



Matches and mismatches between national and EU-wide priorities: Examining the Natura 2000 network in vertebrate species conservation



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ABSTRACT

The Natura 2000 (N2k) is a network of protected areas, established to implement the Birds and the Habitats Directives of the European Union (EU) with the goal of conservation irrespective of national boundaries. We provide the first assessment of the whole terrestrial N2k using spatial prioritizations, and high-resolution vertebrate species distribution data. First, we quantified species' representation in the network, and compared it against outcomes of hypothetical optimal planning scenarios at the EU, member state, and biogeographical levels. Second, we examined the spatial configuration of N2k sites and same-sized hypothetical top priority sites based on the three planning scenarios. We found that N2k covered all vertebrate directive species, and the coverage was significantly better than with a random allocation of sites. We observed substantial differences in representation between taxa, followed by the fact that N2k succeeded better in covering threatened and directive species than non-directive species. The current species representation in N2k was closer to optimal allocations done at member states' or biogeographical levels than the EU-wide allocation. Furthermore, the N2k sites overlapped more with the EU-wide allocation and they were more evenly distributed across the EU compared to sites in all hypothetical optimal allocations. Finally, we found that the biogeographical scenario covered well the ranges of habitats directive species, following the biogeographical approach taken by the EU in the Habitats Directive. Our results show that despite N2k being moderately successful, there is substantial effectiveness to be gained from member state collaboration via potential expansions or complementary conservation policies.

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1. Introduction

The European Union (EU) has been active in biodiversity conservation through the establishment of the Natura 2000 network (N2k). The N2k consists of two types of sites designated on the basis of the Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC)

(Table 1). Currently, there are more than 27,000 sites, covering 18% of the EU's land area (EEA, 2012).

The aim of the N2k to protect biodiversity "irrespective of national or political boundaries" clearly implies that site designation should be developed using EU-level criteria and planning. The selection of Sites of Community Interest (SCIs) for species and habitats listed in the Habitats directive is a cooperative process between the member states and the Commission (European Commission, 2014a, 2014b; Table 1). However, Special Protection Areas (SPAs) for birds listed in the Birds Directive are selected by the member states with no commonly agreed EU-wide criteria (Evans, 2012; Gruber et al., 2012). As a result, the designation of sites has often been criticized as non-systematic, lacking quantitative site selection criteria, and ignoring complementarity and other principles of systematic conservation planning (SCP, Margules and Pressey, 2000; Apostolopoulou and Pantis, 2009; Culmsee et al., 2014; Gaston et al., 2008; Hochkirch et al., 2013; Kati et al., 2015). Additionally, N2k

Abbreviations: N2k, the Natura 2000 network; SPA, Special Protection Area; SCIs, Sites of Community Interest.

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Table 1
The two nature directives (Birds and Habitats Directives) are at the core of the continent-wide biodiversity conservation strategy, guided by the European Commission and implemented by the member states (European Commission, 2014a, 2014b). Note, that SPAs are also designated for regularly occurring migratory species not listed in Annex I (Birds Directive Article 4), but we considered only Annex I (Birds Directive) species in our prioritizations.

Annex	Year of origin/the newest version of the directive	Biodiversity feature to be protected	Conservation target	Site selection process for Natura 2000	Natura 2000 sites
Annex I Birds Directive (BD)	1979/2009 79/409/EEC 2009/147/EC	Bird species and their habitats	Protection of habitats for endangered and migratory bird species	SPAs are selected directly by the member states with no agreed EU criteria for site selection. However, the process should be based on scientific criteria. Finally, the European Commission determines if the designated sites are sufficient.	Special Protection Areas (SPAs)
Annex I Habitats Directive (HD)	1994/2006 92/43/EEC 2006/105/EC	Habitats	Conservation of habitat types of European interest	1. Member states' proposals for sites, based on standard selection criteria specified in the Directive 2. Biogeographical seminars are arranged by the European Commission, aiming to evaluate if sufficient high-quality sites have been proposed by each member state 3. Member states designate all of these sites as Special Areas of Conservation	Sites of Community Interest (SCIs)/Special Areas for Conservation (SACs) SCIs/SACs
Annex II Habitats Directive (HD)	1994/2006 92/43/EEC 2006/105/EC	Species	For species listed in Annex II core areas of their habitat must be protected and managed under the N2k		
Annex IV Habitats Directive (HD)	1994/2006 92/43/EEC 2006/105/EC	Species	A strict protection regime must be applied across species entire natural range within the EU, both within and outside N2k sites		SCIs/SACs

as an effective conservation strategy has been debated (D'Amen et al., 2013; Dimitrakopoulos et al., 2004; Grodzinska-Jurczak and Cent, 2011; Pullin et al., 2009; Wamelink et al., 2013). Each country has its own distinct political history and a pre-existing national protected area network. Therefore, many N2k sites overlap with previously established national protected areas (EEA, 2012).

Despite the hundreds of publications addressing N2k matters (Popescu et al., 2014), the effectiveness and representativeness of the network are still inadequately understood and the studies are often taxonomically or geographically biased (Araujo et al., 2007; Chiarucci et al., 2008; EEA, 2012; Jantke et al., 2011; Lison et al., 2015; Maiorano et al., 2007, 2015; Verovnik et al., 2011). Overall, studies have found that some species rich areas or species have been missed by the network (Abellan et al., 2011; Albuquerque et al., 2013; Bagella et al., 2013; Gruber et al., 2012; Thuiller et al., 2015; Trochet and Schmeller, 2013).

While protected area networks seem to currently perform better than random, recent evidence indicates that they are not optimal, and better achievements could be obtained with more coordinated planning (Bladt et al., 2009; Kark et al., 2015; Mazor et al., 2013; Pouzols et al., 2014). Also, global and local priorities coincide only partially (Moilanen and Arponen, 2011; Moilanen et al., 2013). While it is difficult to assess the efficiency of protected areas taking into account all relevant factors (ecological and socio-economical), it is important to understand the potential efficiency loss that arises from planning that divides conservation effort into ecologically arbitrary subunits. This is particularly interesting in the context of the whole N2k network in the EU, since it has never been compared to a theoretically optimal spatial design. Previous studies investigating N2k with systematic planning methods have been at national scales or focused on species groups other than those investigated here (Jantke et al., 2011; Mikkonen and Moilanen, 2013).

Here, we present an EU-wide assessment for N2k using a comparatively high-resolution dataset covering 841 terrestrial vertebrate species. We use spatial prioritizations to assess the present N2k network in addressing the goals of EU legislation and securing vertebrate diversity. We examine whether the species coverage and spatial pattern of the N2k network better reflect a community effort or interests of independent member states. We perform spatial prioritizations separately at the EU and national scales, testing hypothetical planning outcomes at different administrative levels. We also conduct an analysis where an effectively independent prioritization is done for each biogeographical region, as described in the Habitats Directive as regions characterized by distinctive vegetation, climate, and geology (EEA, 2014a). Such a biogeographical approach has previously been taken in the selection process of SCIs.

2. Material and methods

2.1. Data

Our species data are a subset of the species-specific expert-based distribution models described in Maiorano et al. (2013). We focused on vertebrate species that are listed in the EU nature legislation (EIONET, 2014a, 2014b; Tables 1, 2). Accordingly, data were first extracted within the member states (EU28) for 85 amphibians, 141 reptiles, 180 mammals, and 435 birds, and then, a subset of 395 directive species was included in the present analysis. Since the selection processes of SCIs and SPAs differ significantly (see Table 1 for details), we considered Birds directive species (Annex I) and Habitats directive species (Annex II) separately. Finally, we considered Annex IV species (Habitats directive) together with Annex I and II species, because Annex IV species should be protected both in and outside N2k. While there are over 1000 species including also other taxa such as insects and plants listed in the Habitats Directive (EIONET, 2014a), we had data only for amphibians, reptiles, and mammals (Table 2). Birds were

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