Gamebird feeding hoppers provide winter food for non-target wildlife species including declining songbirds on small farms in the East Midlands, England

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SUMMARY

Since the mid-1970's agricultural intensification and changes in land management practices have been linked with declines in biodiversity amongst key faunal groups, including farmland songbirds. With 7.3 million hectares of land currently managed by gamekeepers in the United Kingdom, there remains an exigent requirement to understand the indirect effects of game management practices on the conservation of non-target species. From January to May 2012, gamebird feeding hoppers were monitored at two small sized mixed farms participating in Environmental Stewardship in the East Midlands using passive 'camera traps'. A total of 3428 video sequences were captured from January to May 2012, cumulatively demonstrating that hoppers were used by a total of 27 different species. Surprisingly pheasants and red-legged partridge made up only 12.2 % of total visitations to hoppers; 28.0 % were from songbirds including five Biodiversity Action Plan (BAP) designated species and 38.2 % were game pest species. The most abundant species recorded overall was *Emberiza citrinella* – the yellowhammer, with 654 observations. The location of the hoppers in either hedgerow or woodland habitats did not influence species diversity or number, but nocturnal species number and diversity was significantly higher during the day than at night across the survey period. The type of hopper spout also affected frequency of use, with a significant preference for the 'tray' feeding head. The findings show that feeding hoppers are well used during the winter period by a range of songbird species and so supplementary feeding may positively affect their survivorship at a time when natural food resources are scarce.

BACKGROUND

Comprising of approximately 18.3 million worked hectares (ha) or three-quarters of all available land, the farmed environment dominates the British landscape. In the East Midlands region, arable cropping and permanent pasture proliferates the gently sloping valleys forming a quintessentially English patchwork landscape. It is long recognised that that farming practices have contrived to become progressively more intensive in the post-war period to meet growing food security issues, and the quadruple increase in yields is juxtaposed with a significant reported declines in farmland biodiversity (Robinson & Sutherland 2002). Accordingly, there has been much debate pertaining to the conservation status of a wide range of wildlife species on farmland (Donald 1998, Krebs *et al.* 1999).

The fate of many farmland bird species has been well documented in England since the mid-1970's, with axiomatic declines in species abundance and range constrictions (Field *et al.* 2011, Fuller *et al.* 1995). Changes have been attributed to agricultural intensification and land use responding to dynamic and shifting rural economic, social and environmental drivers. More specifically, the decline in farmland birds is linked to the reduction in winter food sources as a result of these changing farming practices (Robinson & Sutherland 2002). Indeed, of the 19 bird species that constitute the UK Farmland Bird Indicator index, ten are now regarded as being of the highest conservation concern ('red listed'). Furthermore, nine of

these ten are considered farmland specialists, and when combined have experienced a profound 48 % decline in the last 40 years (Eaton *et al.* 2009). Siriwardena *et al.* (2008) determined that agri-environment prescriptions do not provide enough food in late winter for birds such as the yellowhammer (*Emberiza citrinella*), reed bunting (*E. schoeniclus*), chaffinch (*Fringilla coelebs*) and dunnock (*Prunella modularis*). Yet evidently the key to halting declines lies with appropriate custodianship of the land through an integrated and sustainable farm management approach.

Current rural development policies aim to encourage land-owners to embrace a holistic, multi-disciplinarian approach to managing their land, and shooting and game bird management is often core to this. The role of the wider rural landscape in maintaining targets for biodiversity forms a focus for farmers who can voluntarily select options to create or restore non-cropped land through tenure of the Government's Environmental Stewardship (ES) grant schemes. Targeting of appropriate options may perhaps work towards a panacea of a 'coherent and resilient ecological network' alluded to by Lawton (2010), as the total conservation interest of farmland may well exceed that of designated nature reserves (Krebs et al. 1999).

It is estimated that game shooting in Britain involves 94000 landowners and tenants serving 704500 'participants', with the industry contributing £1.6 billion annually to the UK economy (CRC 1997, NGO 2010). Accordingly, the rearing and subsequent releasing of gamebirds on farmland for game shooting is a widespread practice in the British countryside, with providers ranging from large commercially focussed shooting estates to small scale 'family shoots' on farms. The pheasant (*Phasianus colchicus*) is the most abundant and widespread gamebird in the lowlands of England, is originally native to Asia and is well suited to small farm shoots as it is to prestigious country estates (Tapper 2005). As juvenile birds, pheasants are released from woodland release pens in mid-summer and gradually disperse spatially, utilising territories along woodland edges in winter before spreading out onto cropped land during spring and summer. Supplementary feeding of pheasants is understood to produce higher winter abundance, better winter condition and ultimately influence survival (Stoate 2002). Thusly, to create optimal conditions for the birds to survive and proliferate to the suggested maximum sustainable yield prior to organised shoot days during the open season (October to February), supplementary feeding with wheat occurs through an imbrication of feeding stations / hoppers.

In addition, key to the success of game shoots is the stringent control of pests and predators through lawful trapping devices including cage traps for corvids and rifle shooting through spot lamping at night to control foxes. Conventional predator control is generally recognised as increasing spring and autumn stocks of wild gamebirds (Tapper 2005). As many species of farmland birds nest on or close to the ground, they are vulnerable to a range of predators (Draycott *et al.* 2008) with populations of predators including carrion crows and foxes growing noticeably in the UK over recent decades (Gregory & Marchant 1996). A drop in the number of active gamekeepers now instigating control is no doubt responsible for these trends, and the additional influence of supplementary winter feeding from hoppers is not known.

In their far reaching review of key ecological questions influencing policy, Sutherland *et al.* (2006) postulate that understanding the effects that gamebirds and field sports have on biodiversity remains an important area of study. Yet despite the prevalence of game hunting, the costs and benefits to other wildlife sharing the same habitats are poorly understood (Draycott *et al.* 2008). Whilst there is some anecdotal evidence to suggest that pheasant feeders provide a winter food source for other birds and wildlife (cf. Vickery *et al.* 2004, Tapper 2005), there is no concrete published scientific evidence to support this. The siting and type of hopper may also be critical. This study therefore aims to establish how important game feeders are to gamebirds and granivorous songbirds in late winter and early spring during 'the hungry gap' when food is hardest to come by.

ACTION

Study Sites: Two typical small lowland mixed farms were selected that ran small-scale shoots. The first of these was the 64 ha Rectory Farm near Water Stratford, Buckinghamshire (grid reference: SP655372) and the second the 104 ha East Haddon Hill Farm near Great Brington, Northamptonshire (grid reference: SP662674). The former land holding has an outgoing Countryside Stewardship agreement and the latter is in tenure of a Higher Level Stewardship (HLS) agreement. Both farms operate a basic level of predator control, and in the case of East Haddon Hill Farm shoot days are regarded as an integrated part of their business and more effort is placed on predator control.

Camera traps: Triggered by infra-red sensors, camera traps are usually fixed in one location to effectively 'trap' any images or film of passing animals. With a one year battery life, being non-intrusive and possessing a minimum associated environmental disturbance the use of camera traps as an ecological sampling is now mainstream in conservation (Rowcliffe et al. 2008). The field method is typically used to investigate population dynamics, can aid in the discovery of new species, will provide simple species inventories, can be applied to conservation assessments and to forest ecology (Rowcliffe & Carbone 2008). Indeed, Kilshaw & MacDonald (2011) advocate camera trapping as a robust ecological monitoring tool for the highly elusive *Felis silvestris grampia* (Scottish wildcat).

Bushnell 'Trophy Cam' motion sensitive cameras were used to monitor feeding hoppers and these were placed up to two metres away, typically mounted at an elevated stance overlooking the hopper (*Figure 1*). If triggered by activity cameras were programmed to record short 10 second clips and after activation they were set to not reactivate again for four minutes.

Figure 1: Typical barrel feed hopper pictured in close proximity to highlighted camera trap at Rectory Farm, Buckinghamshire (Grid Reference: SP655341).

The supposition was that the number of photographs taken per unit time expressed as a trapping rate will reflect the density of a particular species (Rowcliffe *et al.* 2008). Both daytime and nocturnal activity was recorded. Pairs of feeding hoppers were monitored at Rectory Farm continuously for 72 hour periods each month from January to April and on two occasions in May 2012. The hoppers monitored at Rectory Farm were fitted with three different feeding dispensers, namely an open feeding head where the seed gathered at the bottom in a tray; a more traditional spiral feeding head; and a window design to allow access to the wheat. Pairs of hoppers were also monitored at East Haddon Hill Farm for 72 hour periods between February and March 2012. The limited survey period at this site was as a result of the gamekeeper on site unable to fill the hoppers with wheat for a longer period. Hoppers were positioned either in mature woodland or hedgerow habitats in both cases.

Analysis: Frequency of visitations were classified into night (21.00 pm to 09.00 am) and day (09.00 am to 21.00 pm) categories for both habitats in each site over the monitoring period. Individual species were identified from the footage and total number of species, number of BAP species and number of pest / predatory species tabulated. For each 12 hour trapping block, a Simpson's (unbiased) Diversity Index was calculated. Frequency of use was also differentiated amongst the spout types, with all data analysed using a range of inferential statistical techniques including chi-square tests and General Linear Models on MINITAB v. 16.

CONSEQUENCES

General trends: A total of 3428 ten second sequences of video were captured over the 384 hour study period, giving a combined trapping incidence rate of 8.93 trips / hour. A total of 4006 observations of 27 different animal species were captured on video over five months, giving a trapping incidence rate of 10.4 animals / hour (*Table 1*).

Species	Common Name	Observations, N	Relative % Frequency	Conservation Status[1]	Group
Emberiza citrinella	Yellow Hammer	654	16.33	Priority Species (UK BAP 2007); Bern Convention annex 2; Red BoCC	Songbird
Apodemus spp	Mice	605	15.10		Other
Corvus frugilegus	Rook	551	13.75	Green BoCC	Pest
Phasianus colchicus	Pheasant	433	10.81		Gamebird
Sciurus carolinensis	Grey Squirrel	356	8.89		Pest
Columba palumbus	Wood Pigeon	263	6.57	Green BoCC	Pest
Columba oenas	Stock Dove	245	6.12	Amber BoCC	Pest
Meles meles	Badger	200	4.99	Badger Act 1992	Other
Prunella modularis	Dunnock	188	4.69	Priority Species (UK BAP 2007); Bern Convention annex 2; Amber BoCC	Songbird
Erithacus rubecula	Robin	127	3.17	Green BoCC; Bern Convention annex 2	Songbird
Perdix perdix	Grey Partridge	52	1.30	Priority Species (UK BAP 2007); Red BoCC	Gamebird
Fringilla coelebs	Chaffinch	43	1.07	Green BoCC	Songbird
Garrulus glandarius	Jay	42	1.05	Green BoCC	Pest
Turdus merula	Blackbird	37	0.92	Green BoCC	Songbird
Corvus corone	Carrion Crow	34	0.85	Green BoCC	Pest
Myodes glareolus	Bank Vole	32	0.80		Other
Muntiacus reevesi	Muntjac	24	0.60		Other
Rattus norvegicus	Brown Rat	23	0.57		Pest
Troglodytes troglodytes	Wren	23	0.57	Bern Convention annex 2; Green BoCC	Songbird
Emberiza schoeniclus	Reed Bunting	17	0.42	Priority Species (UK BAP 2007); Bern Convention annex 2; CRoW Act 2000; Amber BoCC	Songbird
Carduelis cannabina	Linnet	14	0.35	Bern Convention annex 2,CRoW Act 2000,Priority Species (UK BAP 2007), Red BoCC	Songbird

Pica pica	Magpie	13	0.32	Green BoCC	Pest
Parus major	Great Tit	12	0.30	Green BoCC; Bern Convention annex 2	Songbird
Gallinula chloropus	Moorhen	8	0.20	Green BoCC	Songbird
Alectoris rufa	Red-Legged Partridge	4	0.10	No status BoCC	Gamebird
Corvus monedula	Jackdaw	4	0.10	Green BoCC	Pest

[1]: BoCC - Birds of Conservation Concern (Eaton *et al.* 2008): Green (N=1157); Amber (N=450); Red (N=720); UK BAP – Biodiversity Action Plan species.

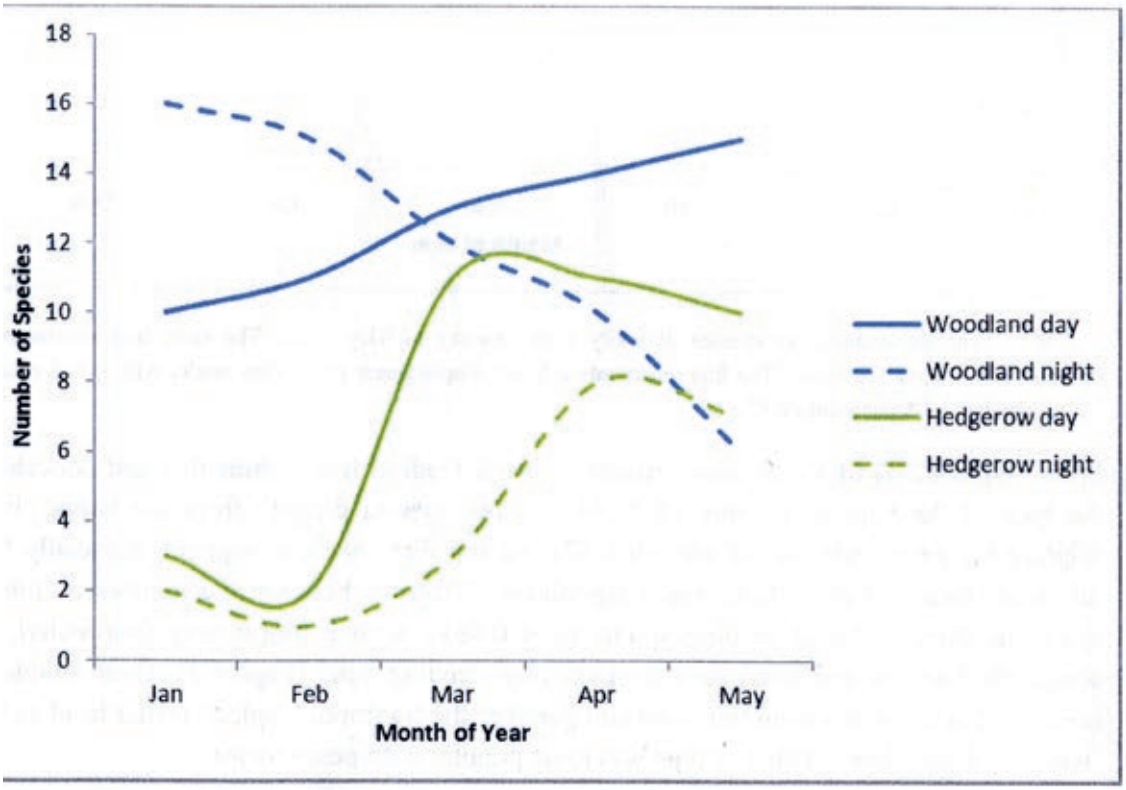
Table 1: Overall number and relative frequency for recorded species visiting feeding hoppers between January and May 2012 at Rectory Farm and East Haddon Hill Farm in the East Midlands.

Observations over the five month monitoring period showed that gamebirds made up 12.21 % (N=863) of observations; songbirds 28.03 % (N=1123); pests 38.22 % (N=1531); others 21.54 % (N=863). Unsurprisingly, differences in frequencies between sites and species groupings were found to be highly significant ($p < 0.001$). A grand total of 58 % of observations consisted of birds classified on the Birds of Conservation Concern (BoCC) register (Eaton *et al.* 2008), with 720 individual observations of 'red listed' songbirds. In fact, yellowhammers accounted for the most records of any species over the monitoring period at one-sixth of all activity, peaking in April and May. *Meles meles* (badgers) were often recorded feeding from the hoppers, and on several occasions were observed physically rocking the hoppers in order to retrieve feed (*Figure 2*).

Figure 2: Video still of a pugnacious *Meles meles* individual recorded at night at Rectory Farm, Water Stratford (Grid Reference: SP659334)

Species number: A General Linear Model (GLM) was used to evaluate trends in the number of species recorded versus the site, time of day, month of the year and habitat. There was no significant difference in the number of species between the sites once the model had accounted for day/night, habitat and month of year ($p = 0.195$). Similarly, there was no

ce the model had accounted for site, day/night and habitat ($p = 0.73$). However, there was a gnificant difference in the number of species between day and night once the model had counted for site, habitat and month of year ($p < 0.001$). Furthermore, significantly more mebirds fed from the hoppers in the day than at night ($p = 0.035$). There were 50% more ecies in the day compared to the night time. The number of species using feeding hoppers night increased as the year went on by virtue of the extra hours of daylight available in arch, April and May. Seasonal variations in species number in response to habitat and time day are depicted in *Figure 3*.



gure 3: Seasonal changes in the mean number of animal species visiting feeding hoppers in hedges and odland during day time and night time periods from January to May 2012.

ıe Rectory Farm site was significantly higher in numbers of BAP species compared to the st Haddon Hill Farm in February and March ($p = 0.007$). The number of BAP species also ffered significantly between months of the year, peaking in April and May ($p = 0.016$).

ecies diversity: Mirroring trends in species number, there were no significant differences species diversity between the two sites or between habitat types. Species richness was gnificantly higher during the day compared to the night ($p = 0.005$), and although mean ecies diversity steadily rose from 0.48 in January to a peak of 0.78 in April, seasonal fferences were not statistically significant (*Figure 4*).

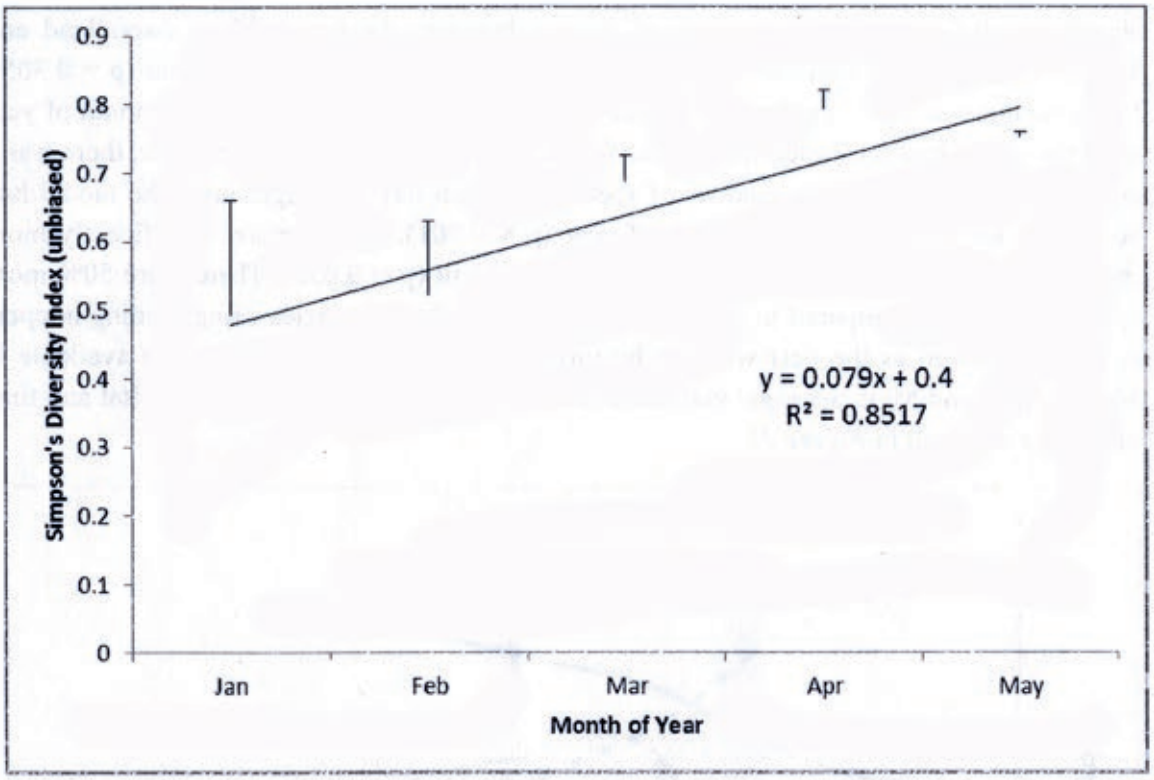


Figure 4: Seasonal changes in species diversity from January to May 2012. The error bars represent one standard error above the mean. The line represents a fitted simple linear regression model with stated equation and coefficient of determination R^2.

Spout type: 82 % of video clips featured animals feeding from wheat that had collected at the base of the hopper, so only 18 % of featured species directly from the hopper itself. Slightly higher proportions of songbirds (21 %) fed directly from hoppers, especially from the 'tray' feeding head. There was a significant difference between the number of animals using the three different feeding spouts ($p < 0.001$), with a propinquity (particularly for songbirds, badgers and deer) for the open 'tray' feeding head (*Figure 5*). Over double the number of animals fed from this head compared to the traditional 'spiral' feeder head and the 'window' feeder head. This last type was most popular with pest species.

Figure 5: The preferred feeding head, an open feeding 'tray' with two access points for birds to gain access to the feed.

Discussion: A total of 27 different species used the hoppers as a food source over the winter and early spring period, adding weight to anecdotal comments of the value of supplementary feeding for wildlife species (cf. Vickery 2004, Tapper 2005). Only approximately one in ten visitations to hoppers were from traditional gamebirds, contrasting with three in ten visits from songbirds and four in ten visits from pest species. The most prolific visitors were the yellowhammer, followed by small mammals, rooks, pheasants and squirrels. The proportional amount of feed consumed by each species is not known.

Species had no preference for hoppers sited in woodlands and hedgerows, although feeding during the daytime was preferred. Although there were no significant differences in the amount of species using both sites, there was a trend for species to favour the Rectory Farm site. It is likely therefore that site specific habitat management policies, tenure of ES, intensity of predator control, pattern and distribution of woodland in terms of landscape heterogeneity and connectivity, management of woodland edges to promote structure (Gray 1986) and the mosaic of supplementary feeders will all influence farmland biodiversity.

As species numbers did not vary across the seasons, species diversity did not either. However, some songbird species that have experienced historical declines were recorded in some numbers including five BAP songbirds - namely yellowhammer, dunnock, grey partridge and more fugaciously in number reed bunting and linnet. This supports Stoate's (2002) supposition game management practices generally initiate no increase in diversity but species experiencing population declines nationally may show significant increases in numbers. The issue of predator control remains contentious, with strongly held views both supporting and refuting the impact of predator control (Stoate & Szczur 2005). Yet paradoxically the apparent 'value' of supplementary feeding for songbirds is offset by the additional 'value' it provides to common pest species that gamekeepers would consider undesirable.

The lack of available winter food is recognised as the main limiting factor for over-winter survival of granivorous farmland birds such as yellowhammer, chaffinch, dunnock and reed bunting (Siriwardena *et al.* 2008). If ES options do not offer enough food to wild birds over the winter then the indirect provision of feed from the hoppers explains why some species rely on them. Farmland birds would normally rely on food sources provided by set-aside, cereal stubble fields and non-cropped land, all of which can persist throughout the winter and potentially supply food into March and April (Siriwardena *et al.* 2007). Although spring feeding may not be advocated as a management technique to improve the breeding success of pheasants (Hoodless *et al.* 1999), there is now an argument that the spring feeding of pheasants may benefit other species. This agrees with Stoate & Szczur (1997) who stipulate that the management of both wild and reared gamebirds that require the provision of food and cover during winter will be exploited by farmland passerines.

Increasing wild bird food through seed mixtures and overwintering stubbles has become a National priority for inclusion into agri-environmental schemes by Natural England (2011). Field *et al.* (2011) delineated that whilst Environmental Stewardship options do help to provide some winter food resources for songbirds, there seems limited evidence for the additional benefits of Higher Level versus Entry Level Stewardship to wintering farmland species. Perhaps in an apparent conservation paradox the 'hungry gap' can in-fact be plugged inadvertently by small scale farm shoots and their activities. It can therefore be supposed that supplementary feeding increases food supply and therefore may increase over-winter survival rates of key songbird species, but only through a conflation of land management ideologies. After all, the most cost-effective conservation outcomes can only be attained by maximising the efficacy of conservation measures that operate in balance where farming, game and wildlife all overlap and are complimentary rather than in competition.

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