FARMING FOR WILDLIFE PROJECT

Jordans Cereals Ltd

Annual report 2006/7

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1. Introduction

Traditional farming practices have created some of the most diverse habitats in north western Europe. However, over the last century agricultural intensification to increase productivity has resulted in the loss of habitats and species, and damage to the environment. It is widely recognised that these impacts of modern agriculture on biodiversity and other natural resources can be mitigated through approaches which either protect areas from intensive farming practices or decrease the intensity of agriculture on farmed land. In the UK this is delivered through voluntary agri-environment schemes, such as Environmental Stewardship (Environmental Stewardship). However, recent monitoring suggests that the majority of farmers are selecting a very limited range of environmental enhancement options (e.g. hedge cutting and grass margins) and that options are not always situated in the most appropriate location to benefit wildlife. In contrast, Conservation Grade (http://www.conservationgrade.co.uk/) is an industry-led assured produce scheme which requires growers to establish a greater diversity of ES options on a higher proportion of farmed land (10%). It also requires provides land manager with a detailed protocol and training in the location and management of these habitats to maximize benefits for wildlife.

The aim of this project is to scientifically evaluate a range of Conservation Grade habitats for wildlife and determine their optimum location in a typical farming situation. This will provide the critical scientific evidence base to underpin this innovative scheme and inform the future revision of the management protocol. In order to achieve this aim the project will answer the following research questions:

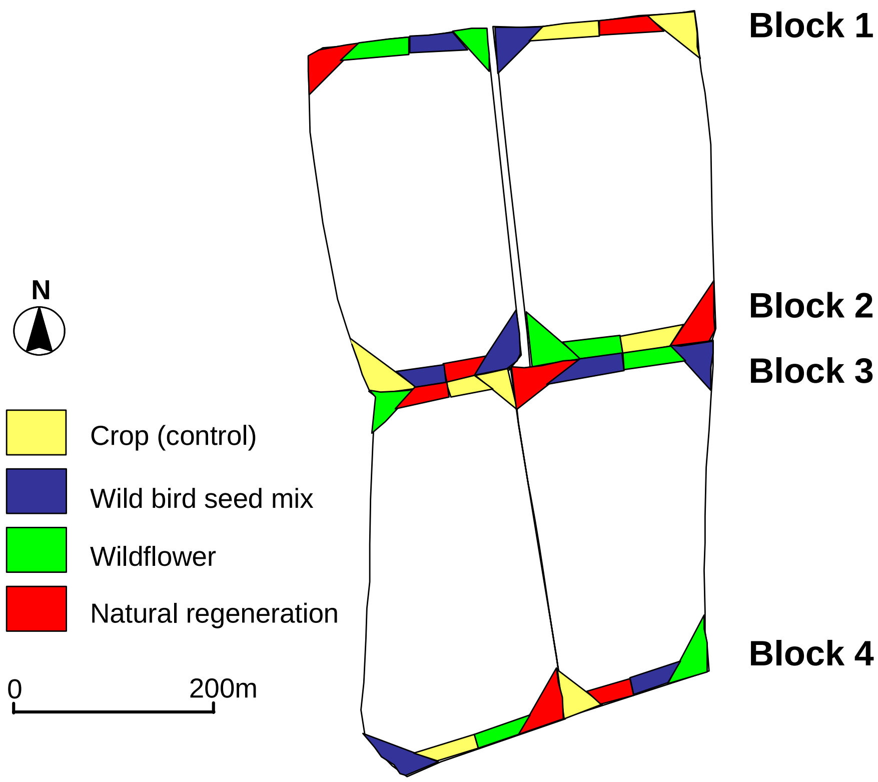
1) What is the best Conservation Grade wildlife habitat type for plants, butterflies, bumblebees, insects and birds?
2) What is the optimum location each habitat type (field corner or margin)?
3) Are there any positive or negative interactions between habitat type and location for biodiversity?
4) What is the most practical and cost-effective mix of habitat type and location from a farming perspective?

2. Methodology

2.1 *Experimental design*

The experiment was undertaken at the Upton Estate, Warwickshire (SP378434) on four arable fields of approximately equal size (5.6 ha) growing Conservation Grade oats in 2006. One of four habitat types (crop, wild bird seed mix, wildflower and natural regeneration) was established in the corner of each field using a latin-square design with four replicates (Fig. 1). Identical habitats were established on the north- and south-facing field margins separating each corner using the same design.

Fig. 1. Experimental design



2.2 *Treatments*

The crop treatment comprised winter oats drilled in mid-October 2005 which were managed with conventional inputs of pesticide and fertilizer. The natural regeneration treatment comprised the establishment of vegetation from the stubble of the previous winter wheat crop. This was unmanaged in 2006. The wild bird seed mixture comprised five species sown at a rate of 14 kg ha^{-1} on 28 April 2006 (Table 1). Flea beetles were controlled in this treatment by two applications of the pesticide Mavrik (EC 240 g l^{-1} tau-fluvalinate A.I. applied at 150 ml ha^{-1}, Makhteshim-Agan UK Ltd) in the first two weeks of May 2006. In late May 75 kg ha^{-1} of nitrogen fertilizer were applied to stimulate growth. The wildflower seed mixture included 4 grass species comprising 90% of the mix and 25 broad-leaved species (dicots) comprising 10% of the mix sown at a rate of 20 kg ha^{-1} on 20 August 2005 (Table 2). In November 2005 emerging grass weeds were controlled by the application of Fluazifop-P-butyl (as Fusilade Max, Syngenta Crop Protection Ltd) at 0.5 litres in 200 litres of water ha^{-1}. These plots were cut and the biomass removed on 10 April, 20 May and 29 October 2006.

Table 1. Details of the wild bird seed mixture

English name	Latin name	Sowing rate (kg ha^{-1})	% of mix
Fodder radish	*Raphanus sativus*	1.4	10
White millet	*Echinochloa esculenta*	3.5	25
Camelina (Gold of Pleasure)	*Camelina sativa*	1.4	10
Buckwheat	*Fagopyrum esculentum*	4.2	30
Quinoa	*Chenopodium quinoa*	3.5	25
Total		**14.0**	**100**

Table 2. Details of the wildflower seed mixture

English name	Latin name	Sowing rate (kg ha^{-1})	% of mix
Crested dogstail	*Cynosurus cristatus*	18.0	3.6
Chewing's fescue	*Festuca rubra ssp commutata*	31.5	6.3
Slender red fescue	*Festuca rubra ssp juncea*	22.5	4.5
Smooth meadow grass	*Poa pratensis*	18.0	3.6
Yarrow	*Achillea millefolium*	0.25	0.05
Common Knapweed	*Centaurea nigra*	0.75	0.15
Wild Basil	*Clinopodium vulgare*	0.25	0.05
Wild Carrot	*Daucus carota*	0.25	0.05
Meadowsweet	*Filipendula ulmaria*	0.30	0.06
Hedge Bedstraw	*Galium mollugo*	0.20	0.04
Lady's Bedstraw	*Galium verum*	0.50	0.10
Field Scabious	*Knautia arvensis*	0.50	0.10
Rough Hawkbit	*Leontodon hispidus*	0.20	0.04
Oxeye Daisy	*Leucanthemum vulgare*	0.40	0.08
Birdsfoot Trefoil	*Lotus corniculatus*	0.40	0.08
Ragged Robin	*Lychnis flos-cuculi*	0.20	0.04
Musk Mallow	*Malva moschata*	0.50	0.10
Hoary Plantain	*Plantago media*	0.30	0.06
Cowslip	*Primula veris*	0.50	0.10
Selfheal	*Prunella vulgaris*	0.50	0.10
Meadow Buttercup	*Ranunculus acris*	1.00	0.20
Yellow Rattle	*Rhinanthus minor*	0.50	0.10
Common Sorrel	*Rumex acetosa*	0.50	0.10
Salad Burnet	*Sanguisorba minor ssp minor*	0.75	0.15
Red Campion	*Silene dioica*	0.50	0.10
Bladder Campion	*Silene vulgaris*	0.25	0.05
Betony	*Stachys officinalis*	0.25	0.05
Red clover	*Trifolium pratense*	0.05	0.01
Tufted Vetch	*Vicia cracca*	0.25	0.05
Total		**20.00**	**100.00**

2.3 *Monitoring*
In July 2006 the percentage cover of plant species was recorded from three 1 × 1 m quadrats placed at random in each plot. The abundance and diversity of bumblebees, butterflies and flowering plants were recorded 3 m either side of a transect walked along the centre line of each plot on five occasions between July and September. Counts were made of all farmland bird species utilising each plot on seven occasions between December 2006 and March 2007. This was achieved by firstly observing each plot from a distant vantage point, avoiding disturbance of the birds, for a 20-min period and then walking a transect through the middle of both plots to flush out any remaining birds. Counts were not made in adverse weather conditions (heavy rain, strong winds or poor visibility). Frequent cutting of the wildflower plots to control competitive weeds meant it was impractical to undertake the proposed sweep net sampling of other invertebrates. This sampling will be undertaken in summer 2007.

2.3 *Statistical analysis*
Mean abundance and species richness values for all groups were calculated for each plot. Differences in abundance and richness were investigated using split-plot analysis of variance (ANOVA) comparing location (corner or margin) main treatments (tested against the block × location mean square), habitat type sub-treatments and location × habitat type interactions (tested against the error mean square). Student-Newman-Kuels pairwise comparisons were used to test for significant differences among individual treatments.

3. Results 2006/7

A total of 55 species of grass and 37 dicots were recorded in the first year of the experiment. Of these, 5 grasses and 23 dicots were sown species. The grass weed Sterile Brome (*Anisantha sterilis*) was the most abundant species, followed by the sown grass Red fescue (*Festuca rubra*) and the sown dicot Fodder radish (*Raphanus sativus*). There were highly significant differences in the total number of plant species recorded between the four habitat types (ANOVA $F_{3,18}$ =78.28; P<0.001; Fig. 2a). Species richness was significantly higher in the wildflower treatment (mean 16.9 species m^{-2}) compared with all others, followed by the wild bird seed mix (10.8 m^{-2}), natural regeneration (6.8 m^{-2}) and the cereal crop (2.0 m^{-2}). Similarly, the number of grasses ($F_{3,18}$=26.24; P<0.001), dicots ($F_{3,18}$ =81.14; P<0.001) and perennials ($F_{3,18}$=165.47; P<0.001) were all significantly higher in the wildflower treatment compared with all other treatments. The number of annual species was significantly higher in the wild bird seed mix compared with the other treatments ($F_{3,18}$=35.15; P<0.001). Location of habitat also had a significant effect on total number of plant species, with richness higher in the corners compared with the margins ($F_{1,3}$=10.48; P<0.05; Fig. 2b). However, there was no significant effect of location on richness of grasses, dicots, annuals or perennials.

Flowers of the sown dicots Yarrow (*Achillea millefolium*) and Fodder radish (*Raphanus sativus*) were the most abundant on the experimental plots, followed by those of the unsown species Scentless mayweed (*Tripleurospermum inodorum*). The abundance of all dicot flowers summed between July and September was significantly higher in the wildflower and wild bird seed mix treatments compared with the crop and natural regeneration ($F_{3,18}$=16.33; P<0.001; Fig. 3a). Location had no significant effect on the abundance of dicot flowers ($F_{1,3}$=0.00; P>0.05), (Fig. 3b).

Bombus terrestris / B. lucorum and *B lapidarius* were the most common species of bumblebee recorded. Also, the rare (UKBAP) Large Garden Bumblebee (*Bombus ruderatus*) was recorded in the wild bird seed mix. The total abundance of bumblebees recorded between July and September was significantly higher in the natural regeneration treatment (mean 55.1 per plot) compared with the crop (0.0) and wildflower (7.1) ($F_{3,18}$=4.92; P<0.05). Location of habitat had no significant effect on the abundance of bumblebees ($F_{1,3}$=0.11; P>0.05) (Fig. 3b).

Small White and Meadow Brown butterflies were the most abundant species recorded in the first year. The declining butterfly species Small Copper and Common Blue were also recorded exclusively in the wildflower treatment. The abundance of butterflies was significantly higher in the wild bird seed mix (mean 24.7 per plot) compared with the crop (1.0) ($F_{3,18}$=4.90; P<0.05). Location had no significant effect on the abundance of butterflies ($F_{1,3}$=0.25; P>0.05) (Fig. 3b).

Linnets and Greenfinches were the most abundant bird species recorded in the winter of 2006/7. The total abundance of birds recorded between December and March was significantly higher on the wild bird seed mix (mean 54.7 per plot) compared with all other treatments (means 0.1 to 1.0 per plot) ($F_{3,18}$=6.92; P<0.01). Location had no significant effect on the abundance of birds ($F_{1,3}$=0.03; P>0.05) (Fig. 3b).

The species richness of dicot flowers was significantly higher in the wildflower treatment compared with all others (mean = 29.4 species), followed by the wild bird seed mix (17.5 species), natural regeneration (12.0 species) and the crop (0.7 species) ($F_{3,18}$=235.62; P<0.001) (Fig. 4a). Richness of dicot flowers was not significantly higher in the corners compared with the field margins ($F_{1,3}$=9.20; P=0.056) (Fig. 4b).

Species richness of bumblebees was significantly higher in the natural regeneration treatment (4.6 species) followed by the wild bird seed mix (3.7 species), wildflower (2.2 species), and lowest in the crop (0.0) ($F_{3,18}$=32.67; P<0.001) (Fig. 4a). Location had no significant effect on the species richness of bumblebees ($F_{1,3}$=0.42; P>0.05) (Fig. 4b).

Species richness of butterflies was significantly higher in the non-crop treatments (means 6.2 to 4.5 species) compared with the crop (mean 0.9 species) ($F_{3,18}$=9.92; P<0.001) (Fig. 4a). Location had no significant effect on the species richness of butterflies ($F_{1,3}$=0.13; P>0.05) (Fig. 4b).

Finally, species richness of birds was significantly higher in the wild bird seed mix plots (mean 3.9 species) compared with all other treatments (means 0.1 to 0.7 species) ($F_{3,18}$=18.70; P<0.001) (Fig. 4a). However, location had no significant effect on the species richness of birds ($F_{1,3}$=0.48; P>0.05) (Fig. 4b).

Fig. 2. Effects of a) habitat type and b) habitat location on the species richness of plants

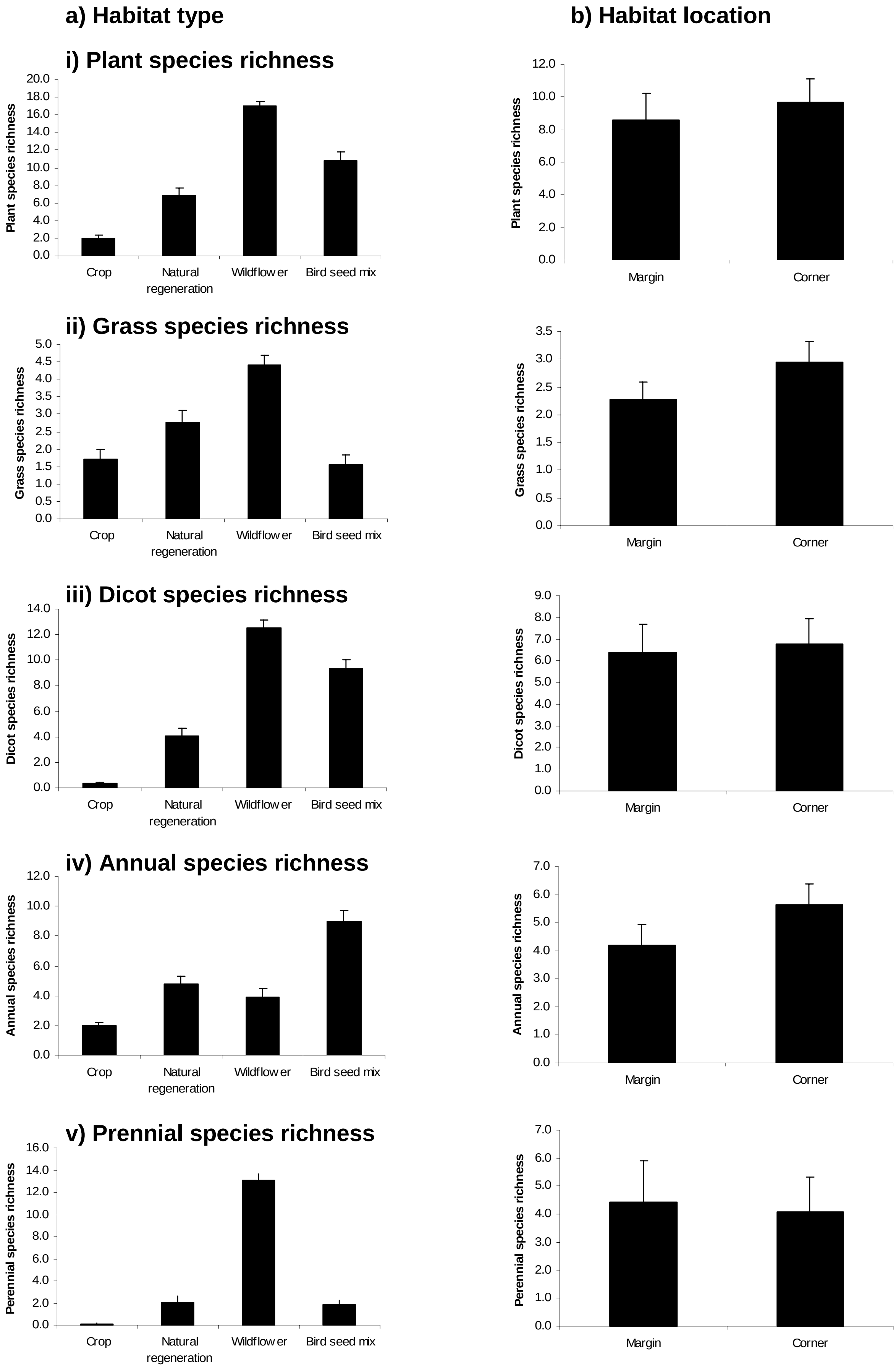
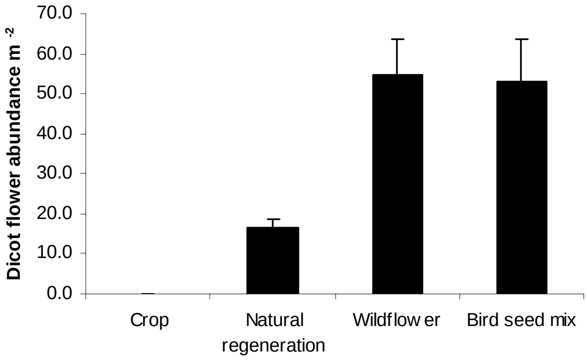


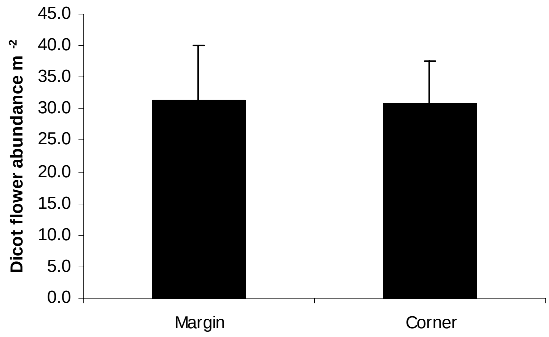
Fig. 3. Effects of a) habitat type and b) habitat location on abundance of flowers, bees, butterflies and birds

a) Habitat type

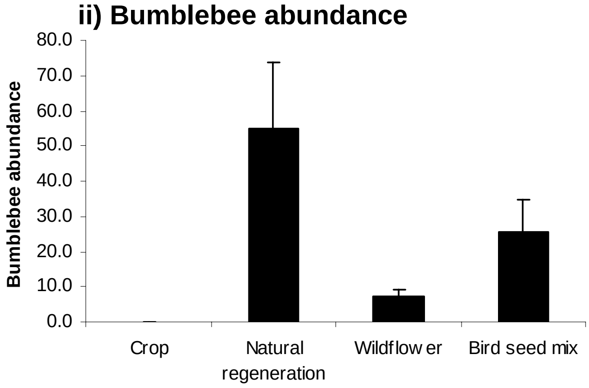
b) Habitat location

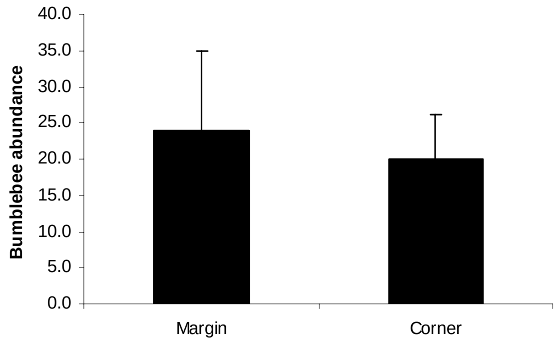
i) Dicot flower abundance



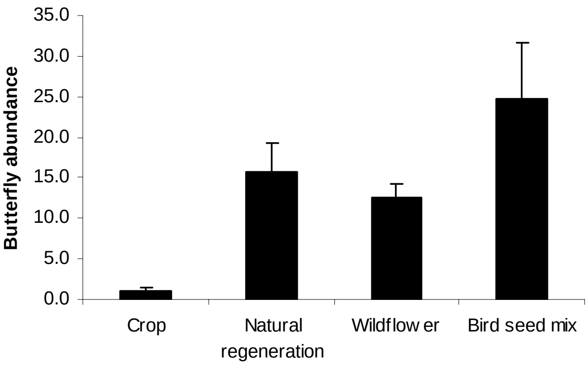


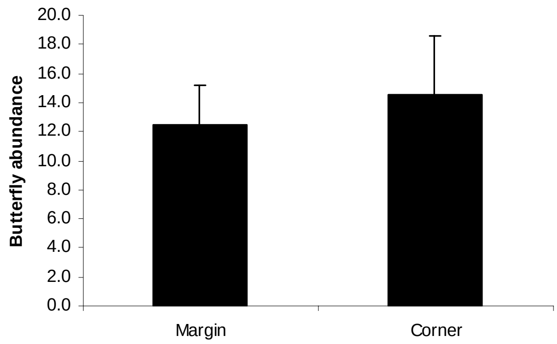
ii) Bumblebee abundance



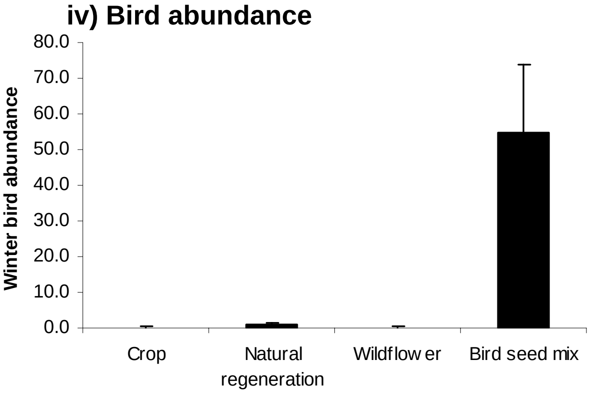


iii) Butterfly abundance





iv) Bird abundance



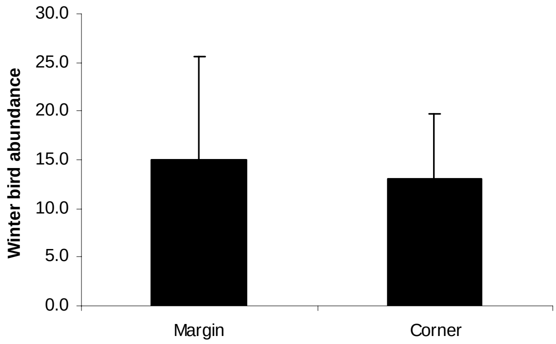
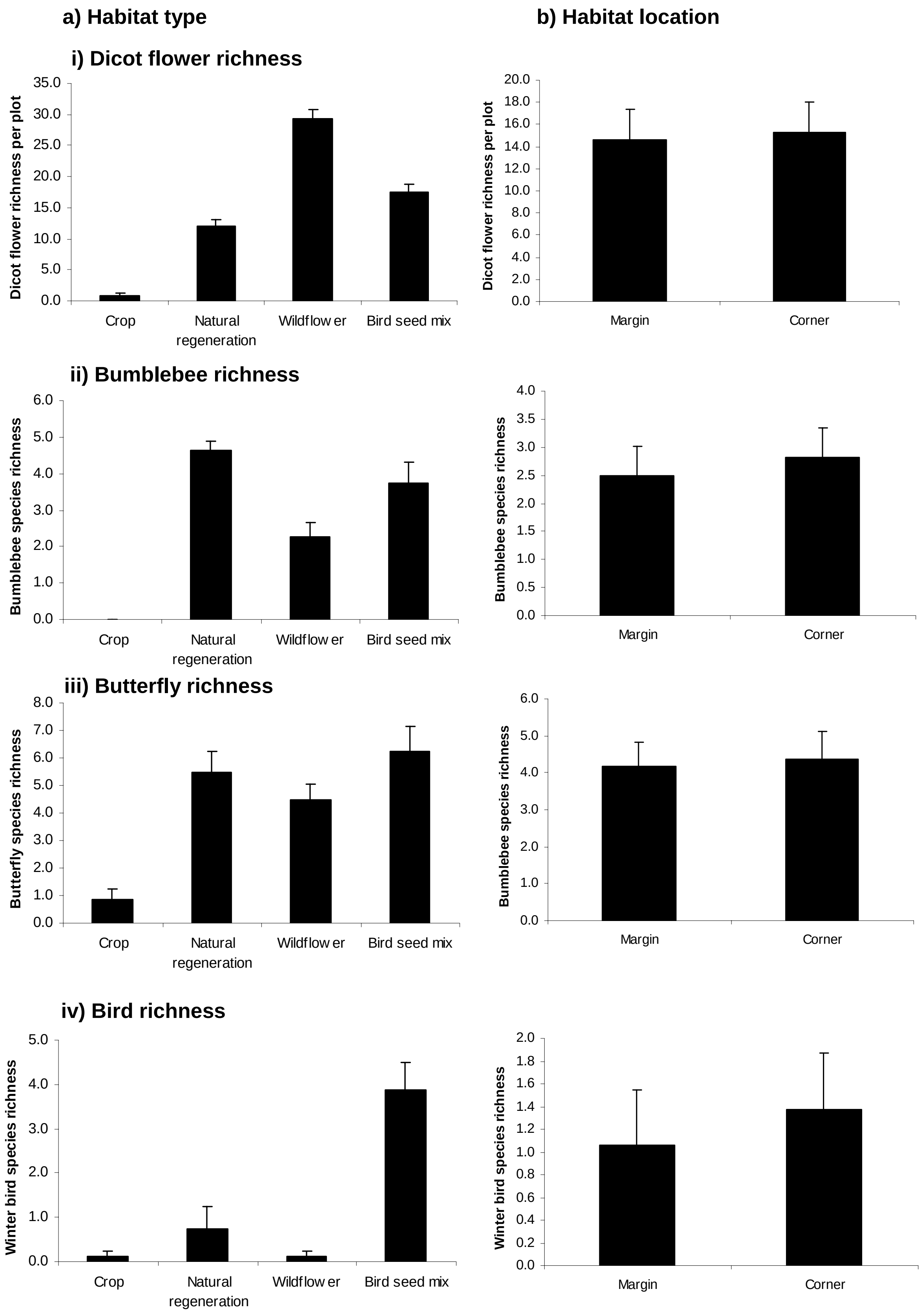


Fig. 4. Effects of a) habitat type and b) habitat location on species richness of flowers, bees, butterflies and birds



4. Discussion

4.1 *Effect of habitat type on biodiversity*

Habitat type had the primary effect on biodiversity enhancement in year 1. The effects of each habitat type on different groups are summarised in Table 3. Intensive cereal crop management was highly detrimental to the abundance and diversity of plants, insects and bird. The popular and cheap ELS option of allowing natural regeneration of vegetation from the crop stubble produced vegetation dominated by competitive and undesirable weed species, such as Sterile brome, (*Anisantha sterilis*), Spear thistle (*Cirsium vulgare*) and Musk thistle *Carduus nutans*. This confirms that wildlife habitat creation on farmland is severely limited by lack of seeds of desirable species in the seed bank and the surrounding landscape. This vegetation will require considerable management input in future years to control the spread of these species. This study demonstrates the most effective non-crop management prescriptions were those specifically targeted to the requirements of declining taxa. Sowing a mixture of perennial wildflowers and fine-leaved grasses, together with management by selective herbicide application and cutting, proved to be a reliable and rapid means of creating a diverse and weed-free vegetation community. This vegetation provided the most abundant and diverse resource of flowers despite the frequent cutting and removal of vegetation. This diversity of nectar sources and larval host plants made this treatment the most attractive to butterfly species. Frequent cutting of the wildflower treatment would have prevented or reduced the flowering of preferred bee forage plants, such as Red clover (*Trifolium pratense*) and knapweed (*Centaurea nigra*). In the absence of flowers of these species, many long-tongued bee species will forage on thistle species which were abundant in the natural regeneration treatment. Finally, sowing the annual mix of seed-bearing crops, together with appropriate management, proved to be a highly effective means of providing food resources for farmland birds during the winter months. Some of these species, such as Fodder radish (*Raphanus sativus*), were also popular forage plants for short-tongued bumblebees.

Table 3. Rank value of each habitat for the different taxa studied

Taxa	Measure	Crop	Natural Regeneration	Wild bird seed mix	Wildflower seed mix
Plants	Richness	4	3	2	1
Dicot flowers	Abundance	4	3	2	1
	Richness	4	3	2	1
Bumblebees	Abundance	4	1	2	3
	Richness	4	1	2	3
Butterflies	Abundance	4	2	3	1
	Richness	4	2	3	1
Bird	Abundance	3=	2	1	3=
	Richness	3=	2	1	3=

4.2 *Effect of habitat location on biodiversity*

In the first year habitat location proved to have a secondary effect on biodiversity enhancement. There were no significant effects of location on many of the groups studies. However, field corners did support a higher diversity of plant species compared with field margins. This probably reflects less efficient weed control and fertiliser application in field corners compared with margins. This greater diversity of plants may have significant, beneficial effects on associated insect in future years. In the early years of restoration, habitats are utilised by highly mobile species with few specific habitat requirements. Location may become a more important determent of habitat quality in future years when the plant communities in the wildflower and natural regeneration treatments becomes more stable and perennial, and they are colonised by insect species with more exacting habitat requirements. Finally, the foraging behaviour of farmland birds may be affected more by location of wild bird seed mixture patches in future years if increasing numbers of predator are attracted to the study site.

5. Conclusions

- There were a large number of differences in the value of difference Conservation Grade habitats for wildlife after 1 year.
- Few species were found in the intensively managed cereal crop.
- Allowing vegetation to regenerate naturally resulted in tall, competitive vegetation dominated by undesirable grass weeds and thistles. However, these were attractive to bumblebees.
- The most effective treatments (wildflower and wild bird seed mix) were those specifically targeted to the requirements of declining taxa.
- Sowing an annual mix of seed-bearing crops was a very effective means of providing food resources for farmland birds during the winter.
- Sowing a mixture of perennial wildflowers proved to be a reliable and rapid means of creating a diverse and weed-free vegetation community which was most attractive to butterflies.
- Effects of habitat location are likely to become more important as vegetation communities become established and colonised by species with more exacting habitat requirements.