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Coverage of vertebrate species distributions by Important Bird and Biodiversity Areas and Special Protection Areas in the European Union

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ABSTRACT

The European Union (EU) has an extensive protected area network, including Special Protection Areas (SPAs) designated under the Birds Directive. Important Bird and Biodiversity Areas (IBAs) are sites of international significance for birds identified by BirdLife International. Here, we perform EU-wide terrestrial spatial conservation prioritizations to evaluate the coverage of IBAs by SPAs, and the coverage of bird and other vertebrate distributions by IBAs and SPAs. We then investigate the distribution of potential locations for expanding the SPA network that maximize bird species' representation, and the coverage of these locations by IBAs. On average, SPAs cover 23% of the EU-wide distribution of each bird species and 25% of the distributions of amphibians, reptiles and mammals together, while IBAs provide marginally greater coverage. Overall, 76% of terrestrial IBAs in the EU are completely or partially covered by SPAs, and 66% of the IBA network area is covered by SPAs. Our results suggest that SPA designation has been significantly informed by data on the location of IBAs. While IBAs are identified using data on particular bird species of conservation concern, they also tend to have high EU-wide representation of other vertebrates. The designation of new or expanded SPAs covering a relatively small amount of currently unprotected land (particularly in the southern EU) would substantially increase SPA coverage of bird species ranges. Our analysis provides insights on the current contribution that these sites make to conserving vertebrates across the EU, and future possibilities for efficiently expanding the network.

1. Introduction

In Europe, one of the oldest policy tools for bird conservation is the 1979 European Union (EU) Birds Directive (2009/147/EC), which covers all naturally occurring wild bird species in the EU (European Commission, 2015a). One of its aims is to conserve the habitats of particularly threatened species (listed on Annex I) and migratory species by designating key sites as Special Protection Areas (SPAs). Along with Sites of Community Interest (SCIs) designated as Special Areas for Conservation (SACs) for other taxa and habitats under the 1992 EU Habitats Directive (92/43/EEC; European Commission, 2015b), SPAs form the EU-wide Natura 2000 network of protected sites, which is at the core of the EU's biodiversity strategy (European Commission, 2011). Site selection for Natura 2000 has been a process guided by the European Commission and implemented in collaboration with the 28 EU Member States (Evans, 2012; European Commission, 2015a, 2015b).

Important Bird and Biodiversity Areas (IBAs) are sites of international significance for bird conservation. Worldwide, >12,000 IBAs have been identified by the BirdLife International Partnership, using standardized data-driven selection criteria based on threat and irreplaceability (Fishpool et al., 1998; BirdLife International, 2011, 2014). In Europe, 20 criteria with different numerical thresholds have been used to identify IBAs of global (A), European (B) and EU (C) significance (Heath and Evans, 2000). The latter were developed and applied explicitly to identify sites qualifying for designation as SPAs, and the IBA inventories listing them have been recognized as providing the best available scientific evidence by the European Court of Justice in several cases brought against Member States for failure to designate sufficient SPAs (e.g. Case C-3/96, Case C-202/01, Stroud, 2011; Evans, 2012; BirdLife International 2013,

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2014). By 2013, two thirds of the terrestrial area of IBAs in the EU had been designated as SPAs (BirdLife International, 2013).

Protected areas are an effective tool for biodiversity conservation worldwide, and many species are highly dependent on them for their persistence (Watson et al., 2014). However, many protected areas have been designated based on little data on biodiversity, or using information on a limited number of taxa (Rodrigues and Brooks, 2007), often leading to a situation where species are only protected coincidentally, rather than intentionally. Birds are known to be useful surrogates for other biodiversity in many cases, and their protection is expected to provide benefits to other taxa (Roberge and Angelstam, 2004; Gregory et al., 2005; Larsen et al., 2012). IBAs have been shown to be important sites for non-avian taxa as well (Brooks et al., 2001; O'Dea et al., 2006; Butchart et al., 2012, 2015; Di Marco et al., 2015).

While the effectiveness of protected areas varies, knowing how well species are covered by protected areas is key to understanding the network's potential impact. Due to increases in available data, spatial conservation prioritization tools have become more common in investigating species coverage by protected areas (Pouzols et al., 2014). While linking to systematic conservation planning (SCP; Margules and Pressey, 2000) and accounting for complementarity, spatial prioritization can be used, for example, to identify spatial priorities, identify locations important for expanding current protected area networks, and understand species' coverage by protected areas.

A number of studies have demonstrated the effectiveness of the Birds Directive and SPAs in conserving wild birds in the EU (Donald et al., 2007; Devictor et al., 2007; Pellissier et al., 2013; Kolecek et al., 2014; EEA, 2015a; Sanderson et al., 2015; Beresford et al., 2016). Nevertheless, other studies have suggested that current SPAs are insufficient to conserve particular species in the EU (Lopez-Lopez et al., 2007; Abellán et al., 2011; Albuquerque et al., 2013; Van der Vliet et al., 2015). Thus, the adequacy and comprehensiveness of the SPA network remains partly unclear. In February 2014, the European Commission received a mandate to deliver a "Fitness Check" of the Birds and Habitats Directives as part of the Commission's Regulatory Fitness and Performance program (REFIT), aiming at simplifying EU law (European Commission, 2014, 2015c). This exercise confirmed the need to assess the relevance and coherence of the Birds Directive.

Here we combine spatial datasets on SPAs and IBAs with high-resolution vertebrate species' distribution maps (Maiorano et al., 2013). We then analyze these data within a complementarity-based spatial conservation prioritization method (Moilanen et al., 2005). The general aim of this study is to investigate the coverage that the IBA and SPA networks provide to birds and other vertebrates, across the EU and at Member State level, considering the overall representativeness (i.e. the average proportion of species' distributions covered in a network).

Specifically, we first aim to quantify the spatial overlap between SPAs and IBAs, and infer how well IBAs have served to inform the designation of SPAs. Second, we investigate the representativeness of SPAs and IBAs in covering the distributions of birds as compared with other vertebrates within the EU. Third, as these networks may undergo site additions or revisions in the future, e.g. in light of international agreements such as the Convention on Biological Diversity (CBD, 2015) Aichi Target 11 to protect 17% of land, we aim to identify unprotected areas that could be incorporated into an expanded SPA network to efficiently increase coverage of species. In doing so, we also assess the extent to which such potential expansion sites have already been identified as IBAs. Such assessments have not previously been done systematically, and they can provide valuable information for decision-makers.

2. Materials and methods

2.1. Study region and data

SPAs are designated only within the EU, and the process of establishing them at sea is still underway, so we restricted our analysis to the terrestrial area of the EU28 Member States. The vertebrate data used as the input for spatial prioritization were species-specific expert-based distribution models over the Western Palearctic, available for 435 birds (including 181 species on Annex I of the Birds Directive), 85 amphibians, 138 reptiles and 179 mammals (Maiorano et al., 2013; see the full list of species in Appendix A). Known ecological habitat requirements were used to refine species distributions via an expert-based modeling approach to produce a map for each species at 300 m resolution, with each pixel classified as suitable habitat (1) or not (0). Finally, the models were validated using randomizations and known points of presence (Maiorano et al., 2013). For computational feasibility, we aggregated the datasets to a 1.5 km resolution by summing the number of suitable 300 m pixels within each 1.5 km pixel, resulting in pixel suitability values between 0 and 25. The same distribution models have been used in similar studies (Maiorano et al., 2013, 2015; Thuiller et al., 2015).

We rasterized the polygons of all terrestrial SPAs (EEA, 2015b) and IBAs in the EU (BirdLife International, 2015a) to the same extent and resolution as the species data. All datasets were rasterized by using the cell centre method in ArcGIS 10.2.

2.2. Spatial conservation prioritizations

We carried out the spatial prioritizations using Zonation v4 (Moilanen et al., 2014). Zonation is software for ecologically-based land-use planning, and it produces a complementarity-based prioritization across the landscape based on the distributions of biodiversity features and optional data such as costs and connectivity. Zonation ranks cells by iteratively removing (ranking) the least valuable remaining cell until the complete landscape has been prioritized (Moilanen et al., 2005; Lehtomäki and Moilanen, 2013). Occurrence levels of features are tracked through the prioritization, which allows maintenance of balance (complementarity) through the ranking, as features that have lost comparatively much rise in their importance. Across all runs, we used the core area method (CAZ; Moilanen et al., 2005, 2014), which bases ranking on the most important occurrence of a (biodiversity) feature in a grid cell, identifying high-priority areas that include high-quality locations for all features, even those that occur in otherwise feature-poor areas. CAZ is a particularly appropriate method for spatial prioritization when data are available for all species of (conservation) interest across the study area (Moilanen et al., 2005), such as is the case in our study.

We started with an EU-wide spatial prioritization where all bird species in our dataset were considered (Appendix A). Second, we included only amphibians, mammals and reptiles, and finally we included all vertebrate species together (Table B.1). We applied a hierarchical prioritization in Zonation for SPAs with a mask raster file for SPAs. In hierarchical prioritization, all the cells are first ranked from the surrounding area of SPAs, and after that Zonation ranks cells within the SPAs (Lehtomäki et al., 2009; Table B.1). In general, this method allows for a gap analysis and optimal expansion of an existing protected area network, and for comparison between the coverage of species' ranges in different networks, such as SPAs or IBAs. We used different GIS layers to focus the hierarchical prioritizations on: i) all SPAs, ii) all IBAs, iii) areas where SPAs and IBAs overlap, and iv) areas covered by IBAs but not SPAs.

Priority areas for a hypothetical expansion of the current SPA network were also identified by the hierarchical analysis in Zonation. Top-priority cells outside the protected areas (i.e. SPAs) are the ones that most rapidly increase aggregate species coverage and representation in the network. EU Member States have committed through CBD Aichi Target 11 to protect at least 17% of their terrestrial and inland water areas, particularly those of importance for biodiversity, by 2020. Hence, we assessed the expansion of terrestrial SPAs from the current 12.5% to cover a theoretical 17% of the EU. A similar approach was also used by Pouzols et al. (2014) to investigate the potential of expanding the global protected area network.