest of each area. Average indicative stocking levels for restoration and maintenance of upland heath range from 0.5 to 1.5 sheep per hectare (0.075 to 0.225 LU) and for blanket bog are between 0.1 and 0.5 sheep per hectare (0.015 to 0.075 LU). Where possible, montane heath, wetter blanket bog, woodland and scrub would benefit if no livestock grazed them. Long term lack of grazing would also give the nationally rare alpine catchfly a chance of increasing its population and spreading beyond the crags on to the surrounding slopes.

More environmentally sustainable levels of grazing would reduce the risk of soil erosion onto the upland streams draining the fells, with consequent benefits for the candidate SAC river systems in this part of Cumbria. Shepherding has vital part to play in the sustainable management of the fells. Re-establishment of hefts (home territories of sheep) is an essential first stage of recovery after FMD and will require intensive shepherding. Fencing is not a complete substitute, particularly in solving problems of local overgrazing, though can be useful in some areas. The scale of grazing management required across the fells is such that there needs to be long term continuation of viable livestock farming enterprises which integrate management of habitats above the moor wall into the farming system. Agri-environment schemes and English Nature's Wildlife Enhancement Scheme agreements have a key role to play in ensuring economically and environmentally sustainable management in the future.

5. Monitoring and research topics

It should not be forgotten that the restrictions on human movement during the outbreak have hampered research and monitoring aimed at the better understanding of the ecology and the conservation needs of England's habitats, flora and fauna. For, instance, no data has been collected in 2001 for the national breeding bird survey. This annual survey is a very important tool for identifying trends in populations of common birds in relation to changes in the countryside. These limitations on scientific work have also meant that the immediate effects of the outbreak itself on biodiversity, for example the possible increase in nesting success of ground nesting birds due to less human disturbance, could not be investigated.

The current assessment of impacts of FMD on biodiversity highlights several possible research and monitoring topics that, when access restrictions permit, would assist in the fuller understanding of the effects, especially in the long term. It is likely that projects would need to cover a range of scales from site-specific to Natural Area, regional and national scales and should examine effects in relation to targets for conservation of priority BAP habitats and species. The following list is not exhaustive and other projects will undoubtedly be proposed in the coming months. Appropriate organisations to carry out these kind of projects are likely to include other organisations with biodiversity responsibilities, as well as English Nature. Some aspects are already part of existing monitoring programmes.

Research and monitoring projects should investigate the scale, character and relative persistence of the range of impacts generated by the outbreak. The list below is organised to indicate topics and more specific projects across this range of impacts. The most robust conclusions are likely to be those made in situations where pre-FMD data is available for comparison, for example from the recent barn owl study (Toms et al 2001) or the lichen monitoring programme in Moccas Park NNR.

Pollution and damage from disease control measures

- Environmental audit of disposal sites and their surroundings to examine whether sensitive habitats and species have been affected, for example by increases atmospheric deposition of nitrogen compounds.
  - Monitoring of plants sensitive to atmospheric pollution, eg epiphytic lichens and mosses, in selected locations.
  - Investigation of leachate risks from disposal sites in the catchments of sensitive wetland and freshwater habitats.
- Environmental monitoring of impacts from disinfectant and rodenticide use.
  - Wildlife and pollution monitoring programme including rodenticide residue monitoring in species such as polecat and barn owl.

- C Monitoring of barn owl populations inside and outside infected areas (link to wildlife and pollution monitoring).

- C Assessment of the impact of disinfectant runoff on macro-invertebrates of freshwater habitats.

- C Evaluation of risks to underground, karstic, geological features in limestone areas from disinfectant runoff.

Loss of livestock grazing, increases in grazing levels and long term changes in the structure of the livestock industry

- **!** Condition assessment of designated sites, supported by detailed monitoring on selected sites, with particular reference to under-grazing and overgrazing effects on biodiversity.

- **!** Study of the changes in plant and animal communities in habitats where grazing is removed over the long term.

- **!** Monitoring of species populations in relation to changes in grazing management, in particular where species populations were in a precarious state before FMD.

    - C Study of population dynamics and diet of the greater horseshoe bat inside and outside infected areas.

    - C Monitoring of marsh fritillary, high brown fritillary and blue ground beetle populations in infected areas.

    - C Monitoring of rare upland plants, such as marsh saxifrage, in relation to grazing levels and research into the significance of flowering and seed set on long term survival.

    - C Monitoring of bird breeding and wintering numbers and distribution at affected nature conservation sites, eg barnacle geese on the Solway Firth.

- **!** Assessment of the progress of re-stocking after the outbreak in relation to grazing required to conserve biodiversity and examination of trends towards intensification and extensification of livestock farming in relation to habitats and species.

- **!** Improvement in the understanding of geographical and stock type relationships in the livestock sector after the outbreak in relation to the requirements for sustainable grazing for biodiversity.

Cessation of countryside management and activities due to access restrictions and related issues such as loss of venison export markets

- ! Repeat recording of a national series of long term woodland monitoring plots, in particular to assess effects due to changes in deer grazing levels.

Changes in land use where livestock grazing ceases

! Investigation of land use change, especially in heavily affected areas, particularly in relation to diffuse pollution loads in sensitive river catchments, and to landscape mosaics that support wide-ranging species such as bats.

Acknowledgements

The production of this report would not have been possible without contributions from a large number of English Nature staff. Contributors included:

National specialists in English Nature: Dr Isabel Alonso (heathland ecologist), Carl Borges (fungi ecologist), Dr Andy Brown (ornithologist), Dr Alastair Burn (pollution ecologist), Alistair Crowle (upland ecologist), Dr Martin Drake (invertebrate ecologist), Jim Foster (amphibian and reptile ecologist), Phil Grice (ornithologist), Dr George Hinton (data analyst), Siâron Hooper (livestock policy officer), Dr Keith Kirby (woodland ecologist), Dr Roger Key (invertebrate ecologist), Peter Lambley (lichen ecologist), Simon Leach (botanist: vascular plants), Chris Mainstone (freshwater ecologist), Dr Roger Meade (peatland adviser), Dr Tony Mitchell-Jones (mammal ecologist), Ron Porley (botanist: vascular plants, mosses and liverworts), Susan Rees (coastal conservation adviser), Dr Heather Robertson (grassland ecologist), Dr David Sheppard, (invertebrate ecologist), Ian Taylor (botanist: vascular plants).

Local Team information co-ordinators : Cumbria Team: Jean Johnston, Devon Local Team: David Appleton, Hampshire and Isle of Wight Team: Russell Wright, Kent Team: Rob Cameron, North and East Yorkshire Team: Paul Evans, Northumbria Team: Chris McCarty, North West Team: Robert Wolstenholme, Suffolk Team: Nick Sibbett, Sussex and Surrey Team: Malcolm Emery, Thames and Chilterns Team: Graham Steven, Three Counties Team: Helen Stace.

Other specialists: Dr Jonathan Foot, Air pollution impacts adviser (Joint Nature Conservation Committee).

Helpful information and comments were also provided by:

John Bacon, Simon Bates, Jonathan Burney, Ian Carter, Richard Cooper, Sarah Cureton, Dr Val Cooper, Mike Edwards, Dr David Evans, Jonathan Graham, Chantal Hagan, Richard Hall, Dr Peter Holmes, Dr John Hopkins, Bruce Keith, Dick Lambert, Jane Lusardi, Kath Milnes, Colin Newlands, Charlotte Pagendam, Rob Petley-Jones, Mick Rebane, Allan Stewart, Jill Sutcliffe, John Torlesse, David Townshend, Simon Webb, Mike Wilkinson, Richard Wilson, Richard Wright (English Nature), Bill Grayson (Grazing Animals Project), Oliver Harwood and Tanya Olmeda-Hodge (Country Land and Business Association), Dr John Harvey (National Trust), John Osmond, Dr Geoff Radley, Elizabeth Knapp (Department of Environment Food and Rural Affairs), Malcolm Stott (Royal Society for the Protection of Birds), Jane Kinniburgh (Environment Agency).

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Figures

Figure 1 Number of FMD cases by week

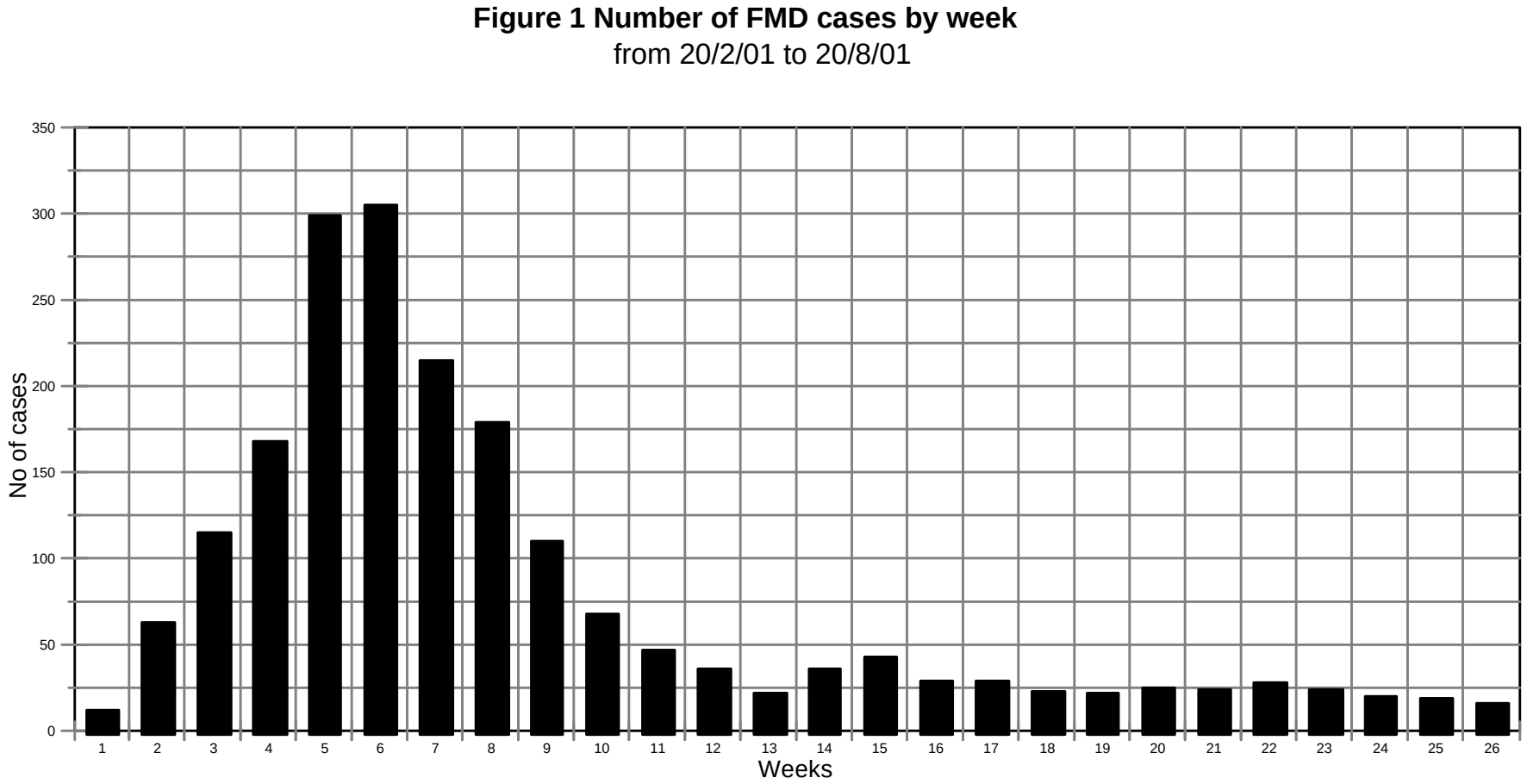


Figure 2
Distribution of FMD infected premises (with 3 km buffer) across England's Natural Areas
DEFRA data for 9 August 2001

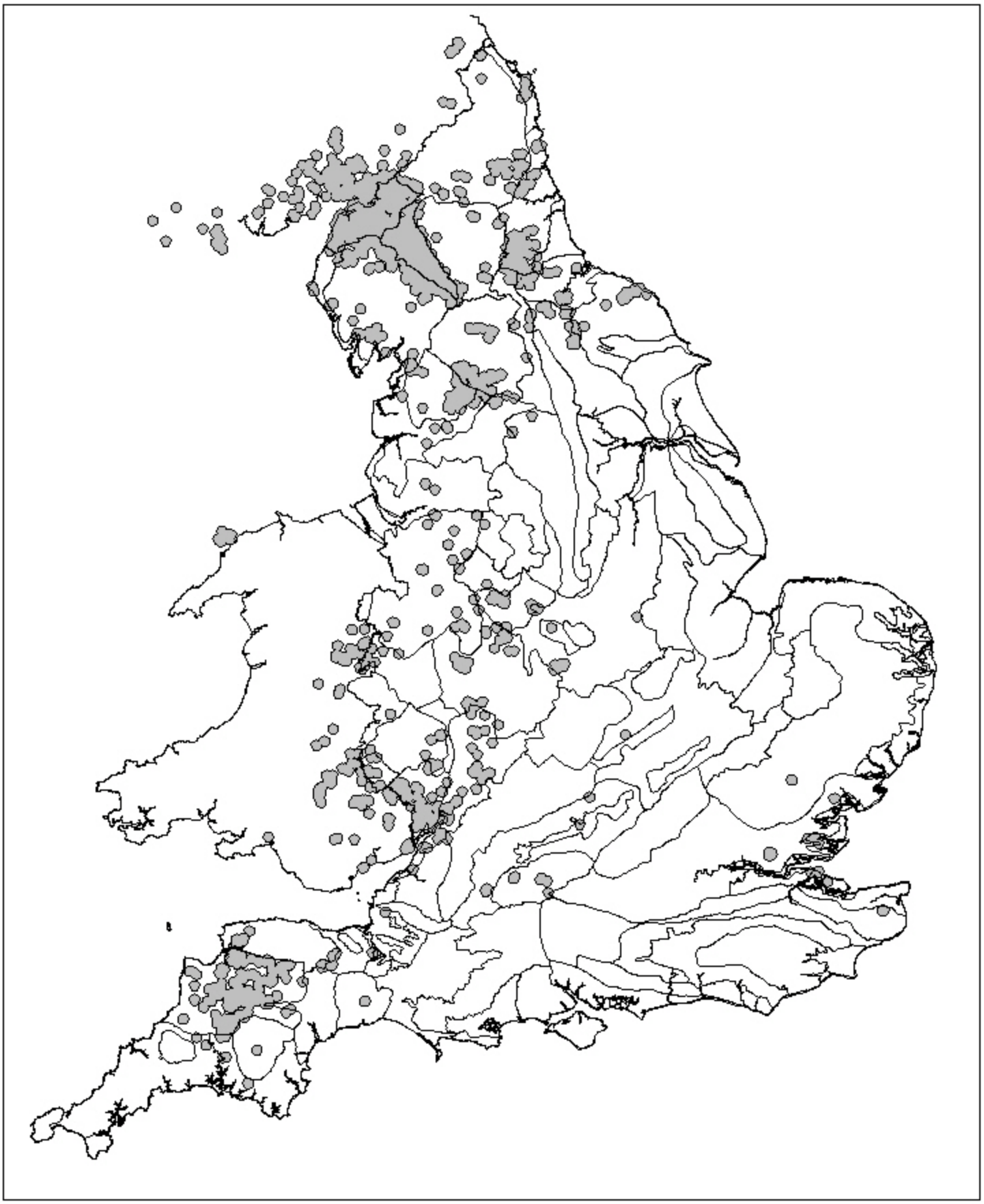


Figure 3
England's Natural Areas showing upland Natural Areas in grey
See Table 2 for key to numbers

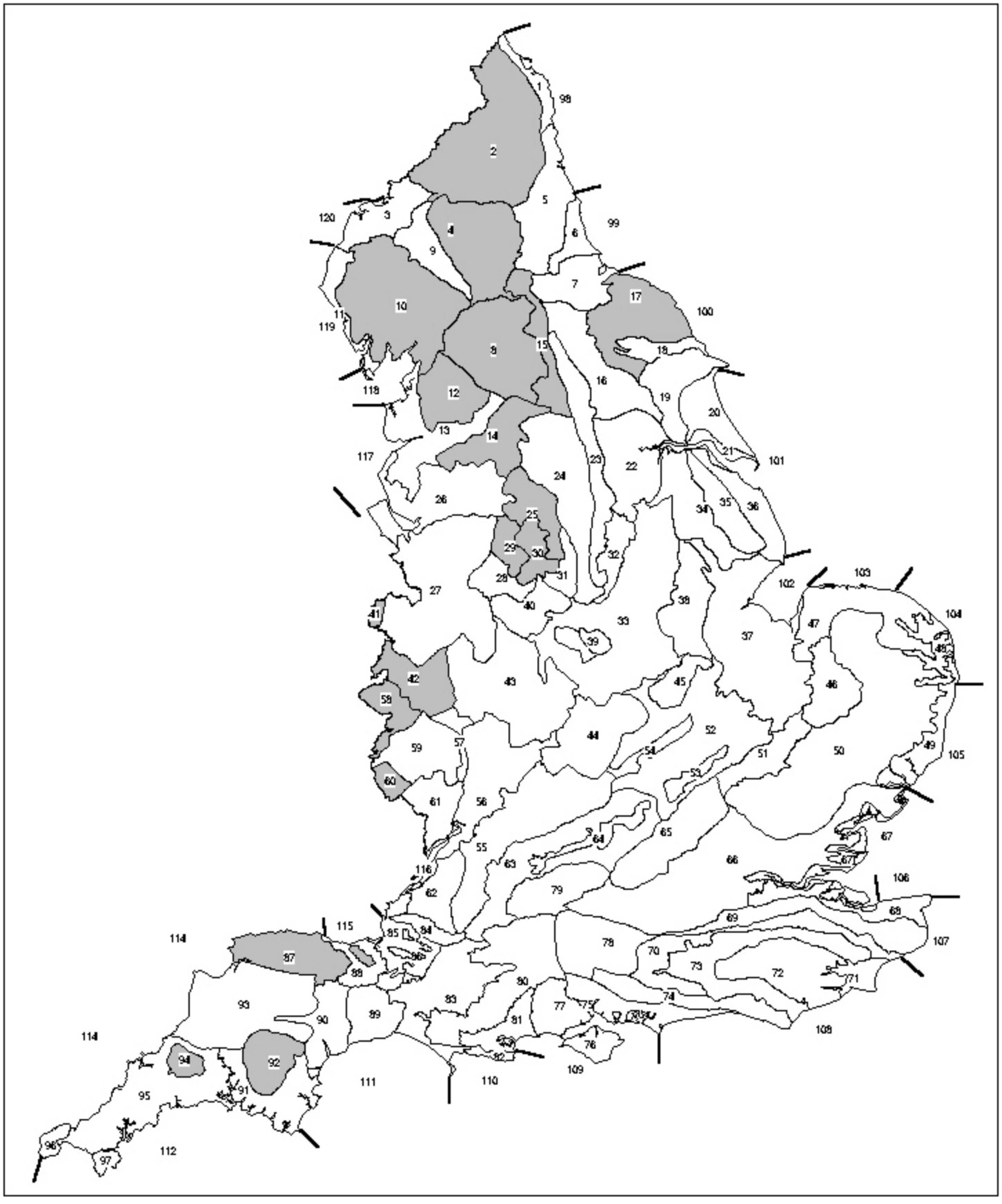


Figure 4
Percentage of sheep flock culled in each county
Based on DEFRA cull data for 21 August 2001
Agricultural census data for 2000

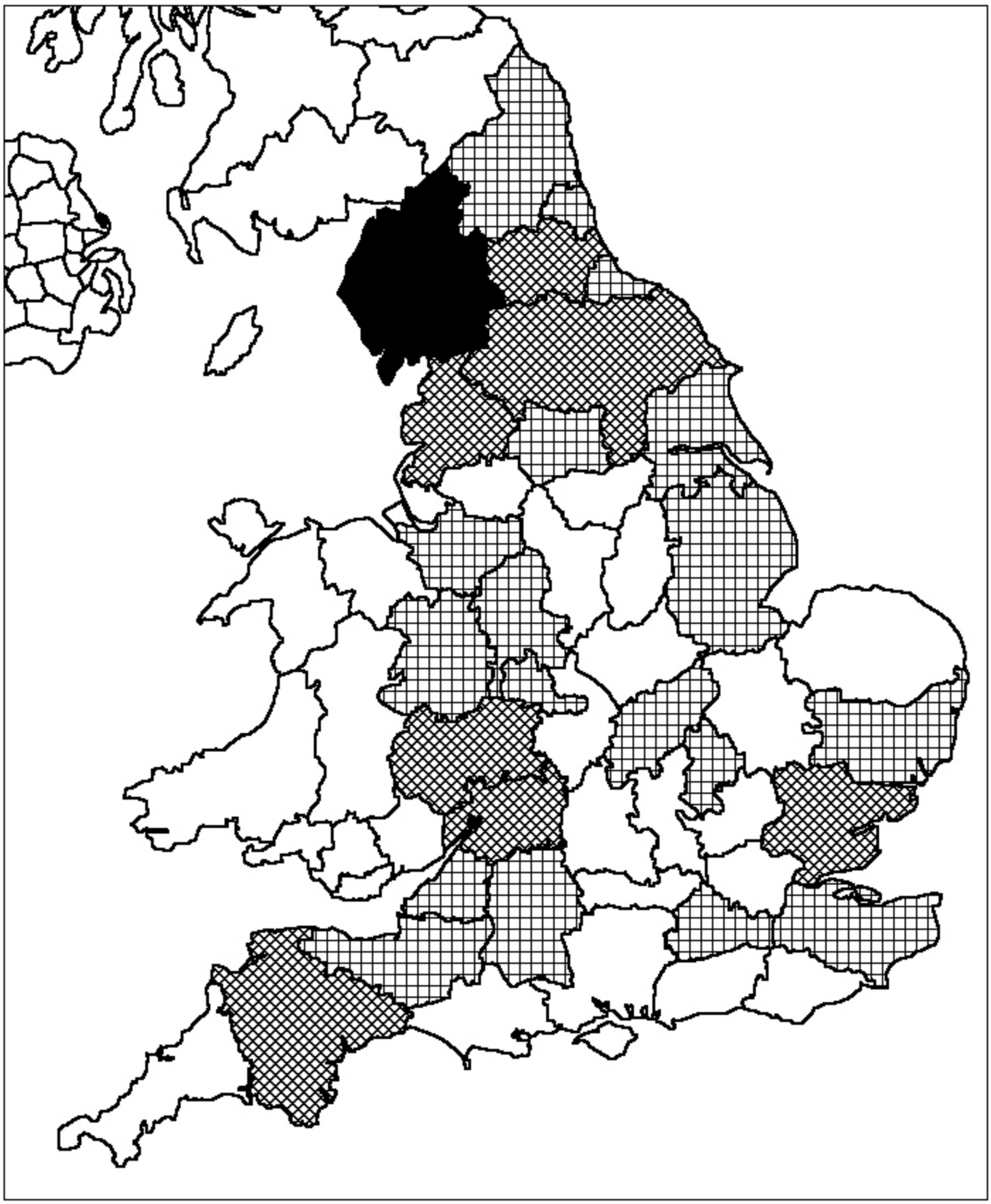


Figure 5
Percentage of cattle herd culled in each county
Based on DEFRA cull data for 21 August 2001
Agricultural census data for 2000

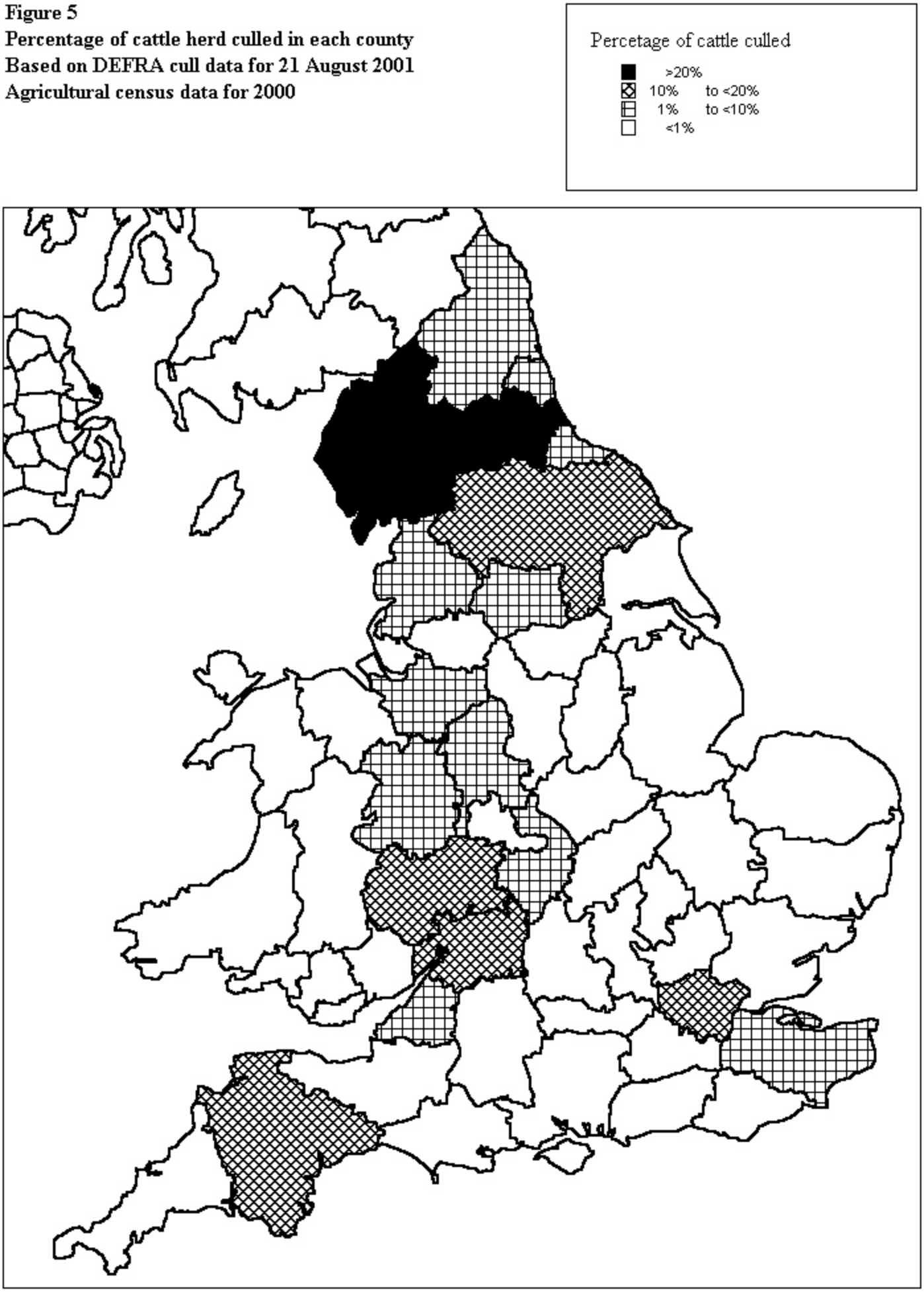
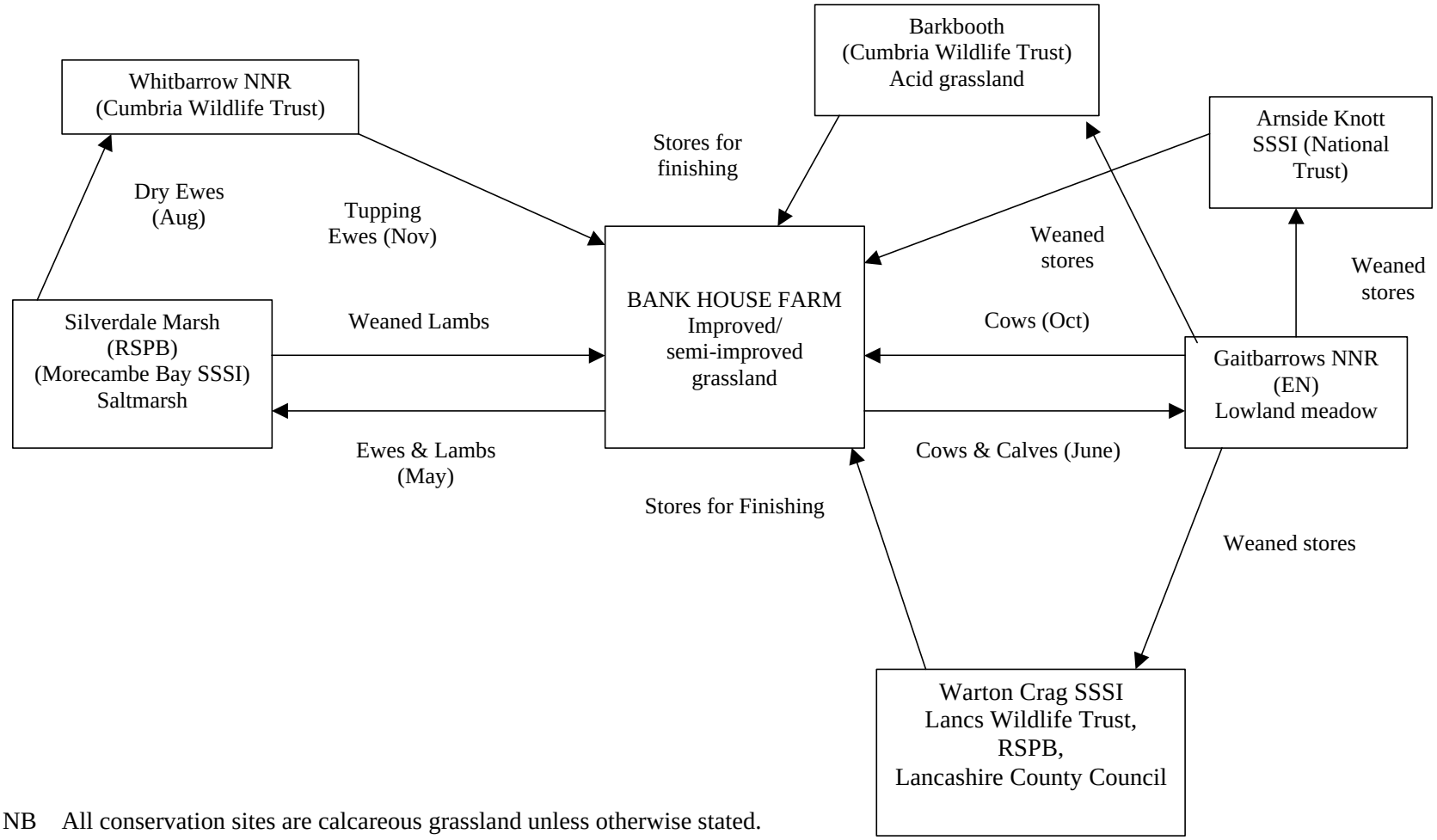


Figure 6 Integrated grazing management at Bank House Farm (Cumbria)



NB All conservation sites are calcareous grassland unless otherwise stated.

Tables

Table 1 Effects of FMD on biodiversity: issues and impacts illustrated by the main examples in the report	
Habitats and species examples and designations	**Issues and impacts**
Lowland grassland landscapes	
Culm grassland and marsh fritillary cSAC and Annex 2 species, SSSIs, priority BAP habitat and species.	Loss of livestock and movement restrictions. Need to keep viable livestock farming going in areas it still exists. Need to consider landscape scale of sustainable post-FMD livestock farming.
Malvern Hills and high brown fritillary SSSI, priority BAP habitats and species.	Precarious species further endangered by FMD effects on livestock farming and habitat management. Possible long term need for regional grazing scheme if local grazing cannot be re-vitalised.
Greater horseshoe bats in Dean Plateau and Wye Valley Annex 2 species, SSSI, priority BAP species.	Loss of livestock. Importance of wider countryside/landscape scale to conservation of wide-ranging species and FMD effects on long term land use.
Lowland heathland	
East Devon Pebble Bed Heaths (southern damselfly) SPA, cSAC, Annex 2 species, SSSI, priority BAP habitat and species.	Long distance origin of stock grazing conservation sites, loss of stock over-wintered off site.
New Forest RAMSAR, SPA, cSAC, Annex 2 species, SSSI, priority BAP habitats and species.	Loss of livestock. Fragility of extensive grazing systems in the lowlands.
Lowland wetlands and freshwater habitats	
The River Wye (salmon and pearl mussel) cSAC, SSSI, Annex 2 species, priority BAP species.	Loss of livestock. Catchment level effects of potential land use change resulting from FMD outbreak
Coastal habitats	
Solway Firth salt marshes (birds, amphibians) SPA, cSAC, SSSI, priority BAP habitat and species.	Loss of livestock. Need for emergency management. Variation in sustainable management for different biodiversity interests post-FMD.
Ainsdale sand dunes cSAC, NNR, SSSI, priority BAP habitat and species.	Movement restrictions. Survival of conservation grazing livestock. Disruption to site management and monitoring.
Silloth Dunes and Mawbray Bank (amphibians) SSSI, priority BAP habitat and species.	Removal of livestock due to FMD. Economically sustainable management by livestock versus machines/people. Recreation access and livestock grazing in post-FMD climate.
Lundy cabbage on Lundy Island (rare plant and invertebrate fauna) Part SSSI, priority BAP habitat and species.	Movement restrictions. Compounding of existing overgrazing problems. Linkage of rare invertebrate and plant conservation.
Lowland woodland, wood pasture and scrub	
Moccas Park (lichens and dead wood invertebrates) NNR, SSSI, priority BAP habitat and species.	Potential pollution effects from pyre disposal site. Reduced grazing in wood pasture.

Table 1 Effects of FMD on biodiversity: issues and impacts illustrated by the main examples in the report	
Habitats and species examples and designations	**Issues and impacts**
Upland landscapes	
Hay meadows in the Yorkshire Dales cSAC, SSSI, priority BAP habitat.	Movement restrictions. Reliance of flora on traditional livestock farming which needs to continue post-FMD.
Geltsdale and Glendue Fells and wading birds of fringing grasslands SPA, cSAC, SSSI.	Loss of livestock. Problems of over-stocking prior to FMD and opportunity for sustainable re-stocking after FMD.
Moorhouse and Upper Teesdale (range of upland habitats, valley to montane, birds, plants, invertebrates) SPA, cSAC, NNR, SSSI, Annex 2 species, priority BAP habitats and species.	Loss of livestock. Problems of overgrazing prior to FMD. Opportunity for environmentally sustainable grazing post-FMD, including increased shepherding. Inter-relations of habitats and management in the landscape.
Northern fells of the Lake District (range of upland habitats, plants, invertebrates, birds) cSAC, SSSI, priority BAP habitats and species.	Loss of livestock. Fragility of upland farming systems. Potential for more overgrazing if away-wintering declines. Opportunities for environmentally sustainable stocking, including increased shepherding post-FMD.

Continued

Table 2 Natural Areas and FMD impacts							
Natural Area no	**Natural Area Name**	**NA type**	**Percent Natural Area in 3km buffer zones**	**No of infected premises**	**Number of cattle culled**	**Number of sheep culled**	**Total livestock culled**
1	North Northumberland Coastal Plain	Lowland	20	5	965	12,800	13,901
2	Border Uplands	Upland	17	47	13,858	126,394	140,991
3	Solway Basin	Lowland	99	376	93,148	207,391	317,775
4	North Pennines	Upland	17	17	4,397	57,757	62,311
5	Northumbria Coal Measures	Lowland	40	88	17,987	68,551	94,043
6	Durham Magnesian Limestone Plateau	Lowland	10	3	306	1,136	1,442
7	Tees Lowlands	Lowland	27	22	7,004	23,931	33,866
8	Yorkshire Dales	Upland	22	54	16,981	148,493	165,711
9	Eden Valley	Lowland	99	262	62,496	255,936	334,675
10	Cumbria Fells and Dales	Upland	33	179	42,577	292,452	340,835
11	West Cumbria Coastal Plain	Lowland	20	7	3,738	25,099	28,908
12	Forest of Bowland	Upland	30	53	22,902	86,160	109,304
13	Lancashire Plain and Valleys	Lowland	13	13	6,250	27,044	33,407
14	Southern Pennines	Upland	7	4	2,694	7,359	10,078
15	Pennine Dales Fringe	Upland	17	10	6,311	21,915	28,632
16	Vale of York and Mowbray	Lowland	13	21	9,141	23,439	47,417
17	North York Moors and Hills	Upland	12	24	6,939	31,570	39,234
18	Vale of Pickering	Lowland					
19	Yorkshire Wolds	Lowland			162	3,071	3,233
20	Holderness	Lowland					
21	Humber Estuary	Lowland					
22	Humberhead Levels	Lowland					
23	Southern Magnesian Limestone	Lowland			34	308	342
24	Coal Measures	Lowland	3	4	652	4,502	5,154
25	Dark Peak	Upland				42	42
26	Urban Mersey Basin	Lowland	3	2	487	221	708
27	Mosses & Meres	Lowland	13	27	5,453	28,229	36,743
28	Potteries and Churnet Valley	Lowland	12	3	561	758	1,329
29	South West Peak	Upland	6	1	91	660	751
30	White Peak	Upland					
31	Derbyshire Peak Fringe and Lower Derwent	Lowland					
32	Sherwood	Lowland				420	420
33	Trent Valley and Rises	Lowland	3	15	2,351	5,324	7,724
34	North Lincolnshire Coversands and Clay Vales	Lowland			170	40	210
35	Lincolnshire Wolds	Lowland					
36	Lincolnshire Coast and Marshes	Lowland					

Table 2 Natural Areas and FMD impacts							
Natural Area no	**Natural Area Name**	**NA type**	**Percent Natural Area in 3km buffer zones**	**No of infected premises**	**Number of cattle culled**	**Number of sheep culled**	**Total livestock culled**
37	The Fens	Lowland				3,781	3,781
38	Lincolnshire and Rutland Limestone	Lowland	<1				
39	Charnwood	Lowland					
40	Needwood and South Derbyshire Claylands	Lowland	22	20	4,902	7,311	12,315
41	Oswestry Uplands	Upland				2,428	2,428
42	Shropshire Hills	Upland	12	7	3,529	14,792	18,336
43	Midlands Plateau	Lowland	14	27	3,532	26,073	33,818
44	Midland Clay Pastures	Lowland				1,800	1,801
45	Rockingham Forest	Lowland					
46	Breckland	Lowland					
47	North Norfolk	Lowland					
48	The Broads	Lowland				86	86
49	Suffolk Coast and Heaths	Lowland			19	3,530	3,549
50	East Anglian Plain	Lowland	<1	1	240	694	1,688
51	East Anglian Chalk	Lowland					
52	West Anglian Plain	Lowland	1	1		1,157	1,157
53	Bedfordshire Greensand Ridge	Lowland				947	947
54	Yardley-Whittlewood Ridge	Lowland	<1			699	699
55	Cotswolds	Lowland	1	1	282	1,413	1,695
56	Severn and Avon Vales	Lowland	30	54	19,556	58,996	91,599
57	Malvern Hills and Teme Valley	Lowland	3		20	1,500	1,520
58	Clun and North West Herefordshire Hills	Upland	4	1	115	4,706	4,821
59	Central Herefordshire	Lowland	14	11	2,911	15,909	19,237
60	Black Mountains and Golden Valley	Upland	49	7	3,699	31,624	35,494
61	Dean Plateau & Wye Valley	Lowland	65	59	9,429	75,758	86,131
62	Bristol, Avon Valleys and Ridges	Lowland	4	1	76	5	99
63	Thames and Avon Vales	Lowland	3	4	30	4,056	4,090
64	Midvale Ridge	Lowland	4	1		266	266
65	Chilterns	Lowland					
66	London Basin	Lowland	2	8	1,206	5,630	7,825
67	Greater Thames Estuary	Maritime	11	4	192	4,500	5,239
68	North Kent Plain	Lowland	2	1	402	251	653
69	North Downs	Lowland	2	2	202	7,684	7,886
70	Wealden Greensand	Lowland				100	100
71	Romney Marsh	Lowland					
72	High Weald	Lowland					

Continued

Table 2 Natural Areas and FMD impacts							
Natural Area no	**Natural Area Name**	**NA type**	**Percent Natural Area in 3km buffer zones**	**No of infected premises**	**Number of cattle culled**	**Number of sheep culled**	**Total livestock culled**
73	Low Weald and Pevensey	Lowland			299	1,951	2,250
74	South Downs	Lowland					
75	South Coast Plain and Hampshire Lowlands	Lowland					
76	Isle of Wight	Lowland					
77	New Forest	Lowland					
78	Hampshire Downs	Lowland					
79	Berkshire and Malborough Downs	Lowland	10	6	121	2,639	5,413
80	South Wessex Downs	Lowland					
81	Dorset Heaths	Lowland					
82	Isles of Portland & Purbeck	Lowland					
83	Wessex Vales	Lowland			38	1,781	1,819
84	Mendip Hills	Lowland	2				
85	Somerset Levels and Moors	Lowland	4	1	296	835	1,478
86	Mid Somerset Hills	Lowland				35	35
87	Exmoor &The Quantocks	Upland	12	15	5,276	35,202	40,864
88	Vale of Taunton and Quantock Fringes	Lowland	13	3	1,191	3,798	4,991
89	Blackdowns	Lowland	3	1	1,577	5,634	7,111
90	Devon Redlands	Lowland	5	3	1,610	9,000	10,747
91	South Devon	Lowland	7	7	2,183	13,619	15,810
92	Dartmoor	Upland	5	1	1,373	2,511	3,884
93	The Culm	Lowland	54	152	61,525	213,009	310,876
94	Bodmin Moor	Upland					
95	Cornish Killas and Granites	Lowland	2	2	799	2,616	3,509
96	West Penwith	Lowland					
97	The Lizard	Lowland					
98	Northumberland Coast	Maritime					
99	Tyne to Tees Coast	Maritime					
100	Saltburn to Bridlington	Maritime					
101	Bridlington to Skegness	Maritime					
102	The Wash	Maritime					
103	Old Hunstanton to Sheringham	Maritime					
104	Sheringham to Lowestoft	Maritime					
105	Suffolk Coast	Maritime					
106	North Kent Coast	Maritime					
107	East Kent Coast	Maritime					
108	Folkestone to Selsey Bill	Maritime					
109	Solent and Poole Bay	Maritime					

Continued

Table 2 Natural Areas and FMD impacts							
Natural Area no	**Natural Area Name**	**NA type**	**Percent Natural Area in 3km buffer zones**	**No of infected premises**	**Number of cattle culled**	**Number of sheep culled**	**Total livestock culled**
110	South Dorset Coast	Maritime					
111	Lyme Bay	Maritime					
112	Start Point to Land's End	Maritime					
113	Isles of Scilly	Maritime					
114	Land's End to Minehead	Maritime					
115	Bridgwater Bay	Maritime					
116	Severn Estuary	Maritime					
117	Liverpool Bay	Maritime					
118	Morecambe Bay	Maritime					
119	Cumbrian Coast	Maritime					
120	Solway Firth	Maritime					
Note: Based on DEFRA data for 9 August 2001							
Total livestock culled include pigs, goats, deer etc.							

Continued

Table 3 Proportions of livestock culled by county									
County	**Size of sheep flock**	**Number of sheep culled**	**Percent sheep culled**	**Size of cattle herd**	**Number of cattle culled**	**Percent cattle culled**	**Total livestock (sheep, cattle, pigs)**	**Number of livestock culled (sheep, cattle, pigs)**	**Percent total culled**
Avon	97,461	1,277	1	96,139	1,413	1	239,210	10,248	4
Bedfordshire	55,998	357	2	16714	0	0	113509	946	1
Berkshire	69,934	357	1	31722	0	0	141,279	357	0
Buckinghamshire	234,129	606	0	78,808	0	0	344,292	606	0
Cambridgeshire	59,783	101	0	28,652	235	1	154,286	336	0
Cheshire	205,575	8,459	4	253,888	2,614	1	522,275	11,995	2
Cleveland	80,900	2,488	3	29,197	784	3	164,596	3,280	2
Cornwall	604,022	4,040	1	361,370	1,342	0	1,015,538	9,498	1
Cumbria	2,627,348	857,247	33	509,567	208,163	41	3,191,227	1,102,750	35
Derbyshire	465,488	2,637	1	197,381	1,310	1	700,835	3,947	1
Devon	1,816,778	273,499	15	617,876	72,363	12	2,600,132	378,225	15
Dorset	217,102	0	0	196,176	0	0	531,401	0	0
Durham	648,982	101,167	16	98,284	23,001	23	772,792	132,374	17
East Sussex	301,958	0	0	64,203	0	0	378,604	0	0
Essex	67,337	7,319	11	39,253	357	1	198,268	9,946	5
Gloucestershire	415,922	61,083	15	142,022	15,424	11	609,337	78,292	13
Greater London	3,998	0	0	5,181	681	13	14,153	687	5
Greater Manchester	70,901	217	0	33,356	116	0	112,257	333	0
Hampshire and Isle of Wight	187,788	0	0	115,432	0	0	401,371	0	0
Hereford and Worcester	1,166,663	139,918	12	213,800	21,764	10	1,534,748	166,945	11
Hertfordshire	37,600	0	0	23,025	0	0	77,260	0	0
Humberside	121,062	2,899	2	64,479	332	1	889,321	3,231	0
Kent	496,348	11,342	2	65,254	1,138	2	588,531	12,480	2
Lancashire	792,700	81,373	10	255,790	21,474	8	1,164,660	104,353	9
Leicestershire	388,776	3,505	1	139,146	619	0	589,041	4,132	1
Lincolnshire	203,937	7,711	4	96,251	0	0	600,760	7,711	1
Merseyside	7,958	0	0	10,306	0	0	23,725	0	0
Norfolk	140,932	86	0	93,928	0	0	754,160	86	0
North Yorkshire	2,084,839	295,099	14	421,837	54,714	13	3,329,850	369,502	11
Northamptonshire	403,646	4,303	1	78,264	0	0	521,689	4,303	1
Northumberland	1,641,248	137,547	8	186,606	16,354	9	1,844,907	155,014	8
Nottinghamshire	84,369	179	0	57,383	0	0	258,841	179	0
Oxfordshire	210,343	803	0	80,169	0	0	460,188	803	0
Shropshire	912,452	42,399	5	280,592	7,063	3	1,255,500	51,901	4
Somerset	675,712	10,914	2	421,434	3,143	1	1,281,151	14,415	1

Table 3 Proportions of livestock culled by county									
County	**Size of sheep flock**	**Number of sheep culled**	**Percent sheep culled**	**Size of cattle herd**	**Number of cattle culled**	**Percent cattle culled**	**Total livestock (sheep, cattle, pigs)**	**Number of livestock culled (sheep, cattle, pigs)**	**Percent total culled**
South Yorkshire	83,287	280	0	48,600	20	0	199,709	300	0
Staffordshire	301,678	24,402	8	247,587	6,729	3	629,461	34,626	6
Suffolk	81,175	3,980	5	48,206	19	0	771,289	3,999	1
Surrey	80,195	2,261	3	39,723	0	0	134,586	2,261	2
Tyne and Wear	10,249	891	9	6,585	421	6	19,039	1,963	10
Warwickshire	355,172	2,001	1	80,666	921	1	456,751	2,922	1
West Midlands	22,924	500	2	11,204	10	0	47,555	510	1
West Sussex	120,490	0	0	66,714	0	0	222,158	0	0
West Yorkshire	228,459	5,862	3	82,418	1,529	2	388,332	7,393	2
Wiltshire	211,129	5,450	3	182,173	151	0	514,510	8,251	2
Note: Based on DEFRA agricultural census data for 2000 and cull data for 21 August 2001									

Continued

Tables 4 and 5: Notes on column contents

General

Where blanks occur in the columns this indicates no records, eg of FMD cases or records for a particular species group or habitat.

FMD area class and FMD cull class

For ease of comparison among Natural Areas, the figures for proportion of Natural Area covered by the 3 km buffers around infected cases and the livestock cull figures (which exclude welfare culls) shown in Table 2 are grouped into classes as follows:

FMD area class	Percent of Natural area in 3 km buffer	FMD cull class	Numbers of livestock culled
Heavy	more than 40%	Very high	100,000 or more
Moderate	11- 40%	High	50,000 to 100,000
Light	10% or less	Moderate	10,000 to 50,000
		Some	less than 10,000

The abbreviation "Adj" is used in the description of the FMD classes for maritime Natural Areas. These occupy the coastal strip along the seaward edge of lowland and upland Natural Areas. Livestock management of coastal habitats such as salt marsh and sand dune in the maritime Natural Areas is usually connected with farmland within the inland Natural Areas. Thus it is difficult to pick up direct effects of FMD in these coastal zones based on location of infected premises and culls, which are centred on the farm itself. To give an idea of the scale of impact in these inland areas that could, in turn, affect coastal habitats, the highest FMD area class and cull class from the inland Natural Areas abutting each maritime Natural Area is given, eg if this was FMD area class "Heavy" then "Adj Heavy" appears against the relevant maritime Natural Area.

Relative numbers of infected premises in inland Natural Areas can also disguise the complexity of geographical distribution of livestock. For instance, much of the western side of the North Pennines Natural Area has lost livestock but the infected premises involved are located in the Eden Valley Natural Area. Thus the impact on the North Pennines is under-estimated.

Significance of Natural Areas for habitats and species

The detail of the categorisation and classes for each habitat and species group can be found in the English Nature Research Reports describing these interests in Natural Areas, as listed in the bibliography (eg Grice et al 1994, Jefferson 1996, Drewitt & Manley 1997). The Natural Area evaluations for birds, lowland grasslands, freshwaters, wetlands and uplands were made using draft Natural Area boundaries and the evaluations have since been updated to correspond to the published Natural Area boundaries. Species were treated as groups, for example, birds, in the reports except in the case of vertebrates where single species evaluations were made. Two examples of vertebrates affected by FMD impacts are given in Table 5, namely dormouse (*Muscardinus avellanarius*) and natterjack toad (*Bufo calamita*). The evaluations are taken from

the reports for each habitat and species group except in the case of the grazing marsh area class. The area figures come from Mountford et al (1999). In the current context "grazing marsh" is equivalent to the lowland wet grassland definition in Dargie (1993) ie "managed land, periodically inundated by water, predominantly permanent grassland and fen meadows, within a flat area with a network of ditches containing standing water". The grassland may include agriculturally improved and semi-improved grassland as well as unimproved grassland. The area classes for grazing marsh adopted for this report are:

Grazing marsh area class	**Area (hectares)**
Outstanding	25,000 to 50,000
Considerable	10,000 to 25,000
Significant	5,000 to 10,000
Notable	1,000 to 5,000
Some	Less than 1,000

The assessments for flowering plants and mosses and liverworts in inland Natural Areas incorporate maritime plants from adjacent maritime Natural Areas. Thus maritime Natural Areas, apart from the Isles of Scilly, have no direct ratings. To indicate the likely level of interest, the same principle as for FMD information in maritime Natural Areas was adopted. The term "Adj" is attached to the highest significance for flowering plants and mosses and liverworts found in the adjacent inland Natural Areas.

The abbreviation "Tr", used for natterjack toad assessments, refers to the potential for translocating toads from other areas into Natural Areas that once had natterjacks. The significance relates to how the Area would rate if this translocation took place.

The nationally important invertebrate habitats column refers to those habitats identified as nationally significant in the invertebrate reports (Drake et al 1998). Where no habitats of national significance were identified, then the next highest rating for habitats in the Natural Area was entered in the column. The nationally important habitats were grouped into the following types:

Abbreviation	**Habitat type**	**Abbreviation**	**Habitat type**
AG	Acid grassland	SD	Sand dune
CG	Calcareous grassland	SH	Coastal shingle
MG	Neutral grassland	SM	Salt marsh
WG	Wet grassland	MC	Maritime cliff, hard and soft
M	Mire, bog, fen, reedbed	SL	Saline lagoons
FW	Freshwater, rivers, ponds, riverine sediments	MH	Maritime heath, grassland, scrub
LH	Lowland heathland	OV	Open vegetation, quarries, scree, inland cliff, arable
UH	Upland heathland	W	Woodland, parkland, hedges, scrub
Mon	Montane	C	Mines and caves
LP	Limestone pavement		

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts													
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Lowland grassland & upland meadows**	**Lowland heath**	**Grazing marsh area class**	**Sand dune**	**Saltmarsh**	**Vegetated shingle**	**Freshwater & wetlands**	**Woodland**	**Mountains & moorlands**
9	Eden Valley	Lowland	Heavy	Very high	Some	Notable	Some				High	Moderate	
3	Solway Basin	Lowland	Heavy	Very high	Some	Some	Significant				Outstanding	Some	
93	The Culm	Lowland	Heavy	Very high	Outstanding	Notable	Some				High	High	
114	Land's End to Minehead	Maritime	Adj Heavy	Adj Very high		Some		International	Local	Local			
120	Solway Firth	Maritime	Adj Heavy	Adj Very high				National	International	Local			
61	Dean Plateau & Wye Valley	Lowland	Heavy	High	Notable	Some	Some				Low	Outstanding	
60	Black Mountains and Golden Valley	Upland	Heavy	Moderate	Some						Medium	Moderate	Notable
118	Morecambe Bay	Maritime	Adj Moderate	Adj Very high				National	International	International			
2	Border Uplands	Upland	Moderate	Very high	Significant						Outstanding	High	Considerable
10	Cumbria Fells and Dales	Upland	Moderate	Very high	Outstanding	Some	Significant				Outstanding	Outstanding	Outstanding
12	Forest of Bowland	Upland	Moderate	Very high	Notable	Some	Notable				Medium	Moderate	Considerable
8	Yorkshire Dales	Upland	Moderate	Very high	Outstanding		Some				High	High	Outstanding
5	Northumbria Coal Measures	Lowland	Moderate	High	Some	Some	Some				Medium	High	
56	Severn and Avon Vales	Lowland	Moderate	High	Considerable	Some	Considerable				High	High	
98	Northumberland Coast	Maritime	Adj Moderate	Adj High				International	National	Negligible			
116	Severn Estuary	Maritime	Adj Moderate	Adj High				Local	International	Negligible			
99	Tyne to Tees Coast	Maritime	Adj Moderate	Adj High				National	National	Negligible			
4	North Pennines	Upland	Moderate	High	Outstanding						Outstanding	High	Outstanding
59	Central Herefordshire	Lowland	Moderate	Moderate	Some		Some				Medium	High	
13	Lancashire Plain and Valleys	Lowland	Moderate	Moderate	Some	Some	Considerable				High	Moderate	

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts

NA No.	Natural Area Name	NA type	FMD area class	FMD cull class	Lowland grassland & upland meadows	Lowland heath	Grazing marsh area class	Sand dune	Saltmarsh	Vegetated shingle	Freshwater & wetlands	Woodland	Mountains & moorlands
43	Midlands Plateau	Lowland	Moderate	Moderate	Significant	Considerable	Some				Medium	Outstanding	
27	Mosses & Meres	Lowland	Moderate	Moderate	Notable	Some	Notable				Outstanding	High	
40	Needwood and South Derbyshire Claylands	Lowland	Moderate	Moderate	Some		Notable				Low	Moderate	
1	North Northumberland Coastal Plain	Lowland	Moderate	Moderate	Notable	Some	Some				Medium	Some	
7	Tees Lowlands	Lowland	Moderate	Moderate	Negligible		Some				Medium	Some	
16	Vale of York and Mowbray	Lowland	Moderate	Moderate	Considerable	Considerable	Notable				High	Some	
11	West Cumbria Coastal Plain	Lowland	Moderate	Moderate	Some	Notable	Notable				High	Some	
115	Bridgwater Bay	Maritime	Adj Moderate	Adj Moderate				National	National	Local			
119	Cumbrian Coast	Maritime	Adj Moderate	Adj Moderate				International	International	International			
117	Liverpool Bay	Maritime	Adj Moderate	Adj Moderate				International	National	Negligible			
100	Saltburn to Bridlington	Maritime	Adj Moderate	Adj Moderate				Negligible	Negligible	Local			
87	Exmoor &The Quantocks	Upland	Moderate	Moderate	Some	Notable	Some				High	High	Considerable
17	North York Moors and Hills	Upland	Moderate	Moderate	Notable		Some				Medium	High	Considerable
15	Pennine Dales Fringe	Upland	Moderate	Moderate	Some		Some				Low	Moderate	
42	Shropshire Hills	Upland	Moderate	Moderate	Notable	Notable	Some				Low	High	Some
28	Potteries and Churnet Valley	Lowland	Moderate	Some	Some	Some	Some				Medium	Moderate	Considerable
88	Vale of Taunton and Quantock Fringes	Lowland	Moderate	Some	Some	Some	Notable				Medium	Some	
67	Greater Thames Estuary	Maritime	Moderate	Some	Some		Considerable	Local	International	Local	Outstanding	Some	

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts													
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Lowland grassland & upland meadows**	**Lowland heath**	**Grazing marsh area class**	**Sand dune**	**Saltmarsh**	**Vegetated shingle**	**Freshwater & wetlands**	**Woodland**	**Mountains & moorlands**
90	Devon Redlands	Lowland	Light	Moderate	Some	Outstanding	Notable				Medium	Moderate	
91	South Devon	Lowland	Light	Moderate	Significant	Some	Some				Medium	High	
111	Lyme Bay	Maritime	Adj Light	Adj Moderate				Local	Local	International			
112	Start Point to Land's End	Maritime	Adj Light	Adj Moderate				Local	International	Local			
14	Southern Pennines	Upland	Light	Moderate	Some		Some				High	Moderate	Considerable
79	Berkshire and Malborough Downs	Lowland	Light	Some	Significant	Some	Some				Medium	High	
89	Blackdowns	Lowland	Light	Some	Some	Some	Some				Medium	Moderate	
62	Bristol, Avon Valleys and Ridges	Lowland	Light	Some	Some		Some				Medium	Moderate	
24	Coal Measures	Lowland	Light	Some	Some	Some	Some				Medium	High	
95	Cornish Killas and Granites	Lowland	Light	Some	Notable	Outstanding	Some				High	High	
55	Cotswolds	Lowland	Light	Some	Outstanding	Some	Notable				Low	Outstanding	
6	Durham Magnesian Limestone Plateau	Lowland	Light	Some	Outstanding	Some					Medium	Moderate	
50	East Anglian Plain	Lowland	Light	Some	Notable	Some	Notable				Outstanding	High	
66	London Basin	Lowland	Light	Some	Notable	Outstanding	Notable				Outstanding	Outstanding	
57	Malvern Hills and Teme Valley	Lowland	Light	Some	Some						Medium	High	
64	Midvale Ridge	Lowland	Light	Some	Notable	Some	Some				Medium	Moderate	
69	North Downs	Lowland	Light	Some	Significant	Some	Some				Medium	Outstanding	
68	North Kent Plain	Lowland	Light	Some	Some	Some	Notable				Medium	High	
85	Somerset Levels and Moors	Lowland	Light	Some	Outstanding		Outstanding				Outstanding	Some	

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts													
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Lowland grassland & upland meadows**	**Lowland heath**	**Grazing marsh area class**	**Sand dune**	**Saltmarsh**	**Vegetated shingle**	**Freshwater & wetlands**	**Woodland**	**Mountains & moorlands**
63	Thames and Avon Vales	Lowland	Light	Some	Considerable		Significant				Outstanding	High	
33	Trent Valley and Rises	Lowland	Light	Some	Significant	Some	Significant				High	High	
26	Urban Mersey Basin	Lowland	Light	Some	Some	Notable	Notable				Medium	Moderate	
52	West Anglian Plain	Lowland	Light	Some	Considerable		Significant				Medium	High	
54	Yardley-Whittle wood Ridge	Lowland	Light	Some	Some		Some				Low	High	
107	East Kent Coast	Maritime	Adj Light	Adj Some				International	Local	Local			
106	North Kent Coast	Maritime	Adj Light	Adj Some				Negligible	Local	Local			
58	Clun and North West Herefordshire Hills	Upland	Light	Some	Some	Some	Some				Low	Outstanding	Some
92	Dartmoor	Upland	Light	Some	Considerable						High	High	Outstanding
29	South West Peak	Upland	Light	Some	Some		Some				High	Some	Notable
38	Lincolnshire and Rutland Limestone	Lowland	Light		Notable	Some	Some				Medium	Moderate	
84	Mendip Hills	Lowland	Light		Outstanding	Notable	Some				Low	Moderate	
53	Bedfordshire Greensand Ridge	Lowland		Some	Some	Some	Some				Medium	High	
73	Low Weald and Pevensey	Lowland		Some	Some	Some	Notable				High	Outstanding	
86	Mid Somerset Hills	Lowland		Some	Some		Notable				Low	Moderate	
44	Midland Clay Pastures	Lowland		Some	Notable	Some	Some				Low	Some	
34	North Lincolnshire Coversands and Clay Vales	Lowland		Some	Notable	Considerable	Some				Medium	High	
32	Sherwood	Lowland		Some	Some	Notable	Some				Medium	Moderate	

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts													
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Lowland grassland & upland meadows**	**Lowland heath**	**Grazing marsh area class**	**Sand dune**	**Saltmarsh**	**Vegetated shingle**	**Freshwater & wetlands**	**Woodland**	**Mountains & moorlands**
23	Southern Magnesian Limestone	Lowland		Some	Notable	Some	Some				Medium	High	
49	Suffolk Coast and Heaths	Lowland		Some	Notable	Outstanding	Notable				High	Some	
48	The Broads	Lowland		Some	Significant	Some	Considerable				Outstanding	Moderate	
37	The Fens	Lowland		Some	Considerable	Some	Significant				Outstanding	Some	
70	Wealden Greensand	Lowland		Some	Notable	Outstanding	Notable				Medium	Outstanding	
83	Wessex Vales	Lowland		Some	Notable	Some	Notable				Low	High	
19	Yorkshire Wolds	Lowland		Some	Significant						Low	Some	
101	Bridlington to Skegness	Maritime		Adj Some				National	Local	Negligible			
108	Folkestone to Selsey Bill	Maritime		Adj Some				Local	Local	International			
104	Sheringham to Lowestoft	Maritime		Adj Some				International	Local	Negligible			
110	South Dorset Coast	Maritime		Adj Some				Negligible	Local	International			
105	Suffolk Coast	Maritime		Adj Some				Local	National	International			
102	The Wash	Maritime		Adj Some				International	International	National			
25	Dark Peak	Upland		Some	Some		Some				High	Some	Some
41	Oswestry Uplands	Upland		Some	Some	Some					Medium	Some	Negligible
46	Breckland	Lowland			Outstanding	Outstanding	Notable				High	Moderate	
39	Charnwood	Lowland			Notable	Some					Medium	Moderate	
65	Chilterns	Lowland			Significant	Some	Some				Low	Outstanding	
31	Derbyshire Peak Fringe and Lower Derwent	Lowland			Negligible	Some	Some				Medium	Moderate	
81	Dorset Heaths	Lowland			Notable	Outstanding	Notable				Outstanding	Moderate	

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts

NA No.	Natural Area Name	NA type	FMD area class	FMD cull class	Lowland grassland & upland meadows	Lowland heath	Grazing marsh area class	Sand dune	Saltmarsh	Vegetated shingle	Freshwater & wetlands	Woodland	Mountains & moorlands
51	East Anglian Chalk	Lowland			Notable	Some	Some				Medium	Some	
78	Hampshire Downs	Lowland			Considerable	Some	Notable				Medium	High	
72	High Weald	Lowland			Notable	Outstanding	Some				Medium	Outstanding	
20	Holderness	Lowland			Notable		Notable				Medium	Some	
21	Humber Estuary	Lowland			Negligible		Some				Low		
22	Humberhead Levels	Lowland			Considerable	Considerable	Significant				Outstanding	Some	
76	Isle of Wight	Lowland			Significant	Some	Some				Low	Moderate	
82	Isles of Portland & Purbeck	Lowland			Considerable	Some					Low	Moderate	
36	Lincolnshire Coast and Marshes	Lowland			Some		Notable				Medium	Some	
35	Lincolnshire Wolds	Lowland			Some						Low	Some	
77	New Forest	Lowland			Outstanding	Outstanding	Notable				Outstanding	Outstanding	
47	North Norfolk	Lowland			Some	Considerable	Notable				Outstanding	Some	
45	Rockingham Forest	Lowland			Notable	Some	Some				Low	High	
71	Romney Marsh	Lowland			Significant		Notable				High	Some	
75	South Coast Plain and Hampshire Lowlands	Lowland			Some	Some	Notable				High	High	
74	South Downs	Lowland			Considerable	Notable	Notable				Medium	Outstanding	
80	South Wessex Downs	Lowland			Outstanding	Some	Notable				Medium	High	
97	The Lizard	Lowland			Some	Outstanding					High	Some	
18	Vale of Pickering	Lowland			Negligible		Notable				Low	Some	
96	West Penwith	Lowland			Some	Outstanding					Medium	Some	
113	Isles of Scilly	Maritime				Outstanding		Local	Negligible	Local	Low		

Continued

Table 4 Significance of Natural Areas for habitats ranked by FMD impacts

NA No.	Natural Area Name	NA type	FMD area class	FMD cull class	Lowland grassland & upland meadows	Lowland heath	Grazing marsh area class	Sand dune	Saltmarsh	Vegetated shingle	Freshwater & wetlands	Woodland	Mountains & moorlands
103	Old Hunstanton to Sheringham	Maritime						International	International	International			
109	Solent and Poole Bay	Maritime						International	International	National			
94	Bodmin Moor	Upland			Some						Medium	Moderate	Notable
30	White Peak	Upland			Outstanding		Some				Low	Moderate	Negligible
Scale of significance/intensity			Heavy	Very high	Outstanding	Outstanding	Outstanding	International	International	International	Outstanding	Outstanding	Outstanding
			Moderate	High	Considerable	Considerable	Considerable	National	National	National	High	High	Considerable
			Light	Moderate	Significant	Notable	Significant	Local	Local	Local	Medium	Moderate	Notable
				Some	Notable	Some	Notable	Negligible	Negligible	Negligible	Low	Some	Some
					Some		Some						Negligble
					Negligible								

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
9	Eden Valley	Lowland	Heavy	Very high	Some	National	M, FW	Significant	Some		
3	Solway Basin	Lowland	Heavy	Very high	Notable	National	SM, M, FW	Some	Notable		High
93	The Culm	Lowland	Heavy	Very high	Notable	National	WG	Significant	Significant	High	
114	Land's End to Minehead	Maritime	Adj Heavy	Adj Very high	Notable	National	MH, SD	Adj Outstanding	Adj Outstanding		
120	Solway Firth	Maritime	Adj Heavy	Adj Very high	Outstanding	National	SM	Adj Some	Adj Notable		High
61	Dean Plateau & Wye Valley	Lowland	Heavy	High	Some	National	W	Significant	Significant	High	
60	Black Mountains and Golden Valley	Upland	Heavy	Moderate	Some	National	FW, W	Some	Some	High	
118	Morecambe Bay	Maritime	Adj Moderate	Adj Very high	Outstanding	Regional		Adj Outstanding	Adj Outstanding		Tr Medium
2	Border Uplands	Upland	Moderate	Very high	Considerable	National	FW, M	Significant	Significant		
10	Cumbria Fells and Dales	Upland	Moderate	Very high	Considerable	National	LP, CG, W, Mon,M, FW, OV	Outstanding	Outstanding	High	High
12	Forest of Bowland	Upland	Moderate	Very high	Considerable	Regional		Some	Notable		
8	Yorkshire Dales	Upland	Moderate	Very high	Outstanding	National	LP,CG,M, FW	Outstanding	Considerable		
5	Northumbria Coal Measures	Lowland	Moderate	High	Some	Regional		Significant	Some		
56	Severn and Avon Vales	Lowland	Moderate	High	Notable	National	W	Considerable	Some	High	
98	Northumberland Coast	Maritime	Adj Moderate	Adj High	Outstanding	Regional		Adj Significant	Adj Significant		
116	Severn Estuary	Maritime	Adj Moderate	Adj High	Outstanding	National	SM, CG	Adj Outstanding	Adj Notable		
99	Tyne to Tees Coast	Maritime	Adj Moderate	Adj High	Considerable	Regional		Adj Significant	Adj Notable		
4	North Pennines	Upland	Moderate	High	Outstanding	National	M	Considerable	Significant	High	
59	Central Herefordshire	Lowland	Moderate	Moderate	Some	Regional		Notable	Some	High	
13	Lancashire Plain and Valleys	Lowland	Moderate	Moderate	Considerable	Local		Some	Significant		Tr Medium
43	Midlands Plateau	Lowland	Moderate	Moderate	Some	National	W	Significant	Some	High	Medium
27	Mosses & Meres	Lowland	Moderate	Moderate	Some	National	FW, M	Significant	Notable	Medium	

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
40	Needwood and South Derbyshire Claylands	Lowland	Moderate	Moderate	Some	Regional		Some	Some		
1	North Northumberland Coastal Plain	Lowland	Moderate	Moderate	Some	Regional		Some	Significant		
7	Tees Lowlands	Lowland	Moderate	Moderate	Some	Regional		Some	Notable		
16	Vale of York and Mowbray	Lowland	Moderate	Moderate	Considerable	National	WG	Notable	Some		
11	West Cumbria Coastal Plain	Lowland	Moderate	Moderate	Some	National	SD	Notable	Notable		High
115	Bridgwater Bay	Maritime	Adj Moderate	Adj Moderate	Some	Regional		Adj Significant	Adj Notable		
119	Cumbrian Coast	Maritime	Adj Moderate	Adj Moderate	Considerable	National	SD,	Adj Notable	Adj Notable		High
117	Liverpool Bay	Maritime	Adj Moderate	Adj Moderate	Outstanding	National	SD	Adj Significant	Adj Considerable		High
100	Saltburn to Bridlington	Maritime	Adj Moderate	Adj Moderate	Considerable	Regional		Adj Notable	Adj Notable		
87	Exmoor &The Quantocks	Upland	Moderate	Moderate	Notable	National	SD, UH	Outstanding	Outstanding	High	
17	North York Moors and Hills	Upland	Moderate	Moderate	Considerable	National	M, W	Notable	Notable		
15	Pennine Dales Fringe	Upland	Moderate	Moderate	Some	Regional		Notable	Notable		
42	Shropshire Hills	Upland	Moderate	Moderate	Some	Regional		Some	Significant	High	
28	Potteries and Churnet Valley	Lowland	Moderate	Some	Some	Local		Significant	Some		
88	Vale of Taunton and Quantock Fringes	Lowland	Moderate	Some	Some	Regional		Significant	Notable	High	
67	Greater Thames Estuary	Maritime	Moderate	Some	Outstanding	National	WG, FW, SM, SH	Significant	Notable		
90	Devon Redlands	Lowland	Light	Moderate	Considerable	National	W	Significant	Some	High	
91	South Devon	Lowland	Light	Moderate	Notable	National	C, MC	Outstanding	Significant	High	
111	Lyme Bay	Maritime	Adj Light	Adj Moderate	Considerable	National	MC	Adj Outstanding	Adj Significant		
112	Start Point to Land's End	Maritime	Adj Light	Adj Moderate	Notable	National	MC	Adj Outstanding	Adj Outstanding		
14	Southern Pennines	Upland	Light	Moderate	Outstanding	Local		Significant	Some		

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
79	Berkshire and Malborough Downs	Lowland	Light	Some	Some	National	W	Significant	Significant	Medium	
89	Blackdowns	Lowland	Light	Some	Some	National	CG, LH	Considerable	Some	High	
62	Bristol, Avon Valleys and Ridges	Lowland	Light	Some	Notable	Regional		Outstanding	Notable	High	
24	Coal Measures	Lowland	Light	Some	Some	National	W	Significant	Some		
95	Cornish Killas and Granites	Lowland	Light	Some	Some	Regional		Outstanding	Outstanding	High	
55	Cotswolds	Lowland	Light	Some	Some	National	CG, W	Outstanding	Significant	High	
6	Durham Magnesian Limestone Plateau	Lowland	Light	Some	Some	National	W	Some	Some		
50	East Anglian Plain	Lowland	Light	Some	Some	National	M, W	Outstanding	Some	Medium	Tr Low
66	London Basin	Lowland	Light	Some	Considerable	National	W, LH, FW	Considerable	Significant	High	Tr Low
57	Malvern Hills and Teme Valley	Lowland	Light	Some	Some	National	FW	Notable	Some	High	
64	Midvale Ridge	Lowland	Light	Some	Some	National	M	Significant	Some		
69	North Downs	Lowland	Light	Some	Some	National	W, CG, MC	Outstanding	Notable	High	
68	North Kent Plain	Lowland	Light	Some	Notable	National	W, WG, FW, SD, SM	Significant	Some	High	Tr Low
85	Somerset Levels and Moors	Lowland	Light	Some	Outstanding	National	FW, M	Significant	Notable		
63	Thames and Avon Vales	Lowland	Light	Some	Some	National	W, FW	Outstanding	Some	Low	
33	Trent Valley and Rises	Lowland	Light	Some	Notable	National	W	Notable	Notable	Low	
26	Urban Mersey Basin	Lowland	Light	Some	Notable	National	SD, MC, LH, W	Significant	Considerable		High
52	West Anglian Plain	Lowland	Light	Some	Some	National	W, FW, M	Significant	Notable	Low	Tr Low
54	Yardley-Whittlewood Ridge	Lowland	Light	Some	Some	Regional		Notable	Some		
107	East Kent Coast	Maritime	Adj Light	Adj Some	Notable	National	CG	Adj Outstanding	Adj Notable		Tr Low
106	North Kent Coast	Maritime	Adj Light	Adj Some	Notable	Local		Adj Significant	Adj Some		
58	Clun and North West Herefordshire Hills	Upland	Light	Some	Notable	Local		Some	Some	High	
92	Dartmoor	Upland	Light	Some	Notable	National	W	Significant	Significant	High	

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
29	South West Peak	Upland	Light	Some	Considerable	Local		Significant	Some		
38	Lincolnshire and Rutland Limestone	Lowland	Light		Some	National	W	Significant	Some		
84	Mendip Hills	Lowland	Light		Some	Regional		Considerable	Significant	High	
53	Bedfordshire Greensand Ridge	Lowland		Some	Some	Local		Significant	Some		Medium
73	Low Weald and Pevensey	Lowland		Some	Notable	National	W, FW, WG	Significant	Notable	High	
86	Mid Somerset Hills	Lowland		Some	Some	Local		Significant	Some	High	
44	Midland Clay Pastures	Lowland		Some	Some	Regional		Some	Some	Medium	
34	North Lincolnshire Coversands and Clay Vales	Lowland		Some	Some	National	W	Notable	Some		Tr Low
32	Sherwood	Lowland		Some	Notable	National	W	Some	Some	Low	
23	Southern Magnesian Limestone	Lowland		Some	Some	Regional		Significant	Significant		
49	Suffolk Coast and Heaths	Lowland		Some	Considerable	National	LH, M, SH, SL	Significant	Some		Medium
48	The Broads	Lowland		Some	Outstanding	National	W, WG, LH, M, FW	Considerable	Significant		High
37	The Fens	Lowland		Some	Outstanding	National	M	Considerable	Some		Tr Low
70	Wealden Greensand	Lowland		Some	Considerable	National	LH, W	Significant	Notable	High	High
83	Wessex Vales	Lowland		Some	Some	National	SH, SL	Considerable	Notable	High	
19	Yorkshire Wolds	Lowland		Some	Some	Local		Some	Some		
101	Bridlington to Skegness	Maritime		Adj Some	Outstanding	Regional		Adj Notable	Adj Significant		Medium
108	Folkestone to Selsey Bill	Maritime		Adj Some	Outstanding	National	SH, WG	Adj Outstanding	Adj Considerable		
104	Sheringham to Lowestoft	Maritime		Adj Some	Considerable	National	MC	Adj Considerable	Adj Significant		High
110	South Dorset Coast	Maritime		Adj Some	Some	National	MC	Adj Considerable	Adj Significant		
105	Suffolk Coast	Maritime		Adj Some	Outstanding	National	M, SL, SH, MC	Adj Significant	Adj Some		
102	The Wash	Maritime		Adj Some	Outstanding	Regional		Adj Considerable	Adj Some		Tr Low

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
25	Dark Peak	Upland		Some	Considerable	Local		Some	Significant		
41	Oswestry Uplands	Upland		Some	Some			Significant	Some		
46	Breckland	Lowland			Outstanding	National	LH, CG, AG, FW, M	Significant	Notable		
39	Charnwood	Lowland			Some	National	W	Some	Notable		
65	Chilterns	Lowland			Some	National	CG	Outstanding	Significant	High	
31	Derbyshire Peak Fringe and Lower Derwent	Lowland			Some	National	W	Notable	Some		
81	Dorset Heaths	Lowland			Outstanding	National	LH, W, SD	Outstanding	Some	High	Medium
51	East Anglian Chalk	Lowland			Some	National	W, OV, M	Considerable	Notable		
78	Hampshire Downs	Lowland			Some	National	CG, W, FW, M, WG	Significant	Notable	High	
72	High Weald	Lowland			Notable	Regional		Significant	Considerable	High	
20	Holderness	Lowland			Notable	Local		Some	Some		
21	Humber Estuary	Lowland			Outstanding	Regional		Some	Some		
22	Humberhead Levels	Lowland			Considerable	National	M, WG	Notable	Significant		
76	Isle of Wight	Lowland			Notable	National	CG, MC	Considerable	Considerable	High	
82	Isles of Portland & Purbeck	Lowland			Some	National	CG, W, MC	Considerable	Significant		
36	Lincolnshire Coast and Marshes	Lowland			Considerable	National	SL, SD	Notable	Some		Medium
35	Lincolnshire Wolds	Lowland			Some	Local		Notable	Notable		Tr Low
77	New Forest	Lowland			Outstanding	National	W, LH, AG, M	Outstanding	Considerable	High	Tr Low
47	North Norfolk	Lowland			Notable	National	M, FW, MC, SD, SM	Significant	Notable		High
45	Rockingham Forest	Lowland			Notable	National	W	Notable	Some	Medium	
71	Romney Marsh	Lowland			Considerable	National	FW, SH	Significant	Some		
75	South Coast Plain and Hampshire Lowlands	Lowland			Notable	National	SM, W, SD, SH, SL, LH	Considerable	Notable	High	
74	South Downs	Lowland			Some	National	CG, FW, W, WG	Outstanding	Significant	High	

Continued

Table 5 Significance of Natural Areas for species ranked by FMD impacts											
NA No.	**Natural Area Name**	**NA type**	**FMD area class**	**FMD cull class**	**Birds**	**Invertebrates**	**Nationally important**	**Flowering plants**	**Mosses & liverworts**	**Dormouse**	**Natterjack toad**
80	South Wessex Downs	Lowland			Considerable	National	CG, W	Significant	Notable	High	
97	The Lizard	Lowland			Some	National	MC	Outstanding	Considerable		
18	Vale of Pickering	Lowland			Some	Local		Some	Some		
96	West Penwith	Lowland			Some	Regional		Significant	Considerable		
113	Isles of Scilly	Maritime			Considerable	National	MH, MC	Outstanding	Considerable		
103	Old Hunstanton to Sheringham	Maritime			Outstanding	National	SD, SM, MC	Adj Significant	Adj Notable		High
109	Solent and Poole Bay	Maritime			Outstanding	National	MC, LH, M, FW	Adj Outstanding	Adj Considerable		Medium
94	Bodmin Moor	Upland			Notable	Regional		Notable	Significant		
30	White Peak	Upland			Some	Local		Notable	Significant		
Scale of significance/intensity			Heavy	Very high	Outstanding	National		Outstanding	Outstanding	High	High
			Moderate	High	Considerable	Regional		Considerable	Considerable	Medium	Medium
			Light	Moderate	Notable	Local		Notable	Notable	Low	Low
				Some	Some			Some	Some		Tr translocation potential

Continued

Table 6 Priority Biodiversity Action Plan habitats likely to be affected by FMD impacts	
Habitat groups in FMD report	Priority BAP habitats
Lowland grassland landscapes	Lowland meadows Lowland calcareous grassland Lowland dry acid grassland Purple moor grass and rush pastures Ancient and/or species rich hedgerows
Lowland heathland landscapes	Lowland heathland
Lowland wetlands and freshwaters	Fens Reedbeds Lowland raised bog Mesotrophic lakes Eutrophic standing waters
Coastal habitats	Maritime cliff and slopes Coastal sand dunes Coastal saltmarsh Saline lagoons Coastal and floodplain grazing marsh
Lowland woods, wood pastures and scrub	Lowland beech and yew woodland Wet woodland Lowland wood pasture and parkland
Grasslands in upland dales	Upland hay meadows
Upland woods and scrub	Upland oakwood Upland mixed ashwoods
Upland calcareous habitats	Upland calcareous grassland Limestone pavement
Upland moorland, blanket bog and freshwaters	Upland heathland Blanket bog

Appendix 1. Glossary

Biodiversity - Defined in Article 2 of the CONVENTION ON BIOLOGICAL DIVERSITY as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

Biodiversity Action Plan (BAP) - In June 1992 the UK Government signed the Convention on Biological Diversity at Rio de Janeiro. This was a demonstration of commitment to halt the worldwide loss of animal and plant species and genetic resources. Each country signing up to the convention agreed to draw up national plans and programmes and to share resources to help implement them. These Plans can relate to either a species or a habitat and seek to serve four purposes:

- to identify practical actions for conserving priority species and habitats, through detailed examination of current research material;
- to provide a strong scientific basis for, and widespread agreement amongst all concerned, to the actions needed;
- to set objectives and targets against which the success of action can be measured;
- to assign actions for determining work programming and budgetary requirements.

Birds Directive - EC Directive on the conservation of wild birds 79/409/EEC which places a general duty on Member States to maintain the population of all "species of naturally occurring birds in the wild state" in their European territory "at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements". Member States are to create protected areas (SPECIAL PROTECTION AREAS), manage habitats inside and outside these areas, re-establish destroyed biotopes and create new ones. A general system of protection for all these species of wild birds is to be laid down by Member States with some exceptions for hunting and certain other reasons. Annexes to the Directive list particularly vulnerable species which are to be the subject of special conservation measure concerning their habitat, species which may be hunted under national legislation, restrictions on the sale of wild birds, prohibited methods of killing birds and research subjects. Member States may introduce stricter protective measure than those provided for under the Directive. In May 1992, the HABITATS DIRECTIVE was agreed. This specifies certain obligations on Member States which will replace those arising as a result of Article 4 (4) of the present Directive. Implemented in UK through the Wildlife and Countryside Act 1981.

Countryside Stewardship Scheme (CSS) - Voluntary, discretionary scheme in England aimed at protection and enhancing certain valued landscapes (chalk and limestone grassland, lowland heaths, old meadows and pastures, waterside and historic landscapes, the coast and uplands, field boundaries and margins), wildlife and public access. It differs from the ENVIRONMENTALLY SENSITIVE AREAS SCHEME in that it is more flexible and not confined to fixed designated areas. Farmers and landowners joining the scheme receive annual and capital payments for following certain management prescriptions over a 10 year period. Like ENVIRONMENTALLY SENSITIVE AREAS, farmers and landowners joining the scheme have a choice of different management tiers which provide varying levels of annual payments. Originally launched by the Countryside Commission in June 1991, the scheme is now co-funded by the EU under AGRI-ENVIRONMENT REGULATION 2078/92. Responsibility for the scheme transferred to MAFF (now DEFRA) in 1996. It merged with the FARM AND CONSERVATION GRANT SCHEME in April 1996.

Environmentally Sensitive Areas (ESAs) - Originally designated in the UK under Article 19 of EC Regulation 797/85 (subsequently superseded by Article 21 of EC Regulation 2328/91 and amendments) which authorised Member States to introduce special national schemes in environmentally sensitive areas. Implemented in the UK by the Agriculture Act 1986 and first round of ESAs launched in 1987. They are areas of high landscape and conservation value in which farmers may voluntarily enter into agreements for 10 years to manage the land according to specific prescriptions in return for certain annual and capital incentive payments. Payments are tiered according to the level of management required. Implemented in all areas of the UK with some regional differences, eg in Scotland the rates are more complex and are closely linked to individual farm situations. Capital grants may also be available. Now part of the UK package of measure

implemented under AGRI-ENVIRONMENT REGULATION 2078/92.

Habitats and Species Directive - Council Directive 43/92 on the conservation of natural habitats and of wild flora and fauna which seeks to encourage the maintenance of biodiversity by establishing a "favourable conservation status" for specific NATURAL HABITAT TYPES and species considered to be of Community interest which are listed in Annexes to the Directive. A "coherent-European ecological network" of sites, to be known as Natura 2000, is to be established. Includes sites designated by Member States as "SPECIAL AREAS OF CONSERVATION" (SACs) taking account of economic, social and cultural requirements and "regional and local characteristics" and SPECIAL PROTECTION AREAS designated under the EC BIRDS DIRECTIVE. Annex 2 of the Directive lists species for which SACs shall be designated to conserve the habitats of these species and populations of which require monitoring. "Necessary conservation measures" involving appropriate management plans and other measures must be adopted for the SACs. Member States are subject to certain obligations to protect all those sites on the European Commission's list of those of Community importance, irrespective of whether they have been designated SACs. These obligations are extended to Special Protection Areas also. Implemented in the UK largely through existing legislation, particularly the Wildlife and Countryside Act 1981, supplemented by the Conservation (Natural Habitats etc) Regulations 1994 which apply to England, Wales and Scotland. All proposed SACs in the UK are SITE OF SPECIAL SCIENTIFIC INTEREST.

Less Favoured Areas (LFAs) - Areas in the EU designated under Directive 75/268 on mountain and hill farming and farming in certain less favoured areas and subsequent amendments. Separate Directives have been issued for each Member State listing the LFAs in their territories which fall within the meaning of Directive 75/268. There are three categories for designation as less favoured (see below). In the UK, LFAs are categorised as Disadvantaged Areas (DAs) or Severely Disadvantaged Areas (SDAs). Additional subsidies are available for those farming in Less Favoured Areas with the Severely Disadvantaged Area receiving the highest payment. LFAs in England total about 1.8 million hectares of agricultural land, ie about 20% of the total agricultural land in the country.

Categories for designation of areas as less favoured:

- Mountain areas handicapped by a short growing season or steep slopes or a combination.

- Regional areas in danger of depopulation and where conservation of the countryside is necessary. These areas exhibit three combined disadvantages; infertility, poor economic situation and a low or dwindling population dependent of agriculture.

- Small areas affected by specific handicaps in which the continuation of farming is necessary to ensure conservation of the environment, including protection of coastal areas, and preservation of tourism potential. The total extent of such areas in any Member State is not to exceed 4% of the total territory.

Livestock Unit (LU) - An index based on the feed requirements of livestock, with 1 dairy cow being the standard (1 LU).

National Nature Reserves (NNR) - Designated areas of national and/or international importance, established by the National Parks and Access to the Countryside Act 1949, which are owned or leased by the UK statutory nature conservation agencies or are managed by means of Nature Reserve Agreements with landowners and managers.

National Parks - Designated protected areas in England and Wales only established by the National Parks and Access to the Countryside Act 1949 and each managed by National Park authorities. The Environment Act 1995 places a duty on all public bodies to have regard to National Park objectives when carrying out their activities in them. In cases of conflict, the Act requires that conservation is given priority. It also increases local authority representation in the National Park authorities.

Public Service Agreements (PSAs) - These bring together in a single document important information on the aim, objectives and performance targets for each of the main departments in Government. An example of one important PSA target related to nature conservation is the target to bring 95% of all SSSIs into favourable condition by 2010.

Ramsar Convention - Convention on Wetlands of International Importance especially as Waterfowl Habitat, aims to stem the progressive encroachment and loss of wetlands. Parties undertake to designate at least one national wetland and to establish wetland reserves. Adopted in 1971 and came into force in 1975. The UK ratified in 1976.

Ramsar site - Wetland area designated under the RAMSAR CONVENTION which requires signatory countries to protect internationally important wetlands, especially those used by migratory water birds, and to use wetlands wisely. In the UK, all Ramsar sites are designated as SITES OF SPECIAL SCIENTIFIC INTEREST.

Sites of Special Scientific Interest (SSSIs) - Designated best examples of habitat types and sites with notable species or groups of species, notified under the Wildlife and Countryside Act 1981, this has been further strengthened through the Countryside and Rights of Way Act 2000. Selection of sites is based on a number of criteria including naturalness, size, diversity, typicalness and species or habitat rarity. All sites of national and international importance on land (including NATIONAL NATURE RESERVES, SPECIAL PROTECTION AREAS, SPECIAL AREAS OF CONSERVATION and RAMSAR SITES) are usually designated as SSSIs. Owners and occupiers of SSSIs require the consent of English Nature before undertaking any operation likely to damage SSSIs. Farmers can enter into positive MANAGEMENT AGREEMENTS for each site.

Special Area for Conservation (SAC) - Areas that need to be protected under the EC HABITATS DIRECTIVE. Sites of Community importance for habitats or species listed in the Directive where "a favourable conservation status" is to be maintained or restored. Expected to be mainly or exclusively SITES OF SPECIAL SCIENTIFIC INTEREST in the UK.

Special Protection Area (SPA) - Areas that are required to be protected under the EC BIRDS DIRECTIVE as habitats for vulnerable species on Annex I of the Directive and also regularly occurring migratory species. Both terrestrial and marine habitats. In the UK they are usually SITES OF SPECIAL SCIENTIFIC INTEREST.

Wildlife Enhancement Scheme - Voluntary and flexible scheme run by English Nature providing positive incentives in the form of annual and standard capital payments for the sensitive management of SITES OF SPECIAL SCIENTIFIC INTEREST in England.