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Farmland birds and the field boundary evaluation and grading system in Ireland

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Abstract
Field boundaries are important habitats for birds within the agricultural landscape. In this study, bird surveys were carried out during the winter and breeding season on nine farms in the east and south-east of Ireland and field boundaries at each site were assessed using the Field Boundary Evaluation and Grading System (FBEGS). Poisson regression demonstrated that FBEGS scores were a good predictor of both winter and breeding bird species richness and diversity within the field boundaries studied. We interpret these preliminary results with caution since our sample size was relatively small (compared to the wide variety of field boundary types found in Ireland) and no single combination of field boundary attributes is likely to be optimum for all bird species. However, our results suggest that FBEGS may be a useful surrogate indicator of overall field boundary bird diversity and we discuss the consequent implications for agri-environmental policy, and for the possible adaptation and use of FBEGS as a tool to monitor the impact of changing farm management practice.

Key index words: Hedges, poisson regression, FBEGS, monitoring, agri-environmental schemes, bird diversity.

Introduction
Field boundaries, including hedgerows, are among the remaining semi-natural habitats still available to birds within farmed landscapes (Lack, 1992; O’Connor and Shrub, 1986). The central role that hedgerows play in breeding bird activity is widely known (Green et al., 1994; MacDonald and Johnson, 1995; Moles and Breen, 1995; Parish et al., 1994, 1994). In Britain, about sixty bird species have been recorded breeding in hedgerows, of which twenty to thirty do so regularly. In the absence of woodland, hedgerows may support a greater number of breeding birds than any other farmland feature (Lack, 1992). Hedgerows provide birds with nesting, roosting and foraging sites. In addition, they also provide cover from predators, and allow movement locally and throughout the landscape (Moles and Breen, 1995; Osborne, 1984). In Britain, it has been suggested that a large proportion of hedgerow is either under-managed or over-managed; accordingly, the potential value of hedgerows in terms of avian diversity and overall biodiversity has yet to be realised (MacDonald and Johnson, 1995).

Studies have shown that there are differences in the relationship between bird incidence and hedgerow characteristics in summer and winter, with foraging requirements being
paramount in the winter season and nesting requirements more important in the breeding season (Arnold, 1983; Moles and Breen, 1995). Resident and wintering bird species utilise hedgerows in winter for physical shelter and as an important foraging habitat. Hedgerows probably supply berries and to a lesser extent invertebrates to a number of different species during this season. Despite the mobility of bird species in comparison to other taxa, hedgerows also provide a major source of cover for safe movement within agricultural landscapes (Hinsley and Bellamy, 2000).

A cautious approach should be taken when extrapolating from the results of studies on the avifauna of agricultural habitats in Great Britain to Ireland, due to differences in avian community structure and the relatively limited number of bird species present in Irish agricultural ecosystems (Lysaght, 1989), and also marked differences in agricultural systems and the topography of landscapes. Comparisons can be further complicated by regional differences in abundance and the behaviour of species (Fuller et al., 1985). A number of Irish studies have examined the interaction between Irish agricultural ecosystems and bird communities (Lysaght, 1989; Moles and Breen, 1995; Flynn et al., 2002; McMahon et al., 2003). Hedgerow and indeed farmland bird communities within Ireland appear to be dominated by five woodland species (wren, robin, blackbird, chaffinch and dunnock) during the breeding season (Feehan et al., 2002; Lysaght, 1989). The general interaction between agricultural ecosystems and birds within Ireland has not been examined in detail, with the influence of field boundary attributes on winter farmland communities requiring particular investigation. In the winter it has been suggested that overall field boundary attributes are less important than during the breeding season for predicting bird numbers (Moles and Breen, 1995). The requirements of farmland birds vary between seasons with breeding birds preferring tall cover whereas wintering birds prefer wet ditches and other foraging habitats (Moles and Breen, 1995).

Land use adjacent to a hedgerow can also have a considerable influence on its bird fauna (Hinsley and Bellamy, 2000). Certain bird species are more abundant in hedgerows and other field boundaries surrounded by pasture compared with arable crops, as grassland can have a different and usually relatively greater availability of soil invertebrates (Tucker, 1992). MacArthur and MacArthur (1961) were the pioneers in predicting bird diversity based on habitat components in deciduous woodland. Recently there have been a number of attempts to evaluate the components of field boundaries and hedgerows in terms of ecological significance. The Hedgerow Evaluation and Grading System (HEGS) was designed to evaluate the attributes of UK hedgerows (Clements and Tofts, 1992). The Field Boundary Evaluation and Grading System (FBEGS) was modelled on the HEGS methodology in an attempt to develop an evaluation and grading system more appropriate to the particular types of field boundaries found in Ireland (hedgerows and stone walls) (Collier and Feehan, 2003).

Although such systems to evaluate the ecological attributes of field boundaries have been devised, there has been no attempt to integrate them with studies of avian biodiversity. We examine the relationship between FBEGS scores calculated for field boundaries on nine study sites and bird species richness (i.e. the number of species recorded) and a number of bird diversity indices.

Methods
Site selection and description
Nine farms participating in the Ag-Biota Project were selected for study: Lyons, Grange, Grange Commercial, Oakpark, Oakpark Commercial, Solohead, Solohead Commercial, Johnstown Castle and
Johnstown Castle Commercial. Apart from the commercial sites, the farms were all research farms, ranging in size from 18ha to 87ha with a mean area of (± SD) of 54.4 ± 21.8 ha and a total of 490ha surveyed. Solohead, Johnstown and their associated commercial sites were diary farms while Lyons, Oakpark, Oakpark commercial and Grange commercial were mixed farms with arable and grassland. Finally Grange was a beef production grassland system. The study was as such a farm scale study.

**Bird data**

Each farm was surveyed on three occasions in winter (December-February) 2002-2003 and on four occasions in the breeding season (April-July) 2003. During each survey, field boundaries were walked at a distance of approximately 1.5m from the field edge where the cropped area ended. The speed of walking depended on the number of birds present; however, due to the open nature of the farmland habitats a standard overall speed of 2km per hour was observed (Bibby et al., 2000). Bird presence and abundance were recorded using both visual and aural methods. A pair of 10 X 42 binoculars was used. In winter, the latest start time was 08.30 and during the breeding season the latest start time was 07.00. As extreme weather affects bird activity and observer accuracy (Bibby et al., 2000) no visits were made in periods of persistent, heavy rain, or wind speeds greater than Beaufort scale 4 (Henderson et al., 2004). At each site visit, wind speed was recorded using an anemometer: (scale: B1, 1.1-5.4km/h: B2, 5.5-11.9km/h: B3, 12-19.4km/h: B4, 19.5-28.4km/h). Precipitation was also recorded (scale: 1 = dry, 2 = drizzle and 3 = showers). The number and abundance of bird species using the surveyed field boundaries were recorded directly onto site maps, including raptors hunting the field boundary overhead. Other species flying overhead but not using the field boundaries were not counted.

Double-counting of birds was minimised by the observer taking into consideration birds that were flushed to other fields or to other part of the area being surveyed (Perkins et al., 2000).

**Field boundary data**

A field boundary was defined as a hedgerow or a stone wall for the purpose of this study. FBEGS was used to evaluate the quality of field boundaries within the nine sites. (Collier and Feehan, 2003). These evaluations were made between June and October 2003. FBEGS was devised as a method for assessing the broad ecological value of Irish hedgerows and stone wall field boundaries using a wide range of relevant criteria. Each field boundary was walked and given a score based on these criteria. Structural features that were scored included boundary height, width and tree number and shrub diversity. Associated features included the presence of earthbanks, drainage ditches and uncultivated/ungrazed field margins, ordinal orientation, linear connectivity to other habitats (such as woodland) and ‘gappiness’ (the percentage of breaks in the field boundary). Scores for all of these features were combined to give an overall FBEGS score. No alterations (e.g. hedge cutting) in the surveyed field boundaries were noted between bird surveys and the FBEGS survey. Each hedgerow and stone wall surveyed was given an overall classification according to the grading systems proposed by Collier and Feehan (2003) for hedgerows and stone walls, respectively.

**Analysis**

In winter, outside the breeding season, the majority of birds are not territorial; they are more likely to be relatively mobile, so that numbers on farms may fluctuate substantially. To take into account this difference in behaviour, bird data were separately analysed for the breeding (April-July) and winter seasons (December-February), pooling the data from
individual surveys done in each season (3 and 4 surveys, respectively). Across the nine sites, bird and FBEGS data were recorded for a total of 40 field boundaries in the winter season and 42 field boundaries in the breeding season.

**FBEGS and bird species richness**

The relationship between FBEGS scores and recorded bird species richness was investigated using regression analysis. Normal regression methods could not be used to analyse our data for two reasons. Firstly, the number of birds identified is a count, and not a continuous variable, so that Poisson regression is more appropriate. Secondly, a number of field boundaries were sampled at each site, and so cannot be assumed to be independent of each other. We therefore included site as a random effect in a Generalised Linear Mixed Model (GLMM) with a Poisson distribution and a log link. The analysis was carried out using PROC GLIMMIX in the SAS/STAT® software (SAS Institute, 2002). The GLIMMIX procedure assumes that the data follow a Poisson distribution, conditional on the random effect. It uses a restricted pseudo-likelihood algorithm as in Wolfinger and O’Connell (1993) and Breslow and Clayton (1993). As we used a log link in our analysis, we back-transform log scale predictions from the model to the original scale of species richness for presentation purposes.

**FBEGS and species diversity indices**

The choice of which of several alternative diversity indices is the most appropriate in any particular context is a common and not yet fully resolved problem in modern ecology (Penev et al., 1994). We calculated three different indices, which have been used in other studies of bird populations in field boundaries (Feehan et al., 2002; Flynn et al., 2002; Parish, 1995), to quantify bird diversity in each of the field boundaries we sampled. Despite the fact that it is influenced by sample size (Magurran, 2004) the Shannon index has had an enduring history of use, resulting in many long-term studies.

The Shannon index is given by the formula:

$$ H = \sum p_i \ln p_i $$

Where $p_i$ is the proportion of the individuals found in the $i$th species.

The Brillouin index was proposed to measure the diversity of an entire population rather than a sample, and so each individual evaluation of this index is unique (Magurran, 2004). Pielou (1975) strongly advocates its use in all circumstances where a complete collection is made or where samples are not random.

The Brillouin index is given by the formula:

$$ HB = \ln N! - \sum \ln n_i $$

Where $n_i$ is the number of species belonging to the $i$th species.

Simpson’s index effectively expresses the probability that any two individuals randomly drawn from a sample or population belong to the same species or taxon and is independent of sample size.

Simpson’s index is given by the formula:

$$ D = \sum p_i^2 $$

Where $p_i$ is the proportion of the species $i$ in the community.

Each of these indices was calculated for our bird data, pooled within each season, and regressed on the calculated FBEGS scores for individual field boundaries. We fitted mixed linear regression models; assuming that the data follow a normal distribution, and because field boundaries within a site are not independent, we included site in each model as a random effect. Analyses were done using PROC MIXED in the SAS/STAT® software, which fits the model using restricted maximum likelihood (REML). There was one field boundary where no birds were recorded during the surveys and this was excluded from the analysis.
Results
A total of 42 bird species were recorded during the entire study period: 34 species amongst a total of 1401 individuals recorded in winter and 30 species recorded in the breeding season amongst a total of 1509 individuals. The total list of the species recorded in each season is given in Table 1.

Grading of field boundaries
A list of hedges, FBEGS score and grades are shown in the Table 2. Eighteen of the thirty-nine hedges were in the very high grade, fourteen were in the high grade and only one hedge was graded poor. All of the sites had a number of different score grades apart from Lyons where all four of the hedges were grad-

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sparrowhawk <em>Accipiter nisus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Kestrel <em>Falco tinnunculus</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Pheasant <em>Phasianus colchicus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Snipe <em>Gallinago gallinago</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Stock dove <em>Columba oenas</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Woodpigeon <em>Columba palumbus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Meadow pipit <em>Anthus pratensis</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Grey wagtail <em>Motacilla cinerea</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Pied wagtail <em>Motacilla alba</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Wren <em>Troglodytes troglodytes</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Dunnock <em>Prunella modularis</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Robin <em>Erithacus rubecula</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Blackbird <em>Turdus merula</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Fieldfare <em>Turdus pilaris</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Song thrush <em>Turdus philomelos</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Redwing <em>Turdus iliacus</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Mistle thrush <em>Turdus viscivorus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Whitethroat <em>Sylvia communis</em></td>
<td>Breeding</td>
</tr>
<tr>
<td>Blackcap <em>Sylvia atricapilla</em></td>
<td>Breeding</td>
</tr>
<tr>
<td>Chiffchaff <em>Phylloscopus collybita</em></td>
<td>Breeding</td>
</tr>
<tr>
<td>Goldcrest <em>Regulus regulus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Long-tailed tit <em>Aegithalos caudatus</em></td>
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</tr>
<tr>
<td>Coal tit <em>Parus ater</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Blue tit <em>Parus caeruleus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Great tit <em>Parus major</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Treecreeper <em>Certhia familiaris</em></td>
<td>Winter</td>
</tr>
<tr>
<td>Magpie <em>Pica pica</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Jackdaw <em>Corvus monedula</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Rook <em>Corvus frugilegus</em></td>
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</tr>
<tr>
<td>Hooded crow <em>Corvus corone cornix</em></td>
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</tr>
<tr>
<td>Raven <em>Corvus corax</em></td>
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</tr>
<tr>
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</tr>
<tr>
<td>House sparrow <em>Passer domesticus</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Tree sparrow <em>Passer montanus</em></td>
<td>Breeding</td>
</tr>
<tr>
<td>Chaffinch <em>Fringilla coelebs</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Greenfinch <em>Carduelis chloris</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
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<td>Winter, breeding</td>
</tr>
<tr>
<td>Linnet <em>Carduelis cannabina</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Redpoll <em>Carduelis flammea</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Bullfinch <em>Pyrrhula pyrrhula</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Yellowhammer <em>Emberiza citrinella</em></td>
<td>Winter, breeding</td>
</tr>
<tr>
<td>Reed bunting <em>Emberiza schoeniclus</em></td>
<td>Breeding</td>
</tr>
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Table 1. The total list of the species recorded in each season
ed very high. A list of stone walls, FBEGS scores and grades are shown in the Table 3. All

Table 2: Hedge code, FBEGS scores and grading system for hedges

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<tr>
<th>Hedge</th>
<th>FBEGS score</th>
<th>Score grade</th>
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<tr>
<td>L4</td>
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<td>Very high</td>
</tr>
<tr>
<td>L5</td>
<td>55</td>
<td>Very high</td>
</tr>
<tr>
<td>L6</td>
<td>66</td>
<td>Very high</td>
</tr>
<tr>
<td>L9</td>
<td>55</td>
<td>Very high</td>
</tr>
<tr>
<td>GR1</td>
<td>48</td>
<td>High</td>
</tr>
<tr>
<td>GR2</td>
<td>57</td>
<td>Very high</td>
</tr>
<tr>
<td>GR3</td>
<td>44</td>
<td>High</td>
</tr>
<tr>
<td>GR4</td>
<td>46</td>
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<tr>
<td>GR5</td>
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<td>GR6</td>
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<tr>
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<td>SH8</td>
<td>40</td>
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<td>SHC3</td>
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<td>40</td>
<td>High</td>
</tr>
<tr>
<td>JCC5</td>
<td>56</td>
<td>Very high</td>
</tr>
</tbody>
</table>

Table 3: Stone wall code, FBEGS score and grading system for stone walls

<table>
<thead>
<tr>
<th>Stone wall</th>
<th>FBEGS score</th>
<th>Score grade</th>
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<tbody>
<tr>
<td>OP2</td>
<td>23</td>
<td>Poor</td>
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<tr>
<td>OP3</td>
<td>29</td>
<td>Poor</td>
</tr>
<tr>
<td>OP4</td>
<td>28</td>
<td>Poor</td>
</tr>
</tbody>
</table>
**FBEGS and bird species richness**

Figure 1 illustrates significant relationship between FBEGS and bird species richness in both the winter ($P<0.01$) and breeding seasons ($P<0.01$). The trend lines represent back-transformed predictions of species richness from the log scale. A positive relationship between the FBEGS and bird species was observed, with each ten-unit increase in FBEGS score resulting in a 22% increase in winter species richness and a 16% increase in breeding season species richness.

Figure 1. The predicted effect of an increase in FBEGS scores on bird species richness. Predictions are back-transformed from the Log scale.
FBEGS and species diversity indices

In the winter season, there were no significant relationships between FBEGS score and any of the calculated diversity indices. However, in the breeding season, positive relationships were recorded between FBEGS score and both the Shannon index ($P<0.05$) and the Brillouin index ($P<0.01$). There was no significant relationship between FBEGS scores and Simpson's index for our breeding season data.

Discussion

Much published work has been devoted to establishing what field boundary attributes are attractive to birds (Arnold, 1983; Chamberlain and Wilson, 2000; Flynn et al., 2002; Green et al., 1994; Hinsley and Bellamy, 2000; Lysaght, 1989; MacDonald and Johnson, 1995; Moles and Breen, 1995; Pollard et al., 1974). This study highlighted significant relationships between FBEGS scores and bird species richness and diversity. Our results suggest that the total FBEGS score may be a useful indicator of bird species richness in a field boundary during both the breeding and the winter season. In addition, significant relationships were found between FBEGS scores and bird diversity as quantified by both the Shannon and Brillouin diversity indices in the breeding season. The lack of significance between FBEGS and any of the diversity indices assessed in winter is perhaps indicative of the greater variation in habitat requirements of farmland birds and their greater mobility (and lessened territoriality) during this season. Such an interpretation is supported by other studies that have concluded that field boundary attributes are less important in determining bird abundance in winter than during the breeding season (Arnold, 1983; Moles and Breen, 1995).

Large hedgerows with trees and large ditches are features that enhance species abundance in both the winter and breeding season (Parish et al., 1995). It may be that in its current form FBEGS does not place sufficient emphasis on these features in a way that would show a significant relationship with winter bird diversity indices. Compared with the Shannon and Brillouin indices, Simpson's index is relatively more influenced by changes in the frequencies of the most abundant species in a community (Lande et al., 2000). The bird populations recorded in this study were dominated by a limited number of species, whose relative incidence varied markedly and which were not evenly distributed. This may plausibly explain why Simpson's index was unrelated to FBEGS scores.

The majority of the FBEGS scores for the hedgerows in this study (thirty-two of thirty-nine) fell into the overall high to very high score grade. FBEGS and HEGS are essentially very similar systems and their respective scores can be readily compared (Collier and Feehan, 2003). HEGS was found not to be predictive of poor to middle-ranking hedgerows (Rich et al., 2000). As such, the results highlight the probability that the majority of hedgerows in this study were high grade hedges, but the significant relationship between FBEGS and bird species richness and diversity that we were able to demonstrate may not necessarily hold true if applied to across a wider sample of field boundaries, including those of substantially lower quality than those sampled in this study. Nonetheless, the results indicate a strong potential for the FBEGS method as a surrogate measure for evaluating and tracking changes in bird diversity in Irish farmland.

Hedgerow length influences bird species presence and abundance (Feehan et al., 2002; Parish et al., 1995) but length of field boundary is not a quantitative contributor to the FBEGS score. It could be argued that the relative length of hedgerows per unit area should be included in the overall FBEGS score. Stone walls need be to assessed in a separate study as the number of such habitats was limited in the present study and the data available on stone wall ecology are poor (Collier, 2002).

It is important to appreciate that no sin-
Single hedgerow structure (shape, size etc.) or combination of shrub species will be suitable for all bird species, and so the aims of management must consider the varying needs of different species (Hinsley and Bellamy, 2000). Management practices that enhance bird species richness are not the same as those required to benefit particular species of conservation concern (Parish et al., 1995). Blackbird abundance is positively related to hedgerow area and number of different shrub species (Osborne, 1984) whereas the habitat requirements of yellowhammers include tall hedges, trees, ditches and boundary strips/field margins during the breeding season, with accessibility to quality wintering habitat such as winter stubble and rotational set-aside (Whittingham et al., 2005). Attention to the variation that exists between hedgerow structures within a given area may be more important than trying to identify the 'ideal' field boundary structure and the optimal range of hedgerow habitats within a region will vary with location and the availability of alternative habitats (Hinsley and Bellamy, 2000). Further investigation is required to examine the specific interactions between individual components of FBEGS methodology and the incidence of individual bird species. This would be particularly beneficial when drawing up conservation guidelines for particular species. FBEGS may be a valuable tool in assessing and evaluating bird biodiversity, but a range of other studies are required to determine if this system could be useful for tracking the diversity of other taxonomic groups, particularly invertebrates and vascular plants. With sufficient knowledge, perhaps, the system could be better adapted for the assessment of particular taxa, including birds. An investigation into how FBEGS scores relate to stone wall biodiversity would also be valuable.

Agri-environmental schemes provide an opportunity to reverse the declines in farmland birds. However, there is an absence of robust ecological studies of agri-environment schemes throughout Europe and as such an accurate judgement on their effectiveness is not possible (Kleijn and Sutherland, 2003). Management strategies, such as Measure 5, within the REPS, should provide a diversity of field boundaries for all biodiversity including birds. However, Flynn (2002) found no significant differences in breeding bird species richness and density of breeding birds between REPS and non-REPS farms. Feehan et al. (2005) found no significant differences in ground beetle (Carabidae) and field margin flora between REPS and non-REPS farms. Both of these relatively small studies suggest that REPS may not be benefiting the surveyed taxa. A much larger national effort is required to monitor and objectively evaluate the effectiveness of REPS in enhancing biodiversity. The results of this study indicate that an FBEGS survey carried out in conjunction with a winter and breeding bird survey could be an efficient method for the evaluation of REPS.

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References:


Chamberlain, D.E. and Wilson, J.D. (2000). The contri-


