



European bird declines: Do we need to rethink approaches to the management of abundant generalist predators?

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Abstract

1. Bird species are declining across Europe. Current European policy, that is, the Birds and Habitats Directives, focus on habitat management as a way of halting the declines. This paper explores the role of predation in causing bird population declines and asks if we need to reconsider our approach to the management of generalist predators.
2. We analysed bird population trends and distribution changes across Europe, Britain and Ireland, reflecting an increasing gradient of generalist predator abundance (principally red fox *Vulpes vulpes* and species of the family *Corvidae*). We tested if ground-nesting bird species, considered more vulnerable to predation, were in greater decline compared to other nesting strategies. We also compared Annex I designated species to non-designated species as a proxy for habitat management.
3. We found that across Europe, 74% of ground-nesting bird species were in decline, compared to 41% of other species. This was especially evident in Britain, where the pattern was 66% compared to 31%, and in Ireland, 71% compared to 20%. Ground-nesting species were significantly more likely to be declining than other species.
4. These patterns are consistent with the idea that population declines are at least partially related to the increased abundance of generalist predators. In Britain, ground-nesting species were less likely to be in decline if covered by Annex I designation. However, in Europe and Ireland, Annex I status did not mitigate the effect of nesting strategy.
5. *Policy implications.* Current legislation is clearly insufficient to prevent widespread declines in ground-nesting birds, and this is the case across Europe, in Britain and Ireland. Ignoring the role of generalist predators in modern landscapes may lead to further declines and losses. We urgently need large-scale experiments to establish causality in the impact of generalist predators on ground-nesting birds in different landscapes. If we value our ground-nesting bird species, consideration needs to be given to the control of widespread generalist predators, at least until landscapes are restored.

KEYWORDS

conservation, Europe, ground-nesting birds, habitat, landscape, mesopredator, predator control, wildlife management

1 | INTRODUCTION

Many European breeding bird populations are in decline (Inger et al., 2015). The causes of these declines reflect recent anthropogenic impacts, many driven by agriculture (Butler, Boccaccio, Gregory, Vorisek, & Norris, 2010; Chamberlain, Fuller, Bunce, Duckworth, & Shrubbs, 2000; Newton, 2004), and studies have focused on the effects of agriculture and other forms of habitat loss, degradation and fragmentation, invasive species and climate change (e.g. Butchart et al., 2010; Stephens et al., 2016). The change to agricultural policy across Western Europe (Stoate et al., 2009) has intensified food production systems and has negatively affected the coexistence of agriculture and biodiversity (Krebs, Wilson, Bradbury, & Siriwardena, 1999; Robinson & Sutherland, 2002). A particular focus has been on the impact of such habitat changes on bird populations and the continuing declines despite the use of conservation instruments (Heldbjerg, Sunde, & Fox, 2018). Sanderson et al. (2016) highlighted the role of habitat management in driving declines of many European bird species. These authors used Annex I listing under the 1979 Birds Directive (2009/147/EC) as a proxy for the effects of habitat management: under the legislation, Annex I species are subject to special conservation measures with a particular focus on habitat interventions (European Union, 2009). Both Sanderson et al. (2016) and Donald et al. (2007) found that species under Annex I showed favourable population trends, compared to non-Annex I species. However, other equivalent studies found mixed results for the effects of European conservation policy instruments on birds (Santana et al., 2014).

Increased predation from generalist predators as a result of anthropogenic changes is also a plausible contributory factor explaining widespread population declines of birds across Europe, but the hypothesis has received relatively little attention. In addition, neither the EU Birds Directive nor the Habitats Directive consider generalist predator management as a way of reversing declines. Despite this, generalist predators are known to play a role in limiting populations of birds, especially ground-nesting birds, such as waders, wildfowl and gamebirds (Fletcher, Aebischer, Baines, Foster, & Hoodless, 2010; Ludwig, Roos, & Baines, 2019; Newton, 1993; Roos, Smart, Gibbons, & Wilson, 2018). Moreover, across Europe, there is evidence of increases in certain generalist avian predators, including carrion crow *Corvus corone* and raven *Corvus corax*, particularly in intensive agricultural landscapes (<https://pecbms.info/trends-and-indicators/species-trends/>; Roos et al., 2018; Sainsbury et al., 2019). If predation is a factor causing declines, then a focus on habitat alone may, in some cases, be misguided.

The role of predation is hard to test, because of the paucity of data concerning predation across Europe. However, two factors

may allow us insight into the potential role of predation in causing population declines. First, we know that ground-nesting birds are particularly sensitive to the effects of predation, especially from mammals (Roos et al., 2018; Yanes & Suárez, 1995). Therefore, if predation is a factor, we might expect ground-nesting birds to be declining more than other species. Second, there is evidence that the abundance of generalist predators, such as red fox *Vulpes vulpes* and corvid species, varies spatially with greater densities occurring in Britain and Ireland compared to other European countries (Harris & Yalden, 2008; Roos et al., 2018). Therefore, we might expect ground-nesting birds to be declining more in Britain and Ireland than in other European countries. In addition, if predation rather than habitat was driving population declines, we would expect the same patterns to be occurring in Annex I species with habitat management measures and non-Annex I species without any such measures.

In this paper, we use existing datasets to explore patterns of population declines in ground-nesting and other species accompanied by associations with their conservation status. We consider the implications of our findings for ground-nesting bird species and the implications for current policy and the way we manage abundant, generalist predators.

2 | MATERIALS AND METHODS

2.1 | Data collection and collation

Data were drawn from the Pan-European Common Bird Monitoring Scheme (PECBMS; <https://pecbms.info/trends-and-indicators/species-trends>) and Bird Atlas 2007–2011 (Balmer et al., 2013). PECBMS provides a percentage change in population represented by an index value between 1980–1998 and 2016 for breeding species in Europe, whereas Balmer et al. (2013) were used to provide an index of distribution change between 1988–1991 and 2008–2011 for species breeding in Britain and Ireland. For the purposes of this study, Britain incorporates mainland UK and Ireland incorporates the island of Ireland. The numbers of species analysed were as follows: Europe ($n = 162$), Britain ($n = 171$) and Ireland ($n = 107$).

Each species was classified according to its nesting strategy, ground-nesting or other (as ground-nesting species are considered more vulnerable to predation), its classification as an Annex I species under the EU Birds Directive 2009/147/EC, Annex I or non-designated (a proxy for habitat management) and its association with agricultural habitats for breeding (primarily agricultural or other, following Tucker & Evans, 1997). We excluded species if there was insufficient data, limited range or distribution or extreme trends.

A range of seabird species were also not included as this study focused primarily on terrestrial species and not those breeding on offshore islands or on cliffs. In addition, species from the PECBMS considered outliers due to effects on the residual plots were removed from the analyses (see Appendices S1 and S2). Taxonomic order and migration strategy (following Snow & Perrins, 1998) were also classified (see Appendix S3).

2.2 | Statistical modelling

Europe, Britain and Ireland data were analysed using three separate linear mixed models (LME4; Bates, Mächler, Bolker, & Walker, 2015). We tested if species index change was influenced by nesting strategy or Annex I status. An interaction term between nesting strategy and Annex I status was included and association with agricultural habitats for breeding was included as a blocking variable. Migration was also tested as a fixed effect but it was removed as there was no significant difference between the four migration status groups. Taxonomic order was included as a random effect. All analyses were conducted using R (R Core Team, 2018; see Appendix S4).

3 | RESULTS

In Europe, 74% of ground-nesting birds were in decline compared to 41% of other nesting birds ($n = 162$). In Britain, this ratio was 66%–31% ($n = 171$) and in Ireland, 71%–20% ($n = 107$). In all three models, the average index change was significantly more negative in ground-nesting birds compared to other species index changes after controlling for variation in taxonomic order (Table 1; Figure 1). In Britain, the average index change was also significantly more negative for non-designated species compared to Annex I species. In contrast, the average index change in Ireland was significantly more negative for Annex I species than for non-designated species. There was no interaction between nesting and Annex I status in any of the models. Full model outputs are presented in Appendix S5. In addition, ground-nesting species were in decline regardless of their associations with agricultural habitats.

TABLE 1 Estimate (β) and standard error (SE) for nesting strategy and designation, after controlling for variation in taxonomic order, along with the associated likelihood ratio test p value for the Europe, Britain and Ireland models

Model	Variable	β	SE	p Value
Europe	Other nesting strategy	39.19	10.29	<0.001
	Annex I designation	3.12	12.4	0.796
Britain	Other nesting strategy	0.14	0.06	0.013
	Annex I designation	0.16	0.07	0.018
Ireland	Other nesting strategy	0.19	0.06	0.003
	Annex I designation	-0.17	0.09	0.043

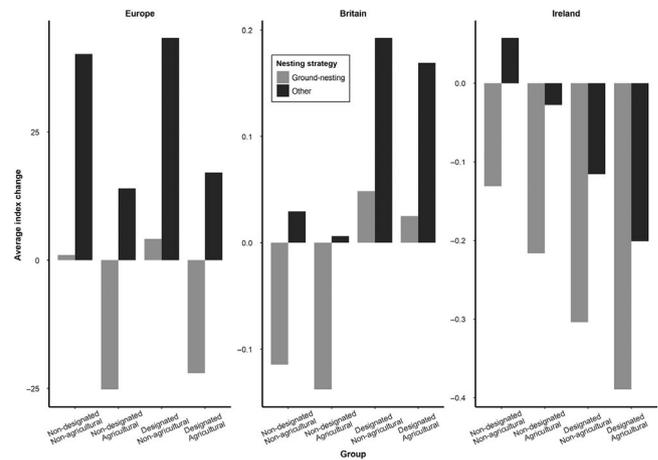


FIGURE 1 Average index change for species in Europe, Britain and Ireland. Groups are specified according to Annex I designation status and agricultural breeding habitat status. The average index change is provided for ground-nesting and other species within each group

4 | DISCUSSION

Our study provides evidence that is consistent with the hypothesis that generalist predators are playing a role in the declines of bird species across Europe. The results highlight the parlous state of European ground-nesting birds, often despite existing conservation efforts. Across Europe, 74% of ground-nesting bird species for which we have data show evidence of long-term decline. In Britain and Ireland, ground-nesting birds are suffering similar declines, with equivalent figures of 66% and 71%, respectively. In all cases, ground-nesting birds are declining or undergoing range contraction significantly more than other species. This pattern is perhaps not so surprising given the evidence that the control of predators can lead to increases in populations of certain ground-nesting bird species (e.g. Fletcher et al., 2010; Ludwig et al., 2019; Newton, 1993; Roos et al., 2018), which indicates that predators can limit populations, and that predators have increased over time but currently there is no policy to deal with this ecological challenge.

The effect of habitat management, in the form of SPA and Annex I designation, was included in our analyses due to the finding that the EU Birds Directive has a positive effect on bird conservation across Europe (Donald et al., 2007; Sanderson et al., 2016). Although we found that Annex I designation reduced the extent of decline in ground-nesting species in Europe, this reduction was not statistically significant. The effectiveness of the primarily habitat-based designation in Ireland is questionable for ground-nesting species based on our findings, as we found that the average 20-year index change in Ireland was more negative for Annex I designated species than non-designated. Perhaps this could be explained by variation in the management strategies and quality of Natura 2000, as Annex I status in Britain had a positive effect on bird species in the current study. For example, an assessment of the status of habitats under the Habitats Directive in Ireland revealed that 9% were in Favourable condition whereas 50% were in Adequate condition and 41% were in Bad condition (NPWS, 2013). Also, the

Republic of Ireland is one of the EU member states with the lowest proportion of Annex I habitats in 'favourable' conservation status, and has among the highest proportion of habitats in 'unfavourable-bad' conservation status, the lowest quality status (EEA, 2015).

Recent changes in landscapes, particularly agricultural mosaics, may facilitate the proliferation of predators and predation and alter predator-prey interactions (Shapira, Sultan, & Shanas, 2008). The Republic of Ireland and the UK have experienced increased forest cover that is considerably higher than the general European trend from 1990 to 2006, although the amount of forest cover is low compared to other European countries (Kuemmerle et al., 2016). In the Republic of Ireland, forest cover grew from 6.8% of total land use in 1980 to 10.6% in 2014 (Central Statistics Office, Ireland, 2016), and in the UK grew from 9% in 1980 to 13.1% in 2017 (Forestry Commission, 2017). In addition, there is increased land management intensity in the west of Europe (Kuemmerle et al., 2016). Mosaics within agricultural landscapes interspersed with human settlements along with afforestation create predation pressure for ground-nesting birds (Batary & Baldi, 2004; Reino et al., 2010).

While the correlative evidence from this study strongly implicates generalist predators in causing declines in European bird populations, this does not mean that predation is necessarily the ultimate cause of the decline. Habitat composition and landscape configuration may also have an impact (Batary & Baldi, 2004; Reino et al., 2010). Such changes may lead to predator impacts being most severe where landscapes have become fragmented and heterogeneous (Andr n, 1994). Similarly, the impact of predators may be a consequence of abundant alternative prey, such as millions of pheasants released for shooting in the UK (Lees, Newton, & Balmford, 2013; Pringle, Wilson, Calladine, & Siriwardena, 2019), or the disappearance of apex predators and the absence of trophic cascades (Crooks & Soul , 1999; Ritchie et al., 2012). There are arguments, therefore, that the impact of increases in generalist predators could be countered through large-scale habitat restoration, changes in land use and the reintroduction of apex predators (Ritchie et al., 2012). However, the large-scale recovery in large carnivores across Europe in recent years (Chapron et al., 2014) has not resulted in reversed declines in birds in the EBCC, as yet.

Predator management is a controversial topic for multiple reasons (Lennox, Gallagher, Ritchie, & Cooke, 2018). Ethical arguments against lethal predator control raises issues about whether it is acceptable or necessary and if it is, how it should be applied (Lennox et al., 2018; Messmer, Brunson, Reiter, & Hewitt, 1999; Reiter, Brunson, & Schmidt, 1999; Warburton & Norton, 2009). In addition, there are disagreements about whether lethal predator control should be a routine part of conservation management (e.g. Bergstrom et al., 2014; Reynolds & Tapper, 1996; Treves & Naughton-Treves, 2005; Warburton & Norton, 2009), particularly when there are many potential negative externalities associated with the loss of predators from a system (Estes et al., 2011). However, there is some evidence that interventional predator control may prove productive at delivering conservation objectives (Gilsdorf & Rossi, 2008; K mmerle & Storch, 2019). This indicates that predator control, in some cases, may be useful for the greater good of populations,

despite the sacrifice of some individual animals. These are important and growing debates. Social drivers are leading to the application of focused ecological solutions to debates around controversial topics in wildlife such as predator management.

There may be a requirement for lethal predator control to protect endangered ground-nesting bird species, at least in the short term (Roos et al., 2018). There is also an imperative to scientifically evaluate the merits or otherwise of this approach in the long term as an effective conservation strategy to aid vulnerable or endangered bird populations (Smith, Pullin, Stewart, & Sutherland, 2010). Ultimately, there is an urgent need for large-scale experiments to test the relative importance of predation, habitat and landscape in driving population declines in ground-nesting birds in different landscape configurations to formulate and justify difficult policy creation and implementation. Changes to landscapes will happen over the long term. In the meantime, if we value our ground-nesting birds, it may be advisable to collect accurate data on predators and to reconsider their management.

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AUTHORS' CONTRIBUTIONS

B.J.M. and S.M.R. conceived the idea and wrote the research paper; S.D., A.G. and S.B.A.K. collated the data; S.D. analysed the data with support from B.J.M. and A.G. All authors contributed to drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Data available via the Dryad Digital Repository <https://doi.org/10.5061/dryad.xksn02vck> (McMahon, Doyle, Gray, Kelly, & Redpath, 2020).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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