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Safe guarding pollinator populations in an intensive grassland landscape

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ABSTRACT

There is growing evidence that insect pollinators are declining globally and agricultural intensification has been identified as a major cause of this decline. To determine how pollinators utilise different habitats within an intensive grassland landscape, bumblebees and butterflies were monitored across a range of agricultural and semi-natural habitats using standardised transect walks. Few pollinators were recorded in intensively managed arable and grassland fields indicating that such habitats provided poor foraging resources. Hedgerows also yielded few pollinators reflecting the lack of pollen and nectar bearing plant species within hedgerows in this landscape. The highest density of pollinators, and richest pollinator assemblages, were recorded in open scrub, road verges and riparian buffer strips. This was most likely the result of such habitats supporting a diverse array of flowering plant species which in turn provided foraging opportunities for pollinators. These prime pollinator habitats should be managed to ensure that they maintain rich botanical assemblages and thus to ensure a continuous supply of nectar and pollen throughout the season.

INTRODUCTION

The post war intensification of agricultural practices and the associated loss of habitat diversity have adversely affected biodiversity across a range of taxa (Benton *et al.* 2002). Concern is growing that this loss of biodiversity will result in a degradation of the multitude of ecosystem services that nature provides (Flynn *et al.* 2009). There is mounting evidence that wild pollinators are in decline globally, with the intensification of farming practices and loss and degradation of semi-natural habitats being implicated in this decline (Vanbergen *et al.* 2013). With insect pollinators enhancing yields in approximately 70% of crops, the decline in pollinators poses a genuine threat to global food security (Klein *et al.* 2007). Furthermore, pollinators are also responsible for the pollination of many species of wild plants and thus have a critical role to play in preserving biodiversity. Furthermore within agricultural landscapes wild plants act as an important reservoir for pollinators (Biesmeijer *et al.* 2006). This study aimed to determine which habitat components within an intensive grassland landscape were important for foraging pollinators.

MATERIALS AND METHODS

The Cessnock catchment, Ayrshire, Scotland (N55°32′50″, W4°22′00″) is dominated by productive ryegrass, *Lolium perenne* L., swards encompassing livestock grazing and/or cutting for silage. Land cover was mapped in GIS (Arc10) and 12 habitats that are either dominant in the catchment, or deemed important with respect to integrating biodiversity goals within intensive agricultural systems, were selected for survey. The selected habitats were Arable, Intensive Grassland, Rough Grassland, Open Scrub, Riparian Buffer Strips, Coniferous Woods, Coniferous Wood Edges, Deciduous Woods, Deciduous Wood Edges, Intact Hedges (hedges with no gaps over 2 m), Sparse Hedges (hedges with gaps over 4 m) and Road Verges. A total of 5 sites were surveyed for each of the 12 habitats thus yielding a total of 60 sampling sites. However, cattle gained access to one riparian buffer strip and this site was subsequently omitted from all analyses. Mosaic-level sampling with sampling points in multiple types of patches was therefore conducted (Bennett *et al.* 2006). Pollinators were monitored June-August (a total of four sampling periods) by standardised transect walks under conditions described as suitable by the Butterfly Monitoring Scheme Standards. Transects were 100 m long by 4 m wide with the exception of road verges where due to width limitations transects were 200 m long by 2 m wide. All butterflies, bumblebees and plants in flower that occurred in transects were identified to species level and quantified. Prior to analyses, all pollinators recorded at any one site were pooled over the four sampling periods and the resulting data log transformed to normalise. To investigate the impact of habitat on pollinator assemblages, analyses of variance were conducted on the following response variables: Number of Bumblebee Species, Abundance of Bumblebees, Number of Butterfly Species and Abundance of Butterflies.

RESULTS AND DISCUSSION

Highly significant effects of habitat were found for all measures of pollinator abundance and species richness (Fig. 1 and Table 1). Transects conducted in intensively managed agricultural habitats (i.e. intensive grassland and arable land) indicated low utilisation of these habitats by pollinators. Few flower species were found in these habitats and it is likely that the lack of pollinators was a result of a lack of floral resources.

Table 1. Impact of habitat on butterfly and bumblebee species richness and abundance.

Response Variable	F-Value P-Value df $_{(11, 47)}$	Location of difference
Butterfly species richness	F=3.57 P<0.001	Open Scrub> Intensive Grassland, Deciduous Woodland, Arable
Butterfly Abundance	F=3.92 P<0.001	Riparian Buffer Strip>Arable and Intensive Grassland
Bumblebee species richness	F=7.33 P<0.001	Open Scrub>Intensive Grassland, Coniferous & Deciduous Woodland, Coniferous Wood Edge, Arable Road Verge >Coniferous Wood Edge, Arable Riparian Buffer Strip>Arable
Bumblebee abundance	F=4.84 P<0.001	Road Verge>Deciduous & Coniferous Wood/Wood Edge, Arable, Rough & Intensive Grassland, Sparse & Intact Hedges Scrub> Deciduous & Coniferous Wood, Coniferous Wood Edge, Arable, Intensive Grassland, Sparse & Intact Hedges Riparian Buffer Strip> Coniferous Wood Edge, Arable, Intensive Grassland, Sparse Hedge

Few pollinators were recorded in hedges (both sparse hedges and intact hedges). Again these habitats within the study landscape had little floristic diversity. This indicates the importance of including plant species which bear nectar and pollen such as honeysuckle (*Lonicera periclymenum*), blackthorn (*Prunus spinosa*) and dog rose (*Rosa canina*) during any future hedgerow planting and regeneration (Jacobs *et al.* 2009).

Coniferous woodlands, deciduous woodlands, coniferous wood edges and to a lesser extent deciduous wood edges were also found to contain few pollinators and pollinator species. The pollinators considered in this survey (i.e. butterflies and bumblebees) are predominately sun loving and thus may have been deterred by the shaded conditions typically found in woodlands. Our survey methodology did not, however, effectively sample pollinators in the tree canopy. Trees such as sycamore (*Acer pseudoplatanus*), lime (*Tilia x europaea*) and bird cherry (*Prunus padus*) can provide important nectar sources and an assessment of the tree species within each woodland transect may assist in determining the likelihood that pollinators were active in the canopy.

Few bumblebees were recorded in rough grassland and the number of bumblebees recorded in rough grassland did not significantly differ from numbers recorded in intensively managed grasslands. The number of butterflies, and butterfly species, recorded in rough grassland, on the other hand, tended to be greater than that of intensive grassland (although this difference was not statistically significant). Rough grasslands support a greater diversity of grass species which in turn provides food for butterflies whose caterpillars feed on grass species such as the small heath (*Coenonympha pamphilus*) and meadow brown (*Maniola jurtina*). Grassland butterfly populations are particularly sensitive to agricultural intensification and many species have declined significantly over the past 20 years (European Environment Agency 2013).

Open scrub, road verges and riparian buffer strips were the most important habitats for both bumble-

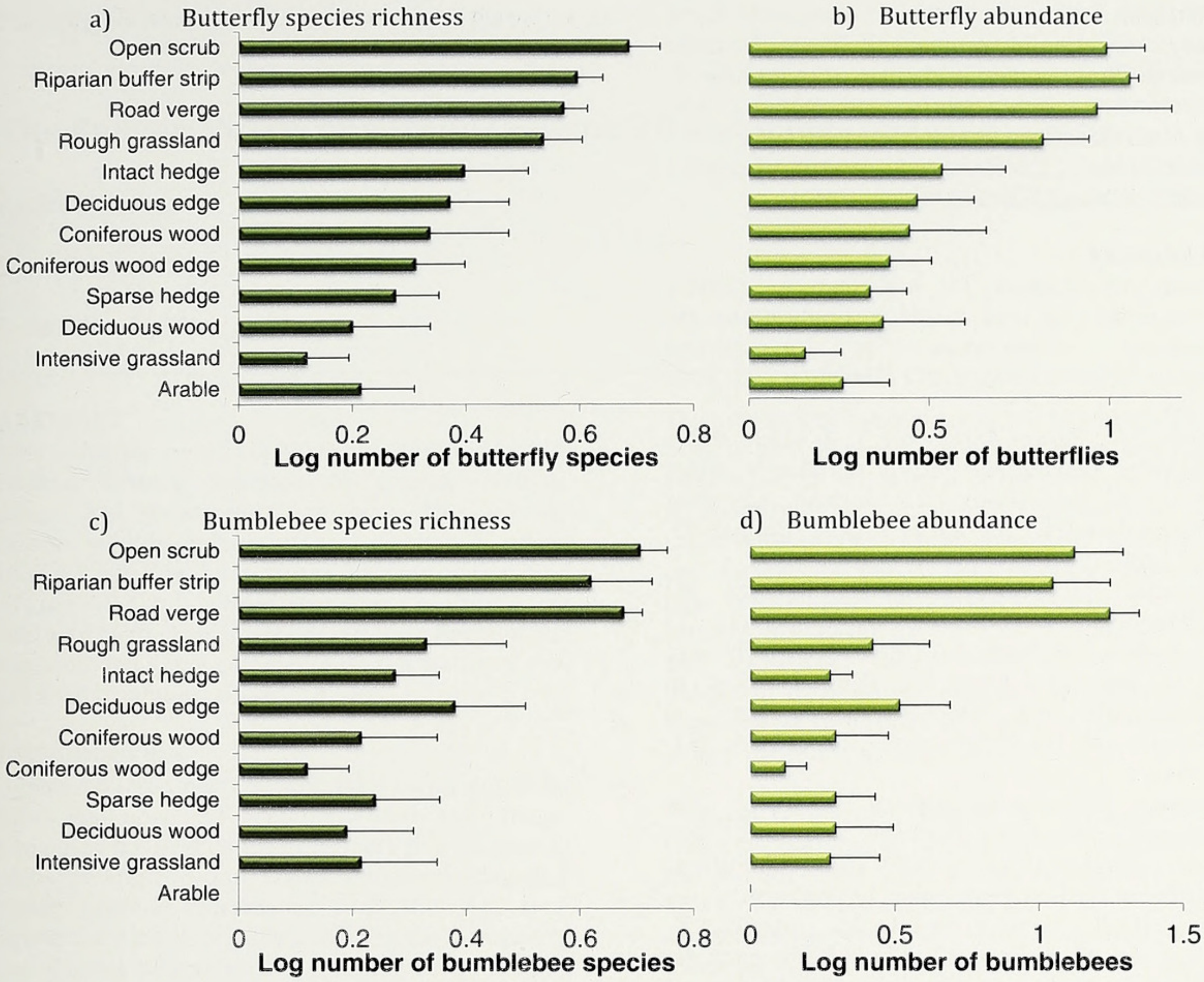

Fig.1. Impact of habitat on butterfly and bumblebee species richness and abundance indicating means (+standard error).

bees and butterflies supporting both taxonomically diverse assemblages and high densities of pollinators. These habitats had a high diversity of plant species which provided a continuous supply of nectar and pollen throughout the season. Such habitats are clearly important in providing foraging resources within intensive agricultural landscapes and this brings into question how these habitats should best be managed to obtain multiple benefits. For example, in the catchment area road verges were cut simultaneously in mid August when pollinators were still actively foraging and before flower seed formation. Delaying verge cutting till late September would not only prolong the availability of flowers for foraging pollinators but also allow flowers to set seed, thereby helping to maintain long term floristic diversity (Hambrey Consulting 2013).

Further analyses will be conducted to determine if habitat effects were solely due to differences in plant diversity. Observational evidence indicates that this may be partly, if not solely, the case. Pollinator presence was strongly linked to specific plant species and numbers of pollinators within a specific site fluctuated depending on what plant species were in flower at the time of sampling. In general, raspberry (*Rubus idaeus*) and Russian comfrey (*Symphytum × uplandicum*) were important plant species in June, thistles (*Cirsium avense, Cirsium vulgare and Cirsium palustre*), woundworts (*Stachys sylvatica* and *Stachys palustris*) were important in July and knapweed (*Centaurea nigra*) and marsh woundwort (*Stachys palustris*) were important in August. Maintaining and enhancing plant diversity will increase the likelihood of providing a constant source of nectar and pollen throughout the pollinator season and thus of safeguarding pollinator populations in intensive agricultural landscapes.

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