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Managing uncropped land in order to enhance biodiversity benefits of the arable farmed landscape: The Farm4bio project

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CONTENTS

1. ABSTRACT

The primary aim of the Farm4bio project was to determine whether management of uncropped land for biodiversity on conventional arable farms could achieve significant and measurable increases in biodiversity that were at least equivalent to those attained on organic farms in primarily arable cropping systems. Using 28 sites each of approximately 100 ha, treatments were established in which the proportion of uncropped land, its management (project-managed, farmer-managed or organic) and spatial configuration was manipulated. On project-managed farms, 1.5-6 ha of four habitats were established (floristically enhanced grass, wild bird seed, insect-rich cover and natural regeneration) to provide key resources for wildlife. Uncropped land on farmer-managed sites consisted of Environmental Stewardship options (predominantly grass margins) and game cover (usually maize). Plants, invertebrates, birds and mammals were assessed over three years following two baseline years.

The proportion of uncropped land (1-18%) was positively related to plant diversity and butterfly diversity in the field boundaries and bee density in the uncropped plots, and numbers of skylarks, linnets, yellowhammers and other farmland birds that are highly dependent on farmland. Overall a positive response to the proportion of uncropped land was found for 17 of the 21 bird species. Farms with <3% uncropped land supported approximately 60% less birds than those with >10%, and even those with <5% were relatively under-populated. The habitats established on the project-managed farms were effective at increasing some invertebrate groups (wild bees, butterflies and chick-food insects) and yellowhammers. On organic compared to conventional farms there were more weed species in the crops, plus more lapwings, wood pigeons, skylarks, rooks and hares. These groups were most likely responding to the organic crops rather than the management of uncropped land. Uncropped land arranged in strips improved butterfly diversity and abundance of skylarks and rabbits, but blocks favoured linnets and grey partridge. For a five-year period the mean annual gross margins for the project-managed habitats and grass margins was £399/ha, and this was £192 per annum lower than that of a winter wheat-oilseed rape rotation. This requires extra financial support through agri-environment schemes to help farmers to increase the proportion of uncropped land to enhance biodiversity. Project-managed habitat quality varied between years and sites depending on soil type and weather, but floristically enhanced grass provided the most reliable cover followed by the wild bird seed mixture.

In conclusion, at the 100 ha scale the results showed that, on average across the 28 sites there was no significant effect of habitat management on bird abundance, as both Biodiversity Action Plan species and the Farmland Bird Index continue to decline between 2006 and 2010. However the declining rate on project-managed farms was slower than on farmer-managed farms, but the differences were not statistically significant. If farmland biodiversity is to be encouraged it is essential to provide all the necessary habitat and resources for each group of organisms on

farmland, for example, food, breeding areas, and shelter throughout the year and this requires better use of uncropped land, that is unharvested and managed for biodiversity through agri-environment schemes.

2. SUMMARY

2.1. Introduction

The decline in farmland biodiversity and the link to agricultural changes over the last 40 years is now well documented and accepted. In response, the UK has global, EU and national commitments to reduce or halt the decline in biodiversity. In order to meet these commitments and targets, the UK government has adopted various policies and strategies. The widespread adoption of agri-environment schemes (AES) is seen as the route by which farmland biodiversity can be revived and this objective is being promoted by industry partners in Campaign for the Farmed Environment. Organic farming can also benefit farmland biodiversity, but whether at the farm-scale organic farming is any better than conventional farming with carefully targeted prescriptions for wildlife habitats has never been tested. Overall the majority of UK arable farmers, for sound financial reasons and ease of management, would prefer to encourage biodiversity through targeted management of limited areas of uncropped land rather than by modifying the management of crops which could reduce the prospect of economically sustainable crop production. This has been proven by the poor uptake of within-crop wildlife management options in Environmental Stewardship.

The success of AES may be dependent on how they are implemented in terms of the advice provided, but also on the level of financial support which can influence option uptake. When uptake of the Entry Level Scheme (ELS) was reviewed in 2009 it revealed that the majority of agreement holders had taken up a relatively few simple options. Furthermore, if farmland biodiversity is to be encouraged it is essential to provide all the necessary habitat and resources for each group of organisms, for example, food, breeding areas, and shelter throughout the year and this may require better use of uncropped land than is currently being achieved. Ideally, changes to cropping as well as the creation of suitable habitats may also be required even though this may be uneconomic for the farming businesses without outside financial support. The scale over which these habitats/resources are provided and their structural arrangement may also be important, although this could vary according to the species mobility and requirements of each species. All of this indicates that a range of complex, interacting components may be driving an individual species success. Overall, the best examples of wildlife recovery have been where evidence based advice has been provided and appropriate habitat established and correctly managed over a contiguous area in which the target species is present.

The main aim of the Farm4bio project was to determine whether management of uncropped land for biodiversity on conventional arable farms could achieve significant and measurable increases in biodiversity, that were equivalent to or greater than those attained on organic farms with primarily arable cropping systems. The project also aimed to investigate some, as yet unanswered, fundamental questions regarding the type and scale of habitat enhancement for wildlife namely: 1) are there relationships between the proportion of uncropped land and levels of biodiversity and can thresholds be identified? 2) does active habitat creation compared to simple farm management lead to higher levels of biodiversity? 3) how should this land be arranged in the landscape? Determining when an appropriate level of wildlife for the farm/landscape has been achieved is also a key question. For some Biodiversity Action Plan (BAP) species this has been determined, but for other species, especially those that are common, targets are sometimes vague or unspecified. By working at the 100 ha scale the project was able to learn more about the real practicalities and additional variables of managing for biodiversity on farm.

2.2. Materials and methods

2.2.1. Selection of study sites

In order to select comparable sites for the study a wider selection of 100 ha blocks, 18 in East Anglia and 17 in Wessex, were first monitored in 2006. Monitoring included assessments of plants in three fields and field verges, pollinating insects in the same field verges and birds across the 100 ha. For the imposition of targeted management of uncropped land from year 2, 12 sites in each region were selected for the study, based upon the biodiversity monitoring, the future rotation, the shape of the block and its neighbouring vegetation and landscape features. Any that appeared atypical for the region were avoided. Two primarily arable organic farm sites were selected in each region at the end of 2006 for inclusion into the project in Year 2.

2.2.2. Experimental design

Six treatments were then allocated at random to the 24 sites, with four replicates per treatment, two in each region with an additional two organic blocks per region. The treatments imposed in spring 2007 were:

1. Each block with 6 ha of project-managed uncropped land arranged in strips[1]
2. Each block with 1.5 ha of project-managed uncropped land arranged in strips
3. Each block with 6 ha of project-managed uncropped land arranged in 1-2 blocks[2]
4. Each block with 1.5 ha of project-managed uncropped land arranged in one block
5. Each block with 6 ha of farmer-managed uncropped land
6. Each block with 1.5 ha of farmer-managed uncropped land
7. Organically managed block with 1.5 ha of farmer-managed uncropped land.

The project-managed uncropped land was split into four equal areas comprising:

[1] In general the strips were 24m wide (4 parallel strips x 6m wide)

[2] In general the blocks were at least 48m wide (4 x 12m)

i. Floristically Enhanced Grass mix (FEG) (6 uncompetitive grasses and 8 flowering plant species) to encourage pollinating insects.
ii. Insect Rich Cover (IRC) (triticale and common vetch in 2007, 2008 and 2010; rye and vetch in 2009) to provide invertebrate chick food for breeding farmland birds in summer and seed in winter.
iii. Wild Bird Seed mixture (WBS) (triticale/mustard in spring 2007; triticale/fodder radish/kale/millet/quinoa in spring 2008; fodder radish/kale/rye in spring 2009; triticale/fodder radish/millet in spring 2010) to provide seed for birds in winter. Failure of autumn sowings and abnormally dry spring weather meant that seed mixes had to be adapted to the conditions.
iv. Natural Regeneration (NR) (annual cultivation) to encourage annual arable plants

The farmer-managed blocks included habitat managed for game cover (either maize or a wild bird seed mixture), grass margins and other Environmental Stewardship habitats and cross compliance margins. As the habitats sown in spring 2007 did not fully established that summer, all the 2007 data were amalgamated with 2006 data to create a baseline data set. Treatment data was collected in 2008 to 2010. A suite of biodiversity measurements was conducted on each block each year with some designed to provide a indication of the impact across the 100 ha block (birds, mammals, pollinators) and others of particular uncropped habitats (plants, insects). The block scale measurements were:

a) plants - in the same three fields weeds assessed at 0, 4, 8 and 32m from the crop edge in spring 2006-2009 and plants along the boundaries (hedge, verge and any additional uncropped habitats) in 2007 and 2008;
b) bees, butterflies and hoverflies assessed along the same three field boundaries used for the plants once in July 2006 and thereafter in June and late July/early August every year 2007-2010;
c) birds, three counts during the breeding season (April-June) 2006-2010;
d) mammals, hares, rabbits, deer, foxes and badgers were counted twice in winter 2006/7, 2007/8 and 2008/9.

The assessments made at the habitat scale were:

a) plants and vegetation structure in each project-managed and predominant farmer-managed uncropped land habitats every year,
b) bees, butterflies and hoverflies twice in June and late July/early August 2008-2010 within each project-managed and predominant farmer-managed uncropped habitats;
c) other insects, collected using a modified Vortis suction sampler once in July 2007-2010 within each project-managed and predominant farmer-managed uncropped habitats.

2.2.3. Analysis

It was expected that the different taxa recorded (birds, plants, invertebrates) would respond to the availability and type of uncropped land at contrasting scales. Therefore, variability in the biodiversity was analysed 1) between the 100ha blocks (using Generalised Linear Mixed Models, GLMM) and 2) between plots of sown habitats within the blocks (using Residual Maximum Likelihood, REML). The analysis at the block scale first tested for differences between the treatments assuming the original factorial design with the scale and arrangement of uncropped land included as categorical variables. A second phase of the analysis included input scale and arrangement of uncropped land as continuous variables. Where appropriate, additional co-variates (e.g. % arable in the surrounding 3-km^2 of each site and the boundary to area ratio of the 100-ha site) were included to account for the effect of landscape structure.

For birds, comparisons were made between individual species and between three species groups according to their level of dependency on farmland and their population trajectory in the last 10 years. The groups were: high farmland-dependency species (including skylark), stable or increasing species (such as woodpigeon) and lower farmland-dependent species (such as song thrush).

Because project managed farms also had other areas of uncropped land within the 100 ha block, there were often not clear divisions between the project treatments in terms of the scale of uncropped land. Therefore, a second analysis was done that included the scale and arrangement of uncropped land as a continuous variable.

2.3. Results

2.3.1. Plants

A relationship was found between the amount of uncropped land and plant species richness: more plant species were recorded in the boundaries of farms with a greater percentage of uncropped land. There was a strong correlation between the amount of uncropped land and heterogeneity of uncropped habitats and it is likely that this partly explains the effect on species richness. Approximately one additional species accumulated with every percentage increase in uncropped land. This may have been a consequence of increased recruitment opportunity but it is also likely that the significant correlation between the amount of uncropped land and habitat heterogeneity of field boundaries (r=0.61, P<0.001) was important. Farms with more uncropped land tended to have a wider range of different management options providing more diverse habitats for species with contrasting ecology. Despite the fact that the project farms had additional species sown, there was no significant effect of the treatments on plant diversity on uncropped land when analysed at the

100 ha block scale (including region and year as co-variates). However, an upward temporal trend in species richness on the project farms was observed as the habitats matured.

There were clear differences between the floras recorded in the cropped areas of the field and the uncropped land with greater plant diversity recorded on the latter. The only significant treatment effect on weed communities in the crops was increased diversity on organic farms. Once region was included as a blocking factor, there were no effects of landscape on weeds although distinct weed communities could be identified in particular crop types. Crop choice was a major driver in determining the weed flora, with weeds being most abundant on the grass/legume crops (found predominantly on organic farms), and on uncropped fields and least abundant in cereal crops.

A multivariate analysis revealed significant differences in plant communities recorded on uncropped land between project and farmer-managed sites. Farmer-managed treatments were dominated by grass margins and therefore the plant community was characterised by grassland species including Yorkshire fog (*Holcus lanatus*) and cock's-foot (*Dactylis glomerata*). In contrast, in addition to the sown species on the project-managed habitats the plant communities were characterised by a ruderal, annual community including groundsel (*Senecio vulgaris*) and scarlet pimpernel (*Anagallis arvensis*). This was a result of the annual disturbance of the NR, IRC and WBS that encouraged an understory of weeds growing beneath the sown species. While, particularly on heavy land, this could present a problem by encouraging weeds, such as black-grass (*Alopecurus myosuroides*), many of these species may also have a biodiversity benefit by providing nectar and seed resources.

2.3.2. Invertebrates

The study clearly demonstrated that pollinating insects (wild bees and butterflies) were enhanced by the provision of extra uncropped land and that there was no detectable upper threshold. But at the 100-ha scale the type of management, project versus farmer managed, and the original treatments were not significant factors. Two habitats (FEG and WBS) were clearly the most attractive to invertebrates. The FEG supported the highest densities of wild bees, hoverflies and butterflies seeking oviposition sites (Satyridae) or nectar (Lycaenidae). The density of wild bees was dependent on floral resources and consequently FEG or nectar flower mixes should be a component of every farm's Agri-environment scheme.

Once the increase in overall percentage of uncropped land had been accounted for, the project-sown habitats had an effect on diversity of bees with increased diversity recorded on farms with project-sown habitats. However, these farms also had less bee abundance and diversity along the field margins suggesting that the project treatments may have been drawing in bees from the surrounding landscape.

Fewer bees were recorded along the margins of the organic farms but it was not possible to identify the cause, although they may have been attracted into fields, such as those containing fertility-building legume crops. The proportion of uncropped land had a positive effect on butterfly diversity along the field margins and wild bee abundance and diversity in the uncropped habitats, with no evidence of any threshold for the first two measures but wild bee diversity reached a plateau at 3-5% uncropped, either because of the level of identification was insufficiently sensitive or there was limited opportunity within the wild bee fauna for an increase. There was evidence that wild bees were being attracted to the project-managed habitats from the field margins which has implications for the pollination of wild plants along margins. Butterfly diversity increased when the uncropped land was arranged in strips rather than blocks. For the invertebrates collected by Vortis sampling there was no effect of management type, the proportion of uncropped land or its arrangement, instead they responded at the smaller, habitat scale. The sown species mixtures, especially the wild bird seed, generally supported higher populations than grass margins. As a result there were higher abundances and biomass on project farms. On average project farms were providing approximately twice the biomass of invertebrates per unit area as the farmer managed (control) farms.

The assessments of individual uncropped habitats revealed that wild bees were mainly bumble bees (92%) and almost 90% of these were of three species (*Bombus pascuorum, B. lapidarius and B. pratorum*). The majority (ca. 70%) of the bumble bees were short-tongued and the only abundant long-tongued species, B. *pascuorum*, occurred predominantly in the floristically enhanced grass (FEG). Overall bumble bees and cuckoo bees were 3-8 times more abundant, depending on the time when sampled, in FEG compared to the other habitats. Solitary bees were most abundant in FEG in June, however, they were 10 times more abundant in the game cover in East Anglia than in the game cover elsewhere. The occurrence of butterfly adults was largely dependent on the presence of larval food plants. The Pieridae (whites) which feed on brassicas were twice as abundant in the WBS (which contained fodder radish and kale) and formed 75% of the species composition compared to the other habitats. Those with grass hosts, especially Satyridae (browns), were most abundant in FEG and grass margins. Butterflies seeking the nectar provided by the sown species were 25-50% more abundant in the FEG compared to the other sown habitats and FEG also attracted the most Lycaenidae (hairstreaks, coppers and blues). Hoverflies were most abundant in FEG and grass margins in June, but by July occurred in similar numbers in all habitats except grass margins where they were 50% lower than in the other uncropped habitats. There were at least four times as many hoverflies in most habitats in Wessex compared to East Anglia in July.

In the Vortis suction samples, the natural enemies of pests formed almost 40% of the species composition with the majority being parasitoids. In contrast, pests only formed a maximum of 32%, these being highest in natural regeneration and lowest in grass margins. The wild bird seed contained the greatest density of invertebrates and pests, and because the pests are consumed by birds, farmland bird chick-food and grey partridge chick-food indices were also highest in this habitat. The biomass of farmland bird chick-food was five times larger in East Anglia compared to Wessex. The abundance of natural enemies was relatively similar across all uncropped habitats, only varying by approximately 25%.

2.3.3. Birds

The study provided important evidence of a scaled effect of habitat provision on the abundance of birds associated with English arable farmland. The strongest and most detectable effect on bird abundance was the gross area cover of uncropped land.

The analysis which controlled for the % area of uncropped land present, showed a significant increase in bird abundance for linnet on farms where the uncropped land was project-managed rather than farmer-managed. Similar, but non-significant trends were also seen for skylark and yellowhammer.

In the regression analysis for individual species, significant effects of uncropped land were detected for linnet, yellowhammer, skylark and lapwing. The effect of organic farms was significant for lapwing, woodpigeon and rook and this suggests that the organic rotation, with grassland content, was a dominant and confounding factor. There was a non-significant positive effect of total uncropped land for 17 out of 21 species.

Using GLMM statistical analyses, for the continuous variable '% area uncropped land', a significant relationship with uncropped land was identified for the three most abundant species present, linnet, yellowhammer and skylark (using the larger dataset and especially on conventional farms; their abundance provided sufficient analytical power to detect a relationship that also appeared to be present in other species but fell short of statistical significance), and for Biodiversity Action Plan (BAP) and Farmland Bird Index (FBI) species as combined groups.

The effect of organic farms compared to conventional farms was significant and positive for lapwing, skylark, woodpigeon, rook and goldfinch. Among groups of species, the response to % area uncropped land was strongest amongst high dependency, declining species. No specific threshold was identified for uncropped land and the relationship was strongest on conventional farmland. Instead, an area of uncropped land below 3% supported significantly lower densities of skylark, linnet and yellowhammer than areas of 10% or more, for which abundance was roughly

60% higher. Among the other high farmland-dependency, declining species (kestrel, lapwing, grey partridge, yellow wagtail, corn bunting and reed bunting), no individually significant effects of uncropped land were detected. However, collectively all showed a positive relationship with uncropped land and with the area of grass margins present, that was in contrast to the lower dependency species (such as song thrush and house sparrow). These percentages of uncropped land are averages for 'average' types of uncropped land and do not account for habitat quality or composition – as is likely to be the case on the majority of farmland locations where wildlife habitat management is not closely supervised. Under such a scenario, the curves suggest disproportionately low bird densities at percentages below 3%. Yellowhammer was also significantly associated with the presence of wild bird seed (WBS).

The effect of perimeter-to-area ratio (which quantifies the 'blockiness' of the uncropped land) was not statistically significant for any species, except for skylark and linnet, and to a lesser extent, grey partridge when in combination with other variables (grey partridge had a preference for larger blocks rather than narrower strips). For skylark, a larger relative edge effect was significant (typical of strips rather than blocks) and probably related to availability of bare ground. For linnet, higher abundance was correlated with larger blocks of contiguous habitat. For other species, including yellowhammer, there was no significant effect of patch size, patch number or perimeter-to-area ratio.

2.3.4. Mammals

The data on hares and rabbits (which were recorded in 2008 and 2009) were only analysed at the 100 ha block scale using the two phase analysis. The effect of keepering was added to the analytical model. Only a small number of significant effects were identified by the models. Hares were more abundant in 2008 than in 2009 (16.4 vs. 11.3 hares / 100 ha) and on organic compared to conventional farms (32.6 vs. 10.7) and rabbits were more abundant on sites with a higher perimeter to area (P / A) ratio (preferring uncropped land arranged in strips because their burrows are located along the margins of annually cultivated fields).

2.3.5. Economics

For a five-year period the mean annual economic gross margins for the habitats, comprised of the Environmental Stewardship payments less the costs of seeds, fertiliser and sprays, were as follows: 4m grass margins (£381), FEG (£433), biennial WBS (£407), annual NR (£388) and WBS/IRC replaced annually (£386). The mean annual economic gross margin for the four project-managed habitats was positive (£398), but in comparison, over four years and based upon national farm business survey, the average annual gross margin for a winter wheat and oilseed rape rotation was £591. The FEG had the highest gross margin and was the easiest to establish and manage, but at present at present this option is not available in ELS.

2.4. Discussion

One of the main objectives of the project was to see whether enhanced management of conventional farms could increase their diversity up to a level seen in organic arable farms. At the 100 ha scale the results showed that, on average across the 28 sites there was no significant affect of habitat management on bird abundance, as both Biodiversity Action Plan species and the Farmland Bird Index continue to decline between 2006 and 2010. However the declining rate on project-managed farms was slower than on farmer-managed farms, but the differences were not statistically significant. Moreover, it may take longer than the period available for a response to be detectable, as found with other investigations appraising the impact of ELS. If farmland biodiversity is to be encouraged it is essential to provide all the necessary habitat and resources for each group of organisms on farmland, for example, food, breeding areas, and shelter throughout the year and this requires better use of uncropped land, that is unharvested and managed for biodiversity through agri-environment schemes.

Overall the differences between the organic and conventional farms were relatively small with significantly enhanced numbers of weeds in fields, five bird species (lapwing, skylark, woodpigeon, rook and goldfinch) and hares on the organic farms. The differences for birds and hares were attributed to the organic rotation that included, on average, a higher grassland component and weedier arable crops. The impact of the project- compared to farmer-managed was restricted to differences in plant species composition and linnets. On farmer-managed farms the plant community was grass focussed because grass margins were the main type of uncropped land, whereas on the project-managed farms annual weeds prevailed in the natural regeneration and annually sown mixes. However, natural regeneration was unsuitable for heavier soils where it encouraged pernicious weeds such as black-grass, and this option is best targeted at sites with light soil types or where there are known populations of rare arable flowers. There was an upward trend over time in plant diversity in the project-managed perennial habitats. Linnets were more abundant on project-managed farms. There were more noticeable and local differences between habitat types, especially for invertebrates. Project-managed habitats encouraged individual groups of invertebrates, for example the FEG attracted wild bees and the WBS contained more invertebrate chick-food. Overall, project-managed habitats had twice as much farmland bird chick-food compared to farmer-managed habitats.

2.4.1. How much uncropped land?

The proportion of uncropped land was positively related to the abundance of wild bees and butterfly diversity, and for 17 of the 21 bird species (5 significantly so) and bird functional groups. There was also an increase in the number of bee groups between 0-3 and 3-5% uncropped land, but no increase beyond this, either because individual species were not identified or because there was limited opportunity for recruitment. Wild bee abundance increased positively with uncropped land at the expense of the margins, indicating redistribution may have been occurring and this merits further investigation to ensure pollination of hedgerows plants is not being compromised by the planting of areas super-rich in floral resources. Butterfly diversity also increased with the proportion of uncropped land and there was no detectable threshold to their enhancement. Grass margins and wild bird seed mixes or game cover comprised a large proportion of the additional uncropped land and this explains the response because the larvae of many species feed on grasses or brassicas.

The Farm4Bio study provided important evidence of a scaled effect of habitat provision on the abundance of birds associated with arable farmland. The strongest and most detectable effect on bird abundance was the gross area cover of un-cropped land. Sites with <5% area (especially <3%) of un-cropped land were relatively under-populated; sites with >10% held significantly higher densities of key species. A rate close to or <5% un-cropped land may be inadequate for population stabilisation under circumstances where un-cropped land *is not* closely managed for biodiversity. Extra provision of specific resources for birds, such as winter bird food, may enable farms to stabilise bird populations without increasing the % uncropped land above 5% but this would need further study. Species considered to be of higher farmland-dependency were the most responsive to the availability of uncropped land, especially the more abundant skylark, linnet and yellowhammer. Collectively, these species represent a range of life-history strategies and ecological requirements that encompass traits found in the other less abundant but declining species present. For example, they represent both open nesting and boundary nesting species, obligate seed-eating species and more generalist seed and invertebrate feeding species. Managing farmland for these three species would to some degree attend to the basic habitat structural requirements of the other high farmland-dependency species that are important to the Farmland Bird Index (FBI) trend. Other species also showed a positive response to the proportion of uncropped land, such as woodland species (e.g., song thrush and dunnock) and urban species (e.g., house sparrow), but these species would preferentially require the provision of surrogate woodland (hedgerows or shade) or urban (buildings) habitats.

2.4.2. Spatial arrangement of uncropped land

The spatial arrangement of uncropped land had very little impact apart from a few exceptions. Butterfly diversity was higher when the uncropped land was in strips. This may be expected because butterflies prefer sheltered areas next to hedgerows which facilitate dispersal and make a more favourable habitat for breeding. There was a weak response by birds, with skylark, linnet and to a lesser extent grey partridge showed differing responses to habitat arranged as blocks or strips.

2.4.3. Economics

All the habitats potentially had lower gross margins than would be achieved by cropping the land over the project's duration. Indeed the Environmental Stewardship payments alone were less than the average gross margin of wheat and oilseed rape. This, however, may overestimate the discrepancy because agri-environment options are often established on less productive land and require a lower fixed cost structure. These figures are therefore only a relatively crude example of the relative economic margins but still any increase in the proportion of uncropped land requires extra financial support through agri-environment schemes to help farmers to increase the proportion of uncropped land. This needs further investigation and may need increasing to maintain their competiveness when crop values are high.

In summary, the quantity of uncropped land was found to be the primary driver for biodiversity and especially farmland birds. However, this study showed that management of uncropped land was unable to reverse the declining trend for both Biodiversity Action Plan species and the Farmland Bird Index within the project's duration. Maximising the availability of uncropped land will positively affect the carrying capacity of conventional arable farmland when measured at a scale of resolution that is consistent with many national and regional bird monitoring schemes, not just in the UK. The quality of uncropped land was important for some groups, notably wild bees and farmland bird invertebrate chick-food. It is also essential to provide all the necessary habitat and resources for each group of organisms, for example, food, breeding areas, and shelter throughout the year and this requires better use of uncropped land through agri-environment schemes, and this was clearly demonstrated in the Farm4bio project.