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The effect of small-scale agro-environmental initiatives on avian diversity in agricultural landscapes

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Research Article

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Summary

As a result of increasingly intensified agricultural practices in Europe over the last century, agroecosystems have experienced severe biodiversity declines. Among the species experiencing negative population trajectories in agricultural habitats are meadow and farmland birds, which have suffered a loss in both habitat and food availability in cultivated fields. In Denmark, biotope plans (a requirement to establish small agro-environmental habitats on properties with stocking of game birds) have been implemented as a measure to mitigate biodiversity declines in the agricultural landscape and, in this paper, we investigate to what extent these initiatives fulfil the intended purpose with respect to birds in the breeding season. We demonstrate that some initiatives like hedgerows, areas of open vegetation, scrub, and lakes seemed to increase avian diversity locally, but also that other measures such as vegetation strips, grass strips, and bare soil strips had little effect given the current implementation of these initiatives. Benefitting species were mostly scrub- and woodland species that now inhabited previously open landscapes after the establishment of suitable habitats, and the initiatives failed to show clear positive effects on meadow birds and farmland birds for which they were originally intended. The most commonly registered species in our data set was (released) Pheasant *Phasianus colchicus*, which emphasised that the stocking of game birds can have a clear effect on avian species composition in areas where this practice is exercised. Future studies are needed to clarify how this stocking may affect local biodiversity of different taxonomic groups.

Introduction

Over the course of the last century, European agricultural landscapes have undergone tremendous change. Technological developments and associated modernisation of agricultural practices have paved the way for intensive and effective exploitation of the land, which has led to the homogenisation of farmland landscapes in many countries (Mueller et al. 2021; Stoate et al. 2009). The most commonly reported landscape effects include an increase in field size and a parallel decrease in area of field margins and number of fields (Baessler and Klotz 2006; Caspersen and Andersen 2016), leading to negative effects on the biodiversity of several taxonomic groups (Fahrig et al. 2015; Sálek et al. 2018). One of the most studied taxa in this context is "farmland birds" and recent declines for many species in this group has been linked to intensified agricultural practices (Donald et al. 2001; Gaüzère et al. 2020; Heldbjerg et al. 2018; Jerrentrup et al. 2017; Rigal et al. 2023). Ultimate drivers of these declines seem to involve habitat loss, deteriorating food supply, and increased predation risk (Evans 2004; Stanton et al. 2018).

In Denmark, 63% of the land area is used for intensive farming (Petersen et al. 2021) and one instrument to oppose the long-term decline in the biodiversity of agricultural landscapes has been the implementation of "biotope plans" (Danish Environmental Protection Agency 2018), based on the Danish act on the release of game, hunting methods, and hunting tools (Danish: Bekendtgørelse om udsætning af vildt, jagtmåder og jagtredskaber, 2017; BEK nr 1652 af 19/12/2017). From this initiative follows, that all larger estates practising game bird stocking for hunting purposes at rates >1 bird/ha (Pheasant *Phasianus colchicus* and Grey Partridge *Perdix perdix*) are required to establish small-scale agro-environmental habitats on their property. These may consist of several different initiatives ranging from bare soil strips and grass strips to the establishment of scrub or lakes. The objective of the biotope plans is to improve habitats and biodiversity of the cultivated areas on large estates, and to ensure that the land can support the stocking of game birds. In practice, most stocking focuses on Pheasant and in 2021 c.960,000 Pheasants were reported released, corresponding to c.99% of all released game birds (Danish Environmental Protection Agency 2022). The allowed stocking intensity is based on a point system considering the area, type, and duration of the different small-scale agro-environmental initiatives implemented, which will not be dealt with in further detail here (see Danish Environmental Protection Agency 2018 for elaboration). The biotope plans aim to specifically target a number of species groups that are expected to benefit from the initiatives, including meadow birds, farmland birds, and game birds (Danish Environmental Protection Agency 2018). In this respect, the biotope plan guidelines define meadow birds as Lapwing *Vanellus vanellus*, Starling *Sturnus vulgaris*, Meadow Pipit *Anthus pratensis*, Yellow Wagtail *Motacilla flava*, and Whinchat *Saxicola rubetra.* Farmland birds include Skylark *Alauda arvensis*, Corn Bunting *Emberiza calandra*, Quail *Coturnix coturnix*, Yellowhammer *Emberiza citrinella*, Linnet *Linaria cannabina*, and Northern Wheatear *Oenanthe oenanthe*, while game birds include Grey Partridge and Pheasant. Until now, an actual assessment of how these plans affect avian biodiversity in general – and the abovementioned groups in particular – has not been completed.

In this study, we carry out an experimental evaluation of the effect of the small-scale agro-environmental initiatives on avian diversity in the breeding season by (1) comparing the number of species registered on plots with different initiatives (treatment plots) and similar control plots without such initiatives, (2) describing the species that benefit from these initiatives and which do not, (3) discussing to what extent the biotope plans can contribute to safeguarding future avian diversity, and finally, (4) we describe the species composition of birds in contemporary agricultural landscapes in Northern Europe.

Methods

Study areas

The effect of the agro-environmental initiatives on avian diversity was investigated on 20 individual estates across Denmark that all practised stocking of game birds (Figure 1). The 20 estates were chosen based on the following criteria. (1) They had registered a "biotope plan" for the years 2020, 2021, and 2022. (2) They had established a minimum of eight different initiatives, including the three most frequent ones, i.e. vegetation strips, grass strips, and bare soil strips. (3) The plan covered at least 50 ha of cultivated land. Finally, we excluded some estates on islands etc. for logistical reasons. From these estates we obtained the registered biotope plan for 2023, including maps of the location of individual initiatives.

Agro-environmental initiatives

We investigated the effect of establishing small-scale, agro-environmental habitats by contrasting avian diversity at point counts with and without such initiatives. Sampling points were defined in a paired set-up, so that each point with an initiative was contrasted with an equivalent control point without this initiative but in the immediate vicinity on the same estate. A sample pair could, for instance, consist of two plots at each end of a large field, on two neighbouring fields or on two different parts of the same estate depending on the initiative investigated. Care was taken to ensure that control plots had the same crop composition, landscape, and structural setting as treatment plots, so that only the initiative differed between the two points. Treatment and control plots were always separated by >250 m and often much longer. The Danish biotope plans cover a total of 25 different agro-environmental initiatives, but only a few of these are important in numbers, others are inseparable from an ecological perspective, and still others are defined as combinations of previously defined initiatives. Consequently, our analysis was restricted to looking at six broadly defined groups of commonly used initiatives (for a full translation of the original 25 initiatives into our six groups see Supplementary material Appendix SA). An explanation of the initiatives included in our study, and the corresponding type of control plot, is given in Table 1. Example photographs of the different initiatives can be found in Appendix SB. Initiatives involving the presence of scrub and lakes were rare, and lake formation was always associated with surrounding developing scrub. Consequently, these two initiatives were combined (Table 1). To capture the actual value of the different initiatives to birds in the breeding season, all initiatives were included as they appeared in the main breeding season at the time of data collection (see below), irrespective of the timing of establishment and/or sowing.

Bird monitoring

To monitor the presence of birds in the breeding season we used point counts. These were performed from predefined treatment and control points, by registering all birds seen or heard during five-minute monitoring bouts at each point, following the protocol of the national Common Birds Census led by BirdLife Denmark (see Vikstrøm et al. 2023). When counting, we distinguished between individuals recorded <50 m from the observer (in or near the initiatives for treatment points, hereafter "close proximity counts") and all other birds registered. The first category was defined to capture potential differences in bird activity resulting directly from the given agro-environmental habitat under investigation at a given point, thereby representing the potential added value of the initiative to birds. The latter included all distant observations of birds during monitoring bouts (including birds flying over), which could be used as a measure of the overall local avian activity surrounding a point. We hypothesised that for any initiative to have a positive effect on avian diversity, the number of species in the close proximity counts should be higher in treatment plots than in control plots, and that the number of distantly observed species was unaffected by the initiatives. All counts were conducted between 11 May and 30 May 2023, within the "breeding census window" defined by the national Common Birds Census (Vikstrøm et al. 2023). It reflects the presence of birds in a given area during the main breeding season but does not confirm actual breeding attempts. Within this window, all point counts on a single estate (8–12 points) were completed on the same morning by the same observer, and paired samples (treatment and associated control) immediately following each other. A total of 208 point counts were conducted.

Data analysis

Our point counts were semi-quantitative in nature, signifying that at each point the number of different individuals seen or heard of a given species was recorded. In practice however, the vast majority of our close proximity counts took the form of presence/absence (1/0) data, and we structured our analysis accordingly. We defined diversity as the number of species recorded at a given point and used pair-wise comparisons between the paired samples (treatment and control) to test for differences in the number of species registered between points with and without initiatives. As the measured differences did not conform to a normal distribution, statistical significance was inferred using the Wilcoxon signed-rank test. A few initiatives did not fit into our broadly defined groups and were too rare to allow for statistical analyses (see Appendix SA), and we only included those with a sample size ≥10. On two points, smaller initiatives (pile of stones, bare soil strip) co-occurred with

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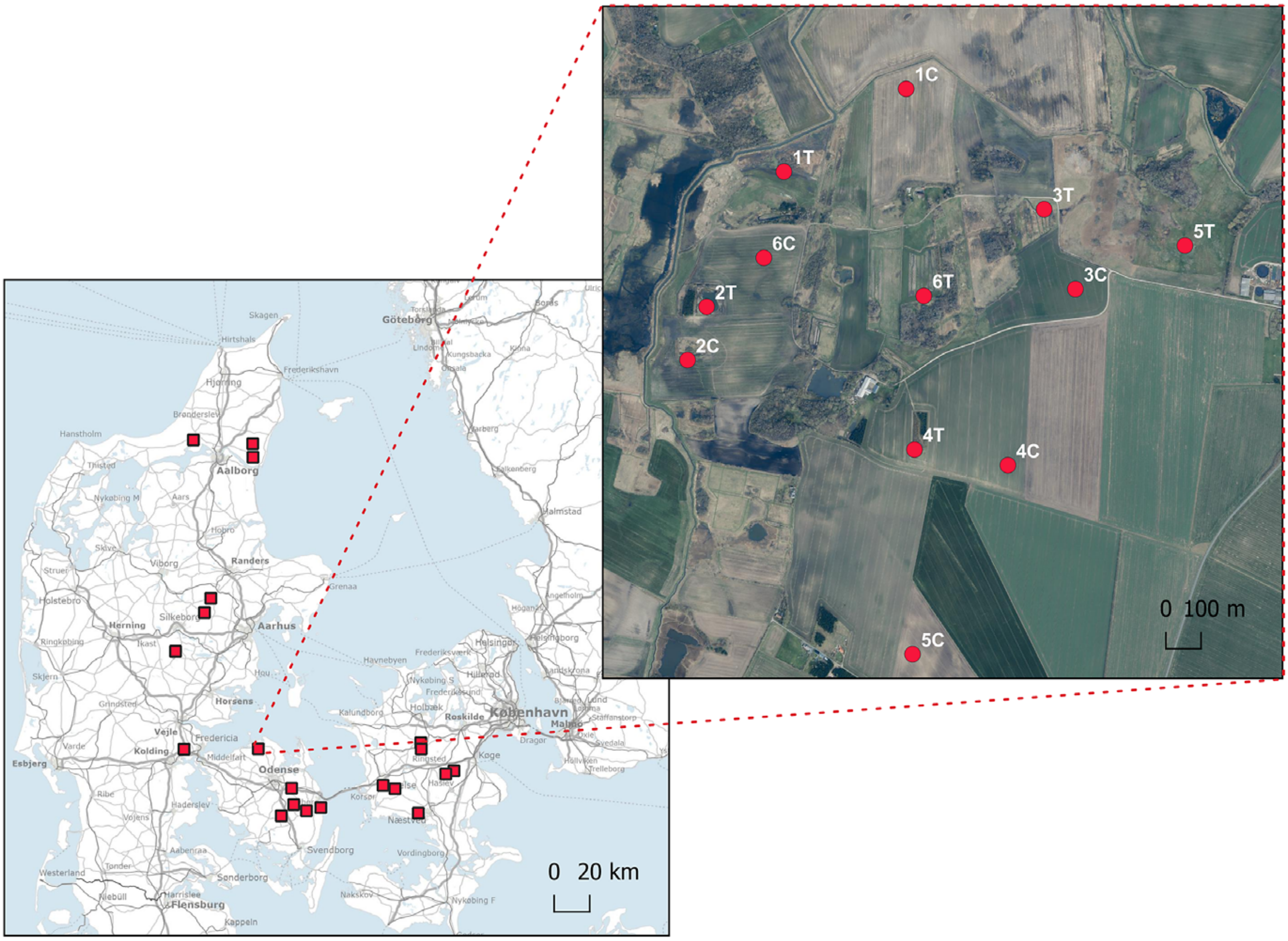

Figure 1. Location of the 20 estates included in our study (left) and a close-up of one estate showing the positions of 12 point counts including six treatment points (T), with initiatives, and six control points (C), without initiatives.

Table 1. Overview of the small-scale agri-environmental initiatives investigated in our study. Temporary initiatives can be established with a duration of one, three or five years, and in the case of three- and five-year plans, the initiatives must be in the same location in all years. A maximum of one-third of the temporary initiatives can be converted (e.g. resown in case of spread of invasive or problem plants) each year

Name (duration)	Definition of initiative	Control plots
Grass strips (temporary)	Cut strips of short grass and to a small extent other natural vegetation >2 m wide and >100 m long, along field boundaries with existing structures such as hedgerows, forest edges, dykes etc.	Cultivated land along field boundary with identical existing structure (hedgerow, forest edge, dyke etc.) but without the presence of grass strips.
Vegetation strips (temporary)	Strips of natural vegetation or sown vegetation defined as wildlife- or bee-friendly, >3 m wide and >100 m long, along field boundaries with existing structures such as hedgerows, forest edges, dykes etc.	Cultivated land along field boundary with identical existing structures (hedgerow, forest edge, dyke etc.) but without the presence of vegetation strips.
Combination strips (temporary)	Combination of a vegetation strip (defined above), a grass strip (defined above), and a bare soil strip >1 m wide and >100 m long, along field boundaries with existing structures such as hedgerows, forest edges, dykes etc.	Cultivated land along field boundary with identical existing structure (hedgerow, forest edge, dyke etc.) but without the presence of a combination initiative.
Hedgerows (permanent)	Hedgerows >2 m wide and >100 m long, consisting of natural, intact vegetation or planting of native trees or shrubs.	Open cultivated land without the presence of a hedgerow as defined here.
Open vegetation (permanent or temporary)	An area (>1 ha) of grassland, set-aside or natural vegetation on cultivated land, kept open by grassing or cutting to maintain a short sward height. Most of the included areas in our study appeared to have been there for several years.	Open cultivated land without the presence of an area with open vegetation as defined here.
Scrub/lake (permanent)	An area (>0.5 ha) of scrubland (trees and/or bushes) or a lake (>600 m^2, de facto always associated with scrubland) on cultivated land.	Open cultivated land without the presence of an area with open vegetation as defined here.

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hedgerows. In the analysis, these were assigned to the hedgerow group. This resulted in 100 matched pairs (200 point counts).

To identify species benefitting from the agro-environmental initiatives, we calculated the odds ratio (OR = proportion of presences among initiatives/proportion of presences among controls) for all species registered on >5 points in the close proximity counts. An OR >1 indicates a positive effect of the initiatives on a given species, whereas an OR <1 indicates a negative effect. Fisher's exact test was used to test whether the OR was significantly different from 1 for each species. Sample sizes where too small for this to make sense at the level of individual initiatives and the OR was therefore calculated for each species as a composite measure covering all six types of initiatives mentioned in Table 1. All statistical analyses were performed in R 4.2.2.

Results

Observed species

A total of 3,756 birds, covering 93 species, were counted on the 208 point counts. Of these, 58 species were registered in the close proximity counts. A histogram of the total number of individuals registered for all species with >5 individuals counted is shown in Figure 2. The most numerous species were Pheasant (365 birds),

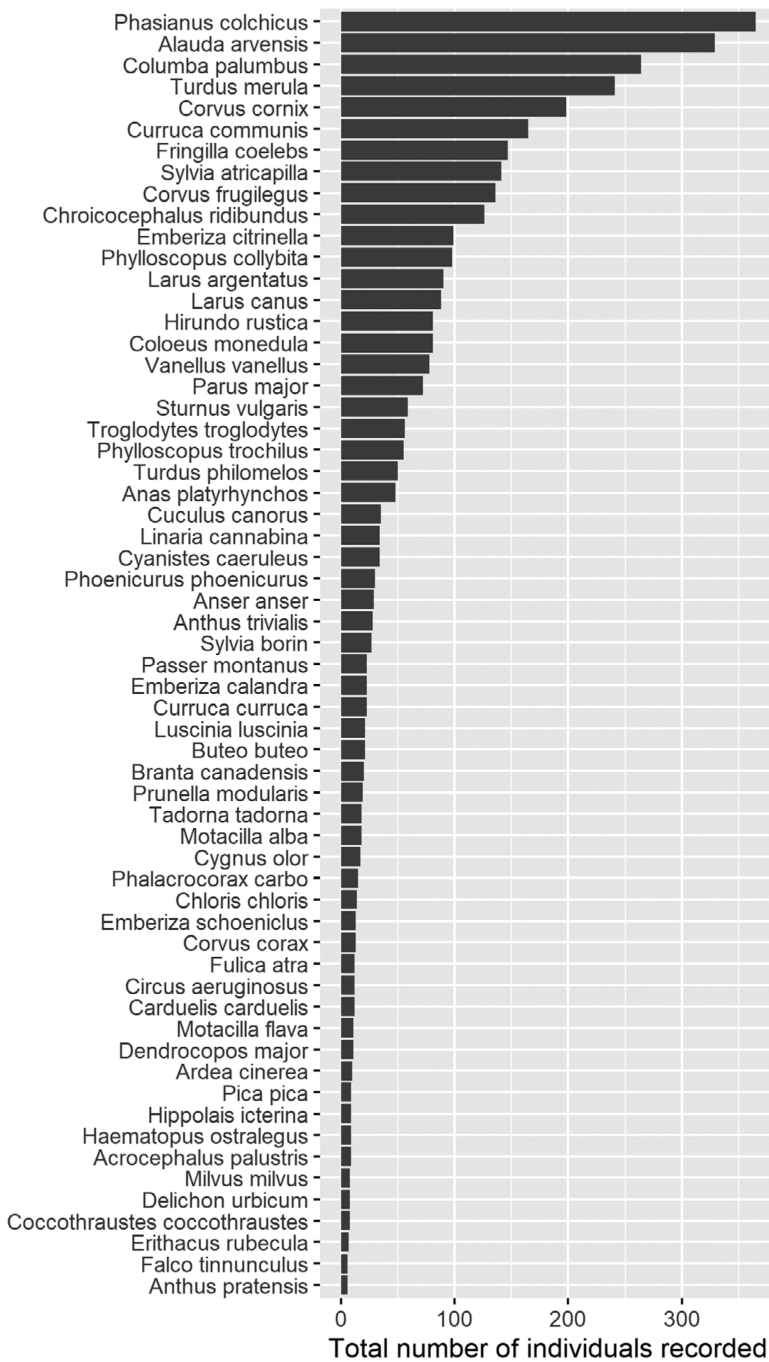

Figure 2. Histogram of all species observed with >5 individuals on the 208 point counts conducted on estates around Denmark. The figure includes all individuals counted irrespective of distance from the observer.

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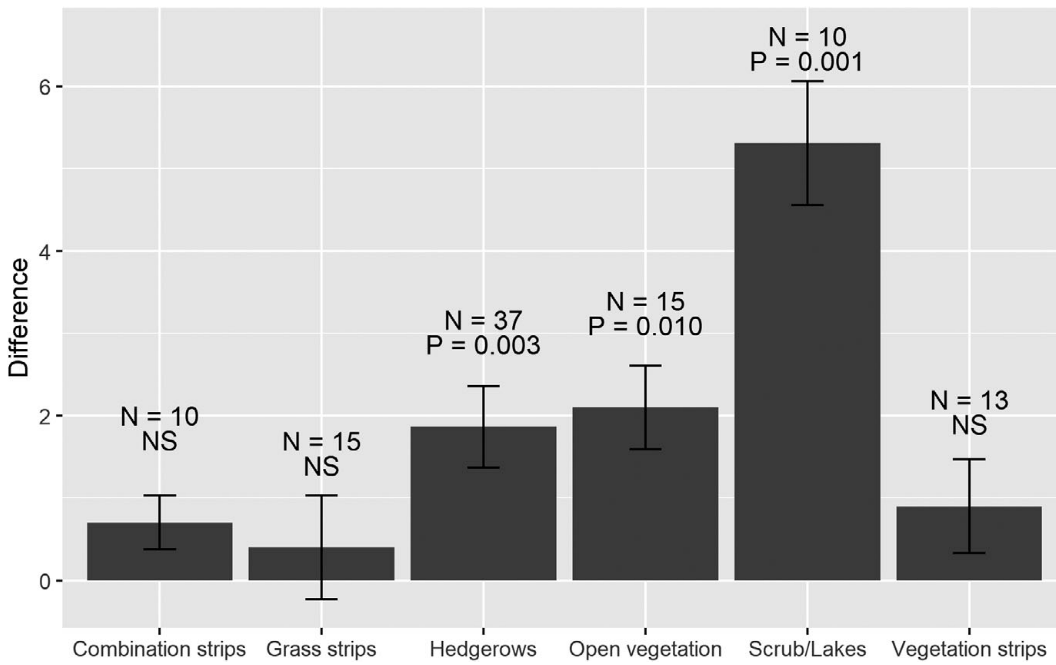

Figure 3. Estimates of mean differences (treatment – control) in avian diversity in the close proximity counts across the six groups of agro-environmental initiatives included in our analysis. Error bars indicate the standard deviations and *N*-values the sample sizes in each group (number of matched pairs). *P*-values are from the Wilcoxon signed-rank test (see Methods).

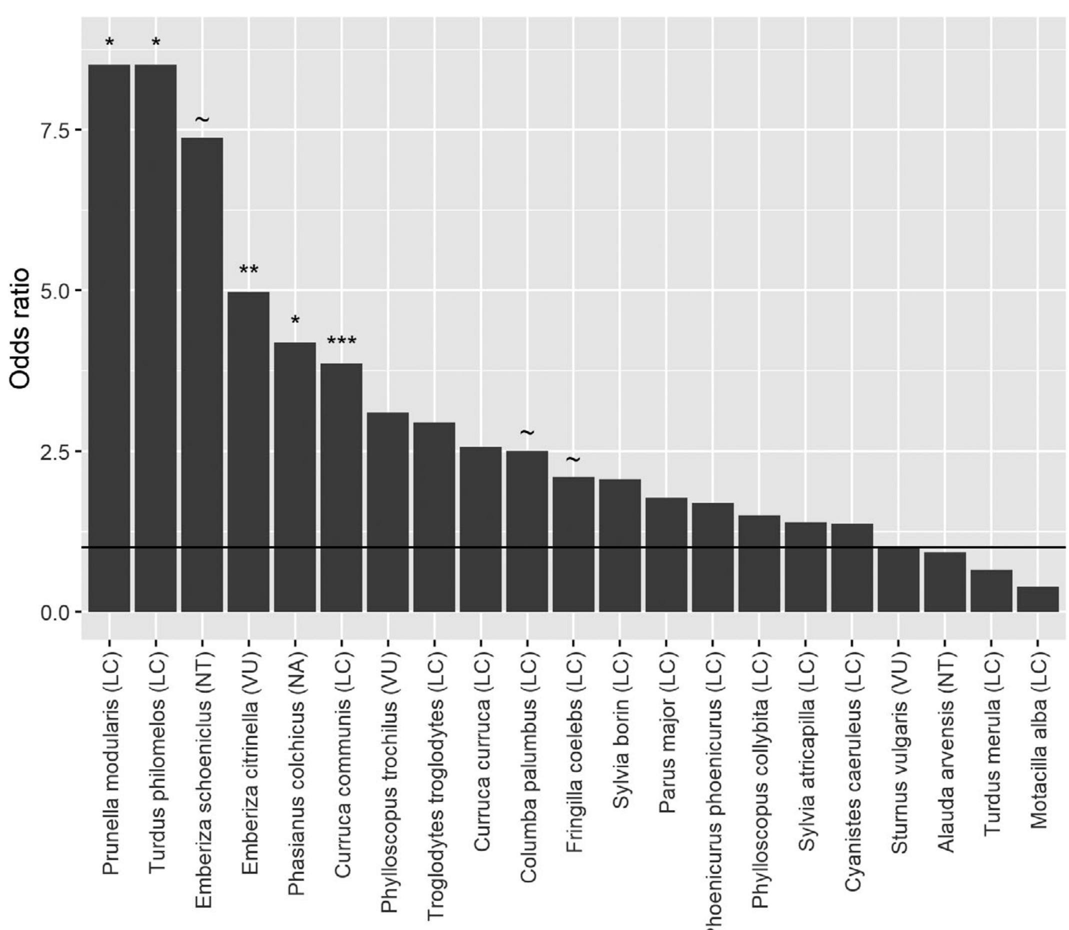

Figure 4. Response to the agro-environmental initiatives for all bird species registered on >5 points in the close proximity counts, expressed as the odds ratio (OR) (proportion of presences in treatments/proportion of presences in controls). The horizontal line indicates an OR of 1, corresponding to no effect of the initiatives. The shown significance levels (Fisher's exact test) are: ****P* <0.0001; ***P* <0.001; **P* <0.05; ~*P* <0.075. The Danish Red List category for all species is included after the species name (VU = Vulnerable; NT = Near Threatened; LC = Least Concern; NA = Not Applicable, introduced).

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Skylark (329 birds), Wood Pigeon *Columba palumbus* (264 birds), and Blackbird *Turdus merula* (241 birds).

Effect of initiatives on avian diversity

For hedgerow, open vegetation, and scrub/lake, the number of species registered in or near these initiatives was significantly higher than at the control points (Figure 3). The positive effect corresponded to a presence of ≈2 additional species for hedgerows and open vegetation and ≈5 additional species for scrub/lake (Figure 3). For the initiatives grass strip, vegetation strip, and combination strip (all bordering existing uncultivated areas), there were no significant added effects on avian diversity when comparing treatment and control points, despite all estimates being marginally positive. In the data set covering distantly observed birds (>50 m from the observer), there were no significant differences in diversity between treatment and control points across any of the six initiative types (all *P*-values >0.146).

Benefitting species

Most species with >5 registrations on the counts demonstrated a positive response to the presence of agro-environmental initiatives (OR >1), but only five species had a statistically significant response given the available data (Figure 4). These were Dunnock *Prunella modularis*, Song Thrush *Turdus philomelos*, Yellowhammer, Pheasant, and Common Whitethroat *Curruca communis*. Near-significant positive responses were observed for Reed Bunting *Emberiza schoeniclus*, Wood Pigeon, and Chaffinch *Fringilla coelebs* (Figure 4). No species showed significant negative responses.

Discussion

Our investigation of the effect of small-scale agro-environmental initiatives on avian diversity showed a significant positive effect for three of these (open vegetation, hedgerows, and scrub/lake). These initiatives are more permanent and more structurally complex than the different kinds of strips (grass, vegetation or bare soil + combinations of these) that showed only non-significant effects in our study. In addition, open vegetation, hedgerows, and scrub/lake may all be considered as habitat-forming, by creating new uncultivated areas with cover and foraging opportunities. On the contrary, the current usage of strips (mostly one-year initiatives established in connection with already uncultivated areas like hedgerows or forests) may function more as continuations of existing habitats, which in our study had no added significant positive effect. Only one vegetation strip was observed in the middle of a field and currently >95% of the area of vegetation strips are found in field margins (C. Fløjgaard, unpublished data). The fact that farmland and meadow birds did not seem to benefit from strips established near existing uncultivated habitats suggests that strips should to a greater extent be established in the interior of fields.

The species benefitting from the initiatives were mainly forest and scrubland species (Larsen et al. 2011), with a preference for habitats consisting of closed, dense vegetation serving as cover (e.g. Dunnock, Song Thrush, Pheasant, and Common Whitethroat). Among the defined target species (cf. Introduction) none of the meadow birds, and only Yellowhammer of the farmland birds, were found to show a positive response to the initiatives. However, it is worth mentioning that Corn Bunting was registered on five points, all with established initiatives, which may indicate that this species could have benefitted if not falling short of our criterion of minimum sample size. Corn Bunting is scarce in the eastern parts of Denmark where most study sites were located and, in areas where the species is more numerous, a significant positive response might be expected. Some of the defined target species are generally not found on rotational arable fields or breed only sporadically in the country (e.g. Whinchat, Northern Wheatear, Meadow Pipit, Quail, and Yellow Wagtail). These cannot be expected to respond strongly to small-scale initiatives on otherwise cultivated land, and their status as relevant target species may be questioned. Others, such as Skylark, Lapwing, Starling, and Linnet, were observed regularly but showed no significant responses. Grey Partridge was expected to find suitable habitats in the investigated initiatives but was only observed once, highlighting how rare this species has become in Denmark in recent years (Kahlert et al. 2008). All in all, the above may indicate a slight mismatch between aim and effect of the biotope plan initiatives. The reason for this may partly be a strong preference for certain types of initiatives among the involved landowners. For instance, not a single "Lapwing depression" (initiative with uncultivated and temporary wet patches favouring meadow birds, Appendix SA) was observed on the 20 estates. In addition, despite the opportunity to create strips of bare soil and/or short grass mid-field, almost all were established along existing hedgerows, scrub or forest. This renders them unsuitable for species such as Skylark, Lapwing, and Meadow Pipit that favour large, open areas (Bertholdt et al. 2017; Copland et al. 2012). To benefit these species, the strips should to a greater extent be established in the middle of fields or in field margins without scrubs and trees. To support this argument, Lapwing was commonly registered on the counts but never near any of the investigated initiatives, and Skylark was the second most registered species but showed no preference for the initiatives used. Alternatively, the strips might be abandoned altogether in favour of establishing more permanent fallows or set-aside areas with open vegetation, which have shown a positive effect on avian diversity both in our study and elsewhere (Staggenborg and Anthes 2022; Traba and Morales 2019). Such areas are also known to have higher biomass of invertebrate foods compared with rotational areas (Wilson et al. 1999).

While the majority of the benefitting species were already common and widespread in Denmark, the positive indications for Reed Bunting and significant positive response of Yellowhammer were noteworthy (listed as "Near Threatened" and "Vulnerable" on the Danish Red List; Moeslund et al. 2023). While the size of the current data set prevents thorough analyses of species-specific responses to certain types of initiatives, Reed Bunting (10 registrations in the close proximity counts) seemed to benefit from the creation of lakes in otherwise drained and cultivated landscapes, while Yellowhammer (29 registrations in the close proximity counts) was associated with all six types of initiatives, and may simply have benefitted from the heterogeneity created in otherwise uniform farmland. The increasing homogenisation of agricultural land is an often-mentioned driver of avian diversity declines (Andersen et al. 2023; Donald et al. 2001; Sálek et al. 2018), and the small structurally complex habitats offered by some of these agro-environmental initiatives may therefore benefit some scrubland and open land species. Previous investigations of small non-cultivated farmland habitats in Denmark suggest that these are often highly nutrient-enriched and low in biodiversity (Fredshavn et al. 2015), but for some generalist avian species the combination of cover and accessible invertebrate food (even if only a few abundant and common species) may be enough to form a suitable habitat. The positive response of species such as Dunnock, Song Thrush, and Common Whitethroat may be examples of this.

The initiatives implemented based on the Danish biotope plans are very similar to agro-environmental initiatives found in several other countries (Di Giacomo and de Casenave 2010; European Commission, 2021), and while agricultural landscapes and avian species composition may differ across geographical regions, our findings are likely to have value beyond national borders. Other studies of how uncultivated habitats in agroecosystems may form avian diversity demonstrate varying outcomes, and the effect is likely to depend on the exact initiatives implemented, the species in question, and the benchmark used for comparison. Nonetheless, initiatives resulting in the break-up of otherwise uniformly cultivated land tend to show positive effects on avian diversity and abundance. To this end, both Traba and Morales (2019) and Staggenborg and Anthes (2022) highlighted that fallow land might be important for the future conservation of birds in agricultural ecosystems, Di Giacomo and de Casenave (2010) found a positive effect of field margins with grass and scrubs, and Kämpfer et al. (2022) demonstrated that even Christmas tree plantations may function as important refuges for farmland birds in intensively cultivated areas. The ability to differentiate between initiatives with and without clear positive effects on biodiversity is important to underpin future decision-making and may be used to guide agro-environmental policy-making such as the EU Common Agricultural Policy (CAP) (Díaz et al. 2021).

The fact that we found no effect of the initiatives on distantly observed species (>50 m from the observer) indicated that the effect on avian diversity was very local. It also supported the important underlying assumption that treatment and control plots were similar in terms of the surrounding context (i.e. landscape and avian activity) and only differed by the presence or absence of the specific initiative under investigation. As shown by, for example, Concepción et al. (2008) and Giralt et al. (2021), the effect of local initiatives may depend on landscape complexity at the regional scale. While this may have affected the degree to which bird diversity responded in our study sites, it is unlikely to bias our analyses as treatment and control plots were placed in the same geographical area and landscape setting.

At the time of data collection in late May, some estates had not yet fully implemented all initiatives registered for the given year. Hence, on a few occasions, bare soil strips were not yet established, grass strips were not yet mown, and vegetation strips appeared as old, withered vegetation that had not yet been reseeded in the new year. To capture the actual value at the time of breeding for local birds, all these initiatives were included as they appeared at the time irrespective of the timing of establishment and/or sowing. However, this highlighted that some initiatives may currently be established too late to benefit breeding birds and we recommend an earlier establishment to maximise benefits.

Looking at the overall species composition of the agricultural landscapes included in our study, the most frequently recorded species on the estates was Pheasant. While this might be surprising given that the species is introduced in Denmark, this was clearly the effect of the stocking of game birds on the estates implementing biotope plans. This highlights that current stocking intensities have clear effects on the composition of the local avifauna. Our study was not designed to look at effects of this stocking on invertebrates or other avian species, but previous work has shown that stocking of Pheasant may affect invertebrate biodiversity locally (Hall et al. 2021; Neumann et al. 2015). Reported effects on avifauna are often mixed or benign, which may be due to opposing effects from assumed negative (e.g. food competition and disease spread) and positive (e.g. habitat improvements and food provisioning) impacts (Draycott et al. 2008, 2012; Sage et al. 2020). In our case, it should be noted that counts were undertaken in May prior to the release of game birds in the given year, emphasising that even before the annual release of Pheasants (usually in late summer), the number of birds surviving from previous years was high enough to render this species the most often registered in these areas. British studies have indicated that <20% of released Pheasants survive until after the hunting season (Game & Wildlife Conservation Trust 2004; Madden et al. 2018), meaning that the number on these estates is probably much higher during autumn and winter. A recent investigation of the release of Pheasants for hunting purposes in Denmark concluded that stocking rates likely exceed the officially reported numbers (Kanstrup and Christensen 2023), and further studies clarifying the effects of stocking on local biodiversity may be important to continue justifying current practice. Nonetheless, the stocking of Pheasants currently is the reason that these agro-environmental initiatives are implemented in the first place, and at present the species (although introduced) is among the targeted species of the biotope plans (Danish Environmental Protection Agency 2018).

Among the other frequently encountered species were a number of large conspicuous birds such as Wood Pigeon, Hooded Crow *Corvus cornix*, Rook *Corvus frugilegus*, Black-headed Gull *Chroicocephalus ridibundus*, and Herring Gull *Larus argentatus*, which are all easily registered because of their behaviour and/or very vocal nature (this holds for Pheasant as well). In addition, several smaller species with high song activity at this time of year were also frequently reported, including Skylark, Blackbird, Common Whitethroat, Chaffinch, and Blackcap *Sylvia atricapilla.* While point counts will undoubtedly be somewhat biased by favouring the registration of species that are very visible and/or vocal (Fontúrbel et al. 2020), the same can be said about all commonly used counting techniques and is something that is difficult to avoid. While this may lead to species-specific differences in detectability, the applied approach including all species seen and heard during the monitoring period, should ensure a representative picture of species composition in the open agricultural landscapes on these estates. Due to our paired set-up and sampling of the paired counts in the same area at the same time and by the same observer, the most obvious sources of bias in our measure of diversity were minimised (Ralph et al. 1995). Apart from the stocked Pheasants released in close vicinity of the conducted counts in this study, there is no reason to believe that species composition on these estates should be markedly different from the rest of the Danish open agricultural landscapes.

Management implications

We conclude that the establishment of biotope plans have an overall positive effect on avian diversity in Denmark and demonstrate that permanent and structurally complex agro-environmental initiatives such as open vegetation, hedgerows, scrub, and lakes can have a positive effect on species richness. The species benefitting the most from current implementation of the biotope plans are already common scrubland and woodland species, while the intended positive effect on open land species (meadow and farmland birds) has not been obtained. At present, there is no clear indications that biotope plans will make a difference for the most threatened species nationally, but they may improve avian diversity locally by benefitting a number of relatively common species, which in turn may raise the recreational value of the nearby agricultural land (Weyland et al. 2021).

To improve the existing scheme and favour more of the targeted meadow and farmland species, we suggest including incentives to implement currently little-used initiatives aimed at the habitat requirements of meadow and farmland birds. These include uncultivated patches, wet depressions with natural vegetation, and the establishment of strips of bare soil and/or low vegetation mid-field. The current usage of strips (placed along field margins near existing uncultivated areas) had no obvious positive effect. The highest benefit may come from encouraging the establishment of more permanently uncultivated open areas, allowing for natural processes and higher biodiversity in both birds and other taxonomic groups (Newbold et al. 2015). Finally, an earlier or permanent implementation of existing measures will ensure that they are in place at the time of breeding for most of the relevant target species.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0959270924000224.

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