Ecological Indicators 85 (2018) 563–569

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Original Articles

Continent-wide test of the efficiency of the European union's conservation legislation in delivering population benefits for bird species

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A R T I C L E I N F O

Keywords:
Birds
Legal protection
Birds Directive
Annex I
Traits
Population trends

A B S T R A C T

Birds are among the most important organisms for indicating the state of environmental health and their population changes may be thus informative for assessments of country-level conservation tools. One such tool applied in the European Union (EU) is the Birds Directive which (together with general protection of all bird species) lists a number of species under its Annex I and these species enjoy specific protection conditions. Although some previous studies found indications of the efficiency of the Annex I in delivering benefits for the listed species, the assessments where either confined to the so called old member states (i.e. countries entered EU before 2004) or did not include countries outside EU as a suitable control group. Therefore, it remains unclear whether this tool is efficient also in the new EU-member states (i.e. countries entered EU from 2004 onwards). For this purpose, we used publicly available information source and assembled a dataset providing country-level population trends of 252 European breeding bird species estimated for the time period 2001–2012 in 33 European countries containing old member states, new member states and non-member states. We predicted that if efficient, then listing the species under Annex I would result in significantly positive population trends of the listed species in EU countries irrespective to the time of their enterance, while no such pattern should be observed in non-EU countries. We tested this prediction using linear mixed effect models controlling for the effects of 11 species' traits reflecting the influence of other factors (e.g. climate change, land cover change, proximity to range edges) on trends and including the species and country indentifiers as random effects. We found that the listing under the Annex I had significantly positive effect on bird trends in both old and new member states, whereas no such effect was observed in the non-member states. Although the positive influence of listing was larger in the old and than in the new member states, the difference was not statistically significant. Our results imply that the Annex I of the Birds Directive is an important tool for bird conservation in Europe and that its positive influence on bird populations is detectable even in the new EU members entering EU relatively recently. As birds are often used as indicators also for other groups of organisms, these results suggest that not only birds may benefit from EU's conservation legislation but comprehensive assessments are needed.

1. Introduction

Due to their generally large body size, diurnal activity and popularity among citizen scientists (Jiguet et al., 2012; Morelli et al., 2014), birds play a major role in indicating efficiency of conservation actions (Butchart et al., 2010). For instance, annual changes in population size of farmland birds were used to develop the Farmland Bird Index (Gregory et al., 2005), which is included among official indicators of environmental health in the European Union (EU). As indicators, populations of bird species mirror influences of factors acting at larger spatial scales (Gregory and van Strien, 2010) and their population changes may be thus informative for assessment of country-level conservation tools.

One of such conservation tools applied at the country level is legal protection of endangered species (McCarthy et al., 2012). By that means, species with unfavourable population status may be listed as protected in a given country and specific regulations (e.g. prohibition of their hunting and disturbance of individuals, restrictions to alteration of their habitats, direct support of impoverished populations) are agreed as the measures aiming to improve their populations (Vorisek et al., 2008). If efficient, population trends of species being listed as legally protected should be more positive than the trends of the species for which no such tool was developed (Koleček et al., 2014), although a time lag may exist between the time of listing and detectable population improvement (Male and Bean, 2005).

In EU, legal protection of birds is applied through the Birds

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https://doi.org/10.1016/j.ecolind.2017.11.019
Received 15 June 2017; Received in revised form 7 November 2017; Accepted 8 November 2017
1470-160X/

Directive which states general conditions for protection of all bird species on the territory of EU-member countries (Council Directive 79/409/EC on the conservation of wild birds). In addition, the Birds Directive also lists a number of species under its Annex I and these species enjoy specific protection conditions, most notably manifested by establishment of Special Protected Areas (SPAs) conserving key sites for these species in individual countries (Donald et al., 2007). Such a combination of species- and area-focused protection may be a particularly powerful tool for conserving of animal populations (Sutherland, 2000) and, for that reason, it deserved high attention from the side of researchers testing its efficiency (e.g. Donald et al., 2007; Pellissier et al., 2013; Sanderson et al., 2016; Gamero et al., 2017). Specifically, they tested whether species listed under Annex I really benefited from their listing, i.e. whether it resulted in significant improvement of their population status.

These previous studies found that the listing of the species under the Annex I of the Birds Directive contributes significantly to their population increase (Donald et al., 2007; Gamero et al., 2017) and that the population improvement was larger with the longer the time since listing (Sanderson et al., 2016). However, the previous tests also showed a great difference between the old and new EU-member states (i.e. the states that entered EU before 2004 and the states entered from 2004 onwards, respectively) when the significant improvement was found only in the old members, but not in the new members (Sanderson et al., 2016). This finding thus poses an important question, whether the efficiency of this legislative tool for bird conservation is confined specifically to some selected countries being part of European democratic structures for considerably long time, while it may fail to provide conservation benefits in the new member states which underwent different historical development, as some studies already showed that these historical differences mirror in bird population changes (Reif et al., 2011; Koleček et al., 2015).

To fill this knowledge gap, our study, for the first time, assembled publicly available data on bird population trends from 2000 to 2012 in 33 European countries of a continent-wide coverage including the states in the Eastern part of Europe (e.g. Russia, Belarus and Ukraine) whose bird populations have almost been neglected up to now. This set of countries includes (i) the states entering EU before 2004 (i.e. the 'old member states' or EU-15), (ii) the states entering EU from 2004 or onwards (the 'new member states') and (iii) the states being non-members of EU. Such a design provides a strong test for the impact of listing the species under the Annex I assuming that the population trends estimated over the focal time period were affected by the entrance of a given country into the EU.

In this context, we tested two predictions. (i) If this legislative tool was efficient, then listing the species under Annex I would result in significantly positive population trends of the listed species in the EU member states irrespective to the time of their enterance, while no such pattern should be observed in the non-member states. (ii) If the time since listing matters, we predict that the population trends of the listed species should be more positive in the old member states than in the new member states.

In addition to the effect of legal protection, interspecific variability in population trends is influenced by various other factors including land use change, climate change or proximity to range edge (e.g. Devictor et al., 2012; Cuervo and Møller, 2013; Diaz et al., 2015). Their influence may be quantified by the relationships between the trends and species-specific traits reflecting the effects of particular environmental filters thereby a group of species sharing a given trait should exhibit similar population trends (Webb et al., 2010). Therefore, we considered the species' traits recently recognized by a review of Reif (2013) as important predictors of bird population trends and accounted for their effects in the analysis (see Table 1 for the expected relationships and their justifications).

2. Materials and methods

2.1. Population trends

We focused on 252 bird species breeding in Europe that were previously analysed for potential range shifts by Koschová et al. (2014), see Supplementary Table S.1. We excerpted their national population trends for 33 European countries (Supplementary Table S.2) over the time period from 2001 to 2012 from the European Red List of Birds (BirdLife International, 2015). Because not all species breed in every country, we finally obtained the dataset with 4459 species-country combinations. These trends were expressed as relative change over the focal time period in per cent when negative percentage values quantified population declines, whereas positive percentage values quantified population increases (BirdLife International, 2015). When the trend was provided as a range of the maximum and minimum estimates (e.g. decline from −30% to −60%), we calculated the mean trend from these values (i.e. −45%). Quantification of population change as percentage raises concerns about comparability of the magnitude of change between declining and increasing species since doubling the population size equals to the increase by 200%, while reducing the population to one half equals to the decline by 50%. These incomparable values make inference from interspecific comparisons of such trends impossible (Lemoine et al., 2007). Therefore, we followed Lemoine et al. (2007) and recalculated the population change using the expression $(N_{t+1} - N_t)/((N_{t+1} + N_t)/2)$, when N_t is population size in the time t (i.e. 2000) and N_{t+1} is population size in the time $t + 1$ (i.e. 2012). N_t was set to 100% and N_{t+1} was the relative population change proportional to the original trend value (e.g. for the population decline by −20%, the $N_{t+1} = 80\%$; for the population increase by 20%, the $N_{t+1} = 120\%$). By that means, we obtained an index of population change ranging from −2 to 2, when negative values correspond to population declines, positive values to population increases and zero to no change. Values of this index are symmetrical for population declines and increase (for instance, doubling the population size equals to the index value of 0.67, while reducing the population size to one half equals to the index value of −0.67). This population index was thus taken as a response variable for further analysis.

2.2. Annex I species and country classification

To focus on testing the efficiency of listing the species under the Annex I of the Birds Directive, we discriminated the species being listed (1) from those being unlisted (0) according to the information in BirdLife International (2015), see Supplementary Table S.1. Since we expected country-specific effects of being listed on species' population trend varying according to the time a given country entered EU, we classified the countries as the old member states (i.e. countries which entered EU before 2004), the new member states (i.e. the countries which entered EU from 2004 onwards) and non-member states (i.e. the countries which did not access EU). This classification was expressed as a three-level factor 'country status' (Supplementary Table S.2) and was used as a country-specific explanatory variable for further analysis.

2.3. Species' traits

For each species, we collected information about the following 11 traits (see Table 1 for summary information and Supplementary Table S.1 for trait values for each species).

Habitat use was expressed using four variables taken from Koschová et al. (2014). Each species was assigned to one of more habitats along a gradient from forest interior (position of 1) to open treeless landscape (position of 7) assessed in Böhning-Gaese and Oberrath (2003). From this assignment (i) habitat niche position was calculated as the mean value of across habitats used by a given species (Reif et al., 2011). As a complement to the habitat niche position, (ii) habitat niche breadth was