Monitoring of Cereal Field Margins in Defra Agri-environment Schemes 2003-2006

Synopsis of Findings

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FINAL REPORT

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Background

Cereal Field Margins are a Priority Habitat in the UK Biodiversity Action Plan (BAP). The objective for the UK Cereal Field Margin Habitat Action Plan is to maintain, improve and restore, by management, the biodiversity of some 15,000 ha of cereal field margins on appropriate soil types in the UK by 2010. Twelve rare arable plant species have also been identified as BAP Priority Species, for which there are targets including maintenance of existing ranges and natural colonisation of new sites. In addition, five bumblebee species are BAP Priority Species, for which targets include maintenance and enhancement of existing populations. BAP targets are currently under review and are likely to require that a proportion of arable field margins achieve good condition in addition to the area targets. The Agri-environment (AE) Schemes are seen as Defra's principal mechanism for delivering its share of BAP targets.

A series of options for the management of arable land were trialled through the Arable Stewardship Pilot Scheme (ASPS). As a result of the initial evaluation of the ASPS (1998-2000) arable options were introduced to the Countryside Stewardship Scheme (CSS) in 2002. These new arable options, in addition to existing CSS (and in a few cases, notably Breckland ESA) prescriptions for grass margins and cultivated margins provide a range of options for the management of Cereal Field Margins for biodiversity.

Field surveys were carried out during 2003 – 2005 to provide information on the contribution of AE schemes to the Cereal Field Margin Habitat Action Plan. The objectives were to assess the a) plant species composition, b) incidence of rare arable plant species and c) provision of foraging resources for bumblebees, in a series of AE scheme field margin options. In most cases, these were compared with normally cropped cereal field headlands.

This report provides an overview of the findings from these assessments. Individual project reports and publications to date are listed at the end of the report.

Although this study focussed on plants and bumblebees, objectives for other groups also need to be taken into account.

Methods

The assessments were focussed on the ASPS, CSS and Breckland ESA, plus a small number of conservation headlands from the South Downs and South Wessex Downs ESAs (Table 1). Nine types of field margin were sampled, including normally cropped cereal headlands and totalling over 530 sites. At individual sites, plant species were recorded from randomly located quadrats and the site searched for rare arable plant species. Bumblebees were counted and flower abundance estimated along transects. Environmental data including soil properties, landscape structure and site management were recorded.

Plant species composition: cultivated margins

Key findings

No-fertiliser conservation headlands had more annuals, forbs and perennials than either conservation headlands or normally managed cereal headlands in both the

countrywide CSS/ESA sample and the more limited ASPS sample. In the countrywide sample, the crop cover, Ellenberg N values and soil extractable P were all lower in no-fertiliser conservation headlands. Differences between conservation headlands and normally managed cereal headlands were much less marked and less consistent. In the countrywide sample, conservation headlands had more perennials and spring germinators whereas in the ASPS sample they had more annuals and dicotyledonous species. In the countrywide sample, species composition was related to the season of sowing and the crop species.

In the countrywide sample, uncropped wildlife strips had the highest diversity of all plant species groups, compared to other cultivated margin types. In the ASPS uncropped wildlife strips however, the cover of perennial species had increased substantially during the first four years of establishment, to the detriment of annual species. In contrast, species richness had increased over an eight year period (in sites aged 10 – 16 years) on the lighter soils in Breckland ESA, with no evidence of perennials becoming dominant. Species composition in the countrywide and Breckland samples was related to cultivation frequency and intensity, perennials being associated with less intensive cultivation. All studies suggested that annual cultivation is desirable.

Spring fallow in the countrywide sample had more bare ground and litter cover than other margin types sampled. Species diversity was generally intermediate between uncropped wildlife strips on one hand and conservation headlands or normally managed cereal crops on the other. Species composition was more strongly related to soil properties in spring fallow and uncropped wildlife strips than in cropped margin types. Wildlife seed mixture sites in the ASPS were mostly sown with Brassicas, cereals or maize. As in uncropped wildlife strips, perennials had built up over four years at the expense of annual species.

Evaluation

Cultivated margins are intended to conserve arable plant species, and particularly annual dicotyledonous species that have declined nationally. Uncropped wildlife strips and no-fertiliser conservation headlands were the most successful in this respect. Spring fallow and wildlife seed mixtures also supported notable numbers of annual arable plants even although their primary objectives are to provide other resources for fauna. Conservation headlands showed fewer benefits although they did contain common plant species that are important foodplants for gamebirds and invertebrates. However, in all cases the success of individual sites was variable.

A significant issue for uncropped wildlife strips and wildlife seed mixtures is the maintenance of annual communities in the longer term. Annual cultivation of uncropped strips is essential. On heavier soils, moving the location of these options every few years might also prevent succession to perennial vegetation, which would be suppressed during normal cropping. Research is required to determine the effectiveness of this approach and its impact on the target annual species.

Differences between conservation headlands and no-fertiliser conservation headlands are probably the result of reduced crop competition in the latter. The reasons for the variable success of conservation headland sites merit investigation.

Cultivated margins should be carefully targeted at sites with the most potential. Farmers require more guidance on their management, especially on cultivation regimes for uncropped wildlife strips. They should be encouraged to vary the cultivation regime during any given year to optimise between-site diversity.

Plant species composition: grass margins

Key findings

In the CSS sample, grass margins with additional wildflowers in the seed mixture had higher species richness and numbers of sown species and perennial forbs than simple grass margins. Forbs characteristic of grassland were only present at very low frequency in simple grass margins (both mature and recently sown) but, in contrast, were relatively common where they had been included in the seed mixture.

In simple grass margins (i.e. sown with six or more common grass species), annuals were more abundant in recently sown sites than mature sites. If established by natural regeneration, grass margins tended to have more weedy perennials or annual arable species than sown margins. However, invasive, competitive perennials were frequent at all types of sown sites. Grass margins had higher species richness and more grass, forb and perennial species than normally cropped cereal headlands. They also had more butterfly larva and bumblebee foodplants.

Two-thirds of grass margins over two years old were cut annually and more than half had cuttings removed. However, species composition was related only to region, soil properties and the addition of sown forbs.

Evaluation

The objective for simple grass margins is to create a dense, tussocky sward to provide shelter for invertebrates and to create a buffer zone between the crop and the field boundary. The addition of wildflowers to the seed mixture is intended to increase botanical diversity and nectar and pollen resources. Grass margins sown with simple grass seed mixtures were established successfully and are a rapid, reliable and relatively cheap option. The inclusion of wildflowers in the seed mixture also achieved its objective at the scheme level although individual sites varied in the extent to which sown wildflowers had established.

The current management appeared to be appropriate for maintaining grass margins. However, there was no evidence, after initial establishment, of any further colonisation and spread of perennial grassland forbs in either simple grass margins or those with additional wildflowers. Scarification and further seed addition might be beneficial to enhance botanical diversity and accelerate colonisation.

Uptake of simple grass margins was substantial but there was relatively low uptake of grass margins with additional wildflowers. Greater priority could be given to encouraging farmers to adopt the latter option.

Grass margins were relatively unaffected by habitat context and so their establishment could be encouraged at difficult sites, for example where there are serious crop weeds.

Rare arable plant species

Key findings

In total there were 183 records (populations) of 36 rare arable plant species in the field margin surveys. This included four BAP Priority Species (*Centaurea cyanus*, *Fumaria purpurea*, *Scandix pecten-veneris* and *Silene gallica*). Records were

strongly biased towards the East, South East and South West Defra administrative regions. Rare species were found in all cultivated margin types, including normally cropped cereal headlands, but none in any grass margins. However, in the countrywide CSS/ESA sample of cultivated margins, rare species were much more likely to be found in agri-environment scheme margins (39%) than normally managed cereal headlands (15%). Rare species were most likely to be found in uncropped wildlife strips, followed by no-fertiliser conservation headlands, spring fallow, conservation headlands and normally managed cereal headlands. In the ASPS sample, most were also found in uncropped wildlife strips.

In the countrywide sample, uncropped wildlife strips had been successfully targeted at areas known to have populations of rare arable plant species. However, there was no correlation between the area of conservation headlands or no-fertiliser conservation headlands and the known distribution of rare species. Spring fallow was negatively correlated with rare species distributions.

Sites with a high proportion of annuals and dicotyledonous species and low Ellenberg moisture values were more likely to contain rare species (in Breckland ESA), as were those with high soil pH values (CSS/ESA sample). In the ASPS sample, rare species records declined in uncropped wildlife strips and wildlife seed mixtures, probably because perennials had become more dominant.

Evaluation

An objective for cultivated margins is to maintain viable populations of rare arable plant species, including BAP priority species, and increase the area of habitat suitable for them. All cultivated margin types contained rare species and therefore this objective was achieved at the whole-scheme level. Differences in the success rate amongst margin types were probably attributable to both the type of management and the extent to which they had been targeted into areas known to contain rare species populations.

One concern was the reduction in rare species records at uncropped wildlife strips and wildlife seed mixture sites where perennials had become more prevalent. As in the case of the whole plant community, annual cultivation is necessary and consideration could be given to moving margins around at more problematic sites.

Grass margins are clearly unsuitable for rare arable plants and cultivated margins should be strongly encouraged where they are known or likely to occur.

Uncropped wildlife strips should continue to be targeted in areas where rare species occur. No-fertiliser conservation headlands and spring fallow should also be targeted more in these areas.

Populations recorded in these surveys should be revisited periodically to check their viability. It would also be beneficial to record management practices at these sites to assess their impact on rare plant populations.

The autecology of many rare species is not well studied and research is needed on their requirements and suitable management practices, focussing particularly on competition with other species and cultivation regimes.

Foraging resources for bumblebees

Key findings

In the ASPS, very few bumblebees were recorded on intensively managed cereal field margins due to the lack of dicotyledonous species. Conservation headlands supported a significantly greater number of flowering dicots, but the majority of these were annuals that did not provide good forage for bumblebees. Uncropped wildlife strips provided good foraging habitat for bumblebee species, but most of the key forage species were pernicious weeds of agriculture (*Cirsium* sp.). Sowing non-crop field margins with wildlife seed mixtures had the potential for providing the best foraging habitat for bumblebees provided preferential forage species were introduced (e.g. *Trifolium pratense*).

In the CSS sample, bumblebee abundance was higher on the pollen and nectar margins compared to the grass margins with wildflowers, mature simple grass margins and recently sown simple grass margins. The observed effects were largely explained by the availability of suitable dicotyledonous flowers. As in the ASPS sample, bees were virtually absent from the normally cropped cereal headlands where dicotyledonous flowers were scarce and the majority were annuals. Bumblebee richness was also significantly higher on the margins sown with additional wildflowers and the pollen and nectar mix. The preferred forage plants in the grass margins were pernicious perennial weeds (*Cirsium* sp.), which had colonised from the field edge. The grass margins with additional wildflowers provided the greatest range of forage species, with the sown perennial dicots accounting for 88% of foraging visits. Dicotyledonous flower abundance was highest in the pollen and nectar margins, with agricultural varieties of legume accounting for 87% of visits.

In the ASPS, there were no differences in the abundance and diversity of the bumblebee assemblage between the two regions (East Anglia and West Midlands) despite a greater abundance of flowers and flowering species on the lighter soils of the latter. However, in the CSS sample, richness of the bumblebee assemblage and total abundance was significantly higher in regions of England with a higher proportion of pastoral and mixed farming enterprises, such as the South West and the West Midlands. There was evidence that richness of the bumblebee assemblage at the 10 km-square scale was positively correlated with land use heterogeneity, the proportion of grassland and the abundance and richness of the flower resource. The density of long-tongued bumblebees was explained by the number of pollen and nectar agreements per 10 km-square, together with flower abundance.

Evaluation

The main objective of field margin options for bumblebees is to provide pollen and nectar resources. The pollen and nectar margins sown with simple, low cost mixtures of agricultural varieties of legumes were an extremely effective and reliable means of providing high quality foraging habitat for long-tongued bumblebees. These seed mixtures were also attractive to a number of rare bumblebees. Wildlife seed mixtures were also effective if they included preferential forage species. Margins containing thistles were also utilised but those with annuals only were little used.

Field margins with forage resources are likely to be a valuable tool for targeted conservation of rare and declining long-tongued bumblebees. Ideally they should be sited on sheltered, sunny field corners and margins.

Future research is required to determine the quantity and location of foraging habitat required to sustain viable bumblebee populations at the landscape scale. Further monitoring is required to determine if the value of the pollen and nectar seed mixtures as a forage resource for bumblebees is maintained in the long term. The provision of suitable nesting and hibernation habitat is also required for the effective conservation of bumblebee populations in the wider countryside and further work is required to define and test the management prescriptions that will provide all of these essential habitats.

Conclusions

1. The UK Biodiversity Steering Group Report has set a target to restore the biodiversity of 15,000 ha of cereal field margins by 2010. The quality, as well as the extent, of this resource is important.

2. Cultivated field margin options in the English agri-environment schemes are effective in sustaining high levels of arable plant diversity within intensively managed landscapes, especially when these options are targeted geographically.

3. Grass margins also make a substantial contribution to the area target. Sites sown with simple grass mixtures were established and maintained successfully. The inclusion of additional forbs in seed mixtures increased the biodiversity value of these sites.

4. Cultivated margins also made a notable contribution to the conservation of rare arable plant species and are likely to have contributed to national targets for the maintenance and expansion of some BAP Priority Species.

5. Pollen and nectar margins and grass margins with additional wildflowers provide significant foraging resources and had high utilisation rates by bumblebees. They could also be making an important contribution to the BAP targets for several Priority Species.

6. More precise targeting of AE options to sites of known or likely importance for particular species or species groups is likely to provide the most effective delivery mechanism for achieving BAP targets in the future.

Recommendations

1. Objectives and priorities should be set for individual sites to define the species or species groups that are most likely to benefit. The most appropriate field margin option for the target groups should then be established.

2. Farmers should be given continual guidance on management of their field margin options to ensure the optimum regime is applied and the maximum return is achieved.

3. Some further research is still required to determine:

    - the quantity and location of bumblebee foraging, hibernation and nesting habitats.

- autecology and management requirements of rare arable plant species.
- the varying success rate of conservation headlands.
- rotational location of uncropped wildlife strips and wildlife seed mixtures.

4. Additional monitoring is recommended to determine:
    - dynamics of rare plant and bumblebee populations.
    - longevity of pollen and nectar resources in flower-rich margins.
    - long-term dynamics of diverse grass margins.

Table 1. Summary of options sampled. p = plants, b = bumblebees.

Survey year	Scheme	Option	Option code	Management	Taxa sampled	Project reports	Notes
2003	ASPS	conservation headland	3A	cereal crop with reduced pesticides	p	1,2	
		no-fertiliser conservation headland	3B	cereal crop with reduced pesticides, no fertiliser	p,b		
		uncropped wildlife strip	4C	uncropped, regularly cultivated field boundary strip	p,b		repeat of 1999 survey
		wildlife seed mixture	5	site-specific seed mixture	p,b		repeat of 1999 survey
		cropped headland	-	normally managed cereal crop	p,b		
2004	CSS	simple grass margin	R3	sown with basic perennial grass mixture	p,b	4,5	mature (pre-2002) & recently sown (post-2001) sites sampled
		grass margin with wildflowers	R3	sown with perennial grasses + forbs	p,b		
		pollen & nectar margin	WM2	sown with pollen- & nectar-rich plants	b		
		cropped headland	-	normally managed cereal crop	p,b		
2004	Breckland ESA	uncropped wildlife strip	Tier 4A	uncropped, regularly cultivated field boundary strip	p	6	repeat of 1996 survey
2005	CSS (ESAs)	conservation headland	CH1	cereal crop with reduced pesticides	p	7	included South Downs ESA Tier 4C & S. Wessex Downs ESA Tier 2.3
		no-fertiliser conservation headland	CH2	cereal crop with reduced pesticides, no fertiliser	p		included South Downs ESA Tier 4C & S. Wessex Downs ESA Tier 2.3
		uncropped wildlife strip[1]	R3	uncropped, regularly cultivated field boundary strip	p		included Breckland ESA Tier 4A
		spring fallow	OS3	overwinter stubble cultivated in spring	p		
		cropped headland	-	normally managed cereal crop	p		

[1] called 'Rare Arable Weed Margin' in CSS

Project reports and publications

Reports

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schemes in providing foraging resources for bumblebees in intensively farmed landscapes. *Biological Conservation*, 129, 192-206.

Critchley, C.N.R., Fowbert, J.A., Sherwood, A.J. & Pywell, R.F. (in press) Vegetation development of sown grass margins in arable fields under a countrywide agri-environment scheme. *Biological Conservation.*