THE COUNTRYSIDE STEWARDSHIP SCHEME

MONITORING AND EVALUATION OF THE COUNTRYSIDE STEWARDSHIP SCHEME

MODULE 2

THE ECOLOGICAL CHARACTERISATION OF LAND UNDER AGREEMENT

by

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1: Project Management & reporting 2: Surveying 3: Database Construction and Analysis

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1. EXECUTIVE SUMMARY

1.1 This report presents the results of an assessment of the ecological quality of land within the Countryside Stewardship Scheme, an agri-environment scheme designed to enhance the environmental quality of farmland in England, first introduced in 1991. This assessment forms Module 2 of the evaluation of the Scheme conducted by ADAS, the Centre for Ecology and Hydrology (formerly the Institute of Terrestrial Ecology) and The Countryside and Community Research Unit at the Cheltenham and Gloucester Higher Education College.

1.2 The objectives of the assessment were to assess the ecological quality of a sample of agreement land in terms of vegetation characteristics and the habitats as listed within the UK Biodiversity Action Plan. The detailed objectives were to:

- obtain national estimates of the extent of Biodiversity Action Plan (BAP) Broad and Priority Habitats under Countryside Stewardship Agreements;
- obtain national estimates of vegetation character, and hence ecological quality of all agreement land;
- obtain national estimates of vegetation character, and hence the ecological quality, of BAP Priority Habitats on Agreement land;
- analyse the distribution of areas and vegetation characteristics of agreement land (with special reference to Priority Habitats) with regard to geographic location, agreement age and type, and other factors as appropriate; and
- establish a baseline for the future evaluation of changes in ecological quality.

1.3 The assessment of ecological quality is essentially comparative in nature. If the targeting of land of high ecological quality is an objective of the Scheme, then there should be measurable differences between agreement land and land in the wider countryside. If already targeted areas, such as Environmentally Sensitive Areas, were to be excluded from the wider countryside the measurable differences would be expected to be greater. The trends in ecological quality through time can only show whether the Scheme has added ecological value if they are considered relative to trends in the English countryside as a whole.

1.4 This assessment provides a timely baseline for the Scheme as a whole as it coincides with Countryside Survey 2000, a national survey of land cover and vegetation, and also uses methods that are largely comparable.

1.5 The method was based upon an unstratified random survey of all agreements in force at the end of 1997, excepting boundary-only agreements. A total of 451 agreements (8.7%) were surveyed, and accounted for 8894 ha (7.2 %) of the total area. At each site, only land within the agreement was surveyed. Surveys took place during 1998 and 1999.

1.6 The land was mapped using UK Biodiversity Action Plan Broad and Priority Habitats. Broad Habitats were mapped using a vegetation key and Priority Habitats were mapped on the basis of expert knowledge and, the definitions current at the time of the start of the survey (largely the same as those that are current at the time of writing). The “Improved grassland” Broad Habitat was subdivided for this survey into “Highly improved grassland”, “Semi-improved/improved grassland” and “Sown light grass mixtures”. All land with a field margin management code was recorded as a Cereal Margin Priority Habitat; as all fell within the

defined Cereal Field Margin Priority Habitat even when cereals were not present. Mosaics were also identified. This information was digitised for analysis using Arc-View.

1.7 A random 200 m^2 vegetation quadrat was recorded within each agreement using Countryside Survey methods. In addition, a quadrat was recorded in every Priority Habitat present at the site, excluding any that had been recorded by the random quadrat. The quadrat positions were mapped and marked in the field to allow precise relocation. Each quadrat was classified in terms of National Vegetation Classification (NVC) and Countryside Vegetation System (CVS); species number and presence of rare and scarce species were also quantified. The quadrats were co-located with the spatial data in the database.

1.8 In addition, a variety of observations were taken (e.g. photographs and target notes on rare species and/or weed infestations) to aid interpretation of future surveys. These data have not been entered digitally, but have been archived.

1.9 By far the most widespread Broad Habitat was Improved Grassland, accounting for around 50 % of all agreement land, which when extrapolated is equivalent to around 61,000 ha across England. Of this, the majority was "Semi-improved/Improved", i.e. its ecological quality could be enhanced with appropriate and relatively low cost management. Habitat mosaics and other grassland habitats accounted for much of the remainder. The distribution of the Broad Habitats varied between MAFF regions depending upon the underlying distribution of the habitats, and on the scope and local priorities of the Scheme.

1.10 Priority Habitats accounted for 15 % of all agreement land (equivalent to around 18,500 ha). In addition to the 15%, there was also land within mosaics containing one or more Priority Habitat. The extra area of Priority Habitat within these mosaics is not calculable. The figure of 15% is likely to be an over-estimate, as the surveyors were instructed to regard habitat patches as Priority Habitat if in doubt, in order to trigger the use of the quadrat. The extent of this over-estimate cannot be given until methods for identifying Priority Habitats are better developed. Calcareous grassland (4 % of agreement land), heathland (4 %) and acid grassland (2 %) accounted for the greatest area of Priority Habitat. A further 2 % of agreement land was accounted for by two large saltmarsh agreements, while agreements with Cereal Field Margins were the most frequently encountered Priority Habitats, but only took up around 1 % of all agreement land.

1.11 The analysis of vegetation revealed that 53 % of all randomly-placed quadrats were categorised as the CVS class Infertile Grassland and 24 % as CVS class Fertile Grassland. The mean number of vascular plant, lichen and bryophyte species per quadrat was 22. The most diverse quadrat was found in chalk grassland and had 69 species, and the least diverse quadrat, on recently cleared ground, had 0 species. 117 of the 447 random quadrats (26%) were found to have been within Priority Habitats. No Red Data Book or Nationally Scarce species was found in quadrats outside Priority Habitats.

1.12 The quadrats within Priority Habitats had a slightly larger mean number of species per quadrat, of 24. The number of species found in Priority Habitats was not much higher than in the random quadrats because some Priority Habitats are not diverse e.g. moorland or some Cereal Field Margins, and also because the random quadrats also included some of the most diverse Priority Habitats. One Red Data Book species, *Thymus serpyllum*, and three Nationally Scarce species *Sesleria albicans*, *Carex humilis* and *Vulpia ciliata* ssp. *ambigua* were

recorded within the quadrats. The vegetation of these quadrats had a lower proportion of CVS Aggregate Class (AC) Fertile Grassland, and a higher proportion of ACs Moorland Grass/ Mosaic and Heath/Bog than the randomly placed quadrats (note that randomly placed quadrats falling within Priority Habitats were double counted). Priority Habitat quadrats also contained NVC communities of conservation importance that were scarce or absent in quadrats falling outside Priority Habitats. They included calcareous grassland (CG1), heathland (H4) and mire (M10 and M21) communities.

1.13 There were no overall trends in species number or proportion of Priority Habitats with agreement age because differences in take-up between years swamped any effects of changing quality through time.

1.14 The correspondences of management codes and habitats were far from total, as several habitats can be found within a unit of land given a single management code. Nevertheless, the results were largely as one would have expected, except that there were frequent examples of grassland that had been identified as Highly Improved Grassland being given support for grassland management regimes such as lowland pastures and lowland hay meadows. This presumably occurred because the land was of landscape or historical importance.

1.15 Survey data were compared with results from the Countryside Survey 2000 on the basis of the three Environmental Zones (EZ1-3) that occur in England (Annex 12,Figure 1). Broadly the three zones can be described as eastern lowlands (EZ1), western lowlands (EZ2) and marginal uplands (EZ3). In EZ1 and EZ2, CSS land had a much higher proportion of grassland habitats and was much more likely to be typical of low fertility situations than the countryside as a whole in these zones. EZ1 and EZ2 also had a greater observed total number of species in grasslands and a greater mean number of species overall than the countryside as a whole. In EZ3, there was again a greater proportion of grassland habitats (again, containing a higher proportion of infertile grassland than in CS2000), but with a reduced proportion of important upland broad habitats, such as Dwarf Shrub Heath and Bog. This suggests that the CSS has failed to target heather moorland so that it reached the same proportion as found in the countryside as a whole. The “countryside as a whole” included the ESA’s which were ineligible for CSS. If the ESA’s were removed from the analysis to give the “wider countryside”, as used for reporting CS2000, then the proportion of the upland habitats would be higher.

1.16 The differences between the CSS and the countryside as a whole clearly reflect the priorities of the CSS, especially the high proportion of grassland. There are encouraging signs within this comparison that the Scheme has successfully included land of a different character than in the countryside as a whole and of a character likely to be considered of greater conservation value.

1.17 Overall, the results show that the Scheme has targeted grassland vegetation at higher proportions than found in the countryside as a whole. Moreover, this grassland tends to be less fertile than grassland in the countryside as a whole, suggesting an increased conservation quality. Furthermore, the presence of a high proportion of Priority Habitats, and the presence of scarce NVC communities, suggests that the Scheme has included land of high conservation value.

1.18 The survey has shown a range of methodological issues that should be addressed in order to exploit fully the possibilities of interpreting the ecological quality of land under agri-environment schemes. They include:

- the development of appropriate statistics for testing for differences between CS2000 data and agreement land
- more evaluation of the correspondence between Broad and Priority Habitat definitions, the NVC, and the CVS classification to add to the preliminary work of ADAS (Critchley & Burke 1999) and CEH (Bunce *et al* 1999b).

1.19 We consider that we have produced a valid and informative comparative means of evaluating land under an agri-environment scheme with the countryside as a whole. This is an approach that would also have wide applicability to other schemes, as well as to other situations such as ESA's, nature reserves and Sites of Special Scientific Interest because the botanical quality of land within such sites could be compared to the countryside outside them. With adequate replication the method could be used to assess management prescriptions but this has not been possible in this study because the management prescriptions within the Scheme changed repeatedly through the years reducing our sample size (see para 3.48).

1.20 The real value of this study will become apparent if the areas are resurveyed in the future, ideally at the same time as another Countryside Survey; only then will it be possible to judge the ecological value added to agreement land through time.

2. INTRODUCTION

Objectives of the Study

2.1 The Countryside Stewardship Scheme (CSS) is being evaluated for the Ministry of Agriculture, Fisheries and Food (MAFF) by a consortium comprising ADAS, the Centre for Ecology and Hydrology (formerly the Institute of Terrestrial Ecology), and the Countryside and Community Research Unit at the Cheltenham and Gloucester College of Higher Education. The project commenced in 1997 and was completed in 2000. The evaluation has been assessed in two parts; Module 1 considered the appraisal of individual agreements and Module 2 considered the ecological quality of land under agreement as a whole.

2.2 This report presents the results of Module 2. This was centred on a field survey performed to assess the ecological quality of the agreement land at both national and regional scales. These findings will assist MAFF in determining the efficacy of the Scheme in achieving both regional and national targets of habitat protection, including those set out by the Biodiversity Action Plan (Anon, 1994). The objectives of the ecological evaluation were to:

- obtain national estimates of the extent of Biodiversity Action Plan (BAP) Broad and Priority Habitats under Countryside Stewardship Agreements;
- obtain national estimates of vegetation character, and hence ecological quality of all agreement land;
- obtain national estimates of vegetation character, and hence the ecological quality, of BAP Priority Habitats on agreement land;
- analyse the distribution of areas and vegetation characteristics of agreement land (with special reference to Priority Habitats) with regard to geographic location, agreement age and type, and other factors as appropriate; and
- establish a baseline for the future evaluation of changes in ecological quality.

2.8The period of the survey (1998-99) was particularly timely in order to achieve these objectives. This is partly because the Scheme had been running long enough (since 1991) that there was a large and varied sample of agreements, and partly because the survey coincided with the fieldwork for Countryside Survey 2000 (CS2000), thus providing a comparison with the English countryside as a whole. As surveys were carried out on agreements that had been running for different lengths of time the data were less useful for determining the effectiveness of individual management prescriptions would be to survey at the start of an agreement and resurvey later.

2.4 The approach adopted was to identify a random sample of all Countryside Stewardship agreements, regardless of age, geographic distribution, lead landscape type or management objectives. These sample agreements were surveyed in the field. All land cover under the agreement was allocated to Biodiversity Action Plan Broad and Priority Habitats (Anon, 1998), and vegetation quadrats were recorded, one at random in each agreement, and one in each of the Priority Habitats found in each agreement.

2.5 Both field methods and subsequent data analysis were closely based on the protocols used in CS2000 (Anon, 2000), a national survey of land cover and vegetation. Therefore, the land and vegetation under agreement can be compared with that in the countryside as a whole.

2.6 All survey sites are relocatable, and the field data records have been archived to allow this exercise to form a baseline for future surveys of land under Countryside Stewardship agreement.

The Countryside Stewardship Scheme

2.7 The Countryside Stewardship Scheme aims to make conservation part of farming and land management practice and offers payments to landowners/managers for implementing changes in management which will improve the natural heritage of the English countryside.

2.8 The objectives of the Countryside Stewardship Scheme are to:

- sustain the beauty and diversity of the landscape;
- improve and extend wildlife habitats;
- conserve archaeological sites and historic features;
- improve opportunities for countryside enjoyment;
- restore neglected land or features; and
- create new habitats and landscapes.

2.9 The Countryside Stewardship Scheme was launched in 1991 by the Countryside Commission. The responsibility for the Scheme was transferred to MAFF in 1996, and it is currently run from MAFF's nine Regional Service Centres. A team of Farming and Rural Conservation Agency (FRCA) project officers provide professional and technical advice to Countryside Stewardship applicants and agreement holders. In the situation where applications exceed the available budget the Scheme seeks to obtain the best value for money by directing limited funds towards agreements for which the greatest benefit is considered likely to be obtained.

2.10 The Countryside Stewardship Scheme operates throughout England (but excluding the ESA's), targeting the following priority situations: chalk and limestone grasslands; waterside land, old meadows and pastures, coastal areas, lowland heath, upland areas, old orchards, field boundaries, field margins on arable land, countryside around towns and the provision of new access. Different counties have their own targets within the Scheme.

2.11 Each Countryside Stewardship agreement runs for 10 years. An annual fee is paid to farmers for following prescribed management practices with supplements for additional work over and above annual management, together with additional payments for new access and for capital items that contribute towards achieving environmental benefits. Currently, in 2000, there are more than 10,000 Countryside Stewardship agreements in operation.

Countryside Stewardship and ecological quality

2.12 As the objectives of the Scheme are not solely ecological, an agreement that contains vegetation of poor quality (e.g. intensively managed grassland) may still be of high value within the Scheme if it achieves other objectives (e.g. conservation of archaeological features) or where there is land that is currently of low conservation status (see Module 1) which is to be

restored. The ecological quality of land at the start of an agreement may therefore be poor but still of importance in achieving the objectives of the Scheme.

2.13 The assessment of the ecological quality of agreement land is essentially comparative in nature. It is necessary both to compare agreement land with similar land outside the agreement, to judge the contemporary quality, and to compare the condition of the land with the past condition of the land to judge the effectiveness of the land management. It is also necessary to compare the trends in condition of land under agreement with those of land outside agreements, to be able to judge the long term effectiveness of the Scheme at raising the ecological standards above the trends on non-agreement land (Fig 2.1).

2.14 In addition to those in Figure 2.1, further scenarios exist e.g. where the agri-environment scheme land can act as a buffer to high quality land. In such an example it is the quality of the buffered land that is important. As long as the quality of the buffered land is maintained or enhanced then the scheme could be considered successful no matter what the quality of the agreement land might be.

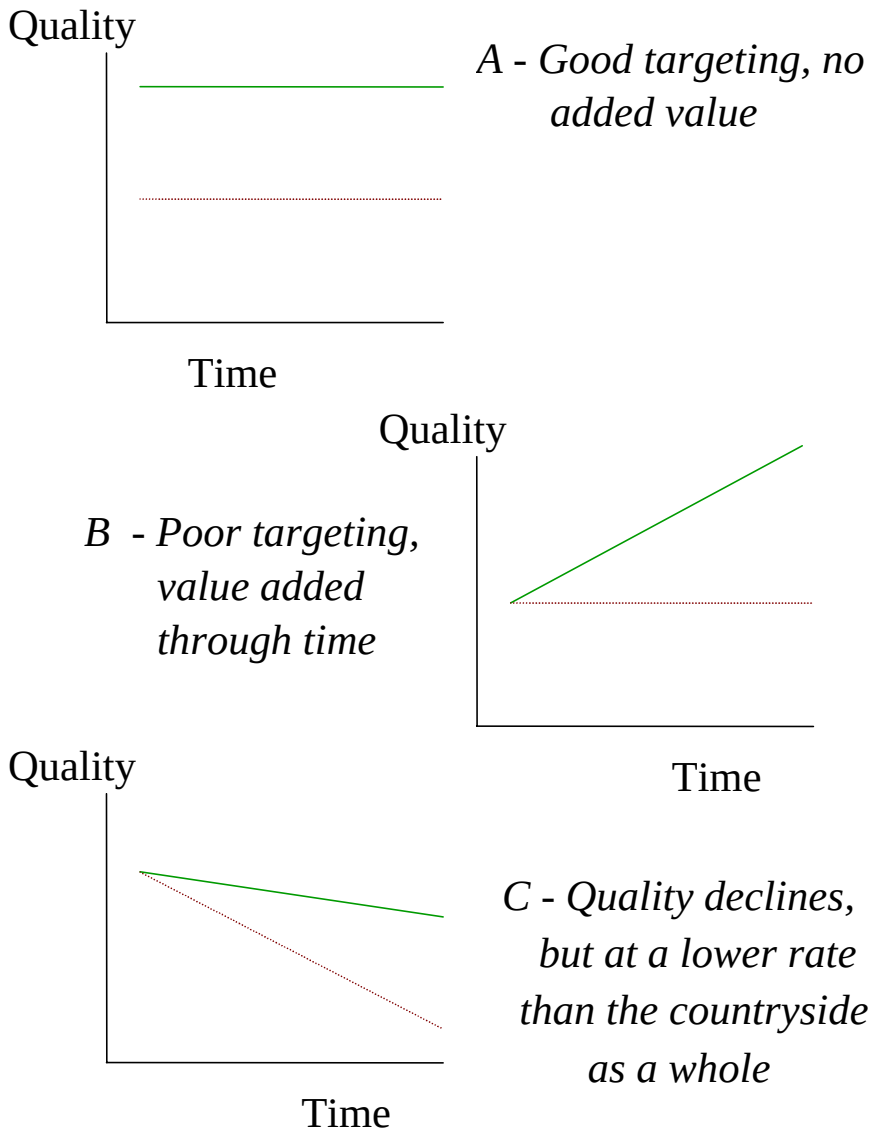
2.15 Three elements were therefore required for this evaluation to fulfil its objectives. The first was to establish a description of land under agreement, in terms of habitat areas and vegetation characteristics. The second was to provide a comparison with land in the English countryside as a whole, this is done using data from CS2000. The third element was to provide a baseline for future surveys and analyses, which in turn will allow the kind of analysis through time that is required to assess fully the contribution of the Scheme to England's ecological quality.

Ecological evaluation of land under Countryside Stewardship agreement

Defining ecological quality

2.16 Ecological quality involves both subjective and objective elements. The subjective element is the perception of the preferred state where the objective element is the extent to which the observed matches the ideal. To determine the preferred ecological state, the quality needs to be described in measurable terms around which there is some degree of consensus. There is a variety of statements that define what is high quality in terms of biodiversity; they include the National Vegetation Classification (NVC) (Rodwell, 1991-95) and, especially, the UK Biodiversity Action Plan (Anon, 1995a). In these statements the presence of a single, globally rare, species is considered of greater importance than the presence of numerous, but common and widespread species. As Bunce *et al*., (1999b) puts it, "The quality of vegetation depends upon an anthropocentric assessment of its value according to its abundance, its contribution to the perception of high environmental character, or its importance to other elements of biodiversity which are regarded as of value in their own right." These attributes are enshrined in the criteria for Sites of Special Scientific Interest (SSSIs); they should "comprehensively cover the major conservation interests .. in terms of the best examples of the full range of natural and semi-natural ecosystems…; include sites necessary to support viable populations of vulnerable, endangered or nationally scarce species" (Department of the Environment, 1998).

Figure 2.1 - The assessment of the success of an agri-environment scheme requires information about initial quality of land, and how it changes through time, for both land within the scheme and land within the countryside as a whole. Three possible scenarios are shown (scheme land in solid, wider countryside in dotted lines) although there are others. A: the scheme conserves high quality land compared with the countryside as a whole, and there are no trends in time. Here the scheme would be considered successful at targeting land, but it would not be clear whether it adds value to that land through time. B: the initial quality of land within the scheme is typical of the countryside as a whole, but its quality increases, compared with the countryside as a whole. Here, the scheme would have failed to target high quality land, but would have added value through time. C: the quality of land under agreement declines with time. However, comparison with the countryside as a whole shows that the scheme targeted high quality land, and increased its quality through time relative to the countryside as a whole – implying success. Note that without the comparison with the countryside as a whole, scenario A would suggest that the scheme is not adding value; scenario B would be interpreted as a success and scenario C interpreted as a failure. It would be impossible to judge targeting without some form of comparison with the countryside as a whole.



2.17 The UK Biodiversity Action Plan addresses ecological quality in terms of named species and habitats of importance, along with plans for their conservation (Anon, 1995b). To help this task, the biotopes of the United Kingdom have been classified into Broad Habitats and Priority Habitats (Annex 1). Broad Habitats are intended to be comprehensive, exclusive, measurable and consistent. All of UK's land cover can be exclusively classified into one or other of the terrestrial Broad Habitats. Priority Habitats are of particular conservation quality, and they are nested within the Broad Habitats. Each Priority Habitat is associated with a single Broad Habitat, except for certain mosaics such as Coastal and Flood Plain Grazing Marsh, Lowland Wood Pasture and Parkland. This habitat classification is increasing in importance when assessing ecological quality. For example, results from CS2000 will be reported by Broad Habitats.

2.18 Ecological quality can be measured using a wide range of indicators over a wide range of scales. This study concentrates on two major indicators, namely Broad and Priority Habitat type at the biotope scale (400 m^2 to fields and larger areas of open ground) and vegetation quality at the 200 m^2 scale.

Assessing ecological quality at the biotope scale

2.19 In this study, a sample of Countryside Stewardship agreements were mapped in terms of Broad and Priority Habitats (Table 2.1, Annex 1), allowing the characterisation of land under agreement in terms of the distribution of these Habitats. The quality of land under agreement can be quantified in terms of the proportion that is of Priority Habitat standard. The distribution of Broad Habitats can be compared with that of the English countryside as a whole using data from CS2000, but comparable estimates from CS2000 in terms of Priority Habitats are not available.

2.20 The situation was complicated by the fact that at the time of the survey, the precise descriptions of the Broad and Priority Habitats were still being finalised. The approach adopted was to use the field keys developed for CS2000 in consultation with the Joint Nature Conservation Committee. For example in 1998, springs and flushes were considered a Priority Habitat and were surveyed as such. In 2000, however, they were no longer included in the list of Priority Habitats.

Table 2.1 - The Biodiversity Action Plan Broad and Priority Habitats as used for the survey of Countryside Stewardship agreement land and as used in this report. The Priority Habitats are nested within Broad Habitats. Note that since the survey began, there have been slight changes to the official list. See Annex 1 for further details.

Code	Broad habitat	Code	Priority habitat
1	Broadleaved, mixed and yew woodland/scrub	A	Lowland wood pastures and parkland
		B	Upland oak woodland
		C	Lowland beech
		D	Upland mixed ash woodland
		E	Wet woodlands
2	Coniferous woodland	F	Native pine wood
3	Boundaries and linear features	G	Ancient and/or species rich hedgerows
4	Arable and horticulture	H	Cereal field margins
5	Improved grassland		
6	Neutral grassland	J	Lowland hay meadow
		K	Upland hay meadow
		L	Coastal and floodplain grazing marsh
7	Calcareous grassland	M	Lowland calcareous grassland
		N	Upland calcareous grassland
8	Acid grassland	P	Lowland dry acid grassland
9	Bracken		None
10	Dwarf-shrub heath	Q	Lowland heathland
		R	Upland heathland
11	Fen, marsh and swamp	S	Purple moor grass and rush pastures species-rich
		T	Fens
		U	Reedbeds
		V	Spring and flush
12	Bogs	W	Blanket bog
		X	Lowland raised bog
13	Standing open water		
14	Rivers and streams		
16	Inland rock	Y	Limestone pavement
18	Supralittoral rock	Z	Maritime cliff and slope
19	Supralittoral sediment	AA	Sand dunes
		AB	Coastal vegetated shingle
21	Littoral sediment	AC	Saltmarsh
			Mudflats
			Seagrass beds *Zostera noltii*
			Sheltered muddy gravels
			Ascopyllum nodosum ecad mackii beds

Assessing ecological quality at the scale of vegetation stands

2.21 This study also considered ecological quality at the smaller scale of vegetation plots, as recorded within quadrats. The vegetation in such plots does not necessarily equate with the Broad Habitat within which it is found; for example, a quadrat may fall on a patch of grassland in a clearing within a "Broadleaved, Mixed and Yew Woodland". There may be small areas of vegetation typical of Priority Habitats outside Priority Habitat patches, and also small areas of lower quality vegetation inside Priority Habitat patches, simply because of the different scales of sampling. Problems may arise when using data from one scale of sampling to characterise ecological quality at another scale. Therefore, it was decided to identify the habitat of each parcel of land before using the quadrat to assess vegetation at the plot level.

2.22 The vegetation data may be used to derive a number of indicators of botanical diversity (Bunce *et al*., 1999b). Species number per plot is a valuable indicator for many, but not all, habitats. Another is the presence of scarce and rare species. Some indicators are concerned with the characteristics of the whole assemblage of plants. One is the presence of scarce or "high quality" NVC assemblages. However, the NVC is less useful for considering assemblages that are of low quality, yet occur widely. A new classification devised for the Countryside Survey vegetation data was used in this project. This is the Countryside Vegetation System (CVS), that classifies British vegetation into 100 classes, and 8 Aggregate Classes, using data from previous Countryside Surveys (Bunce *et al*., 1999a). Just as the Broad Habitat classification provides a comprehensive means of characterising land cover, the CVS provides a comprehensive means of characterising vegetation, and, unlike the NVC, it is based on random sampling, rather than on the sampling of "uniform" stands. Thus the CVS provides a valuable basis for comparing land under agreement with the countryside as a whole, using the CS2000 results. It also provides the basis for evaluating change between surveys at the same locations (Bunce *et al*., 1999b). However, NVC remains a valuable measure of high conservation quality and providing targets to aim for.

Analyses of agreement characteristics with respect to different factors

2.23 The sample frame for the study was all land under agreement, regardless of age, management and geography. This sample lends itself to a range of additional analyses by these and related factors, and they can be undertaken using the database that has been delivered as part of this project. In this report the following analyses are presented:

Breakdown of habitats by geographic location

2.24 Different MAFF Regions (as currently served by the Regional Service Centres) may have different priorities (manifested as regional/county targets) for land under agreement, and they inevitably have different profiles of habitats likely to be submitted for support under the Scheme. We present breakdown of Broad Habitats and vegetation characteristics by MAFF region. Similar breakdowns could be derived from the database for other regional classifications, such as Countryside Character Areas, with the proviso that the fewer agreements sampled within the area of interest, the greater the margins of error.

Relationships between plant species richness, vegetation and habitats, and age of agreements

2.25 The oldest agreements in our sample were established in 1991 and the most recent in 1997. Therefore, it is possible that plant species number per quadrat has been influenced by the age of the agreements, and of different annual profiles of those agreements that were

accepted in particular years. A breakdown of Broad Habitats and Priority Habitats and also vegetation characteristics by year of agreement is included in this report.

Relationships between agreements and management codes

2.26 The management codes refer to the agreed methods of managing land under agreement. In broad terms, one should expect correspondence between these codes and the habitats, as many codes are habitat-specific. However it must be stressed that some codes can cover a wide range of habitats e.g. P1 pasture management can cover anything from acid to neutral grassland that could be unimproved or improved. We attempted the analysis of management code but the results should be regarded with caution, as the codes evolved significantly from the first to last agreements included in this sample (although they remained constant for individual agreements). The vegetation found on agreement land at the end of an agreement should be a function of the starting condition, the management code (and all the variations of it), and random variation in the climate and other factors.

A baseline for the future evaluation of changes in ecological quality

2.27 The design of our survey takes into account the needs of future surveys, again drawing on the Countryside Surveys as a model. All sample points are relocatable, and photographs and notes have been used to aid the interpretation of changes in habitat and vegetation that may be recorded in the future.

3. METHODS

Sample selection

3.1 The target sample size was 500 agreements, sampled from all of England where CSS is possible, regardless of age or other criteria. It should be noted that the sample refers to land under agreement, not the whole farm; also, in some cases there is more than one agreement per farm. Boundary only agreements were excluded. The Farming and Rural Conservation Agency (FRCA) supplied a list of 500 agreements that were sampled at random from the total population of all agreements begun from 1991 until December 1997. A reserve list of 50 agreements was also generated, again at random. MAFF Regional Service Centres provided agreement maps and management prescriptions and wrote to the agreement holders whose site had been selected for the study informing them of the forthcoming survey.

Field visits

3.2 After the letters had been sent by MAFF, the landowners were contacted by CEH (then ITE) to arrange the field survey by telephone call and/or letter. On reaching the site, the surveyors reported to the landowner, unless previously agreed otherwise. The agreement land was walked around, within sight of all its internal and external boundaries, in order to make a broad assessment of the site and to aid mapping.

Field data collection

3.3 The objectives of the field survey for this project were to map the Broad and Priority Habitats at each of the agreements and to position and record the plants from a random quadrat in every agreement and in each Priority Habitat. Other aspects were noted (e.g. Linear features, Target notes, Pen sketch) as an aid to future surveys. The vegetation quadrats were also permanently marked and photographed to facilitate future re-sampling.

3.4 The field surveys took place between June – October 1998 and May – early November 1999.

Broad and Priority Habitat mapping

3.5 All the land under agreement in the sample sites was surveyed and the Broad and Priority Habitats identified. At the time of the beginning of the survey in 1998, there was no agreed key for the recognition of these habitats. Therefore, Broad Habitats were identified using the "Key to vegetation and Broad Habitat codes" (Annex 2), produced for CS2000.

3.6 The one change to the CS2000 key resulted from concerns that the "Improved Grassland" Broad Habitat was so broad that it would conceal much important information about land under Countryside Stewardship agreements. Therefore, three subcategories were created.

3.7 "Highly Improved" were very species poor swards where, typically, the land had been ploughed and reseeded with clover, ryegrass and perhaps a few other aggressive grass species. Such grassland would be used for silage production and/or intensive livestock production and would have had fertiliser and herbicides added annually. They could be termed "industrial grasslands".

3.8 "Semi-improved/Improved" grasslands were species poor to relatively species rich and may have been seeded in the past and may have had fertilisers and herbicides added occasionally or in low amounts annually. Phase I semi-improved grassland fits this category.

3.9 "Sown Light Grass Mixtures" was a category created to account for grassland that had been created only in agri-environment schemes. The seed mixes prescribed under the ESAs and CSS produce swards that are unlike anything else in the countryside, at least in the first few years. This is because they are species poor, but the species that they contain are the ones desirable to create a diverse sward and they are found at unusually high percentages (e.g. one field had 90% meadow brome).

3.10 Priority Habitats, defined as subsets of the Broad Habitats, were identified using the list given in Table 2.1 (also Annex 1). They were recognised by subdivision of the Broad Habitats on the basis of Priority Habitat characteristics, the NVC and expert knowledge. No changes were made to the key or the descriptions of Broad and Priority Habitats between 1998 and 2000 even though the official lists of these habitats were altered slightly and published in the meantime by the Joint Nature Conservation Committee (JNCC). Changes were not possible within the survey because the data collected from sites surveyed in 1998 and 1999 had to be comparable. For example, if the conversion of semi-improved grassland from the Improved Grassland Broad Habitat to Calcareous, Neutral or Acid Grassland Broad Habitats between 1998 and 1999 had been included it would have affected the results in a major way.

3.11 If surveyors were unsure whether a parcel of land was Priority Habitat or just a good example of the Broad Habitat, they were instructed to treat it as if it were a Priority Habitat, in order to trigger the use of a vegetation quadrat to allow more detailed assessment. This means that there was a tendency for Priority Habitats to have been over-recorded. The extent of this tendency may be clarified in the future should vegetation data from Priority Habitats in CS2000 become available.

3.12 Areas of land being treated as field margins within the Scheme were recorded as "Cereal Field Margin" Priority Habitats, since all the margins recorded fit into the Priority Habitat as defined (Anon 1995b):

i. A 'Wildlife Strip' 6m wide adjacent to a cereal crop, together with a 1m 'Sterile Strip' between the wildlife strip and the crop. The wildlife strip is cultivated once a year but not cropped; the Sterile Strip is maintained so as to prevent aggressive arable weeds spreading into the adjacent cereal crop.
ii. A 'Conservation Headland' either 6m or 12m wide forming the outer margin of the crop and separated from an adjacent field boundary or other vegetation by a 1m Sterile Strip. The Conservation Headland is cropped with cereal but is managed with reduced inputs of pesticides so as to favour wild arable plants and invertebrates.
iii. A combined Wildlife Strip and Conservation Headland, separated by a Sterile Strip and managed as described above.
iv. Game crops, stubble or grassland fallows lying between annually cropped land and the field boundary.

3.13 The definition (Anon 1995b) continues to say that the focus is on cereal rather than arable field margins. However crops other than cereals are included in most farm rotations e.g. oil seed rape, linseed, field beans, etc. As a result, over the ten years of a CSS agreement, any

margin may be next to a cereal crop for, perhaps, 7 years and a non-cereal crop for 3 years. So in 7 years it would be Priority Habitat and 3 years not, unless category iv is taken into account for crops in the rotation that are not cereals. After consultation with JNCC and the head of the steering group for this habitat at MAFF, **a margin alongside a field that is in cereal rotation is to be called Cereal Field Margin Priority Habitat no matter what the crop happens to be in any particular year.**

3.14 Nearly all of the margins in the Scheme that were surveyed in this project fall into category iv and this category now includes margins next to any arable crop and also short-term leys. Therefore it was concluded that all of the margins next to annually cultivated land that were surveyed, no matter what the quality, fulfil the requirements to be a Priority Habitat.

3.15 The Broad Habitats and Priority Habitats were marked on the map using the codes given in Annexes 1 and 2. Frequently, each parcel of land on the map had a single code. However, where two or more habitat types exist in the same parcel of land, the boundaries were determined visually and mapped. In the case of mosaics where the boundaries were too small to map (<400m^2 i.e. 20 x 20 m or 10 x 40m etc.), the parcel of land was given a unique code representing the particular mosaic.

Linear features

3.16 Even though linear features were not included in the study in their own right, they were still recorded on the paper maps to aid the interpretation of future surveys. They were characterised as: hedge, fence, wall, ditch, and all combinations of these, wood and road; edges of land parcels that appeared on maps but did not exist on the ground were recorded as no boundary.

Pen sketch

3.17 Additional information was recorded at the time of the survey, not for immediate data analysis, but rather to provide contextual information that will inform any subsequent surveys. A description was given for each agreement in terms of setting, management and the surrounding land use such as:

- altitude, topography;
- a brief description of habitats mapped, e.g. 'much of the site is dominated by calcareous grassland dominated by *Bromus erectus*, with several species-rich *Juncus acutiflorus* flushes';
- vegetation stands too small to map but scattered throughout e.g. sparse bracken, scrub patches, trees;
- surrounding land use e.g. housing estate on northern edge, wheat field to south;
- evidence of use of site e.g. dog walking;
- presence of stock and other animals e.g. rabbits, that affect sward height;
- evidence of a specific management type not related to stock e.g. burning;
- presence of ridge and furrow or other large archaeological features;
- any feature pertaining to Countryside Stewardship Scheme management of the land e.g. hedge laying, scrub clearance; and
- other features of wildlife interest to the site e.g. ground nesting birds, badgers, butterflies.

Target Notes (TN)

3.18 Target notes were completed for, features smaller than a minimum mappable unit (400 m^2) that might have a significant effect on the development of the habitat, were Priority Habitats, or were features considered important to the landscape. Again, these were more to help subsequent analyses than to inform the present report. Target Notes were numbered consecutively for each agreement. If the target note referred to a feature, it was marked as a cross on the map and the number written beside it. If the target note added extra information to an area of Broad or Priority Habitat, e.g. an area of calcareous grassland with more scrub than the other areas, then the target note number was placed next to the habitat code on the map for that area. Text for the target notes was recorded on or separately to the map. The list of features that were target noted, if present, are listed below:

- areas of a different habitat less than minimum mappable area;
- scrub patch if infrequent on site;
- archaeological features e.g. tumuli;
- veteran trees;
- ponds/ditches/areas of standing water;
- springs;
- quarries/mines/workings/caves/dene holes/shake holes if not on map and vegetation different from surrounding area;
- major blow-outs in sand dunes;
- recreational areas e.g. car parking on grass, picnic site;
- new feature not on ordnance survey map e.g. footbridge, information board, bird hide;
- poached areas;
- dung heaps and silage clamps;
- fly-tipping;
- area of ant hills if significant;
- local populations of rare plants (if populations were more widespread then this was mentioned in pen sketch instead);
- rabbit warrens and badger setts;
- tree planting including round boundaries or felling;
- small rock outcrop/cliff/erratic;
- line/clump of trees; and
- infestations of injurious weeds.

Selection of vegetation quadrat locations

3.19 One vegetation quadrat was sampled for each agreement at random (the random quadrat). The location was decided before the site visit by overlaying a transparent grid on to the map of land under Countryside Stewardship agreement and selecting the co-ordinates of the south corner of the quadrat using the random number tables. If the position meant that the quadrat could not be fitted in (e.g. it was too close to a field boundary), it was relocated. The initial positions of the quadrats were recorded on the agreement map.

3.20 In addition a priority quadrat was placed randomly in each Priority Habitat identified within the agreement land. If the agreement consisted of a single Priority Habitat or the random quadrat was situated in the only Priority Habitat present, then only the random quadrat was recorded which served to characterise both the national character of agreement land and the characteristics of Priority Habitats. The priority quadrat was positioned after the field

mapping was completed, and all areas of Priority Habitats had been identified. If there were Priority Habitats not represented by the random quadrat, then each had a priority quadrat located within it. Hence there could be a number of priority quadrats at each site. If there was doubt as to whether a particular habitat was a Priority Habitat or not, a priority quadrat was sampled.

3.21 The position of priority quadrats was randomly selected using the transparent grid method given above but the grid was placed over the areas of Priority Habitat marked on the map rather than the whole agreement.

Procedures to aid the relocation of quadrats

3.22 All quadrats were marked using the same method as used in CS2000. Wherever possible (except for archaeological sites), the position of the southern corner of the quadrat in the field was marked with a metal plate, aligned at 45° to the soil surface and sloping away from the plot to give maximum chance of successful relocation with a metal detector. Elsewhere (notably on wetlands and cultivated land), a plate was inserted at the nearest field boundary, along a cardinal line, and the distance from the centre of the random quadrat to the plate was measured. On some occasions it was more appropriate to use a landmark rather than a boundary, especially for archaeological sites.

3.23 In all cases, the position of the quadrat and marker plate was sketched and annotated with distances (measured with a tape). If measurements were not possible (which was the case in larger upland agreements and lowland heaths), compass bearings (not corrected for magnetic deviation, as this was negligible at the time of the survey) were used. All distances and bearings were taken from the centre of the plot (unless otherwise stated) to easily recognisable, permanent features in the surrounding landscape. Hence, the maps and metal plates will allow precise relocation of the field quadrats. Indeed, since the survey, all of a sample of 50 quadrats have been relocated by workers from another organisation.

3.24 In order to help relocation of quadrats, and also to inform future surveys, each agreement site was photographed from the ground, using 35 mm print film, showing the relationship between the sampled quadrat(s) and the surrounding land. Two photographs were taken of each quadrat, one along a north-south line and one along an east-west line through the quadrat. Each photograph shows the agreement number and the quadrat number. The databack on the camera was set to record the date of the field survey.

Recording the vegetation quadrats

3.25 Each quadrat was laid out using specially designed plot equipment according to Countryside Survey protocols. The selected position of the south corner was located using tape measures, and the quadrat was set up using survey poles with strings to form the diagonals of the square, orientated carefully north-south and east-west, ensuring that they were at right angles. Different coloured strings linking the appropriate positions on the diagonals gave the positions of the nested quadrats. They gave squares of sides 2, 5, 7.07, 10 m, all centred on the centre of the main plot.

3.26 All quadrats were 200 m^2, (i.e. 14.14 m on each side), except for those that were in Priority Habitats that had to be smaller than 14.14 x 14.14m (which included most, if not all, examples of the Cereal Field Margins). In these cases only the innermost nest of the quadrat, (ie 4 m^2), was used, again, reflecting CS2000 methodology.

3.27 The vegetation species recording sheet design was based on the CS2000 sheet. It lists the most common 200 plant species (including mosses and lichens), with space for others to be added as necessary. The species in the centre 2 x 2 m square were recorded first, either by ticking off the name on the list, or adding the new name if not present. A '1' was entered into the 'Q' column, and the estimated cover, in 5 % bands, recorded in the second column. Then, the second nested quadrat was examined, and any new species noted, with the number '2' recorded in the 'Q' column. No cover estimate was given. The procedure continued until all quadrat sizes were recorded. After a final check for any missed recordings the final cover estimate was given for all species with over 5 % cover for the whole 200 m^2 quadrat. Brief details of the plot, such as land use, slope, and presence of grazing animals, were also entered onto the recording sheet.

Quality assurance

3.28 Field surveyors attended a week-long training course in May 1998, held concurrently with the CS2000 training course, thus ensuring uniformity of methods within and between the two surveys. There was also a one day refresher training course in May 1999 when additional surveyors were also trained. The members of survey teams were rotated throughout the field seasons to remove the bias caused by the "recorder effort" of individual partnerships. During 1998 one field team was accompanied by Prof. R.G.H. Bunce to ensure the methodology was following CS2000 protocols.

Data entry

Spatial data

3.29 The mapped data of the Broad and Priority Habitats were digitised into a pre-existing ArcView shapefile provided by FRCA. This shapefile contained the boundaries of the sample agreements together with a corresponding attribute table containing the fields: shape, Countryside Stewardship case number, region (ie. the MAFF region the agreement is located in), the agreement number, and the CPH (county, parish, holding) number. Four extra fields were added by CEH to this attribute table: Age (the year the agreement began); County (where the holding is located), the lead landscape type of the agreement (this refers to the general nature of the biotope that is being addressed by the Scheme) and the RSC (ie the Regional Service Centre that deals with the agreement).

3.30 The boundaries in the FRCA shapefile contained the outline of the whole holding, rather than just the land under Countryside Stewardship agreement (except for cases where parcels of land such as individual fields had also been digitised). Also, collections of boundaries representing numerous parcels of land under agreement on one holding had been merged into one boundary. Consequently, it was not possible, without further data manipulation, to enter data relevant to individual parcels of land (such as the BAP habitat codes from the field survey maps) as there was only one line of data in the corresponding attribute table which represented numerous parcels of land. Therefore, the script file 'EXPLODE' was used to un-merge the merged parcels of land. The data for each individual parcel of land was then accessible in a second attribute table. Extra fields were added to this second table: area $(m)^2$; Habitat code (Broad and Priority Habitat codes from the field survey data); quadrat (the number of the vegetation quadrat(s)) and fields for the various management codes pertaining to the individual parcels of land. It should be noted that where a particular

Broad or Priority habitat spanned more than one parcel (for example two fields) with different management codes the boundaries between the fields were not digitised.

3.31 Mosaics were entered into the database as the combinations of the Broad and Priority Habitats forming them e.g. 1/10Q would be a mosaic of scrub and lowland heath. In some cases there were three habitats in the mosaic e.g. 8/9/1 (acid grassland/bracken/scrub). The constituents of the mosaic are written in the database e.g. 8/9/1.

3.32 Where necessary (e.g. in cases where the whole holding had been digitised and only a small proportion of the holding was in the Countryside Stewardship Scheme), the land currently under agreement was first digitised. The field survey information (ie. the area of each of the Habitat codes) was then digitised where necessary and the corresponding attribute data (eg. Habitat code, quadrat numbers) entered into the attribute table as appropriate.

3.33 Digitising and spatial data analysis were conducted using ArcView.

Quality assurance

Spatial data

3.34 The total areas in the original boundary file as sent to CEH from FRCA were compared to the sum of the areas of all the parcels digitised and in the database, hence giving a % difference between them. Anomalies were identified and examined by two of the field surveyors to provide reasons for the differences and corrections were made where possible.

Botanical data

3.35 The botanical data from the field sheets were entered into an Access database. The header data (giving descriptions of quadrat location, date of sampling etc) were single punched (ie entered once) into the database, and checked against a list of quadrats sent for data entry to ensure they had all been entered. The vegetation data were double punched (i.e. two separate files were created from each data sheet) thus allowing for error checking between the two copies of the data. Mismatches in Quantity and Cover for each record between the two copies of the data were checked with the original data sheets and the appropriate entry changed. New codes produced during data entry were checked, where possible correct codes entered, codes for ambiguous entries were deleted. Possible errors that may not have been detected were where the same mistake has been made in two punches or the same record has been omitted by the data punchers.

Data transfer

3.36 All vegetation recording sheets, agreement details and paper maps were delivered to CEH Merlewood from CEH Monks Wood by mid-November 1999. The ArcView shapefile from FRCA containing the majority of Countryside Stewardship Scheme holding boundaries that were selected for sampling was delivered to Merlewood in mid-August 1999. The boundaries identified as missing from this original file were delivered to CEH Merlewood by February 2000.

Data archiving

3.37 All data entered electronically have been compiled into an ArcView project file and delivered as a CD-ROM. Details of this file are given in Annex 3.

3.38 All field sheets and negatives will be stored in a fire-resistant store, and photocopies and prints are kept at two CEH stations. All digital data are archived electronically at two CEH locations, and the database has been delivered to MAFF as part of this report. The maps, photographs and notes will be archived to inform any follow-up survey.

Data analyses

Analysis of coverage of BAP Habitats

3.39 Total area, mean area and the boundaries of both Broad and Priority Habitats were quantified for each agreement using the ArcView Geographic Information System. These statistics were analysed in terms of location (i.e. nationally and by the nine MAFF Regions), the age of the agreement, and management prescriptions to identify patterns of variation within the data. Making the assumption that the sample is representative of the Scheme as a whole, estimates of the area of each Broad and Priority Habitat in the whole Scheme up until 1997 were made. This was achieved by multiplying proportions of the total area occupied by individual habitats in the sample by the total area in the Scheme up until 1997.

Vegetation

3.40 The vegetation from each quadrat was categorised in terms of the Countryside Vegetation System (CVS) and the NVC. In addition, species counts were given, and Red Data Book and nationally scarce species found in quadrats highlighted. As each quadrat was located within an individual parcel of land with its own Broad or Priority Habitat code, it was possible to analyse the frequency distribution of these indicators by Habitat, and also by the other codes held within the database, e.g. location in the country and age of the agreement. Note that all quadrats were treated alike, even those of smaller size, following the earlier finding that these analyses are relatively insensitive to quadrat size (Bunce *et al*., 1999a).

The Countryside Vegetation System

3.41 The CVS was created to describe the vegetation of Great Britain (Bunce *et al.,* 1999a). It was constructed using objective methods to analyse over 13,000 vegetation plots surveyed in the Countryside Surveys of 1978 and 1990. The countryside surveys sampled vegetation of all qualities from the most diverse chalk grassland to the most uniform *Lolium* ley in a rigorous and uniform way. Because of this the CVS is a more representative classification of the wider countryside than the NVC that was created from data collected from semi-natural vegetation only and was collected from many different projects and surveys in a non-uniform way.

3.42 The procedure used originally to derive the CVS involved two steps:

- The botanical data for all 13,614 individual samples in both 1978 and 1990 were included in the analysis and were grouped into 100 Countryside Vegetation System (CVS) classes using a standard statistical method (TWINSPAN).

- The 100 CVS classes were then analysed using a statistical ordination technique to measure the similarity between them. The classes were distributed along the multivariate axis derived from DECORANA which accounted for the greatest degree of variation among them. The classes were then orientated along a second axis which accounted for the greatest degree of the remainder of the variation, and so on. Those CVS classes which were close together on the resulting axis were more similar than those which were far apart. Eight aggregate classes (AC) were

then generated by clustering the individual classes according to their relative positions on the first four DECORANA axes:

I	Crops/weeds
II	Tall Grassland/herb
III	Fertile Grassland
IV	Infertile Grassland
V	Lowland Wooded
VI	Upland Wooded
VII	Moorland Grass/mosaic
VIII	Heath/bog

The individual CVS classes are named in Annex 4.

The National Vegetation Classification

3.43 The NVC is used as a benchmark for natural and semi-natural vegetation within the UK and certain communities are specifically written into Habitat Action Plans as characteristic of particular habitats. The vegetation data from the quadrats sampled in this project were fitted to the NVC to give an indication of the quality of communities within the Broad and Priority Habitats identified.

3.44 The program SIMIL (provided by the Unit of Vegetation Science at the University of Lancaster) was used to construct the best fit to NVC classes using the data collected from the quadrats. The highest value of the similarity coefficient between a plot and NVC unit was selected as the best fit with no visual inspection of the data. As a result some mismatches were expected since implicit differences in species importance that would be applied by 'expert judgement' can lead to very different allocations of plots. For example a small number of plots were assigned by SIMIL to two maritime cliff communities (MC). Inspection of the species data showed that the key diagnostic species *Armeria maritima*, *Plantago maritima* and *Daucus carota* were absent. In this instance, even though the matching program gives an objective allocation, the allocation remains unsatisfactory and it would be consistent with the way the NVC is applied to change the assignment based on expert opinion. The disadvantage of this is that assignment acquires a subjective, arbitrary component where the 'right' unit is a matter of judgement and repeatability independent of the observer, is impossible. In tests, computer matching routines allocated plot data to the 'correct' NVC sub-community chosen by the expert in about 40% of cases (Palmer 1992). The proportion is likely to increase substantially when community level allocations are considered as reported here. Since vegetation samples were randomly placed they are likely to exhibit more noise than those used to construct the published tables of the NVC, since the latter were based on samples taken from stands deliberately delimited to be homogenous in species composition. This is likely to decrease similarity between Stewardship plots and NVC units overall.

Rare species

3.45 Records of Nationally Scarce and Red Data Book species were also extracted from the database and these represent the species for which Biodiversity Action Plans have been written.

Statistical issues

3.46 The data of Broad and Priority Habitats are presented in terms of proportions without confidence limits. This is because the underlying distributions are unlikely to be normal, because the way that individual agreements "sample" Broad Habitats and vegetation types tends to be all-or nothing. As a result, usual methods of assessing errors may be highly misleading. It may prove possible to develop confidence limits of such estimates using the statistical technique known as bootstrapping, that involves deriving estimates without strong assumptions of distribution. The area of land of vegetation determined by quadrats can, however, be assigned errors because the data were collected objectively, but with the assumption that the quadrat is representative of the whole parcel of land.

3.47 Statistical tests of the botanical characteristics of the random quadrats and priority quadrats are difficult to interpret because the random quadrats contain a large proportion of the quadrats on Priority Habitats by chance, creating a great deal of overlap between the two categories.

Management Codes

3.48 Each agreement had various management codes associated with it, indicating the nature of the work that was being funded. Examples included managing and recreating upland and lowland grassland, managing upland and lowland heath, creating arable field margins and managing historic landscapes. The codes pertaining to the various management prescriptions were changed over the years so that a particular code in one year could mean something completely different in another year. For example code H1 from 1991- 1993 referred to a base payment to sustain existing heath, but from 1993 onwards it refers to lowland hay meadows. This obviously presented problems regarding data entry. Hence, following our request, the Policy unit at FRCA produced a table containing the old Countryside Stewardship codes grouped to the nearest fit current codes as given in Annex 5. The codes for management prescriptions for such projects as scrub management and pond restoration were taken from Booklet 3 (management guidelines directory) of the Countryside Stewardship Scheme application pack.

3.49 Data analysis involved quantifying the frequencies of combinations of management codes and Broad and Priority Habitats. It is not possible to give figures of area of habitats under particular management codes, as the boundaries of land for which management codes were applied, and those of Broad and Priority Habitats were not coincident.

3.50 There are minor discrepancies in sample size between analyses, because there were occasional gaps in information that meant that not all spatial and botanical data could be included in every analysis.

Comparison with Countryside Survey 2000 data

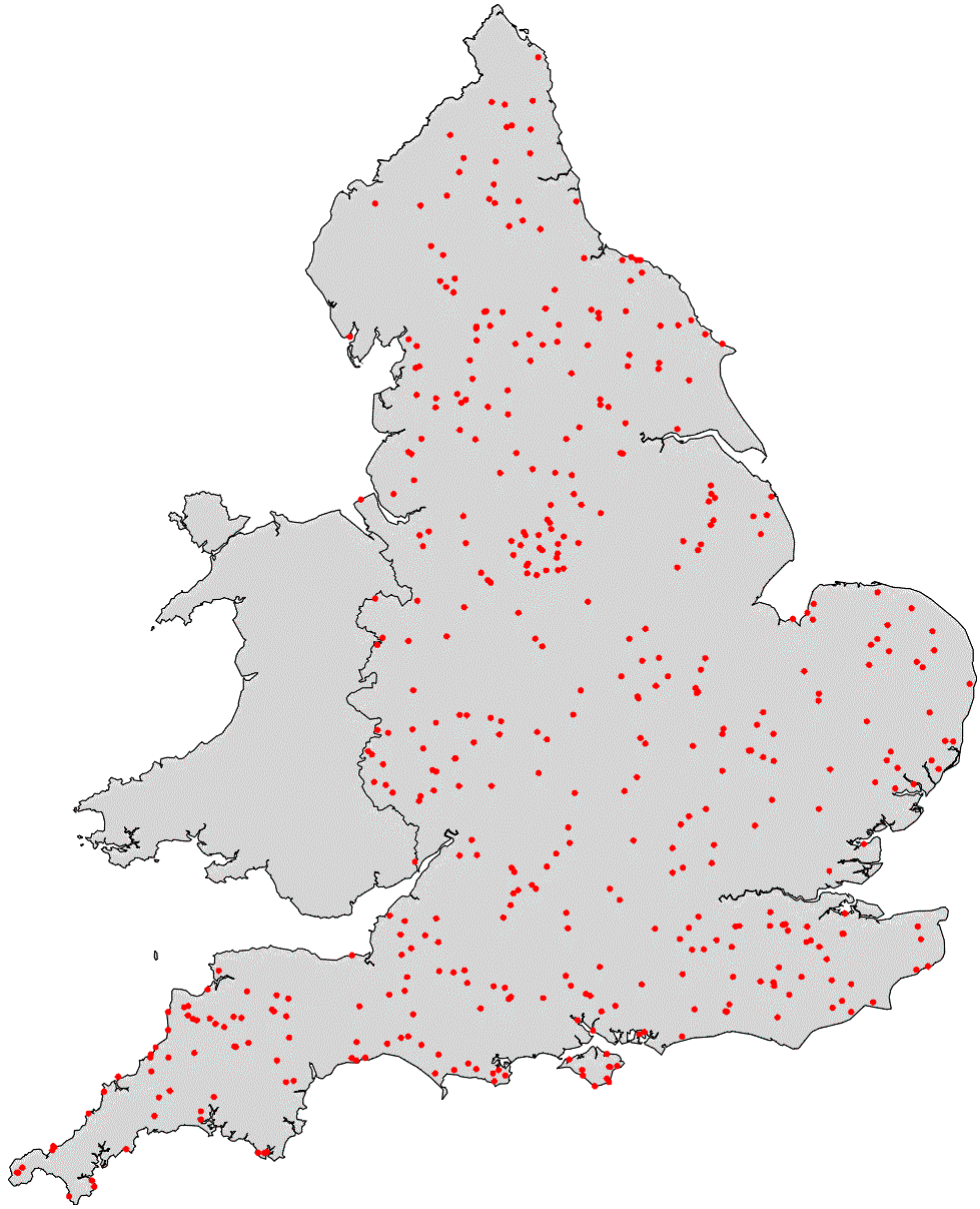
3.51 The distribution of CVS classes and Broad Habitat classes can be compared with the results of CS2000 to give a general comparison between the vegetation under agreement and the vegetation in the English countryside as a whole. These analyses are presented in Annex 12 to this report.

4. RESULTS

Statistics of the whole of the survey

4.1 The agreements surveyed (Figure 4.1) were selected by random sampling by FRCA Leeds and represent the geographic spread of agreements (see Overview Report of this project and uptake reports from FRCA for details). Only one notable cluster exists, in the Peak District, and this reflects targeting in the early years of the Scheme. Gaps occur where ESAs occur e.g. Cumbria and in areas of low uptake e.g. Cambridgeshire/Lincolnshire fens.

Figure 4.1 - The distribution of surveyed agreements



4.2 441 agreements were surveyed from the original sample of 500, with a further 10 agreements from the reserve list giving a total of 451. This represents 8.7 % of the 5203 agreements that were in place at the time of the sampling (i.e. up to and including 1997), excluding boundary-only agreements. Of these, 118 were completed in 1998 and 333 in 1999.

4.3 The shortfall of sites was for several reasons:

- land had been removed from the Countryside Stewardship Scheme since the sample selection, or survey staff were unable to gain access to the land (n=22 and three more from the reserve list);
- the MAFF Regional Survey Centres could not provide the agreement information required (n=14); and
- unable to complete survey due to lack of time (n=13). This was in part due to the unexpectedly high mean number of Priority Habitats per agreement that made it difficult to complete the sample given the level of available resources.

4.4 A total of 35 categories of Broad and Priority Habitats were identified from the field survey. A total of 45 mosaic types were recorded, which have been grouped in the Annexes as follows:

- Priority mosaics are any mosaics that contain a Priority Habitat; then
- Triple mosaics are any mosaics with three habitats; then
- 7 mosaics are mosaics with two habitats which did not feature Priority Habitat but where there was non-priority calcareous grassland; or
- 8 mosaics like 7 mosaics but with acid grassland; or
- 6 mosaics like 7 mosaics but with neutral grassland; then
- other mosaics.

These categories are combined in the main tables.

National estimates of the extent of Broad and Priority Habitats under Countryside Stewardship agreements

4.5 The total area of land assessed within the field survey was 8894 ha. This figure represents 7.2 % of the total area under agreement at the time (excluding boundary-only agreements), of 123,798 ha.

4.6 Half of land under agreement was improved grassland, with other grassland Broad Habitats and mosaics accounting for much of the remainder. Of the improved grassland, the majority was “Semi-improved/Improved”; this category accounted for over 1/3 of all agreement land, and equivalent to around 43,000 ha in total for 1997 (again, excluding boundary agreements) (Table 4.1, Annex 6). The estimated total area must be treated with caution as habitat data were collected in such a way that the attachment of standard errors would not be straightforward (see para. 3.46).

Table 4.1 – The area of the Broad Habitats (including any Priority Habitats found within them) in all of the agreement land in the sample and the estimated total areas under agreement (see para 3.39 for method). The Improved Grassland category is also shown subdivided into the 3 subcategories created for this study.

Habitat Code	Description	Total Area in Sample (ha)	Proportion of Total Area in Sample	Est. Total area under agreement in England (ha)
1	Broadleaved mixed woodland/Scrub	541	0.06	7535
4	Arable/horticulture	240	0.03	3336
5	Improved grassland	4410	0.50	61385
6	Neutral grassland	256	0.03	3564
7	Calcareous grassland	587	0.07	8165
8	Acid grassland	582	0.07	8104
9	Bracken	264	0.03	3680
10	Dwarf shrub heath	464	0.05	6460
11	Fen, marsh & swamp	107	0.01	1490
12	Bog	14	0.00	196
13	Standing open water	56	0.01	773
14	Rivers and streams	2	0.00	27
16	Inland rock	6	0.00	82
17	Built up areas/gardens	5	0.00	68
19	Supra-littoral sediment	46	0.01	636
21	Littoral sediment	233	0.03	3245
	Mosaics	1081	0.12	15052
	TOTAL	**8894**	**1.00**	**123798**
5.1	Highly improved grassland	981	0.11	13650
5.2	Semi-improved/improved grassland	3121	0.35	43439
5.3	Sown light grass mixtures	309	0.03	4295

4.7 Priority Habitats were identified in 166 agreements (37%). They also accounted for over 20 % of the total area under agreement (roughly equivalent to 25,000 ha) including mosaics that contained Priority Habitats (Table 4.2, Annex 6). Three quarters of the 25,000ha did not include the mosaics but was only Priority Habitat and this was equivalent to 15% of the total area under agreement. Calcareous grassland and heathland Priority Habitats accounted for the greatest proportions of agreement area. Two agreements including saltmarsh also accounted for a substantial area. The Cereal Field Margin Priority Habitat was found on the greatest number of agreements, but accounted for little of the overall area.

Table 4.2 – The area of the Priority Habitats (including mosaics containing Priority Habitats) in all of the agreement land in the sample and the estimated total areas under agreement**.**

Habitat Code	Description	Total Area in Sample (ha)	Proportion of Total Area in Sample	No of Agreements	Est. Total area under agreement in England (ha)
1E	Wet woodland	3	<0.01	3	40
4H	Cereal Field Margins	83	0.01	48	1151
6J	Lowland hay meadow	49	0.01	13	682
6L	Coastal & floodplain grazing marsh	37	<0.01	7	517
7M	Lowland calcareous grassland	267	0.03	40	3716
7N	Upland calcareous grassland	94	0.01	5	1311
8P	Lowland dry acid grassland	146	0.02	10	2030
10Q	Lowland heathland	262	0.03	13	3643
10R	Upland heathland	122	0.01	6	1700
11S	Rush pastures- species rich	2	<0.01	2	27
11T	Fens	42	<0.01	10	587
11U	Reedbeds	16	<0.01	9	227
11V	Spring and flush	21	<0.01	19	298
12W	Blanket bog	2	<0.01	2	31
19AA	Sand dunes	10	<0.01	1	133
21AB	Saltmarsh	156	0.02	2	2169
	Priority mosaic	524	0.06	27	7293
	TOTAL PRIORITY HABITATS	**1836**	**0.21**	**217**	**25555**
	TOTAL AREA UNDER AGREEMENT	*8894*			*123798*

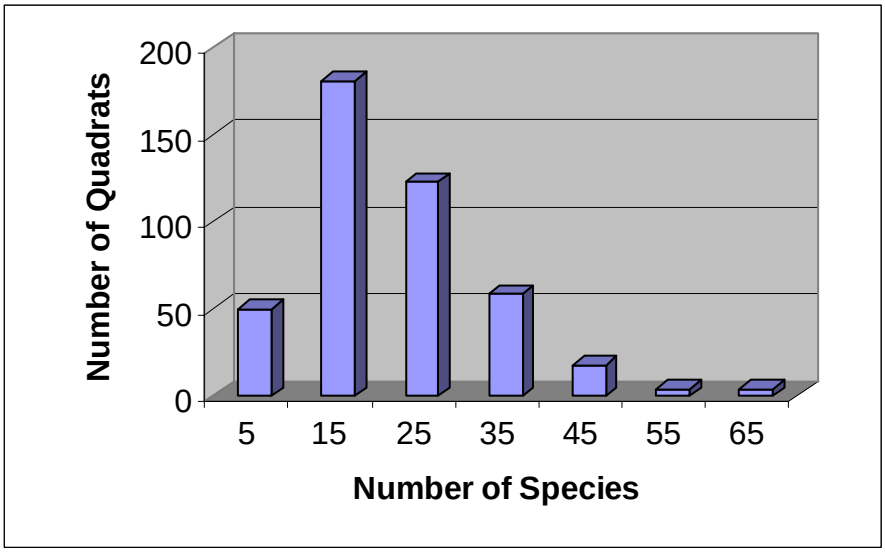
National estimates of vegetation character of all agreement land

4.8 The statistics presented in this section were obtained by considering data from all random quadrats, including those that fell within Priority Habitats, except where otherwise stated.

The number of species found in agreements

4.9 The mean number of species found in the 447 random quadrats was 22 and ranged from 0 to 69 (Figure 4.2).

Figure 4.2: the number of species found per quadrat in random quadrats. The x-axis labels give the centre of each division.



The occurrence of Red Data Book and scarce species in quadrats outwith Priority Habitats

4.10 No Red Data Book species or Nationally Scarce species was found outside Priority Habitats.

The CVS characterisation of agreements

4.11 Three quadrats contained a combination of species that was not recognised by the CVS. One quadrat was in a potato field where the arable margin had not been created, and the other two were saltmarsh (excluded by CVS).

4.12 The most common CVS Aggregate Class (AC) was Infertile Grassland, found in 53% of the random quadrats. A further 24% of the random quadrats had vegetation characteristic of Fertile Grassland (ACIII) (Table 4.3).

4.13 The most common CVS class (24%) found in the random quadrats was Rye-grass/ Yorkshire-fog Grassland (40), a member of the Infertile Grassland AC. The next most common CVS class was Fertile Mixed Grassland (30, ACIII) and that was found in 17% of all random quadrats. No other CVS class was found in more than 8% of quadrats, although there were notably high proportions of Calcareous Grassland and Wet Rushy Grassland (Annex 7).

Table 4.3 – The vegetation Aggregate Classes that random quadrats were assigned to and the areas of the parcels of land in which they were found.

	Aggregate Class	Number of Quadrats	Proportion of Quadrats	Total area in Sample (ha)	Proportion of area in Sample	Mean area (ha)	Standard error of mean
I	Crops/weeds	6	0.01	17	<0.01	2.7	1.9
II	Tall grassland/ herb	36	0.08	137	0.04	3.9	1.8
III	Fertile grassland	106	0.24	999	0.26	9.4	1.7
IV	Infertile grassland	236	0.53	2141	0.56	9.3	0.9
V	Lowland woodland	7	0.02	7	<0.01	1.1	0.6
VI	Upland wooded	17	0.04	171	0.04	1.0	3.2
VII	Moorland grass/ mosaic	22	0.05	182	0.05	8.7	2.1
VIII	Heath/ bog	12	0.03	169	0.04	14.1	3.2
	Unclassified	3	0.01				
	Total	445		3823			

4.14 The area of vegetation in each parcel of land containing a quadrat was calculated from the GIS database, assuming that the random quadrats were representative of the vegetation in the land parcel in which they were found, The area of Infertile Grasslands (ACIV) accounted for 55% and Fertile Grasslands (ACIII) accounted for 25% of the area of land parcels containing random quadrats (Table 4.3), broadly reflecting the high proportion of the grassland broad habitats. The mean area of land parcels for these two most common aggregate classes was very similar at 9.3 and 9.4 ha respectively.

The occurrence of NVC classes in the agreements

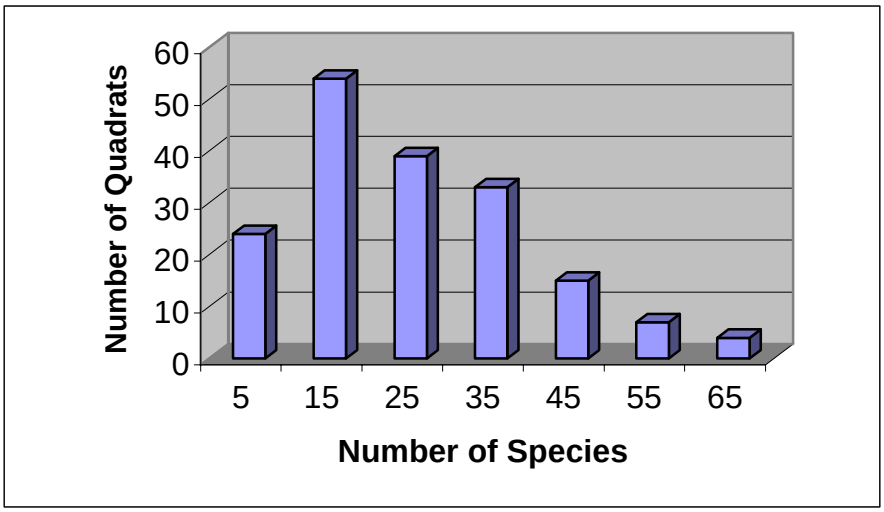
4.15 In random quadrats 67 different NVC classes were identified (Annex 8), the most common were mesotrophic grasslands: *Lolium perenne-Cynosurus cristatus* pasture MG6 (103 quadrats), *Cynosurus cristatus – Centaurea nigra* meadow and pasture MG5 (57 quadrats) and *Lolium perenne* leys and improved grassland MG7 (47 quadrats).

National estimates of vegetation character of Priority Habitats

4.16 Of the 447 randomly located quadrats, 117 were found to be in Priority Habitats. A further 89 quadrats were created where there were Priority Habitats not covered by the random quadrat. The results in this section treat both sets of quadrats within Priority Habitats together.

4.17 The mean number of species per quadrat was 24, slightly higher than in the random quadrats, varying from 3 to 69 (Figure 4.3).

Figure 4.3:The number of species per quadrat found in Priority Habitats. The x-axis labels give the centre of each division.



The occurrence of Red Data Book and scarce species in quadrats

4.18 One Red Data Book species, namely *Thymus serpyllum,* was found, and that was found in two quadrats. Three Nationally Scarce Species were also recorded in Priority Habitats: *Vulpia ciliata* ssp. *ambigua*, *Sesleria albicans* and *Carex humilis*.

The CVS characterisation of Priority Habitats

4.19 The vegetation of Priority Habitats was also dominated by Infertile Grassland (ACIV). The main difference from the random quadrats is that the proportion of quadrats located in Fertile Grassland (ACIII) was lower, with relatively more in the Moorland Grass/mosaic and Heath/bog Aggregate Classes (Table 4.4).

Table 4.4 – The Aggregate Classes of the vegetation in quadrats in Priority Habitats.

	Aggregate Class	Number of Quadrats	Proportion of Quadrats	Total Area in Sample (ha)	Proportion of Area in Sample	Mean Area in Sample (ha)	Standard error of mean
I	Crops/weeds	4	0.02	2	<0.01	0.6	0.3
II	Tall grassland/ herb	23	0.11	8	0.01	0.4	0.1
III	Fertile grassland	25	0.12	189	0.18	7.9	6.4
IV	Infertile grassland	98	0.48	429	0.41	4.5	0.7
V	Lowland woodland	4	0.02	1	<0.01	0.2	0.2
VI	Upland wooded	14	0.07	100	0.10	7.2	3.9
VII	Moorland grass/ mosiac	16	0.08	127	0.12	8.5	2.4
VIII	Heath/ bog	17	0.08	176	0.17	10.3	2.7
	Unclassified	3	0.01				
	Total	204		1028			

The occurrence of NVC classes in the agreements

4.20 In the Priority Habitats (Annex 8) 61 NVC classes were identified, the most frequent being *Cynosurus cristatus – Centaurea nigra* meadow and pasture (MG5), found in 28 out of 201 quadrats that could be analysed.

4.21 A number of community types local at the national scale, and of high conservation importance, were represented in Priority Habitat plots but were absent from the random quadrats. These were CG1 *Festuca ovina-Carlina vulgaris* grassland, H4 *Ulex gallii-Agrostis curtisii* heath, M10 *Carex dioica-Pinguicula vulgaris* mire and M21 *Narthecium ossifragum-Sphagnum papillosum* valley mire. Also more frequent in Priority Habitats were three typically species-poor and eutrophic swamp communities, namely S26 *Phragmites australis-Urtica dioica* fen, S4 *Phragmites australis* reedbed and S5 *Glyceria maxima* swamp.

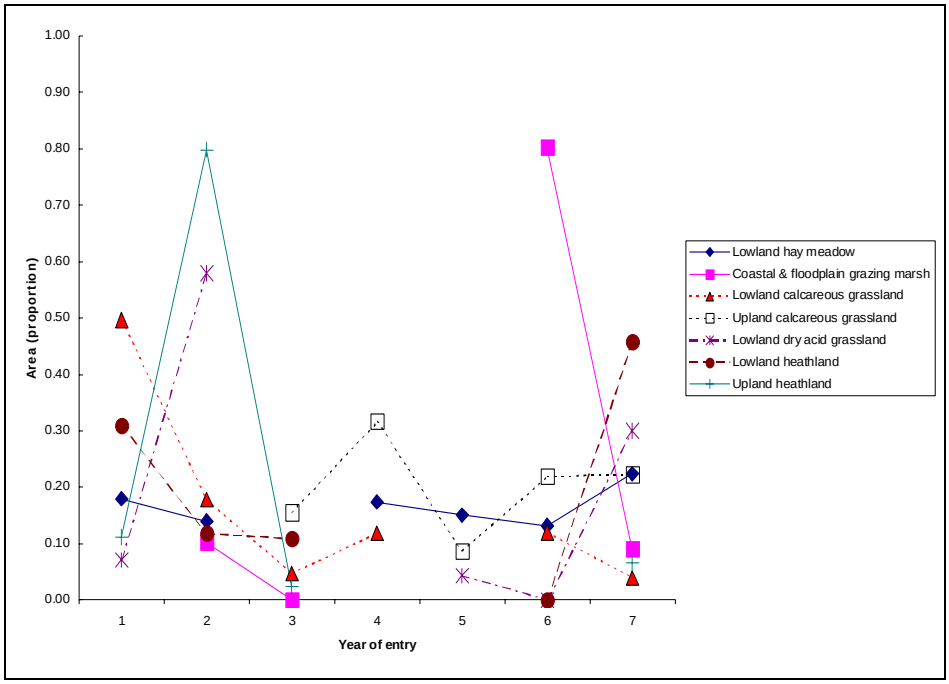
Factors influencing the characteristics of land under agreement

The effects of agreement age on habitat quality

4.22 There was no sign of particular trends in Broad and Priority Habitats with the year of entry into the Scheme (Annex 9). In particular, Priority Habitats did not form a higher proportion of the total in older agreements.

4.23 Furthermore, for individual Priority Habitats, clear trends in area with age of agreement were not observed, rather the relative proportion of the different habitats in the different years reflect the episodic nature of submissions into the Scheme.

Figure 4.3: The relationship between area of selected Priority Habitats and the year of entry into agreements. Areas are presented as proportions of each Priority Habitat



4.24 Differences were observed between the number of species found in the random quadrats from agreements that started in different years (Table 4.5), but they were not statistically significant when modelled using GLM (MINITAB 12) alongside the significant regional variation in the number of species (n=438; df=8, 6; F=3.34, 1.48; p=0.001, 0.182). Nor was there any trend for increased species number with age of agreement.

Table 4.5: The variation in the mean number of species per quadrat found in agreements that began in different years.

Year of agreement	Mean Number of Species	Standard Error	Number of quadrats
1991	24	1.6	60
1992	22	1.0	89
1993	19	1.2	61
1994	24	1.4	67
1995	21	2.1	26
1996	24	1.6	58
1997	20	1.2	80

Regional differences between land under agreement

4.25 Different Broad and Priority Habitats were represented to different extents within the MAFF regions (Table 4.6 shows a selection of these Habitats; all are shown in Annex 10). These reflect both the distributions of the Habitats in the wider countryside, but may also reflect the priorities and targets within MAFF regions e.g. this seems the most likely explanation for the high proportion of Cereal Field Margins found in the Reading region.

Table 4.6: The distributions of a selection of Broad and Priority Habitats across the MAFF regions. The figure of 0.24 for Highly improved grassland for South West shows that 0.24 of this particular habitat is found within this particular region (i.e. the rows add up to 1).

Habitat code	Description	South West	Wessex	Reading	Cambridge	South Mercia	North Mercia	East Midlands	Northern	North Eastern
5.1	Highly improved grassland	0.24	0.07	0.12	0.02	0.01	0.06	0.28	0.07	0.13
5.2	Semi-improved/improved grassland	0.15	0.11	0.21	0.06	0.05	0.10	0.11	0.10	0.11
5.3	Sown light grass mixtures	0.01	0.10	0.44	0.18	-	-	0.03	0.17	0.07
6	Neutral grassland	0.11	0.16	0.08	0.22	-	0.07	0.03	0.03	0.29
7	Calcareous grassland	0.01	0.72	0.05	-	-	0.13	0.01	-	0.08
8	Acid grassland	0.10	0.01	-	0.02	0.01	0.02	0.14	0.11	0.60
10	Dwarf shrub heath	0.60	0.01	-	-	-	<0.01	0.15	0.22	0.02
4H	Cereal field margins	<0.01	0.12	0.37	0.12	0.02	0.01	0.15	0.03	0.17
6J	Lowland hay meadow	-	0.18	0.38	0.30	-	0.07	0.07	-	-
6L	Coastal & floodplain grazing marsh	-	0.10	0.08	0.72	-	-	-	-	0.10
7M	Lowland calcareous grassland	0.05	0.18	0.57	0.06	0.01	-	0.06	0.07	<0.01
7N	Upland calcareous grassland	-	-	-	-	-	-	-	-	1.00
8P	Lowland dry acid grassland	0.07	-	0.31	0.04	-	-	0.03	0.07	0.48
10Q	Lowland heathland	0.09	0.11	0.63	0.16	-	-	-	<0.01	-
10R	Upland heathland	-	-	-	-	-	0.05	-	-	0.95

4.26 Species number also varied to some extent between regions (Table 4.7). The reduced species number in the north can be accounted for by the greater occurrence of species-poor habitats such as upland heaths, and also by the biogeographic trend for species richness to increase from north to south. The low species number in East Midlands corresponds with the low levels of species-rich grasslands (Table 4.6).

Table 4.7: Variation in the mean number of species between MAFF regions.

Region	Mean number of species	Standard Error	Number of quadrats
South Western	26	1.4	56
Reading	24	1.5	81
Wessex	25	1.8	52
Cambridge	22	1.5	52
South Mercia	23	1.6	35
North Mercia	22	2.0	27
East Midlands	20	1.4	43
North Eastern	19	1.1	60
Northern	17	1.0	41

4.27 There were variations in the proportions of CVS Aggregate Classes found within each MAFF region (Table 4.8). Even so, the proportions of quadrats falling within the Infertile Grassland (ACIV) were always high.

Table 4.8 – The proportion of random quadrats found within each CVS Aggregate Class within each MAFF region.

Aggregate Class	South West	Reading	Wessex	Cambridge	South Mercia	North Mercia	East Midlands	Northern	North Eastern
I	-	0.04	0.02	0.02	0.03	-	-	-	-
II	-	0.10	0.02	0.27	0.06	0.11	0.09	0.05	0.03
III	0.14	0.28	0.16	0.21	0.23	0.11	0.30	0.34	0.31
IV	0.54	0.46	0.75	0.37	0.57	0.63	0.56	0.49	0.49
V	-	0.04	-	0.06	-	0.04	-	-	-
VI	0.07	0.04	-	0.04	0.09	0.07	-	-	0.05
VII	0.18	-	0.02	-	0.03	0.04	0.02	0.12	0.05
VIII	0.04	0.04	0.02	0.02	-	-	0.02	-	0.07
Unclassified	-	0.01	0.02	0.02	-	-	-	-	-
Total	57	81	52	52	35	27	43	41	59

Analysis of Management Codes

4.28 The management codes that applied to the 2309 parcels of land that were under agreement were determined using the definitions provided by FRCA (Annex 5). The most frequent combinations of management codes applying to the parcels and the frequency of Broad and Priority Habitats found in them are summarised in Table 4.9 (full details are presented in Annex 11). This matrix shows a wide variety of management codes applied across the Habitat types, but not in a way that is surprising, given the fact that several habitats can combine to form a unit of land for which an individual management code may apply. There are quite high frequencies of lowland hay meadows and lowland pasture grassland management codes being applied to Highly Improved Grassland and it is debatable whether this is an appropriate habitat to be included in agreements (see Module 1 Topic reports). Scrub clearance was being applied to a very wide range of habitats.

Table 4.9. The frequency that Countryside Stewardship management codes occurred with Broad and Priority Habitats. Only those Habitats with at least 20 records, and those management codes with at least 50 records are shown: the full dataset is given in Annex 11.

Broad and Priority Habitats	**Lowland hay meadows** **H1, H1-GRP**	**Lowland pastures on neutral/acid soils** **P1, P1-GRP**	**Lowland Chalk and limestone grassland** **P4**	**Regeneration of grassland/semi natural vegetation** **R1**	**Creation of permanent grass margins (6m)** **R3**	**Creation of 2m grass margins or beetle bank** **R4**	**Sustain existing heath** **LH1**
Broadleaved mixed woodland/Shrub	32	61	72	11	-	-	38
Lowland heathland	-	-	1	-	-	-	48
Spring and flush	5	14	6	-	-	-	1
Standing open water	9	34	1	5	-	-	1
Arable & horticulture	2	7	1	5	-	-	-
Cereal field margins	-	1	-	-	132	145	-
Highly improved grassland	16	53	5	20	-	-	1
Semi-improved/improved grassland	84	167	39	49	-	-	6
Sown light grass mixtures	-	5		15	-	-	-
Neutral grassland	22	11	3	8	-	-	-
Calcareous grassland	-	4	8	4	-	-	-
Lowland calcareous grassland	1	11	54	1	-	-	-
Acid grassland	2	4	4	-	-	-	1
Lowland dry acid grassland	-	-	-	-	-	-	11
Bracken	5	22	3	-	-	-	34
Other mosaic	9	27	2	2	-	-	20
Priority mosaic	1	3	9	-	-	-	9
TOTAL	188	424	208	120	132	145	170

Table 4.9 cont[d]

BAP habitat	**Improving heath** **LH2**	**Upland Hay meadows** **UH1. UH1-GRP**	**Upland Limestone grassland** **UP4**	**Regenerating suppresed heather moor** **UM2**	**Scrub clearance** **SA,SB,SC**	**Bracken clearance** **BC, BM**	**TOTAL**
Broadleaved mixed woodland/Shrub	30	4	12	2	67	9	338
Lowland heathland	37	-	-	-	27	13	126
Spring and flush	1	-	2	1	1	-	31
Standing open water	1	-	-	1	5	-	57
Arable & horticulture	-	34	-	-	4	-	53
Arable margins	-	-	-	-	1	2	281
Highly improved grassland	-	6	10	-	6	1	118
Semi-improved/improved grassland	3	20	29	1	42	4	444
Sown light grass mixtures	-	-	-	-	-	-	20
Neutral grassland	-	2	1	-	6	2	55
Calcareous grassland	-	-	7	-	4	-	27
Lowland calcareous grassland	-	-	21	3	28	1	120
Acid grassland	-	2	-	14	5	9	41
Lowland dry acid grassland	9	-	2	4	2	3	31
Bracken	25	-	3	22	13	18	145
Other mosaic	9	3	2	1	25	10	110
Priority mosaic	7	-	6	14	13	5	67
TOTAL	122	71	95	63	249	77	

5. DISCUSSION AND CONCLUSIONS

Main Findings of the survey of agreement land

National estimates of the extent of Broad Habitats

5.1 The survey has provided national estimates of the areas of Broad and Priority Habitats under Countryside Stewardship agreements. The estimates of Broad Habitats (Table 4.1) show high proportions of grassland habitats, which is not surprising given the importance of grassland management within the Scheme, and also recognising that land used for access, landscape and historical features are often found within grassland. Half of the land under agreement is within the "Improved Grassland" Broad Habitat. At first sight, this suggests land of poor ecological quality. However, much of this falls within the "Semi-improved/improved Grassland" sub-category, implying that much of this land may indeed be suitable for management for botanical diversity. Indeed, if the current definitions for grassland were available in 1998 almost all of the Semi-improved/improved Grassland would have been designated Calcareous, Neutral or Acid Grassland depending on the substrate. Of course, even Highly Improved Grassland may have ecological value for other species groups, such as wintering geese, and/or be important for historic reasons.

5.2 The spatial distribution of the Broad and Priority Habitats among the MAFF regions (Table 4.6) is more complex to interpret. This is partly because Environmentally Sensitive Areas (ESAs) that represent well known areas of particular habitats are not included in the sample, e.g. the low proportions of upland habitats that are found within the Northern region in this survey could be explained by large areas that are within ESAs such as the Pennine Dales which are excluded from the CSS. The figures presented in Table 4.6 also reflect differences in county priorities within the Scheme. This also had implications for the comparison of the CSS with the English countryside as a whole (see para 5.12 below).

National estimates of the extent of Priority Habitats

5.3 Our results suggest that 15 % of all agreement land falls within Priority Habitats, and this figure does not include the area of Priority Habitats in mosaics. However, the figure has undoubtedly been inflated because of our decision to treat, in the field, doubtful cases as Priority Habitats. The extent of this inflation is impossible to tell at the moment, as definitions of the Priority Habitats are not yet sufficiently precise. Comparable Priority Habitat data are not available within CS2000.

5.4 Even so, the estimated area of around 25,000 ha of Priority Habitat and the individual figures for heathland and lowland grassland Priority Habitats are especially encouraging.

National estimates of vegetation character

5.5 The differing proportions of land under different Habitats was, inevitably, reflected by the analysis of vegetation within the quadrats (Table 4.3). However, the high proportion of Infertile Grassland (ACIV) gives a more optimistic view of conservation quality of the land than that given by the Broad Habitat data, and suggests that much of the land under agreement was of reasonable ecological quality, and is capable of being managed to develop its diversity even further.

5.6 This assessment is supported by the NVC analyses. The community types that were particularly frequent comprised a predictable suite of improved or semi-improved mesotrophic

grasslands. In particular, *Lolium perenne-Cynosurus cristatus* pasture MG6 was very widespread, and includes swards that are likely to have been derived from plant communities once managed for hay. However, some communities have more conservation value, including MG8, MG4 and MG5. MG5 *Cynosurus cristatus-Centaurea nigra* meadow and pasture is the typical community of traditionally managed hay-meadows in lowland England and has consequently become more scarce over the past 50 years. Considerable importance is attached to its current status and distribution since MG5 is one of the priority community types listed by Jefferson & Robertson (1996) with less than 5000 ha estimated to still exist in England. The high frequency of MG5 within both Priority and non-Priority Habitats strongly suggests that the Countryside Stewardship has been successful in targeting this community. However it must be stressed that much of the MG5 identified by the program SIMIL would be at the poorer end of the spectrum for this NVC community. Although poorer it should be targeted with the hope that it may be restored, at least partly.

5.7 The vegetation in Priority Habitats tended to be of higher conservation quality than outside them; thus nationally localised NVC communities were only found within them. This is largely inevitable given the way the Priority Habitats were identified in the field (Table 4.2). However, the vegetation in Priority Habitat quadrats (Table 4.4) contained more vegetation typical of the uplands than indicated by the Priority Habitat characterisation. This may well help explain the relatively small difference in species number per quadrat (24 in Priority Habitats, 22 in the random quadrats), as these plant communities tend to be species-poor.

5.8 The regional differences between proportions of Aggregate Classes did not appear to be typical of the landscape as a whole; thus the greatest proportion of Moorland grass/ mosaic (AC VII) was found in the south west, rather than in the North and North East (Table 4.8). Such data need to be interpreted in the light of local targets, again, taking into consideration the extents and roles of ESAs.

5.9 It is perhaps disappointing that more Red Data Book (RDB) and scarce species were not found, but this is inevitable given a quadrat approach to sampling, rather than compiling species lists over larger areas of land. Indeed, many more RDB and scarce species were observed outside the quadrats and were target noted.

The effects of year of entry into agreement

5.10 There was apparently no trend for increasing species number (Table 4.5), nor of increased proportion of Priority Habitats (e.g. Fig 4.3) with time. Rather, the data show that differences between years have appeared to be sporadic, indicating that any effects of habitat succession and maturity have been swamped by differences in patterns of uptake between the years.

Relationships between habitat and management code

5.11 The degree of correspondence between management codes and habitats may be expected to change with time, as the habitat characteristics shift towards those codes implying positive management (e.g. the grassland regimes) and away from those implying negative management (e.g. scrub clearance). In general, the matrix of habitats and management appears logical; grassland regimes are concentrated on grassland, upland regeneration on upland habitats, and scrub clearance was associated with a wide variety of habitats (Table 4.9). However, there are some combinations of habitat and management that should cause concern, notably the variety of management codes for Highly Improved Grassland.

Comparisons with the wider countryside

5.12 Survey data were compared with results from the Countryside Survey 2000 on the basis of the three Environmental Zones (EZ1-3) that occur in England (Annex 12,Figure 1). Broadly the three zones can be described as eastern lowlands (EZ1), western lowlands (EZ2) and marginal uplands (EZ3). In EZ1 And EZ2, CSS land had a much higher proportion of grassland habitats and were much more likely to be typical of low fertility situations than the countryside as a whole in these zones. EZ1 and EZ2 also had a greater observed total number of species in grasslands and a greater mean number of species overall than the countryside as a whole. In EZ3, there was again a greater proportion of grassland habitats (again, containing a higher proportion of infertile grassland than in CS2000), but with a reduced proportion of important upland broad habitats, such as Dwarf Shrub Heath and Bog. This suggests that the CSS has failed to target heather moorland so that it reached the same proportion as found in the countryside as a whole or that a high proportion of these habitats is not eligible for CSS (e.g. is within ESA's).

5.13 These differences clearly reflect the priorities of the CSS, especially the concentration of grassland. Nevertheless, there are encouraging signs within this comparison that the Scheme has successfully included land of a different character than in the countryside as a whole – and a character likely to be considered of greater conservation value.

Issues concerning survey design and analysis

5.14 This project was intended to provide an ecological overview of land under Countryside Stewardship agreements. It has certainly done that, and we feel that the database that has been produced is capable of far more detailed queries and analyses than has been attempted here. However, the study has revealed several valuable points about the evaluation of agreement land, and also about the use of Biodiversity Action Plan Habitats and the Countryside Vegetation System.

5.15 There are major statistical issues to be developed, especially in terms of land cover. The survey methodology used here samples blocks of land that are likely to be fairly homogeneous, and so error estimates using Gaussian statistics are almost meaningless and cannot be attached to Tables 4.1 or 4.2. Also, the areas of habitats surveyed in this project where parcels of land were targeted are difficult to compare with estimates from CS2000 where whole 1km squares were selected and these contained many incomplete land parcels at

the edges. This survey targets certain landcover types more than others (urban is excluded completely) whilst CS2000 includes all landcovers.

5.16 There appear to be differences between the Broad and Priority Habitat classification and the CVS; the CVS analysis suggests a greater proportion of high quality vegetation than implied by the habitat classification. This would have been even more extreme had we not chosen to subdivide the "Improved Grassland" category. We need a formal cross-classification of Habitats and CVS classes in order to identify the cause of this discrepancy. To what extent is it a real difference, perhaps related to scale, and to what extent is it a matter of attaching labels at different points along the continuum between highly fertile, species-poor grassland and infertile, species-rich swards (see Bunce 1999b for further discussion)?

5.17 The appropriate method of assessing Priority Habitats is still not clear. This is because the habitat definitions are likely to rely on more precise species data than the Broad Habitats, and so it is more difficult to establish an evaluation of these habitats without introducing circularity. One possible approach would be to define Priority Habitats fully in terms of some other classification, such as the NVC, and then assess them in terms of the degree of correspondence with the desired NVC community or communities, or by employing English Nature Condition Assessments.

5.18 The interpretation of management codes and regional variations require much more consideration of the details of the Scheme than has been attempted here. However, two points can be made. The first is that the long-term assessment of management prescriptions is best undertaken using baseline data of agreements as they start, ideally using samples made up of agreements that start in different years. In this sense the field data collected under Module 1 may be more appropriate than the data reported here; however, as Module 1 did not include the use of relocatable quadrats, changes may be difficult to detect. The second point is that to hypothesise an "expected" regional breakdown of habitats is far from trivial, depending on the local priorities of the Scheme, including variable and almost random uptake by landowners (targeting in some areas is non-random), as well as the national distribution of the habitats themselves, with ESAs masked out.

5.19The methodology used here cannot be used to inform on the status of individual BAP species. This can only be achieved by detailed monitoring of population dynamics in a similar way to studies that began in the 1960's (Wells 1967) for what were later called Schedule 8 species. This monitoring continues to the present day for certain species but not necessarily funded by English Nature or directly funded by government (e.g. Waite and Farrell 1998, Carey 1999).

5.20 We have ensured that the survey can be used effectively as a baseline for future studies by using the tried and tested protocols of Countryside Survey. However, the experience of Countryside Survey suggests that there are problems in mapping mosaics of habitats, especially in open land. Without global positioning systems (and, quite likely, even with them), differences between recorders can be as great as differences between sample periods. Therefore, in open countryside at least, the vegetation quadrats may be a more useful means of assessing change between surveys.

5.21 Even despite these issues, we have demonstrated that it is possible to assess ecological quality of agri-environment schemes at the habitat and vegetation level, using quality

measures that are also being used for biodiversity policy, and thus to provide estimates of land that can be considered to contribute to the UK Biodiversity Action Plan. Moreover, by establishing a baseline for a repeatable survey, it will be possible to judge the ecological value of the Scheme compared with changes in the wider countryside.

Conclusion

5.22 We have demonstrated that the ecological quality of land under Countryside Stewardship agreements is, indeed, of higher quality than the land in the English countryside as a whole (including ESA's), especially in the lowlands. In particular, it has been successful in capturing large areas of infertile grassland that are either already of high conservation quality, or may have the potential to achieve high conservation care with appropriate management. If ESA's were excluded from the "countryside" to show the "wider countryside" used for CS2000 reporting, the land under CSS agreements would probably appear to be of even higher quality in relation to the wider countryside than has been shown in this report.

5.23 However, the real test of the Scheme will only come when the land is resurveyed at some stage in the future. Such a survey should, again, be timed to coincide with a Countryside Survey, to show to what extent the differences that we have found within and beyond the Scheme are maintained, increased or even decreased through time.

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8. GLOSSARY

Aggregate Classes	The 100 CVS classes were aggregated into 8 classes (see Annex 4 for details.
ARCVIEW	A Geographic Information System available for PCs.
BAP	Biodiversity Action Plan
Broad Habitats	The system evolved by JNCC to categorise the habitats of the UK in response to the Rio convention.
CEH	The Centre for Ecology and Hydrology
Countryside as a whole	All of English "countryside" including urban green areas and ESA's.
CPH	County/Parish/Holding: The numbering system by which CSS agreements are catalogued
CS2000	Countryside Survey 2000: a systematic survey of more than 500 1km squares of the countryside of the UK
CSS	Countryside Stewardship Scheme
CVS	The Countryside Vegetation System: A classification of British vegetation created from pooling and analysing the data of all Countryside Survey quadrats from 1978 and 1990 (see para 3.41-3.42).
Environmental Zones	The division of Great Britain by climatic, soil and other environmental variables based on the ITE land classification (see para A12.15).
FRCA	Farming and Rural Conservation Agency
JNCC	Joint Nature Conservation Committee
Lead Landscape Type	The CSS is stratified by 11 lead landscape types e.g. upland, waterside, countryside around towns.
NVC	National Vegetation Classification. A classification of British vegetation based on targeted quadrats in semi-natural vegetation.
Phase I	A classification of habitats designed in the 1970's by the Nature Conservation Council. All of England has been classified using this system.
Priority Habitats	A sub-categorisation of the Broad Habitats that are targeted as of priority for conservation. They form an integral part of the BAP for habitats.
Project Officer	The FRCA staff responsible for day to day administration of the CSS, including scoring agreement applications.
Rare	Found in less than 16 10km squares in Great Britain.
RSC	MAFF regional service centres
Scarce	Found in 16-100 10km squares in Great Britain.
SIMIL	A program for assigning the data collected from quadrats to the nearest NVC community.
SSSI	Site of Special Scientific Interest
Wider countryside	England excluding ESA's.