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Buffer strip management to deliver plant and invertebrate resources for farmland birds in agricultural landscapes

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ABSTRACT

To address the decline in farmland birds across agricultural landscapes a key approach under agri-environment schemes has been the widespread creation of perennial grass-only buffer strips along field boundaries. However, despite a high dependency on these strips to enhance biodiversity in agricultural landscapes, it appears that benefits for farmland birds during the breeding season have been limited. We investigated the provision of plant and invertebrate resources for farmland birds in buffer strips that were established with three different seed mixes, including the standard grass-only habitat. We hypothesised that resource provision would differ between seed mix types due to differences in original composition. We also investigated three different types of management aimed at influencing sward composition and habitat structure, namely cutting, scarification and the application of graminicide. These approaches were used to influence the accessibility of structurally complex swards to farmland birds. We hypothesised that the abundance of plant and invertebrate resources and access to these resources would be directly related to management type. The abundance of plant resources and sward structure were determined using quadrats and the drop disc method respectively, whilst the invertebrates were assessed using suction sampling. The study demonstrated the value of including forbs (herbaceous plant species) in seed mixes used to establish buffer strips by increasing plant resources for farmland birds, although this was not coupled with an increase in beetle abundance and mass. However, grass-only buffer strips managed with annual cutting were shown to provide similar levels of invertebrate resources to farmland birds as with the more complex seed mixes, but it is likely that access to these resources was restricted by tall homogenous swards and a limited amount of bare ground. The study demonstrated that novel buffer strip management techniques can strongly influence both the resource abundance and resource access by farmland birds. Scarification in particular was shown to be highly effective at opening up the sward to increase access by farmland birds, but was associated with a reduction in plant resources. Given the financial barriers for the use of seed mixes that contain forbs to establish buffer strips, importantly the study has shown that the value of existing grass-only buffer strips for farmland birds can be enhanced through the use of scarification. Consequently, as an alternative to annual cutting, we recommend that scarification is periodically applied to narrow (1–3 m) strips next to the crop edge to enhance the value of grass-only buffer strips for farmland birds.

1. Introduction

Throughout Europe substantial declines in farmland birds have occurred since the 1970's (Fuller et al., 1995; Donald et al., 2001) due to agricultural intensification. In the UK, this led to an extensive research programme to investigate the ecological requirements of priority bird species (Peach et al., 2001; Peach et al., 2004; Butler et al., 2010 Peach et al., 2004; Butler et al., 2010), and culminated with the development of a farmland bird package (Winspear et al., 2010). This package advocates the creation of new habitat and the appropriate management of cropped areas to provide essential resources for birds, including seed and invertebrate prey. Through the delivery of UK agri-environment schemes several red listed bird species have benefitted from the adoption of these approaches, primarily due to an increase in winter food resources (Baker et al., 2012). However, options aimed at providing

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resources during the breeding season have had either mixed or very limited benefits (Baker et al., 2012). A key approach has been the widespread creation of perennial grass-only buffer strips along field boundaries (Critchley et al., 2006; Vickery et al., 2009), which can support a range of other taxa including invertebrates (Field et al., 2005; Woodcock et al., 2005; Merckx et al., 2009), reptiles (Biaggini and Corti, 2015), and small mammals (Aschwanden et al., 2007; Broughton et al., 2014). However, these buffer strips have had limited benefits for farmland birds during the breeding season (Baker et al., 2012). In fact, the presence of buffer strips in arable fields have been linked with negative population growth rates of corn bunting (*Emberiza calandra*), goldfinch (*Carduelis carduelis*) and yellow wagtail (*Motacilla flava*) (Baker et al., 2012). This is despite corn bunting preferring to establish territories in arable fields containing buffer strips (Burgess et al., 2015) and goldfinches regularly foraging in buffer strip vegetation (Vickery and Fuller, 1998).

In England there is an estimated 30,000 ha of perennial grass buffer strip habitat that has been established either by sowing grass-only seed mixtures, or by a process of natural regeneration (Harold Makant, Natural England, *personal communication*, 2016). These simple and basic approaches have been driven by the lack of farmer incentives to sow floristically-rich seed mixes and the lower cost of grass-only seed mixes. The association between plant diversity and the abundance and diversity of higher trophic levels is well documented (Woodcock and Pywell, 2010), and whilst grass-only buffer strips will provide additional resources for birds (Vickery et al., 2009), their widespread adoption across agricultural landscapes is unlikely to have resulted in large gains in invertebrate resources that support bird populations. To address the issue of current measures not delivering benefits for farmland birds during the breeding season (Baker et al., 2012) there is clearly a need to investigate how grass-only buffer strips can be managed to enhance benefits for farmland birds. Furthermore, if floristically-rich buffers strips are to be advocated, there is also a need to investigate how this type of habitat can be managed to maximise benefits for farmland birds.

In addition to the availability of resources within newly created habitats, a further factor limiting use by many farmland birds is the extent to which the physical structure of the sward makes those resources accessible (Vickery et al., 2001; Atkinson et al., 2005). A number of studies have investigated the management of grass leys and pastures to increase access for farmland birds (Vickery et al., 2001; Vickery et al., 2004; Atkinson et al., 2005; Whittingham and Devereux, 2008), but in contrast, there has been very limited research on the management of grass buffer strips to increase resource provision and access. In an effort to enhance the value of grass-only buffer strips for yellowhammers (*Emberiza citrinella*), Douglas et al. (2009) investigated the influence of cutting to create and maintain short, open patches of vegetation throughout the breeding season. It was found that foraging by yellowhammers increased significantly between early and late summer due to greater access to invertebrates, especially beetles. Beetles (Coleoptera) are highly important in the diets of farmland birds during the breeding season (Wilson et al., 1999) and as a consequence, the management of buffer strips to increase the abundance and accessibility of this resource is likely to be of benefit.

We investigated the provision of plant and invertebrate resources for farmland birds in buffer strips established with three different seed mixes, including the standard grass-only seed mix that represents the lowest cost option typically used by farmers. We hypothesised that resource provision would differ between seed mix type due to differences in original composition. As access to resources, rather than food abundance *per se* could be the critical factor in determining habitat use by farmland birds (Atkinson et al., 2005), we also investigated three different types of management aimed at influencing sward composition and therefore habitat structure. We hypothesised that the abundance of plant and invertebrate resources and access to these resources would be directly related to management type.

2. Methods

2.1. Experimental design

At three UK sites, non-cropped perennial arable buffer strips were established on clay (ADAS Boxworth, 52°15'10"N, 0°1′54″W.), sand (ADAS Gleadthorpe, 53°13'28"N, 1°06'45"W) and chalk soils (ADAS High Mowthorpe, 55°08'55"N, 0°49'39"W). At each site, five replicate blocks consisting of nine experimental plots measuring 25 m × 5 m were established along hedgerow field boundaries, with three different seed mixtures. Individual plots were separated by 5 m buffers. In each of the five blocks, three randomly selected plots were sown with a grass-only (GO) seed mixture, three with a tussock grass and forb (herbaceous plant species) mixture (TG), and three with a fine grass and forb mixture (FG) (see Appendix for species lists). The sowing rates for the mixes were 20.0, 35.1 and 36.2 kg ha^{-1}, respectively and plots were sown once only. The different forb-based seed mixes (TG and FG) contained species including *Centaurea nigra* and *Silene dioica* that are important in the diets of a range of farmland birds (Holland et al., 2006). The seed mixes were selected to provide a contrast in plant community composition and vegetation structure, and are frequently used for habitat creation. Boxworth and High Mowthorpe were both sown in autumn 2001, whilst due to inundation, Gleadthorpe was sown in spring 2002. During the establishment year (2002) all plots were cut in late summer with a tractor-mounted flail cutter to a height of approximately 15 cm and cuttings were left *in situ*.

From 2003, the management treatments of cutting, sward scarification and selective graminicide were applied annually in March/April for a period of four years to each of the three seed mixtures. This created a randomised three by three factorial design within each replicate block. The treatments were selected to directly benefit farmland birds by influencing the composition and sward structure of the different plant communities, and therefore access to resources. Treatments were applied in spring rather than late summer to increase the impact of treatments during the breeding season. Cutting is the standard technique for managing perennial buffer strips, and swards were cut to a height of 15 cm using a flail cutter and cuttings were left *in situ*. This approach was compared to the novel treatments of sward scarification and the application of graminicide as these have greater potential to increase plant species diversity (Westbury and Dunnett, 2008) and enhance access to resources. Scarification was applied using a power harrow to create approximately 60% soil disturbance by cultivating the top 2.5 cm. For the graminicide treatment the chemical fluazifop-P-butyl (Fusilade Max™, Syngenta Crop Protection Ltd) was applied using a tractor-mounted sprayer at half the label rate (0.8 L of product ha^{-1}), in a volume rate of 200 L ha^{-1}. This is equivalent to 100 g active ingredient ha^{-1}. The reduced application rate was to suppress, rather than eliminate susceptible grass species (Westbury and Dunnett, 2008). To improve the efficacy of the sward scarification and graminicide treatments, plots were cut to a height of approximately 30 cm with a flail cutter 2–3 weeks prior to application. Management of the cropped area adjacent to the buffer strips was based on a four-year crop rotation, which commenced with three years of winter wheat, followed by either potatoes, winter oil seed rape, or field beans.