Queen's University Belfast

Biological Monitoring of the Countryside Management Scheme in Northern Ireland 2002/03 - 2006/07

Report to Department of Agriculture and Rural Development

Agri-environment Monitoring Unit
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Agri-environment Monitoring Unit

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SUMMARY

1. The Countryside Management Scheme (CMS) was introduced in Northern Ireland by the Department of Agriculture and Rural Development (DARD) in 2000. The scheme focuses on biodiversity, water quality of rivers and lakes, landscape and heritage features. It is voluntary, and open to all farmers and landowners outside designated Environmentally Sensitive Areas (ESAs). Specific management prescriptions must be followed for all habitats. Uptake of the scheme has been successful with over 8,800 landowners having entered the scheme by December 2007, bringing around 320,000ha of land under CMS agreement.

2. Biological monitoring forms the core of a programme to evaluate the effectiveness of CMS management prescriptions in maintaining and enhancing biodiversity. The main focus of the biological monitoring is on assessing changes in diversity within plant and invertebrate communities.

3. Quantitative sampling of plant and invertebrate communities on various habitats under CMS agreement was undertaken in 2002/03 as a baseline for monitoring (Flexen *et al*. 2004). Sampling sites were selected on a stratified random basis. At each site, plant communities were assessed using quadrats, with data used to calculate species richness, species diversity indices and C-S-R values for each habitat and site. Condition assessment was also carried out for selected habitats to give an indication of their baseline condition. Soil analysis was undertaken for grassland habitats only.

4. Botanical resurveys of habitats were carried out in 2006 and 2007. The total sample size of resurveyed sites was 352. Changes in plant species richness, diversity indices, C-S-R values and in the abundance and frequency of key plant indicator species for habitats were determined. Condition assessment was carried out for species-rich grassland and moorland habitats.

5. With the exception of woodland, no significant changes in plant species richness, diversity indices or C-S-R values were found in any habitats suggesting that these habitats were being maintained in terms of botanical diversity and composition since baseline.

6. For species-rich grassland sites, species diversity indices tended to slightly decrease since baseline. There were no significant changes in the mean percentage cover or frequency of key indicator species. There was a small increase in the number of species-rich wet grassland and species-rich hay meadow sites in favourable condition at resurvey. No species-rich dry grassland sites were in favourable condition at resurvey, which may be related to lack of adequate management, particularly in relation to grazing.

7. There was little change in mean heather (*Calluna vulgaris*) or dwarf-shrub cover on moorland and raised bog habitats. The exception was degraded heath sites where there was an increase in cover compared to baseline, indicating improved habitat condition. This may be related to reduced stocking rates prescribed by the CMS. In terms of habitat condition, no sites were favourable although some sites did show signs of improvement.

8. There was a slight but significant decrease in plant species richness of woodlands since baseline. The majority of resurveyed woodlands had no livestock grazing, with two sites subject to heavy grazing. Regeneration of woody species was evident on most sites, with saplings found on over 66% of sites. Scrub sites tended to be undergrazed and had little active management, with neglected sites showing a decrease in species richness.

9. There were no significant changes in plant species diversity or composition between baseline and resurvey for any wetland habitats. Lowland wet grassland had one third of sites in favourable condition. However two-thirds of sites had greater than 50% rush cover and may require rush control or management.

10. In conclusion, there was little evidence of change in plant species diversity or vegetation composition since baseline. Any impacts of prescribed management changes on the habitat types sampled in the monitoring programme are likely to be gradual. Lack of management of some species-rich grassland and woodland sites may be important, especially in relation to grazing. Condition assessment showed some improvements in habitat condition but the majority of sites could not be considered favourable, and this was the case since baseline. Specific options for pro-active management may be considered to attempt to restore or enhance suitable sites.

Longer term monitoring would be required to detect any further changes and assess the effectiveness of the scheme in terms of contributing to enhanced biodiversity.

1. INTRODUCTION

1.1 The scheme

In the 1980s the emphasis of European agricultural policy significantly changed to encourage farming practices compatible with protection of the environment. Agri-environment schemes in Northern Ireland have been administered by the Department of Agriculture and Rural Development (DARD, previously DANI) since 1988, when the first Environmentally Sensitive Area (ESA) was introduced. Subsequently, four other ESAs were designated under Regulation 2078/92, covering 20% of the land area of Northern Ireland.

The Countryside Management Scheme (CMS) was introduced by DARD in 2000, in compliance with Rural Development Regulation (EU) No. 1257/99. The CMS is a voluntary whole-farm scheme open to all farmers and landowners outside designated ESAs. The scheme is designed to encourage farmers to implement environmentally sensitive farming practices, with the focus on biodiversity, water quality and landscape features. All participants are required to follow Good Farming Practice and a series of general environmental requirements. Specific management prescriptions must be followed for each habitat and feature on a farm (DARD, 2001). In return for carrying out management under CMS agreement, participants receive annual area-based payments for up to 10 years.

1.2 Policy background

Since their first introduction, DARD has been committed to monitoring the performance of agri-environment schemes in relation to their stated environmental objectives. As part of this monitoring programme, biological and landscape data have been collected. However, since 1988, UK policies for biodiversity and rural development have evolved, mainly in response to policies introduced by the European Union. Agri-environment schemes now reside under the Northern Ireland Rural Development Plan (NIRDP). In addition to reporting of scheme performance *per se*, there is now a requirement for DARD to report on the performance of schemes within a wider policy context.

The main policy driver for biodiversity is currently the UK Biodiversity Action Plan (BAP). There are 40 BAP priority habitats in Northern Ireland and action plans are being produced for these based on the existing UK plans (Northern Ireland Biodiversity Group, 2000). These rare or declining habitats are critically important for biodiversity in Northern

Ireland. Agri-environment schemes are one of the main vehicles by which BAP objectives and targets for many habitats and species are expected to be met and delivered. Therefore, the current and future monitoring programmes will take account of BAP objectives for priority habitats.

1.3. Scheme uptake

By December 2007, over 8,800 farmers and landowners had entered the CMS, bringing approximately 317,000ha of land under agreement (Appendix 1). This includes a diverse range of farm habitats and options. Modifications to the scheme since its introduction have led to the revision and reclassification of some habitat types. The scheme has been closed to new applicants since April 2007, and was re-launched as the Northern Ireland Countryside Management Scheme (NICMS) in June 2008.

1.4 Monitoring programme

Biological monitoring forms the core of a programme to evaluate the effectiveness of the CMS management prescriptions in maintaining and enhancing the wildlife value of the countryside. The main focus of the biological monitoring has been on plant species and certain invertebrate groups. A further aim of the monitoring programme is to assess the contribution of CMS in delivering targets for BAP priority habitats.

Changes in plant species composition can be used to examine the relationship between plant communities and agricultural management practices. Quantitative sampling of plant communities using quadrats was used to determine species richness, species diversity and C-S-R signature co-ordinate for each habitat and to describe vegetation composition. Monitoring aimed to determine changes in key indicator species of habitats as a result of CMS management prescriptions. Another component of the biological monitoring was the use of vegetation condition assessment for certain habitats. A review of botanical monitoring methodology recommended that vegetation condition assessment be carried out alongside quadrat or plot monitoring of agri-environment scheme sites (Critchley *et al*. 2002).

Baseline surveys of plants and invertebrates on habitats under CMS agreement were carried out in 2002 and 2003. The baseline monitoring report provided details on the plant and invertebrate communities found on each habitat type (Flexen *et al*. 2004). Botanical resurvey and condition assessment of all habitats were carried out in 2006 and 2007.

2. METHODS

2.1 Sampling strategy and selection of sites

Due to the extensive nature of the scheme, i.e. open to farmers in 80% of the land area of Northern Ireland, baseline monitoring was carried out over 2002 and 2003 on CMS participant farms. These were farms that had joined in tranches 1 and 2, respectively. It was impractical to use non-participant sites as experience from previous monitoring had found that a high number of original non-participants had joined the scheme before resurveys could take place. Monitoring habitats on participant farms aims to determine the effect of management prescriptions over time. A total of 11% of CMS agreement farms available at the time of survey in 2002/03 were surveyed. Not all habitats present on each farm were surveyed as the priority was to have an adequate proportion of each of the sampled habitats.

Sites were chosen on a stratified random basis from a database provided by DARD to reflect the geographical and ecological range of habitats encompassed by the scheme. A site could be equivalent to a whole field, a habitat parcel or a management unit. Sampling was stratified by county to ensure sites were geographically representative of Northern Ireland. Sites for botanical monitoring were selected randomly, with common habitats sampled in proportion to their availability within the scheme. Less common habitats were sampled at a proportionally higher intensity to ensure adequate sample size for analysis.

In total, 352 sites on 23 habitat types were resurveyed in 2006/07 (see Figure 1; and Table 1).

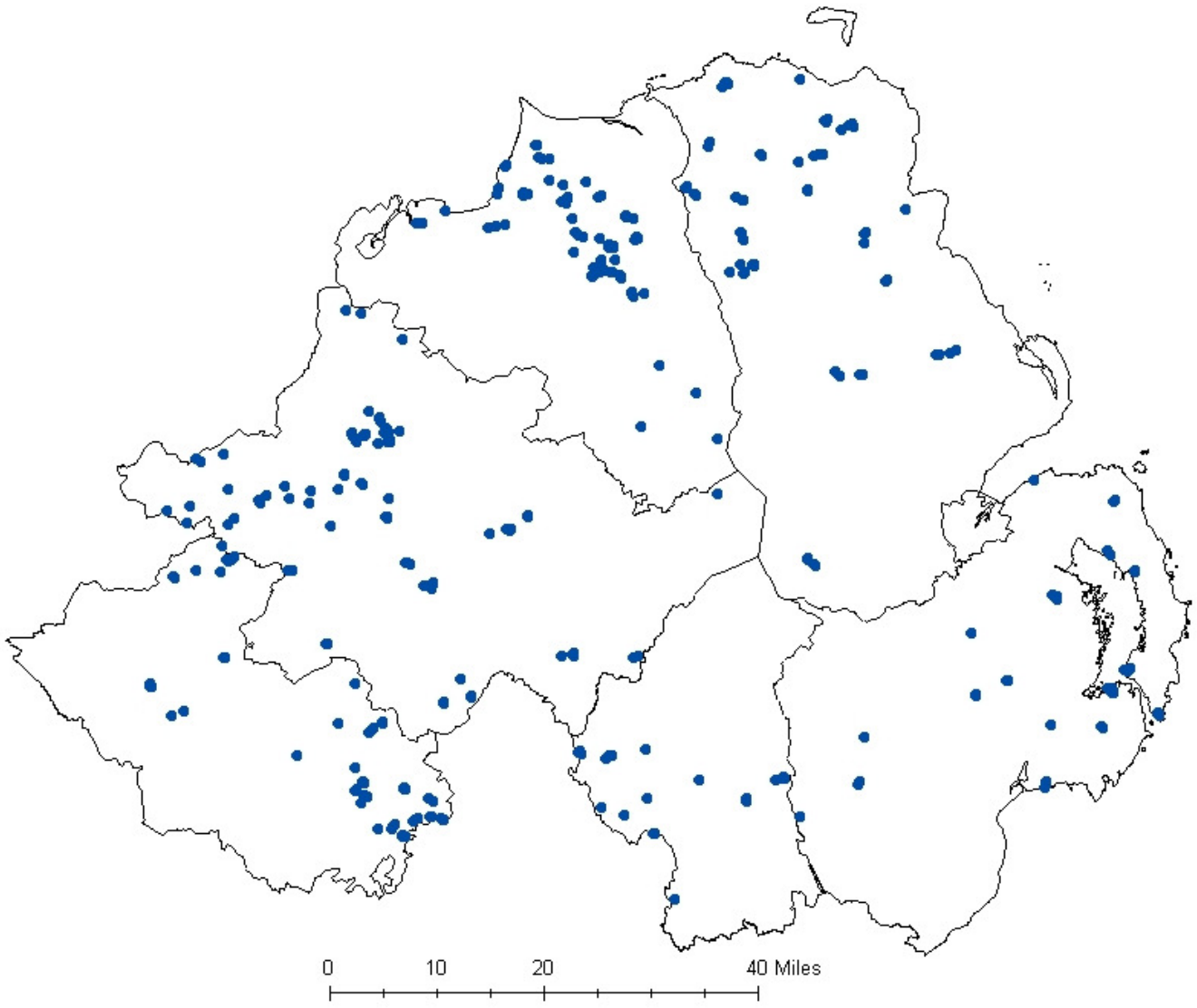

Figure 1. Location of Northern Ireland CMS monitoring sites (*n* = 352) originally surveyed in 2002/03 and resurveyed in 2006/07.

Table 1. The number of sites resurveyed for each CMS habitat type in 2006/07.

Habitat Code	CMS Habitat Type	No. of sites resurveyed (2006/07)
SRD	Species-rich dry grassland	18
SRW	Species-rich wet grassland	31
SRH	Species-rich hay meadow	9
HMD	Dry heath	8
HMW	Wet heath	32
HMB	Blanket bog	5
DHM	Degraded heath	22
RMG	Rough moorland grazing	18
LRB	Lowland raised bog	18
FWS	Woodland	62
FSC	Scrub	25
CAR	Carr woodland	4
LWG / EBW	Lowland wet grassland / Enhanced breeding wader	30
FEN / SWA / REE	Fen / Swamp / Reedbed	9
CGW / AFW	Wild bird cover	15
BUU / BUI	Buffer strips	10
FBR	Field boundary restoration	25
RGF	Rough grass field margin	7
TOTAL		**352**

2.2 Botanical sampling

Grasslands / Wetlands

Plant communities were sampled between June and August using standard nested quadrats. Quadrats were equally spaced along a transect across the diagonal of a field or area to give a representative sample of the vegetation. At baseline survey, two permanent metal poles were placed at opposite sides of each sampled field or area to mark the transect line. The position of markers was recorded using a Garmin 12 XL Global Positioning System (GPS). A magnetic compass bearing was taken of the direction of each transect and a sketch map drawn.

The estimated percentage cover of plant species in five 1m x 1m quadrats, and presence of additional species in a surrounding 2m x 2m, was recorded. All vascular plant species

(higher plants) in each quadrat were recorded. Mosses and liverworts were collectively recorded as bryophytes. Other information recorded for each quadrat was vegetation height, bare ground, litter and dung, together with any management observations. Any rare or uncommon plant species observed on the site were noted.

Monitoring of wetlands, i.e. fen, swamp and reedbeds, posed some difficulties as habitats were frequently waterlogged or flooded. Transects were therefore located on the most safely accessible part of these habitats. Wetland sites were visited from July onwards to avoid disturbance to nesting birds.

Moorland and raised bog

These habitats were surveyed during August and September. Transects were 100m in length with five quadrats, recorded as above, at 20m intervals. At baseline, the origin and end point of each transect were marked with metal poles and the position of these recorded with GPS.

Heather cover and mean height in each quadrat, along with growth phase and morphology was recorded during monitoring of CMS moorland and raised bog sites as changes in these are indicative of changes in management practices. Bryophyte and lichen species were individually recorded on these habitats as they form an integral and characteristic component of the vegetation.

Woodland

Woodland sites were surveyed during May. At baseline survey, a 14m x 14m (200m^2) permanent quadrat was marked out for each site using metal poles at the centre and corners. The position of the central pole was recorded using a GPS.

Plant species and percentage cover estimates were recorded from a central 2m x 2m quadrat. Mosses and liverworts were recorded collectively as bryophytes. Tree and shrub species percentage cover was recorded in the 200m^2 quadrat, together with any additional ground flora species. The number of seedlings and saplings (i.e. >25cm in height) of tree and shrub species were counted within each quadrat. Any recent management was noted, i.e. presence of fencing, livestock, degree of any grazing, browsing and/or poaching.

Scrub

The cover of shrubs and ground flora in scrub sites were recorded in a single 4m x 4m quadrat. Dense patches of scrub were often inaccessible so quadrats were located in areas with more scattered shrubs or on edges. All scrub habitats were surveyed during May.

Arable

Options chosen to survey for higher plants were, creation of rough grass field margin and planting wild-bird cover as arable crop margin or on improved grassland. The majority of sites surveyed were in Co. Down and Co. Londonderry where most cereal crops in Northern Ireland are grown. Sites were visited during July and August.

In rough grass field margins, a 100m long sampling zone was located and six 0.5m x 0.5m quadrats were recorded at 20m intervals along the centre of the margin. Any additional species observed in the plots were noted. On wild-bird cover plots, six 0.5m x 0.5m quadrats were recorded at equidistant positions across the site, generally every 10m.

For all options percentage cover estimates were made for all plant species within a 0.5m x 0.5m quadrat and the presence of additional species recorded from a surrounding 1m x 1m quadrat. Vegetation height was measured in the centre of each quadrat. The position of each field or plot was entered onto GPS. Permanent marker poles were not used as the position these habitats may be rotated every 1 to 3 years.

Buffers

A 100m transect was located through the centre of the buffer strip and five 1m x 1m quadrats recorded at intervals. Sample size was small due to the comparatively small number of farms with this option.

Field boundary restoration

Sites consisted of hedges that were to be restored through coppicing, inter-planting or laying during a five-year plan. A standardised procedure for surveying hedges in the UK was followed (Bickmore 2002).

At each hedge a 30m length was randomly chosen. The start of the sampled length was permanently marked with a metal pole and a GPS position recorded. Within the 30m

surveyed all woody species, i.e. shrubs and trees, were recorded. The percentage area of the 30m length contributed by each shrub species was assessed, together with the percentage of gaps. The number and age of any trees present was recorded. In addition two 2m x 1m quadrats were positioned at the base of the hedge to record ground flora. These were located at points measured 10m and 20m intervals. Bryophyte and bare ground cover were also recorded. Information was also gathered on the hedge structure, management, associated features (e.g. banks, ditches) and adjacent land-use.

2.3 Vegetation condition assessment

Grassland

Key attributes recorded for each grassland habitat were derived from English Nature rapid assessment methods for lowland grassland Areas of Special Scientific Interest (ASSIs) (Robertson & Jefferson 2000). Appropriate attribute targets have since been developed for non-statutory BAP priority grasslands in England (Robertson *et al*. 2002). Grassland attributes were based on sward composition (Table 2) and sward structure (Table 3). Targets were values that had to be met for a site to pass a particular attribute. Some modification was required for application of condition assessment to CMS habitats, e.g. defining appropriate targets and positive indicator species.

Site condition was monitored from an assessment of the whole site, carried out in approximately 30 minutes. A walk was done over the site to estimate the frequency of positive and negative indicator species (Appendix 2). Definitions of frequency were as follows: frequent or more (F) = found regularly throughout stand; occasional (O) = scattered plants; rare (R) = few individuals of a species. Herbs were defined as vascular plants except grasses, sedges and rushes. Rush cover included all species of *Juncus.* Mean sward height was also recorded.

One failure among mandatory attribute criteria meant that the site was classified as being in unfavourable condition. Sward structure attributes (i.e. sward height, bare ground and litter cover) were discretionary, as these can be easily altered by management changes and did not contribute to final decisions on favourable status.

Table 2. Grassland attributes and targets for sward composition.

Habitat Code	Positive indicator species	Negative indicator species	Herb Cover	Tree/ shrub cover	*Juncus* species cover
SRW	2 or more frequent and 2 occasional	Not frequent and <5% cover		<5%	<75%
SRD	2 or more frequent and 2 occasional	Not frequent and <5% cover	>25%	<5%	<25%
SRH	2 or more frequent and 2 occasional	Not frequent and <5% cover		< 5%	<75%
LWG	2 or more frequent and 2 occasional	Not frequent and <5% cover		< 5%	<75%

Table 3. Grassland attributes and targets for sward structure.

Habitat Code	Sward height	Bare ground cover	Litter cover
SRW	5-50cm	<10%	<25%
SRD	5-25cm	<5%	<25%
SRH	na	<10%	<25%
LWG	5-50cm	<10%	<25%

Moorland and raised bog

Methods were adapted from English Nature's assessment of upland vegetation condition (Jerram & Drewit 1998) and Environment and Heritage Service (EHS) methods for upland monitoring in Northern Ireland. The condition of the CMS habitat types wet heath, dry heath, blanket bog, rough moorland grazing and lowland raised bog were assessed using certain attributes (see Tables 4, 5, 6 & 7). Degraded heather moorland was assessed using appropriate criteria. The area assessed was the whole of the management unit, if practicable, or if very large, a representative area of approximately 5 to 10ha. Time taken was 30 to 45 minutes for a walk over each site.

Dwarf-shrub cover included heathers (*Calluna vulgaris*, *Erica* spp.), bilberry (*Vaccinium myrtilis*), crowberry (*Empetrum nigrum*) and western gorse (*Ulex gallii*). Graminoid species were all grasses, sedges and rushes, including cotton-grasses (*Eriophorum* spp.) and deer-grass (*Trichophorum cespitosum*). Bryophyte cover included *Sphagnum* species

(except for blanket bog and raised bog where these were recorded separately). Bare ground included ground covered by *Campylopus* spp., *Polytrichum* spp., algal mats or crust-forming lichens. Frequent dead heather was recorded in the general assessment as it may indicate heather beetle damage.

Vegetation was classed as being in unfavourable condition if the survey area failed to meet all the attribute targets. A scoring system closely based on English Nature methods was devised to determine the degree of unfavourability. Scores were totalled for each attribute and sites graded as follows: 0 points = favourable, 1-5 points = unfavourable, >5 points = severely unfavourable.

Table 4. Attributes and targets for wet heath.

Attribute	Favourable	Unfavourable		
	(0 points)	(1 point)	(2 points)	(4 points)
Dwarf-shrub cover	51-75	>75% or 26-50%	5-25%	<5%
Range of dwarf-shrubs	2 or more spp. widespread and frequent	1 spp. widespread and frequent		
Bryophyte abundance	frequent		occasional	rare
Graminoid cover	<50%	50-75%	>75%	
Alien trees and shrubs	none/rare	frequent/ occasional		
Grazing impact	light	moderate	heavy	
Age structure	>50% unburnt	<50% unburnt		

Table 5. Attributes and targets for dry heath.

Attribute	Favourable	Unfavourable		
	(0 points)	(1 point)	(2 points)	(4 points)
Dwarf-shrub cover	>75%	26-75%	5-25%	<5%
Range of dwarf-shrubs	2 or more spp widespread and frequent	1 spp. widespread and frequent		
Bryophyte abundance	frequent	occasional	rare	
Alien trees and shrubs	none/rare	frequent/ occasional		
Grazing impact	light	moderate	heavy	
Age structure	>33% unburnt	<33% unburnt		

Table 6. Attributes and targets for blanket and raised bogs.

Attribute	Favourable (0 points)	Unfavourable (1 point)	(2 points)	(4 points)
Dwarf-shrub cover	>33%	<33% except in wetter areas	<5%	
Range of dwarf-shrubs	2 or more spp. widespread and frequent	1 spp. widespread and frequent		
Bryophyte abundance	abundant, Sphagnum spp. frequent+	frequent, Sphagnum spp. occasional	occasional, Sphagnum spp. absent	rare
Graminoid cover	<50%	50-75%	>75%	
Extent of bare ground	none	present	frequent	
Trees and shrubs	none/rare	frequent/ occasional		
Active peat extraction	none	present	extensive	
Grazing impact	light	moderate	heavy	

Table 7. Attributes and targets for rough moorland grazing.

Attribute	Favourable (0 points)	Unfavourable (1 point)	(2 points)	(4 points)
Bryophyte abundance	frequent		occasional	rare
Extent of bare ground	absent	present	frequent	
Alien trees and shrubs	none/rare	frequent/ occasional		
Grazing impact	light	moderate	heavy	

2.4 Soil sampling

One of the performance indicators for certain CMS habitats, particularly species-rich grasslands, is the maintenance of low soil fertility. There is an EU requirement to determine whether reduction of fertiliser inputs under agri-environment schemes is positively linked to species diversity. The procedure for sampling followed a standardised method. Soil samples were taken from grassland habitats only. The top 10cm of soil from 10 random points along each vegetation transect was taken using a 3cm diameter soil auger. These were mixed to give a composite sample for the site.

After air drying, chemical analysis was carried out for pH, phosphorus and potassium using standard methods. Soil test results for P and K were reported as concentration in milligrams per litre (mg/l). An index for soil phosphorus (extracted using Olsen's method) was calculated for each grassland site as a measure of nutrient input levels (RDS 2006). In the current report, data on soil chemistry is provided for grassland habitats only.

2.5 Data analysis

To monitor the success of the CMS in maintaining or enhancing diversity of habitats, changes in plant species richness and diversity, and also frequency and mean cover of key species were analysed between years. C-S-R signature analysis was also applied. Some analyses were applied to certain habitats only and did not include arable options or hedge boundary restoration sites. The location of arable options can be changed every one to three years and could also be sown. Hedge boundary restoration was mainly concerned with attaining structure attributes. Changes in quantitative measures of biodiversity (e.g. species richness, mean % cover) between baseline and resurvey were assessed using paired t-tests (where data was normal) or Mann Whitney tests (where data was non-normal) with significance accepted at $P<0.05$. In the current report, unless change values between baseline and resurvey are associated with a *P* value they are not significant. Normality was assessed visually and where necessary tested using Kolmogorov-Smirnov tests. Changes in qualitative data (i.e. frequency or counts) were tested using contingency table analysis.

Species richness

Species richness is one of the basic measures of biodiversity and is a count of the number of individual species that occur in a particular habitat type or given area (Magurran, 1988).

Shannon-Wiener diversity index

The Shannon-Wiener diversity index (*H*) is commonly used to characterise species diversity in a community. It accounts for both abundance and evenness of the species present. An index for each site was calculated as follows:

$$H = -\sum_{i=1}^{s} p_i \log_{10} p_i$$

where s = the number of species
pi = the abundance of the *i*th species expressed as a proportion of total cover

Plant strategy theory

Plant strategy theory (or C-S-R theory) is a descriptive tool that aims to describe plant species, habitats and communities on the basis of a three-way trade off between adaptation to high productivity/high competition habitats; high environmental stress habitats and high disturbance habitats (Grime *et al*. 1988). Plant species can be classified into three primary functional types based on their response to productivity and disturbance: competitors (C) (adapted to low stress/low disturbance), stress-tolerators (S) (adapted to high stress/low disturbance) and ruderals (R) (adapted to low stress/high disturbance).

For any given species list and associated abundance data a unique signature value can be derived based on the functional characteristics of individual species within the C-S-R framework (Hunt *et al*. 2004). The percent abundance of each functional type is calculated and then a weighted average ordinate is derived for C, S, and R producing the signature co-ordinate value. Establishing a C-S-R signature value for each site at baseline can allow detection of change or shifts in plant communities over time as a result of changes in habitat management.

3. RESULTS

3.1 SPECIES-RICH GRASSLAND

3.1.1 Vegetation analysis

The mean species richness of higher plants per transect and the mean diversity index at baseline and resurvey were calculated for each grassland habitat (Table 8). There were no significant changes in mean species richness or diversity indices between baseline and resurvey.

Table 8. Mean higher plant species richness and diversity index for species-rich grassland in 2002/03 and 2006/07.

Habitat type	Sample Size (*n*)	Mean species richness per transect (±SE)		Mean diversity per transect (±SE)	
		2002/03	2006/07	2002/03	2006/07
Species-rich wet grassland	31	34.48 (1.7)	33.16 (1.7)	1.09 (0.02)	1.07 (0.02)
Species-rich dry grassland	18	31.72 (3.0)	29.67 (2.5)	1.08 (0.04)	1.05 (0.04)
Species-rich hay meadow	9	35.66 (2.3)	34.89 (2.4)	1.12 (0.03)	1.11 (0.03)

Species-rich wet grassland

There was no significant change in plant species diversity (Table 8), although a general decrease in diversity was observed, 66% of sites having a lower diversity index at resurvey than at baseline. In terms of species richness, 55% of sites had decreased or remained the same.

There was a slight decrease in the mean cover of rushes with sharp-flowered rush (*Juncus acutiflorus*) decreasing from 25.2% to 21.5% and soft rush (*Juncus effusus*) from 15.7% to 11.8%. Only one transect showed a notable increase in rush cover. There were no changes in mean cover of the most abundant grass species, i.e. yorkshire fog (*Holcus lanatus*), sweet vernal-grass (*Anthoxanthum odoratum*) and creeping bent (*Agrostis stolonifera*). There had been an increase in perennial rye-grass (*Lolium perenne*) cover on one site.

There were slight decreases in the frequency of several wet grassland indicators such as yellow sedge (*Carex demissa*), marsh ragwort (*Senecio aquaticus*) and marsh violet (*Viola palustris*). An increase in the frequency of other indicators such as orchids *Dactylorhiza* spp. and greater bird's-foot trefoil (*Lotus uliginosus*) was also recorded.

There were no significant changes in mean C-S-R signature values (Table 9). Species-rich wet grassland had a higher mean S value and a lower mean R value than dry grassland or hay meadows, i.e. more stress-tolerators and fewer ruderals.

Species-rich dry grassland

There was no significant change in plant species diversity (Table 8), although 61% of sites displayed a decrease in Shannon-Weiner diversity index. In terms of species richness, 66% of sites showed a decrease. Sites with a decrease of four or more species were generally undergrazed and rank. In general, species-rich dry grassland sites had the lowest species richness values.

There were small decreases in the mean cover and frequency of the most abundant grasses, common bent (*Agrostis capillaris*), sweet vernal-grass and yorkshire fog, together with small increases in the frequency of cocksfoot (*Dactylis glomerata*) and perennial rye-grass. There was little apparent change in the frequency or abundance of herb species. There were no obvious trends associated with management, with some sites having less grazing than baseline, whereas on others, grazing levels appeared to have increased.

There were no significant changes in mean C-S-R co-ordinate values between baseline and resurvey (Table 9). Values for C, S and R co-ordinates were generally similar, although there was possibly a trend towards an increase in competitor species.

Species-rich hay meadow

There were no significant changes in mean species diversity, species richness or C-S-R co-ordinate values (Tables 8 & 9). Species-rich hay meadows had the highest values in terms of species diversity.

There was very little change in the frequency or abundance of most plant species. There were no changes in mean cover of soft rush or sharp-flowered rush. Changes recorded

included a decrease in creeping buttercup (*Ranunculus repens*) and meadow buttercup (*R. acris*), and an increase in white clover (*Trifolium repens*) and lesser trefoil (*Trifolium dubium*) (all NS). Other herb species were present at very low mean cover.

Table 9. Mean C-S-R co-ordinate values for species-rich grassland types in 2002/03 and 2006/07.

Habitat type	Sample Size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
All species-rich grassland	58	0.38 (0.01)	0.38 (0.01)	0.36 (0.01)	0.36 (0.02)	0.26 (0.01)	0.26 (0.01)
Species-rich wet grassland	31	0.40 (0.01)	0.39 (0.01)	0.39 (0.02)	0.40 (0.02)	0.21 (0.01)	0.21 (0.01)
Species-rich dry grassland	18	0.34 (0.02)	0.36 (0.03)	0.33 (0.02)	0.33 (0.03)	0.33 (0.01)	0.31 (0.02)
Species-rich hay meadow	9	0.38 (0.02)	0.38 (0.01	0.31 (0.02)	0.32 (0.03)	0.30 (0.02)	0.30 (0.03)

3.1.2 Condition assessment

The percentage of species rich grassland sites in favourable condition at baseline and resurvey was calculated (Table 10). The condition assessment summary tables for all attributes on each habitat type can be found in Appendix 3.

Table 10. Summary of the percentage (%) of sites passing targets for all mandatory attributes for each species-rich grassland habitat in 2002/03 and 2006/07.

Habitat type	Sample Size (*n*)	% of sites in favourable condition	
		2002/03	2006/07
Species-rich wet grassland	31	45	61
Species-rich dry grassland	18	0	0
Species-rich hay meadow	9	33	44

Species-rich wet grassland

In terms of positive indicator species, 26% of sites did not meet the target in 2006/07 and could therefore be described as relatively species-poor (Appendix 3). There was a decrease in the number of sites failing the target for tree/scrub cover of <5%. All sites in 2006/07 passed the target for rush cover of <75%, but four sites had >50% cover of soft rush. In terms of structural attributes, 23% of sites had a sward height of >50cm, and 16%

had litter cover >25% and were therefore above discretionary targets, primarily due to lack of grazing.

In 2006/07, 61% of sites passed all targets for mandatory attributes and were in 'favourable condition' (Table 10), an increase of 16% since baseline. However, of these sites approximately half did not pass the targets for discretionary attributes of sward height or litter cover.

Species-rich dry grassland

Although 83% of sites met the target for herb cover in 2006/07, only 44% had the required positive indicator species (Appendix 3). Negative indicators such as ragwort (*Senecio jacobea*), thistles (*Cirsium* spp.) or bracken (*Pteridium aquilinum*) were frequent on 39% of sites. Over half of sites (61%) had frequent tree or shrub species and 28% had indicator species of waterlogging, e.g. rushes, at >25% cover. In terms of discretionary attributes, 61% failed because sward height was greater than the target of <25cm. Five sites showed no signs of recent grazing by livestock, although two of these had rabbit grazing.

None of the sites met all mandatory attributes at baseline or resurvey and, therefore, were not in favourable condition (Table 10). However, fifteen sites failed on more than one attribute target at baseline, as compared to twelve sites in 2006, which may indicate possible improvement in condition of some sites.

Species-rich hay meadow

Sampled hay meadow sites were closest to species-rich wet grassland and therefore the same attribute targets were used, except for sward height. Only 56% of sites met the target for positive indicator species (Appendix 3). One site had alder colonisation around the edge, although there were signs of scrub control at resurvey. Another site had a considerable amount of litter indicating that it had not been cut for hay or grazed for several years. There was an increase in the number of sites in favourable condition (from 3 to 4) due to decrease in rush cover on one site.

3.1.3 Soil analysis

There were no significant changes in mean soil pH and phosphorous levels between baseline and resurvey (Table 11), although in species-rich hay meadows there was a decreasing trend in soil phosphorus. In 2006/07, the index of soil phosphorus (P) was

ranked 0 (very low) or 1 (low) in all species-rich dry grassland and species-rich hay meadow sites. On 89.3% of species-rich wet grassland sites soil P was ranked 0 or 1.

There was a significant increase in mean potassium (K) level in species-rich wet grassland (p<0.01). However, potassium levels were very variable between sites.

Table 11. Mean soil pH and nutrient levels for species-rich grassland in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Soil pH (±SE)		Soil P (mg/L) (±SE)		Soil K (mg/L) (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Species-rich wet	29	5.28 (0.07)	5.23 (0.09)	6.41 (0.92)	6.91 (0.93)	85.93 (5.76)	122.72 (11.83)
Species-rich dry	13	5.33 (*0.06*)	5.38 (0.08)	4.85 (0.74)	5.64 (1.11)	167.31 (28.17)	201.20 (37.2)
Hay meadow	7	5.41 (0.12)	5.50 (0.13)	9.71 (1.15)	7.81 (1.39)	116.57 (11.93)	100.43 (8.49)

3.2 MOORLAND AND RAISED BOG

3.2.1 Vegetation analysis

There were no significant changes in the mean species richness of plants (including bryophytes and lichens) per transect or the mean diversity index between baseline and resurvey for each moorland and bog habitat (Table 12). However there were slight decreases in diversity, particularly on dry heath, wet heath and blanket bog.

There was little change in mean C-S-R co-ordinate values between years with relative proportions of each functional type being maintained (Table 13). Mean values for the R co-ordinate were low, with the exception of rough moorland grazing, i.e. there were more ruderal species on this habitat. Blanket and raised bog habitats had the highest mean S co-ordinate value, i.e. higher numbers of stress-tolerator species.

Table 12. Mean plant species richness and diversity index for each moorland habitat in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Mean species richness per transect (±SE)		Mean diversity index (±SE)	
		2002/03	2006/07	2002/03	2006/07
Dry heath	8	38.50 (5.14)	35.62 (4.73)	0.97 (0.11)	0.92 (0.10)
Wet heath	32	33.47 (1.30)	31.06 (1.20)	1.04 (0.02)	1.02 (0.02)
Blanket bog	5	25.20 (2.76)	23.80 (2.67)	0.94 (0.06)	0.89 (.07)
Degraded heath	22	39.59 (1.65)	38.45 (1.67)	1.07 (0.02)	1.03 (0.02)
Rough moorland grazing	18	37.00 (1.35)	35.94 (1.53)	1.07 (0.04)	1.06 (0.03)
Lowland raised bog	18	24.72 (1.63)	23.83 (1.17)	1.04 (0.02)	1.01 (0.02)

Table 13. Mean C-S-R co-ordinate values for moorland habitats in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Dry heath	8	0.29 (0.01)	0.30 (0.01)	0.63 (0.01)	0.63 (0.01)	0.08 (0.01)	0.08 (0.01)
Wet heath	32	0.28 (0.01)	0.30 (0.01)	0.69 (0.01)	0.67 (0.01)	0.03 (0.01)	0.03 (<0.01)
Blanket bog	5	0.29 (0.03)	0.29 (0.03)	0.70 (0.02)	0.70 (0.02)	0.01 (0.01)	0.02 (0.01)
Degraded heath	22	0.29 (0.01)	0.30 (0.01	0.67 (0.01)	0.66 (0.02)	0.04 (0.01)	0.04 (0.01)
Rough moorland grazing	18	0.31 (0.02)	0.31 (0.01	0.57 (0.03)	0.56 (0.02)	0.12 (0.02)	0.13 (0.02)
Lowland raised bog	18	0.29 (0.01)	0.29 (0.01	0.69 (0.01)	0.69 (0.01)	0.02 (<0.01)	0.02 (<0.01)

Dry heath

There was no change in mean dwarf-shrub cover recorded between baseline and resurvey (52.1% to 52.3%). The mean cover of heather (*Calluna vulgaris*) remained the same (46.7% to 46.8%). A single site showed a notable decrease due to burning over part of the transect. There was an increase in the mean cover of purple moor-grass (*Molinia caerulea*) between years from 15.5% to 23.3%. Graminoid cover increased, mainly due to the increased purple-moor grass. There were no apparent changes in the frequency of indicator species.

Wet heath

There was no significant change in mean dwarf-shrub cover (40.2% to 40.0%) or heather cover (32.2% to 30.9%) between years. At baseline survey, 17 sites (53%) had a mean cover of heather <25% recorded across the transect, compared to 15 sites (47%) in 2006/07. However, on 31% of sites some decrease in heather was recorded since baseline. Large changes were generally associated with sites where heather degeneration and mortality were evident, or on two sites where some burning had occurred. The mean cover of purple moor-grass had increased from 14.3% to 20.3% and the mean cover of common cotton-grass (*Eriophorum angustifolium*) had decreased from 11.5% to 7.4%. Bare ground cover decreased slightly with fewer sites recorded with bare ground.

Blanket bog

There was no change in the mean cover of dwarf-shrubs (51.1% to 51.8%). There was an increase in mean heather cover (27.3% to 32.8%), mainly accounted for by an increase on a single transect. One site subjected to mechanical cutting had <5% heather cover recorded over the transect. There was a decrease in the mean cover of hare's tail cotton-grass (*Eriophorum vaginatum*) from 20.6% to 17.2%.

Degraded heath

These sites included degraded wet heath, dry heath and blanket bog habitat. Degraded heath had higher mean species diversity than other heather moorland habitats (Table 12), due to the presence of a greater number of species more typical of grassland habitats.

There was an increase in mean cover of heather recorded across the transect from 10.9% to 16.1%. In total, 91% of sites showed an increase in heather cover between baseline and resurvey. The number of sites with a mean dwarf-shrub cover of >25% recorded

increased from four sites at baseline to six sites at resurvey. There was an increase in the mean cover of purple-moor grass from 18.7% to 24.1% and small decreases in the cover of other graminoids such as *Eriophorum* spp. and deer grass (*Trichophorum cespitosum*). Bare ground cover had decreased slightly and was recorded on 59% of sites at resurvey as compared to 77% at baseline.

Rough moorland grazing

Rough moorland grazing habitats were variable in terms of vegetation composition and had relatively high species diversity as sites were often mosaics of different vegetation types. There was very little apparent change in species diversity and vegetation composition between baseline and resurvey. There was no change in mean cover of purple-moor grass. The cover of sharp-flowered rush had decreased from 15.9% to 11.9%. Heather was recorded on 66% of sites but had a very low mean cover, although this had increased slightly from 2.6% to 4.7%.

Lowland raised bog

Lowland raised bog had comparatively low higher plant species diversity than heather moorland habitats. There was no significant change in the mean cover of dwarf-shrubs (53.3% to 49.2%). There was some decrease in heather on 44% of sites, although with the exception of three transects this was small. The mean cover of *Sphagnum* moss species had increased slightly from 24.0 to 26.5%. There was generally little change in mean cover or frequency of higher plant species.

3.2.2 Condition assessment

Individual sites were scored (Appendix 4) and a mean condition score for each habitat was calculated (Table 14) with a lower score representing better vegetation condition. As there were different attributes and scoring systems for each habitat, direct comparison of mean scores between habitats is not appropriate. Tables showing the percentage of heather moorland sites passing each attribute target at baseline and resurvey can be found in Appendix 5.

Table 14. Mean condition score for each moorland habitat in 2002/03 and 2006/07

Habitat type	Sample Size (*n*)	Mean score	Mean score
		2002/03	2006/07
Dry heath	8	2.9	3.0
Wet heath	32	3.6	3.3
Blanket bog	5	3.4	3.0
Degraded heath	22	5.4	4.9
Rough moorland grazing	18	1.9	1.9
Lowland raised bog	18	3.6	3.3

Dry heath

There was very little change in the condition of dry heath sites between baseline and resurvey. All sites were classified as being in unfavourable condition (i.e. scoring 1 to 5 points) with no sites passing all attribute targets (Appendix 5).

The percentage of sites passing attribute targets remained the same between baseline and resurvey except for an increase in spruce recorded on one site (Appendix 4). Only two of the sites passed the target of 75% dwarf-shrub cover. Another two sites had dwarf-shrub cover of <25%, indicating very poor condition. Most sites had light or moderate grazing levels, with only one site showing signs of heavy cattle grazing.

Wet heath

There were no sites in favourable condition at baseline or resurvey (Appendix 4). However, there was a small decrease in overall mean score (Table 14), which may indicate a slight improvement in condition. Three sites were classed as severely unfavourable at resurvey as compared to four sites at baseline.

In terms of dwarf-shrub cover only 25% of sites passed the target of 50-75% cover in 2006/07 (Appendix 5). However, 63% of sites were within the range 25-75% cover, which may be more appropriate to use for CMS sites. There were 28% of sites with <25% dwarf-shrub cover at resurvey (including two recently burnt sites), compared to 34% at baseline. Graminoid cover was high at most sites with only 16% meeting the target of <50% cover in 2006/07. At resurvey, fewer sites had moderate or heavy grazing as compared to baseline, 53% and 66%, respectively. Approximately 25% of sites had no sign of any recent grazing at resurvey.

Blanket bog

None of the five sample sites were in favourable condition at baseline or resurvey (Appendix 4). However, scores were low with the exception of one site classed as severely unfavourable due to mechanical peat cutting and heavy sheep grazing. There was very little change in condition with the exception of one site that had reduced grazing impacts at resurvey (Appendix 5). Four of the sites met the target of >33% dwarf-shrub cover and also had light grazing levels.

Degraded heath

The same scoring system was used as for wet heath sites. There were no sites in favourable condition at baseline or resurvey (Appendix 4). However a decrease in mean condition score indicated a general improvement in the degree of favourability (Table 14). One third of sites had a decreased score and none had an increased score. There were 32% of sites classed as severely unfavourable in 2006/07, a reduction from 45% of sites at baseline.

The percentage of sites with >25% dwarf-shrub cover had increased from none to 36% of sites in 2006/07. Bare ground and heavy grazing impacts were recorded on fewer sites at resurvey.

Rough moorland grazing

Condition of this habitat was difficult to determine as there were no targets for attributes such as the presence of dwarf-shrubs. There was little change in the condition of sites between baseline and resurvey (Appendix 4). Mean scores were low as there were fewer attributes assessed than for other moorland types. One site was in 'favourable' condition passing all defined targets. Eight sites (44%) failed on only one attribute.

Only 28% of sites showed heavy grazing levels and bare ground was absent from 61% of sites (Appendix 5). Although there was no specific target for dwarf-shrub cover for rough moorland grazing there were four sites with 5-25% cover in 2006/07.

Lowland raised bog

No sites were in favourable condition at baseline or resurvey. The mean score had decreased slightly between years (Table 14). Three sites were classed as severely unfavourable at resurvey compared to four sites at baseline survey.

The target for dwarf-shrub cover (i.e. >33%) was met by 83% of sites, an increase since baseline (Appendix 5). With the exception of one site, none had any active grazing by livestock. Active peat extraction was occurring on two sites in 2006/07 compared with five sites at baseline survey.

Trees and/or shrubs were present on all raised bog sites except two. In particular, birch (*Betula* sp.) was abundant or frequent on half of sites. Four sites would have been in favourable condition if they had not been subject to colonisation by trees or scrub.

3.3 WOODLAND

During 2006/07, 62 woodland sites were resurveyed. At resurvey, 16% of sites had some degree of livestock grazing as compared to 32% at baseline. The grazing level was high on only two of these sites, with the rest subjected to occasional livestock grazing. A greater number of sites had been fenced since baseline, with only 8 woods remaining unfenced. Widespread poaching occurred on 12 sites at baseline compared to two at resurvey. There was also a reduction in the percentage of sites with >10% bare ground.

There were no significant differences in the mean number of higher plant species per $4m^2$ quadrat between years (Table 15). Mean diversity indices in woodland sites between baseline and resurvey did not differ significantly (Table 15).

The most frequent ground flora species recorded (i.e. occurring on >50% of sites) were rough meadow-grass (*Poa trivialis*), lesser celandine (*Ranunculus ficaria*), creeping bent, broad-buckler fern (*Dryopteris dilatata*), yorkshire fog, ivy (*Hedera helix*), herb robert (*Geranium robertianum*) and nettle (*Urtica dioica*). There were no significant changes in the mean cover per $4m^2$ quadrat of any species since baseline. Mean bare ground cover had decreased slightly from 4.5% to 2.3% and 19% of sites showed a decrease in bare ground cover of at least 5%, mostly those where grazing had ceased since baseline.

The mean species richness recorded per $200m^2$ quadrat (i.e. ground flora and woody species) showed a significant decrease since baseline ($p<0.001$). Ash (*Fraxinus excelsior*) was the most common tree species found on 60% of sites, with sycamore (*Acer pseudoplatanus*), birch (*Betula* spp.) and hazel (*Corylus avellana*) also frequently recorded. The most frequently occurring shrub was bramble (*R. fructicosus)*, recorded on

85% of sites. The mean cover of bramble per 200m^2 had increased from 10.3% to 14.6% (p<0.05).

Table 15. Mean higher plant species richness per 4m^2 quadrat (Q1) and 200m^2 quadrat (Q2) and mean diversity index for woodland sites, in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Mean species richness Q1 (±SE)		Mean species richness Q2 (±SE)		Mean diversity index(±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Woodland	62	11.06 (0.92)	10.60 (0.70)	27.82 (1.38)	26.10 (1.20)	0.60 (0.04)	0.61 (0.04)

There were no significant changes in mean C-S-R co-ordinate values in woodland sites between baseline and resurvey (Table 16). Possible trends were an increase in stress-tolerator species and a decrease in ruderal species.

Table 16. Mean C-S-R co-ordinate values for woodland sites in 2002/03 and 2006/07

Habitat type	Sample size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Woodland	62	0.36 (0.02)	0.36 (0.02)	0.33 (0.02)	0.34 (0.02)	0.31 (0.02)	0.30 (0.02)

At resurvey the majority of woodland sites had regeneration by seedlings (77.4% of sites) and/or saplings (61.2% of sites) within the 200m^2 quadrat. Sixteen woodland sites had at least 100 seedlings present in the 200m^2 quadrat, with the most common species recorded being ash (62.5% of sites) and sycamore (31.2% of sites). Thirteen sites had 10 or more saplings recorded within the 200m^2 quadrat, of which the most frequently occurring species were ash (30.7% of sites), holly (*Ilex aquifolium*) (15.4%) and birch (15.4%). Other regenerating species included sycamore, hazel and rowan (*Sorbus aucuparia*). There were no significant differences in either the mean number of seedlings or saplings per 200m^2 quadrat since baseline (Table 17).

Table 17. Mean number of seedlings and saplings within a 200m^2 quadrat in woodland sites in 2002/03 and 2006

Habitat type	Sample size (*n*)	Mean no. of seedlings per 200m^2 quadrat (±SE)		Mean no. of saplings per 200m^2 quadrat (±SE)	
		2002/03	2006	2002/03	2006
Woodland	62	42.32 (6.12)	37.70 (6.50)	5.64 (1.13)	5.96 (1.03)

3.4 SCRUB

There were 25 scrub sites resurveyed during 2006/07. Evidence of recent management by scrub control was observed at only one of the sample sites. There was no livestock grazing on 40% of sites and these had generally become overgrown and inaccessible.

There was no significant difference in either mean species richness or diversity indices of $16m^2$ quadrats since baseline (Table 18). The diversity index for scrub was higher than woodland due to the fact that scrub often occurred in a mosaic with different habitat types. Plants included both typical woodland and grassland species.

Table 18. Mean higher plant species richness and diversity index per $16m^2$ for scrub sites in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Mean species richness per $16m^2$ (±SE)		Mean diversity index (±SE)	
		2002/03	2006/07	2002/03	2006/07
Scrub	25	19.04 (1.30)	17.60 (1.24)	0.82 (0.04)	0.77 (0.03)

With the exception of one site, the ungrazed scrub sites showed a decrease in species richness. The mean species richness of ungrazed sites (*n*=10) decreased (19.6 to 15.8 species per quadrat), in comparison to grazed sites (*n*=15) where it had slightly increased (18.6 to 18.9 species per quadrat).

The most frequently occurring woody species on scrub sites during 2006/07 were bramble*,* gorse (*Ulex europaeus*), hawthorn (*Crataegus monogyna*) and blackthorn (*Prunus spinosa.* In terms of the mean cover of woody species, gorse was most abundant, with cover of bramble and blackthorn also high. The mean cover of bramble had increased from 9.5% to 17.1%.

At resurvey, the most frequently occurring ground flora species were creeping buttercup*,* creeping bent, rough meadow-grass, yorkshire fog, common sorrel (*Rumex acetosa*) and sweet vernal-grass. In terms of mean cover, the most abundant ground flora species were bluebell, creeping bent and wood sorrel (*Oxalis acetosella*). There were no significant changes in the mean cover of any species since baseline.

In terms of mean C-S-R co-ordinate values, there were no significant differences in scrub sites since baseline (Table 19). Possible trends were an increase in stress-tolerator species and a decrease in ruderal species.

Table 19. Mean C-S-R co-ordinate values for scrub sites in 2002/03 and 2006/07.

Habitat	Sample Size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Scrub	25	0.40 (0.03)	0.40 (0.03)	0.37 (0.02)	0.38 (0.02)	0.23 (0.03)	0.21 (0.03)

3.5 WETLANDS

3.5.1 Lowland wet grassland

The total number of sites sampled was 30, which included four enhanced breeding wader sites. Lowland wet grassland was a variable habitat, occurring on wet or waterlogged mineral or peaty soils, generally with abundant rushes (*Juncus* spp.). Vegetation varied from species-poor to relatively species-rich grassland, or graded into fen/swamp type communities. There were no significant changes in mean species richness or diversity indices between baseline and resurvey for wetland habitats (Table 20). Mean species richness was lower than that for species-rich grassland habitats (Table 20).

Table 20. Mean higher plant species richness and diversity index for wetland habitats in 2002/03 and 2006/07.

Habitat type	Sample Size (*n*)	Mean species richness per transect (±SE)		Mean diversity per transect (±SE)	
		2002/03	2006/07	2002/03	2006/07
Lowland wet grassland	30	28.87 (1.71)	26.87 (1.42)	0.95 (0.04)	0.94 (0.03)
Fen, Swamp, Reedbed	9	22.11 (1.76)	24.33 (2.43)	0.94 (0.05)	0.93 (0.07)

There were no significant changes in mean C-S-R co-ordinate values between baseline and resurvey (Table 21). There were no significant changes in plant species composition between years. The mean cover of soft rush and sharp-flowered rush at resurvey was 22.3% and 14.4% respectively, with no significant increases since baseline.

Table 21. Mean C-S-R co-ordinate values for wetland habitats in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Lowland wet grassland	30	0.48 (0.01)	0.48 (0.01)	0.31 (0.02)	0.33 (0.02)	0.21 (0.01)	0.20 (0.01)
Fen, Swamp, Reedbed	9	0.52 (0.03)	0.51 (0.04)	0.22 (0.04)	0.23 (0.05)	0.26 (0.03)	0.25 (0.03)

Vegetation condition assessment in 2006/07 indicated that 53% of sites met the target for positive indicator species. There was no evidence of livestock grazing for at least two years on 30% of sites. Some of the sites were too wet for grazing whilst some were neglected and rank. Vegetation height was >50cm on ungrazed sites, with only one exception. Only two sites showed impacts of heavy grazing.

Vegetation height on half of all sites was >50cm. A single site had bare ground cover >10%. At resurvey, 63% of sites had an estimated >50% rush cover. Rush control was evident on only two sites. Overall, one third of sites met all mandatory attribute targets at resurvey and could therefore be considered to be in favourable condition. However, three of these had a sward height >50cm and a continuous litter layer, which may have indicated undergrazing.

Soil analysis showed that there were slight increases in soil phosphorus (P) and potassium (K) between baseline and resurvey (Table 22). Sample size was low due to difficulty of obtaining adequate soil samples from waterlogged sites. Of the sampled sites only one had a relatively high soil P status (i.e. index 3), with the rest of sites having low soil P status (i.e. index 0 or 1).

Table 22. Mean soil pH and nutrient levels for lowland wet grassland in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Soil pH (±SE)		Soil P (mg/L) (±SE)		Soil K (mg/L) (±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Lowland wet grassland	11	5.45 (0.06)	5.50 (0.17)	8.64 (2.23)	9.36 (2.04)	100.00 (19.25)	111.73 (11.47)

3.5.2 Fen, swamp and reedbed

Sample sites included five swamp, two fens and two reedbeds. Due to the small sample sizes and the fact that the sites were generally mosaics of wetland habitats, data from

these habitats was pooled. There was no significant change in mean species richness, diversity indices or mean C-S-R values between 2003 and 2007 (Tables 20 & 21).

Grazing of wetlands is permitted at very low stocking density. However, most sites were probably never actively grazed, due to waterlogged conditions. There was no livestock grazing in 2007 except on one site where cattle were present, compared to three sites in 2003. This was probably due to the wetter summer of 2007.

The most frequently occurring species were creeping bent, soft rush, and meadowsweet (*Filipendula ulmaria*). Other characteristic species were water horsetail (*Equisetum fluviatile*), common sorrel and floating sweet-grass (*Glyceria fluitans*). In terms of changes in plant species abundance, mean cover of meadowsweet and creeping buttercup showed some decrease. There was no change in mean cover of soft rush.

3.5.3 Carr woodland

Four sites were resurveyed in 2007. Three sites were fenced and ungrazed at the time of survey. The other site showed signs of recent cattle poaching and trampling. The canopy was dominated by grey willow (*Salix cinerea*), alder (*Alnus* glutinosa) and/or birch (*Betula pubescens*). The most frequent ground flora species were meadowsweet, marsh bedstraw (*Galium palustre*), water horsetail and creeping bent. Meadowsweet had the greatest mean cover (24%), which showed no change since baseline. There were no changes in mean species richness between baseline and resurvey (Table 23). Only one site showed an increase in the species richness recorded.

Table 23. Mean higher plant species richness per 4m^2 quadrat (Q1) and 200m^2 quadrat (Q2) and mean diversity index for woodland sites, in 2002/03 and 2006/07.

Habitat type	Sample size (*n*)	Mean species richness Q1 (±SE)		Mean species richness Q2 (±SE)		Mean diversity index(±SE)	
		2002/03	2006/07	2002/03	2006/07	2002/03	2006/07
Carr	4	10.50 (1.04)	11.75 (1.8)	24.50 (5.5)	25.75 (5.5)	0.69 (0.07)	0.71 (0.07)

3.6 ARABLE

3.6.1 Rough grass field margins

This option requires the creation of a strip of land at least 2m wide around the margin of arable fields on which a suitable grass mixture is sown. A total of seven sites were resurveyed in 2007. These included margins sown with grass, as per prescription, and

other margins that had regenerated naturally. The width of the margins was between 2m and 4m, with the exception of one site with a margin of approximately 12m.

At resurvey, the mean vegetation height was 44cm ± 8.6, with most sites having tall rank vegetation. A single site had been recently mown. There was virtually no bare ground on most margins except for the recently mown site where vegetation was sparse and another site, possibly disturbed by ploughing. The desired tussocky structure had developed on some older margins with good tussocks of cocksfoot grass present on three sites. Other sites had tall vegetation but few tussocks present.

The species richness of margins was variable with between 8 and 35 species recorded per site in 2007. The mean number of higher plant species per 0.25m^2 quadrat was 8.8 ± 1.3. There was no significant change in mean species richness between 2003 and 2007.

The mean cover of the grass species creeping bent, cocksfoot, yorkshire fog and couch (*Elymus repens*) had increased since baseline. Species with decreases in mean cover included red fescue, white clover and crested dog's-tail (*Cynosurus cristatus*). The abundance of grasses had increased between years from a total mean cover of 57% to 66%. The mean cover of dicotyledons had decreased slightly from 40% to 36%, but was very variable. There had been a general loss of ruderal species such as spear thistle (*Cirsium vulgare*), prickly sow-thistle (*Sonchus asper*) and broad-leaved plantain (*Plantago major*), which were widespread at baseline survey.

3.6.2 Wild bird cover

There were 15 sites surveyed in 2007. The main differences between sites derived from seed mixtures used and the time since sowing. Seven sites had wild-bird cover that had been established the previous year and was still in place. The remaining sites had been sown in the spring before the survey. Several of the sites, particularly in Co. Down, were on estates where pheasants were reared so there was an additional use as game cover.

As sites were not permanent habitats and could be relocated within a farm, data could not be directly compared between baseline and resurvey. The mean number of higher plant species in 2007 per 0.25m^2 quadrat was 9.2 ±0.9, and ranged from 14 to 33 species per site. The relatively high species richness of some sites was due to sowing of mixtures and the high incidence of arable weed species.

The most commonly sown species recorded in 2007 was kale (*Brassica oleracea*), occurring on over 90% of sites. Other frequently sown species included phacelia (*Phacelia tanacetifolia*), white mustard (*Sinapsis alba*), buckwheat (*Fagopyrum esculentum),* quinoa (*Chenopodium quinoa*), sunflower (*Helianthus anuus*), flax (*Linum* spp.), oats (*Avena* sp.*)* and barley (*Hordeum* sp.), each found on between 2 and 5 sites. There was an average of 2.7 ±0.3 sown species per site. On some sites a single sown species dominated whereas on other sites there was a more diverse mixture with up to five sown species. Sown species accounted for around 50% of cover on most sites. Areas that had been established the previous year were dominated by tall kale with other sown species infrequent. Vegetation height was variable, ranging from 15cm on late sown areas up to 2m where tall mature species such as sunflowers (*Helianthus anuus*) or kale occurred.

There was generally a higher cover of herbs on sites that had been sown two years since survey. Species included those associated with arable/disturbed ground as well as typical grassland species. Widespread naturally regenerated species were creeping buttercup, chickweed (*Stellaria media*), broadleaved dock (*Rumex obtusifolius*), prickly sowthistle, redshank (*Polygonum persicaria*), spear thistle and nettle, all occurring on more than 60% of sites. The most frequent grasses were rough meadow-grass, creeping bent and annual meadow-grass (*Poa annua*). Grass cover was very variable from 0.01 to 43%, and was usually low on first year sites.

3.7 BUFFER STRIPS

In 2007, six buffer strips on improved grassland (BUI) and four on unimproved grassland (BUU) were surveyed. Seven sites were adjacent to watercourses, two were adjacent to woodlands, one was adjacent to dune/shore vegetation (ASSI) and two were adjacent to water (ASSI). Grasses and agricultural 'weeds' dominated most sites but there were also rushes and some typical wetland species, particularly on sites next to watercourses.

The width of the buffers varied from 5m to around 25m. At resurvey all sites were fenced and ungrazed by livestock, fulfilling management prescriptions. At least three had rabbit grazing noted. One site had been partially mown in 2007. Mean vegetation height had increased from 46.4 ±7.2 cm to 56.1 ±4.3 cm between 2003 and 2007.

Due to small sample size BUI and BUU were analysed together. The mean species richness of higher plant species per transect and the mean diversity index at baseline and

resurvey were calculated for all buffer strips (Table 24). There were no significant changes in mean species richness or diversity indices between baseline and resurvey.

Table 24. Mean higher plant species richness and diversity index for buffer strips in 2003 and 2007.

Habitat type	Sample Size (*n*)	Mean species richness per transect (±SE)		Mean diversity per transect (±SE)	
		2003	2007	2003	2007
Buffer	10	22.20 (2.4)	18.70 (2.0)	0.84 (0.04)	0.85 (0.06)

There were no significant changes in mean C-S-R co-ordinate values between baseline and resurvey (Table 25). Competitor species, adapted to low stress/low disturbance, had the highest score values.

Table 25. Mean C-S-R co-ordinate values for buffer strips in 2003 and 2007.

Habitat type	Sample size (*n*)	C co-ordinate (±SE)		S co-ordinate (±SE)		R co-ordinate (±SE)	
		2003	2007	2003	2007	2003	2007
Buffer	10	0.50 (0.04)	0.52 (0.03)	0.17 (0.03)	0.17 (0.03)	0.33 (0.04)	0.31 (0.02)

The most frequent species were yorkshire fog, creeping bent, rough meadow-grass and soft rush. There was a loss of perennial rye-grass and other 'agricultural' species e.g. white clover, with a general increase in the cover of grasses, in particular an increase in the abundance of creeping soft-grass (*Holcus mollis)*. The mean cover of some herbs had increased e.g. creeping buttercup and creeping thistle. There had been scrub and bracken invasion into one of the sites next to a wood, and an apparent increase in bracken on the dune site.

The results of soil analysis showed an increase in soil pH and decreases in soil phosphorus and potassium on buffer strips between 2003 and 2007 (Table 26). With the exception of one site, levels of soil phosphorous were low (i.e. P index 0 or 1).

Table 26. Mean soil pH and nutrient levels for buffer strips in 2003 and 2007.

Habitat type	Sample size (*n*)	Soil pH (±SE)		Soil P (mg/L) (±SE)		Soil K (mg/L) (±SE)	
		2003	2007	2003	2007	2003	2007
Buffer	6	6.10 (0.31)	6.52 (0.52)	14.50 (3.23)	12.28 (2.86)	105.83 (19.40)	81.67 (17.75)

3.8 FIELD BOUNDARY RESTORATION

Of the 25 hedges sampled in 2007, 68% had been subject to management for restoration/regeneration, compared to 40% in 2003. The remaining 32% of sites had not been subject to any management in 4 or 5 years of scheme participation. Of the managed hedges, 5 had been coppiced (all or part of the hedge), 2 had interplanting of gaps, 7 had been both coppiced and interplanted, and 3 had been laid. Of the 9 sites that had been interplanted, only 4 had a mixture of 3 or 4 woody species planted. There were 3 sites with hawthorn only and 2 had a mixture of hawthorn and blackthorn. There were new fences adjacent to 64% of sampled hedges, mainly double fencing. There was no evidence of recent management by flailing or trimming of any of the hedges.

The mean height of hedges at resurvey was 1.8m ±0.2, which includes sites that had been recently coppiced. Nine hedges had a height of >2m and a width of >1.5m, with two of these very overgrown (i.e. >5m tall).

The mean percentage of gaps over the sampled 30m length of hedge was 28%. This includes hedges that had recently been coppiced and therefore had very little shrub cover. Only 9 (36%) sites had 10% gaps or less. Of 5 sites with an increase in gappiness of >5% since baseline, 3 had been coppiced and 2 had no management.

Five (20%) of the sampled hedges had five or more woody species present in the surveyed 30m length. (N.B. Bramble was not included as a woody indicator species). However 11 (44%) sites were species-poor with only one or two shrubs present. The mean number of woody species recorded per 30m length in 2007 was 3.84 (±0.34). Hawthorn was the most frequent shrub, present on all sites. Abundance varied from 5% to 100% and hawthorn was generally the most dominant species. Hawthorn cover in hedges had increased or remained the same since baseline survey, except on 3 sites recently coppiced. The mean cover of hawthorn had increased slightly from 56% to 61% of the 30m surveyed length. The other most frequent woody species were bramble (72% of sites) and dog rose (*Rosa canina*) (44% of sites). Over a quarter of the sites surveyed had mature ash trees present.

The hedge base or bank was usually dominated by tall grass and agricultural ‘weed’ species. Species richness had not changed between baseline and resurvey with a mean species richness recorded per 2m x 1m quadrat of 10.8 ±0.6 species. However it was

variable ranging from 3 to 22 species recorded per quadrat. The most frequent species were grasses, yorkshire fog, creeping bent, cocksfoot and rough meadow-grass. Typical herb species present (on >25% of sites) were nettle, common sorrel, creeping thistle, creeping buttercup and cleavers.

In terms of herb abundance, mean nettle cover had increased from 5.8% to 10.6%. The mean cover of bramble in the ground layer had increased from 1.6 to 8.4%. Increases of certain species were probably due to fencing of hedges from adjacent fields, meaning that bases were no longer subjected to grazing. Some bases of recently coppiced hedges were dominated by nettles, which may have a negative effect on regeneration. Spraying of herbicide is only permitted to control weeds along newly planted hedges.

Those hedgerows with fewer than five woody species but a rich basal flora with woodland species can also be defined as species-rich (NIBG 2003). Dog violet for example, occurred on five sites but few of the sampled sites had one or more indicator species. Only three of the hedges could be described as having a species-rich bank or base. The most diverse of these was on a high bank alongside a track, which had not been affected by spraying.

4. DISCUSSION

4.1 Species-rich grassland

There were no significant changes in plant species diversity on any species-rich grassland type, although there was a slight decrease in diversity on some sites. In some cases this may have been related to undergrazing, particularly on species-rich dry grassland sites. There were also no significant changes in plant community composition suggesting that vegetation has been maintained since baseline. It may take a longer time period for any changes to become evident.

The three functional-types (C, S and R) relate directly to land use factors that are currently implicated in the destruction or degradation of many semi-natural habitats (Hunt *et al*. 2004). The C value relates to abandonment, the S value to eutrophication and the R value to disturbance. The monitoring showed no significant changes in mean C-S-R values suggesting stability of vegetation over the time period between baseline and resurvey. Species-rich wet grassland had a higher mean S value and lower mean R value than dry grassland or hay meadow. This indicates a greater number of stress-tolerator species and fewer ruderal species in species-rich wet grassland, suggesting lower fertility and disturbance on this habitat.

Condition assessment indicated that 61% of species-rich wet grassland and 44% of species-rich hay meadow sites were in favourable condition at resurvey. The condition of some sites had improved since baseline. Most of the sites that were in unfavourable condition at resurvey, was doe to the presence of few positive indicator species. No species-rich dry grassland sites were in favourable condition at baseline or resurvey and many of the sites tended to be not particularly species-rich, i.e. only 44% had the required positive indicators. However, many sites had the potential to improve with appropriate grazing management. Sward height was greater than desirable in many species-rich grassland sites, and some sites were ungrazed and rank, particularly species-rich dry grassland. Management may need to be addressed with stipulated minimum grazing levels being adhered to. The condition assessment results for species-rich grasslands are perhaps not surprising given that a survey of around 500 non-statutory grassland sites in England, previously recorded as high quality, showed that only 21% were in favourable condition (Hewins *et al* 2005). The remaining sites failed most frequently because they lacked positive indicators in sufficient number and at frequency levels characteristic of good quality semi-natural grasslands.

There was a decreasing trend in soil phosphorus levels in species-rich hay meadows, which may be related to reduced fertiliser inputs. There was a significant increase in soil potassium in species-rich wet grassland sites, but concentrations of this element were very variable and may not only be related to artificial inputs. Phosphorus is the most important nutrient influencing sward diversity. The majority of all species-rich grassland sites had very low or low levels of soil phosphorus and are, therefore, suitable for restoration and development of increased botanical diversity. Consideration of the enhancement of suitable species-rich grassland sites, by site-specific management prescriptions and including options such as sowing selected native species could be valuable.

Species-rich grasslands under CMS do not directly correspond to BAP priority habitats. Therefore it is difficult to ascertain the level at which they contribute to action plan targets. However, the majority of species-rich wet grasslands and hay meadows could be described as 'purple-moor grass and rush pasture' and condition assessment has demonstrated maintenance and improvement of this habitat.

4.2 Moorland and raised bog

In moorland and raised bog habitats, there were no significant changes in plant species diversity or C-S-R signature values since baseline. Heath and bog habitats are relatively species poor in terms of higher plants, and plants associated with these habitats are adapted to live under high stress conditions (i.e. low fertility and low disturbance). Therefore, any increase in species diversity may not be an indication of improvement in condition and could indicate negative changes in condition due to disturbance or nutrient inputs.

No changes in mean heather or dwarf-shrub cover were recorded, except on degraded heath where there was an increase. Stocking rates may not be adequately low to increase heather cover on some moorland sites. An increase in purple moor-grass cover on wet heath, dry heath and degraded heath was recorded, which may be related to the short-term effect of reduced stocking rates. Research on the effect of ESA prescriptions on upland vegetation in England has found that on formerly overgrazed moorland a reduction in stocking rate was beneficial in maintaining existing cover of heather but did little to enhance its extent (Hetherington & Gardner 2002). Where grazing was reduced and heather was in poor condition, grass species (particularly purple moor-grass) became

dominant and may have limited heather growth by competition. Therefore increases in purple moor-grass and other grass species on CMS heathland sites may not be desirable.

Condition assessment indicated that no moorland and raised bog sites were in favourable condition at resurvey. There was limited evidence that some sites had improved, i.e. a decrease in scores and fewer sites being classed as severely unfavourable. It is, however, important to consider that favourable condition may never be reached in moorland and raised bog sites, even over the longer-term. For example, bog habitats degraded through extensive cutting and drainage are not likely to be restored under current management prescriptions. Attribute targets for condition assessment may need to be modified to make them more applicable for CMS habitats, i.e. non-designated sites.

Approximately one-third of wet heath sites had <25% dwarf-shrub over the whole site at resurvey. This had decreased slightly since baseline and there were currently less sites showing heavy grazing impacts. In general, wet and dry heath sites failed condition assessment due to past overgrazing prior to entering the scheme. Current CMS grazing levels were generally maintaining dwarf-shrub cover and current condition but on some sites, levels may have been too high for any improvement in condition to occur. Rough moorland grazing sites with potential to be restored to heathland (i.e. with >5% dwarf-shrub cover) should have reduced stocking rates applied where possible. On degraded heath, 36% of sites had >25% dwarf-shrub cover compared to none at baseline. The CMS had successfully improved the condition of these sites, mediated via reduced stocking rate prescriptions. This restoration of upland heathland and blanket bog habitat is contributing to HAP targets for improving the condition of degraded habitat (e.g. EHS 2003).

There has been little change in lowland raised bog sites since baseline. At resurvey only a single site was actively grazed and two were subject to peat cutting. There are very few intact raised bog sites in Northern Ireland. All sites surveyed had been subjected to hand peat cutting in the past. All but one site had trees or shrubs present (mainly birch), which is an indication of the drying out of peat surfaces due to drainage and cutting. It should be noted that only 21% of statutory lowland raised bog ASSIs/SSSIs in the UK are currently in favourable condition, with failure mainly due to drainage, neglect and invasive species.

4.3 Woodland

There was a slight but significant decrease in plant species richness recorded in 200m^2 quadrats in woodlands since baseline. This was similar to results from the monitoring of ESA woods in Northern Ireland, where a decrease in species richness was found during a ten-year monitoring period (Flexen *et al*. 2005). In terms of species composition within 4m^2 quadrats, there were no significant changes between years. However the mean cover of bramble per 200m^2 had increased significantly, by approximately 5% since baseline. Therefore the decline in species diversity may be due to the lack of livestock grazing in woods, which had led to an increase in competitive species such as bramble.

At resurvey, 84% of woodland sites had no livestock grazing, complying with the original scheme prescription for the exclusion of livestock from woodland. Of the currently grazed sites, only two had been subjected to heavy grazing (although fenced) with the rest having only occasional, and possibly accidental, grazing by sheep. The CMS scheme has been revised since baseline and there are now two management options for woods entering the scheme: i) no grazing option with livestock excluded throughout year or ii) lightly grazed option with grazing June to September less than 0.5LU/ha.

In general, each woodland site was inherently variable and, therefore, site-specific management plans may be useful in promoting their biodiversity. Other than exclusion of grazing by fencing, no other management was evident on the sample sites. Regeneration of woody species was evident on most woodland sites, with saplings present on around two-thirds of quadrats. The light grazing option should be introduced on sites where regeneration is occurring but that have become overgrown, i.e. where species diversity has declined due to an increase in competitive species such as bramble.

Under current CMS agreements, woodland is now classified as mixed ash woodland, oak woodland or wet woodland to correspond BAP priority habitat types. It should be noted that a number of woods under CMS management do not correspond with BAP priority habitats e.g. mature broadleaved/mixed plantations.

4.4 Scrub

Under the terms of CMS management agreement, scrub habitat must be grazed and some control by cutting should occur to retain open areas. At resurvey, there was no grazing on 40% of the sites and these were becoming overgrown and inaccessible. There

was no significant decrease in mean plant species diversity over all sites. However ungrazed sites showed a general decrease in species richness, indicating a decline in diversity due to lack of management. Evidence of recent scrub control was recorded on only one site resurveyed in 2006/07. Scrub control should be a priority where scrub is in a mosaic with species-rich grassland. In scrub habitats it is important to retain a high edge to area ratio for greatest diversity of wildlife (Hopkins 1996).

4.4 Wetlands

There were no significant changes in species diversity or composition between baseline and resurvey for lowland wet grassland or enhanced breeding wader sites. The main objective for this vegetation was to improve habitat for breeding waders. Condition assessment of lowland wet grassland indicated that a third of sites were in favourable condition at resurvey. Just over half of all sites had frequent positive indicator species and were species-rich. A further positive result was that only 2 sites (7%) were subjected to heavy grazing and/or poaching. There was evidence that 30% of sites had not been grazed or managed for at least two years, and in some cases considerably longer. This was due to fact that many sites were too waterlogged for livestock, although for some sites undergrazing may need to be addressed.

Lowland wet grassland showed no significant increase in mean cover of rush (*Juncus* spp.) species since baseline. However, condition assessment of fields showed that at resurvey, almost two-thirds of sites had a greater than 50% rush cover, with recent rush control evident on only two sites. Under current management prescriptions some rush control is required if rush cover is exceeding 50% of the field.

Lowland wet grassland was one of the most common habitats under CMS agreement, being an optional habitat for management. It is not included as a habitat type in the revised CMS scheme but sites should continue with management as such until the end of current agreements. Management of lowland wet grassland may contribute to delivering BAP targets for ‘purple moor grass and rush-pastures’. A small proportion of sample sites was closer to fen vegetation in terms of species composition, and therefore these correspond to the BAP priority habitat ‘fens’.

Wetlands are vulnerable to changes in water conditions and therefore threatened by nutrient enrichment and land drainage. Several of the monitored fen, swamp and reedbed

sites had been affected in the past by such factors. However plant species diversity had generally been maintained since management under CMS. In particular, changes in abundance of plant species that are indicators of changes in fertility and water quality were analysed.

In the revised CMS scheme, carr is now classified as the habitat type 'wet woodland'. The small sample size made it difficult to assess any overall changes in condition of carr woodland. It was likely that most of the woods had not been actively grazed in the past due to the waterlogged conditions. Sites did not show any changes in species diversity or composition since baseline survey. Certain plant species are indicators of nutrient enrichment from adjacent agricultural land and future monitoring should determine any changes in their abundance.

4.5 Arable

The aim of wild bird cover is to provide crop and weed seed for birds, particularly in winter. Where kale had been sown, by the second year it was dominant and providing seed. If practical, some patches within a wild bird cover plot could be sown with another mixture in the spring of the second year, which would increase the variety of plants available for insects and birds. Many of the species sown in mixtures were annuals and therefore did not persist to the second year. Where wild bird seed mixture was not re-sown after one year and there was little or no kale, perennial grasses dominated. Annual cultivation should therefore be recommended, depending on mixture used and success of establishment.

The relatively high cover of dicotyledons other than sown species was due to the absence of herbicide or fertiliser use after sowing and the relatively open structure of the vegetation. Many of the naturally regenerated weed species recorded from wild bird cover plots, e.g. redshank, fat-hen and chickweed, are of known benefit for seed eating birds (Wilson 1999). The wider range of food types and sources provided by CMS arable options should allow more individuals to survive and also encourage a wider range of bird species. Studies on wild bird seed mixtures in England concluded that they potentially provide multiple benefits for a wide range of declining farmland taxa (Pywell *et al*. 2007).

The aim of rough grass field margins is to provide forage and nesting sites for birds and mammals and provide habitat for overwintering insects. There is a clear link to the

objectives of the HAP for 'cereal field margins' and potential benefits for several BAP priority species, e.g. yellowhammer and Irish hare.

The development of grass tussocks within rough grass field margins is desirable as they provide shelter for small mammals and insects. Just under half of sites in 2007 had a tussocky structure suggesting that this may not develop in all margins within the 3 to 5 years time period that margins are required to stay in place. Tall rank vegetation may develop rather than a tussocky structure due to high residual soil fertility (Anon 2001).

The botanical diversity of margins and their value for wildlife, e.g. bees and butterflies, can be increased by the introduction of perennial herbs when sowing (Critchley *et al*. 2007; Pywell *et al*. 2007). An option for putting in pollen and nectar mixtures will be available in the new NICMS under the NIRDP 2007-13.

4.6 Buffer strips

Buffer strips were not generally of high interest in terms of botanical diversity but provide good habitat for a range of wildlife species and also act as nutrient sinks limiting run off into adjacent rivers, streams and other watercourses. There was a high proportion of competitor species in buffer strips compared to other habitat types, which may be related relatively high soil fertility and lack of disturbance. The majority of buffers at resurvey were fenced and had no livestock grazing, thus, adhering to management prescriptions.

4.7 Field boundary restoration

The main objective of hedge restoration is to encourage regeneration of mature gappy hedges to enhance wildlife and landscape value and improve agricultural uses. Approximately two-thirds of hedges had been subject to restoration/regeneration management at resurvey. In terms of shrub species, most sites were species-poor with only one or two shrubs present. In most cases, interplanting of gaps had been undertaken with only one or two shrub species, whereas the recommendation is for a mixture of shrubs to be planted. The majority of hedges still had gaps of greater than 10%, and it will take a longer time period to assess if restoration has been successful.

The erection of protective fencing on newly restored hedges prevents livestock grazing and browsing. However it may also allow competitive species to dominate, which may eventually reduce the diversity of the ground flora. Most sites had poor basal flora

communities and in some cases vegetation was tall and rank. Although the mean plant species richness of hedge bases had not decreased since baseline, there had been an increase in the mean cover of bramble and nettle. The development of species-rich basal flora communities is dependent on existing soil, light and management conditions and can be influenced by field management practices i.e. fertiliser application.

5. CONCLUSION

Uptake of the CMS has been successful with NIRDP targets exceeded. By December 2007, over 8,800 farmers and landowners had entered the CMS, bringing approximately 320,000ha of land under agreement. The scheme has been revised since its introduction and more habitat options will be implemented under the new NIRDP 2007-13.

Overall, there had been few significant changes in plant species diversity and vegetation composition on any habitat since baseline survey. Therefore, in general terms the CMS has been successful in maintaining species diversity. Slight declines in species diversity of species-rich grassland and woodland habitats may be related to lack of appropriate management. It is important to ensure that management prescriptions are being implemented and in some cases revision may be needed.

Condition assessment showed some improvements in vegetation condition of habitats, in particular on degraded heath, but the achievement of favourable condition of many sites was not likely within the period of monitoring. Any impacts of prescribed management changes on the habitat types sampled in the monitoring programme are likely to be gradual. A recent survey of statutory ASSIs in Northern Ireland between 2002 and 2004 found that 59% of habitat features were in unfavourable condition (EHS 2005). Therefore, it is perhaps not surprising that non-designated habitats under CMS management have not met the targets for condition attributes. Restoration and enhancement by more pro-active management through the introduction of new options may be required to achieve higher quality, more diverse habitats. This may be the case especially in relation to species-rich grassland and moorland habitats.

Longer-term monitoring to assess the effectiveness of CMS in fulfilling its principal biodiversity objectives should continue. However, this should be supplemented with targeted studies of habitats and/or options where particular issues of concern have been demonstrated.

6. REFERENCES

Anon (2001). *Ecological evaluation of the Arable Stewardship Pilot Scheme, 1998-2000.* Report to MAFF by ADAS, University of Newcastle, University of Oxford, Game Conservancy Trust. London: MAFF

Bickmore, C. J., (2002). *Hedgerow Survey Handbook, a standard procedure for local surveys in the UK*. Countryside Council for Wales.

Critchley, C.N.R., Maskell, L.C., Mitchley, J., Adamson, H.F., Burch, F.M., Carey, P.D., Firbank, L.G., Fowbert, J.A., Parkin, A.B., Smart, S.M., and Sparks, T.H. (2002). *Review and Recommendations of Methodologies to be used for Botanical Monitoring of Agri-environment Schemes in England.* Report to DEFRA. Project no. RMP/1607 (AE03).

Critchley, C.N.R., Walker, K.J., Pywell, R.F. and Stevenson, M.J. (2007). The contribution of English agri-environment schemes to botanical diversity in arable field margins. *Aspects of Applied Ecology 81*, *Delivering Arable Biodiversity*, pp 293-299.

DARD (2001). *Countryside Management Scheme Explanatory Booklet*. DARD, Belfast.

Environment and Heritage Service (2003). *Northern Ireland Habitat Action Plan – Blanket bog*. *Final draft- April 2003*. Unpublished document

Environment and Heritage Service (2005). *EHS report on ASSIs condition assessment in Northern Ireland the first three years.* Unpublished report

Flexen, M., Johnston, R.J., Cameron, A. and McAdam, J.H. (2004). *Baseline Biological Monitoring of the Countryside Management Scheme in Northern Ireland 2002-2003.* Queen's University Belfast. Report to DARD.

Flexen, M., McEvoy, P.M., Johnston, R.J. and McAdam, J.H. (2005). *Biological evaluation of the ESA scheme between 1994 and 2004*. Queen's University Belfast. Report to DARD

Grime, J. P.,Hodgson, J.G. and Hunt, R. (1988). *Comparative plant ecology: a functional approach to common British species*. Unwin Hyman, London.

Hegarty, C., McFerran, D., Cameron, A., Mulholland, F. and McAdam, J. H. (1994). *Environmentally Sensitive Areas in Northern Ireland. Biological Monitoring Report, Year One, 1993.* Belfast: Queen's University of Belfast.

Hetherington, S. and Gardner, S. (2002). *Management of Upland Vegetation in ESAs*. ADAS Wolverhampton.

Hewins, E.J., Pinches, C., Arnold, J., Lush, M., Robertson, H., and Escott, S. (2005). *The condition of lowland BAP priority grasslands: results from a sample survey of non-statutory stands in England*. English Nature Research Reports, No. 636. Peterborough.

Hopkins, J.J. (1996) Scrub Ecology and Conservation. *British Wildlife 8*, 28-36.

Hunt, R., Hodgson, J.G., Thompson, K., Bungener, P., Dunnett, N.P. and Askew, A.P. (2004). A new practical tool for deriving a functional signature for herbaceous vegetation. *Applied Vegetation Science* **7**, 163-170

Jerram, R. and Drewitt, A. (1998). *Assessing vegetation condition in the English uplands*. English Nature Research Reports, No.264. Peterborough.

Magurran, A. E. (1988). *Ecological diversity and its measurement.* London: Croom Helm.

Northern Ireland Biodiversity Group (2000). *Biodiversity in Northern Ireland: Recommendations to Government for a Biodiversity Strategy.* Belfast: HMSO.

Pywell, R.F., Meek, W.M., Carvell, C. and Hulmes, L. (2007). The SAFFIE project: enhancing the value of arable field margins for pollinating insects. *Aspects of Applied Ecology 81*, *Delivering Arable Biodiversity*, pp 239-246.

RDS (2005). *Soils and agri-environment schemes: interpreting soil analysis for habitat creation/restoration.* Rural Development ServiceTechnical Advice Note 31.

Robertson, H. J. and Jefferson, R. G. (2000). *Monitoring the condition of lowland grassland SSSIs - English Nature's rapid assessment method.* English Nature Research Reports, No.315, Peterborough.

Robertson, H.J., Jefferson, R.G., Wilson, P.J., Reed, M.E., McDonnell, E. and Wheeler, B. (2002). *Interim report: Monitoring grassland Biodiversity Action Plan Targets: condition and restoration assessment methodologies for non-statutory grasslands.* English Nature, Peterborough.

Southwood, T. R. E. (1978). *Ecological methods*. London: Chapman and Hall.

Wilson, J. D., Morris, A. J., Arroyo, B. E., Clark, S. C. and Bradbury, R. B. (1999). A review of the abundance and diversity of invertebrate and plant foods of granivorous birds in northern Europe in relation to agricultural change. *Agriculture, Ecosystems & Environment,* **75**, 13-30.

APPENDICES

Appendix 1.
Area of each CMS habitat and feature under agreement by December 2007

Appendix 2.
Positive and negative plant indicator species for use in grassland vegetation condition assessment.

Appendix 3.
Grassland condition assessment summary tables

Appendix 4.
Condition assessment scores for heather moorland

Appendix 5.
Heather moorland condition assessment summary tables

Appendix 1: Area of each CMS habitat and feature under agreement by December 2007.

HABITAT TYPE	AREA UNDER AGREEMENT (ha)
Improved grassland	214821.3
Unimproved grassland	38582.5
Species-rich dry grassland	867.2
Species-rich wet grassland	6017.3
Species-rich calcareous grassland	19.2
Species-rich hay meadow	136.4
Breeding wader and lapwing site	4669.3
Wetlands - lowland wet grassland	2008.2
Wetlands - fen	159.2
Wetlands - swamp	425.4
Wetlands - carr woodland	161.3
Wetlands - reedbed	92.4
Dry heath	1386
Wet heath	15483
Blanket bog	2527.4
Degraded heath	3472.1
Rough moorland grazing	7303.1
Lowland raised bog	4582.3
Woodland	3509.3
Scrub	2569.7
Land adjacent to lakes	223
Parkland	1961.1
Archaeological feature	345.7
Arable - Retention of winter stubble	4934.8
Arable - Spring cereals	370.8
Arable - Wild bird cover	1647.2
Arable - Rough grass field margin	343.1
Arable - Conservation cereal/crop margin	350.2
Winter feeding sites for swans and geese	1089.2
Buffers / Grass margins	957.5
Restoration / recreation of traditional orchards	66.8

Appendix 2. Positive and negative plant indicator species for use in grassland condition assessment.

Table 1. Indicator species for species-rich dry grassland.

Positive indicator species	Negative indicator species
Alchemilla spp.	*Cirsium arvense*
Anemone nemorosa	*Cirsium vulgare*
Carex spp.	*Galium aparine*
Centaurea nigra	*Plantago major*
Conopodium majus	*Pteridium aquilinum*
Euphrasia spp.	*Senecio jacobea*
Galium verum	*Rumex crispus*
Hypochaeris radicata	*Rumex obtusifolius*
Lathyrus pratensis	*Urtica dioica*
Leontodon autumnalis	
Leucanthemum vulgare	
Lotus corniculatus	
Orchidaceae spp.	
Polygala spp.	
Potentilla erecta	
Prunella vulgaris	
Rhinanthus minor	
Thymus spp.	
Viola riviniana	

Table 2. Indicator species for species-rich wet grassland.

Positive indicator species	Negative indicator species
Ajuga reptans	*Cirsium arvense*
Angelica sylvestris	*Cirsium vulgare*
Caltha palustris	*Rumex crispus*
Cardamine pratensis	*Rumex obtusifolius*
Carex spp.	*Senecio aquaticus* (if abundant)
Cirsium dissectum	*Senecio jacobea*
Filipendula ulmaria	*Urtica dioica*
Galium palustre	
Hydrocotyle vulgaris	
Lotus uliginosus	
Lychnis flos-cuculi	
Mentha aquatica	
Orchidaceae spp.	
Pedicularis sylvatica	
Potentilla erecta	
Potentilla palustris	
Ranunculus flammula	
Succisa pratensis	
Valeriana officinalis	
Viola palustris	

Appendix 3. Grassland condition assessment summary tables.

Table 1. Species-rich dry grassland (*n* = 18)

MANDATORY ATTRIBUTES	% sites passing each attribute target	
	2002/03	2006/07
	78	83
Herb cover		
Positive indicator species	44	44
Negative indicator species	72	61
Tree/shrub cover	39	39
Waterlogging indicator species	72	72
DISCRETIONARY ATTRIBUTES		
	44	39
Sward height		
Litter	83	78
Bare ground	89	100
ALL MANDATORY ATTRIBUTES	0	0
ALL ATTRIBUTES	0	0

Table 2. Species-rich wet grassland (*n* = 31)

MANDATORY ATTRIBUTES	% sites passing each attribute target	
	2002/03	2006/07
Positive indicator species	77	74
Negative indicator species	94	94
Tree/shrub cover	74	84
Rush cover	87	100
DISCRETIONARY ATTRIBUTES		
Sward height	61	77
Litter	74	81
Bare ground	97	100
ALL MANDATORY ATTRIBUTES	45	61
ALL ATTRIBUTES	26	45

Table 3. Species-rich hay meadow (*n* = 9)

MANDATORY ATTRIBUTES	% sites passing each attribute target	
	2002/03	2006/07
Positive indicator species	56	56
Negative indicator species	89	100
Tree/shrub cover	89	89
Rush cover	89	100
DISCRETIONARY ATTRIBUTES		
Litter	89	89
Bare ground	100	100
ALL MANDATORY ATTRIBUTES	3	4
ALL ATTRIBUTES	2	3

Table 4. Lowland wet grassland (n=30)

MANDATORY ATTRIBUTES	% sites passing each attribute target	
	2002/03	2006/07
Positive indicator species	43	53
Negative indicator species	97	97
Tree/shrub cover	80	73
Rush cover	90	93
DISCRETIONARY ATTRIBUTES		
Sward height	40	50
Litter	53	63
Bare ground	97	97
ALL MANDATORY ATTRIBUTES	30	33
ALL ATTRIBUTES	13	20

Appendix 4. Condition assessment scores for moorland and raised bogs.
(0=favourable, 1-5=unfavourable, >5=severely unfavourable)

Wet heath (*n* = 32)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	0	0
1	5	4
2	6	7
3	5	8
4	6	8
5	6	2
6	1	1
7	0	1
8	3	1

Dry heath (*n* = 8)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	0	0
1	1	0
2	3	4
3	1	1
4	2	2
5	1	1

Blanket bog (*n* = 5)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	0	0
1	1	2
2	2	2
3	1	0
9	1	1

Lowland raised bog (*n* =18)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	0	0
1	3	4
2	4	4
3	4	4
4	3	2
5	0	1
6	1	1
7	2	1
8	0	0
9	0	1
10	1	0

Degraded heather moorland (*n* = 22)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	0	0
1	0	0
2	0	1
3	1	1
4	3	5
5	8	8
6	8	6
7	1	0
8	1	1

Rough moorland grazing (*n* = 18)

CONDITION SCORE	No. of sites	
	2002/03	2006/07
0	1	1
1	6	6
2	6	6
3	1	1
4	4	4

Appendix 5. Moorland and raised bog condition assessment summary tables

Table 1. Dry heath (*n* = 8)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Dwarf-shrub cover	25	25
Range of dwarf-shrubs	50	50
Bryophyte abundance	75	75
Alien trees and shrubs	100	88
Grazing impact	25	25
Burning	100	100

Table 2. Wet heath (*n* = 32)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Dwarf-shrub cover	28	25
Range of dwarf-shrubs	72	75
Bryophyte abundance	88	94
Graminoid cover	22	16
Alien trees and shrubs	91	91
Grazing impact	34	47
Burning	100	94

Table 3. Blanket bog (*n* = 5)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Dwarf-shrub cover	80	80
Range of dwarf-shrubs	100	100
Bryophyte abundance	80	80
Graminoid cover	0	0
Extent of bare ground	60	80
Trees and shrubs	60	60
Active peat extraction	80	80
Grazing impact	60	80

Table 4. Lowland raised bog (*n* = 18)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Dwarf-shrub cover	72	83
Range of dwarf-shrubs	78	78
Bryophyte abundance	72	72
Graminoid cover	44	39
Bare ground cover	50	50
Trees and shrubs	11	11
Active peat extraction	72	88
Grazing impact	94	94

Table 5. Degraded heather moorland (*n* = 22)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Dwarf-shrub cover	0	0
Range of dwarf-shrubs	45	59
Bryophyte abundance	95	91
Graminoid cover	4	0
Alien trees and shrubs	95	91
Grazing impact	18	18

Table 6. Rough moorland grazing (*n* = 18)

ATTRIBUTE	% of sites passing each attribute target	
	2002/03	2006/07
Bryophyte abundance	89	83
Bare ground cover	61	61
Alien trees and shrubs	100	100
Grazing impact	17	22