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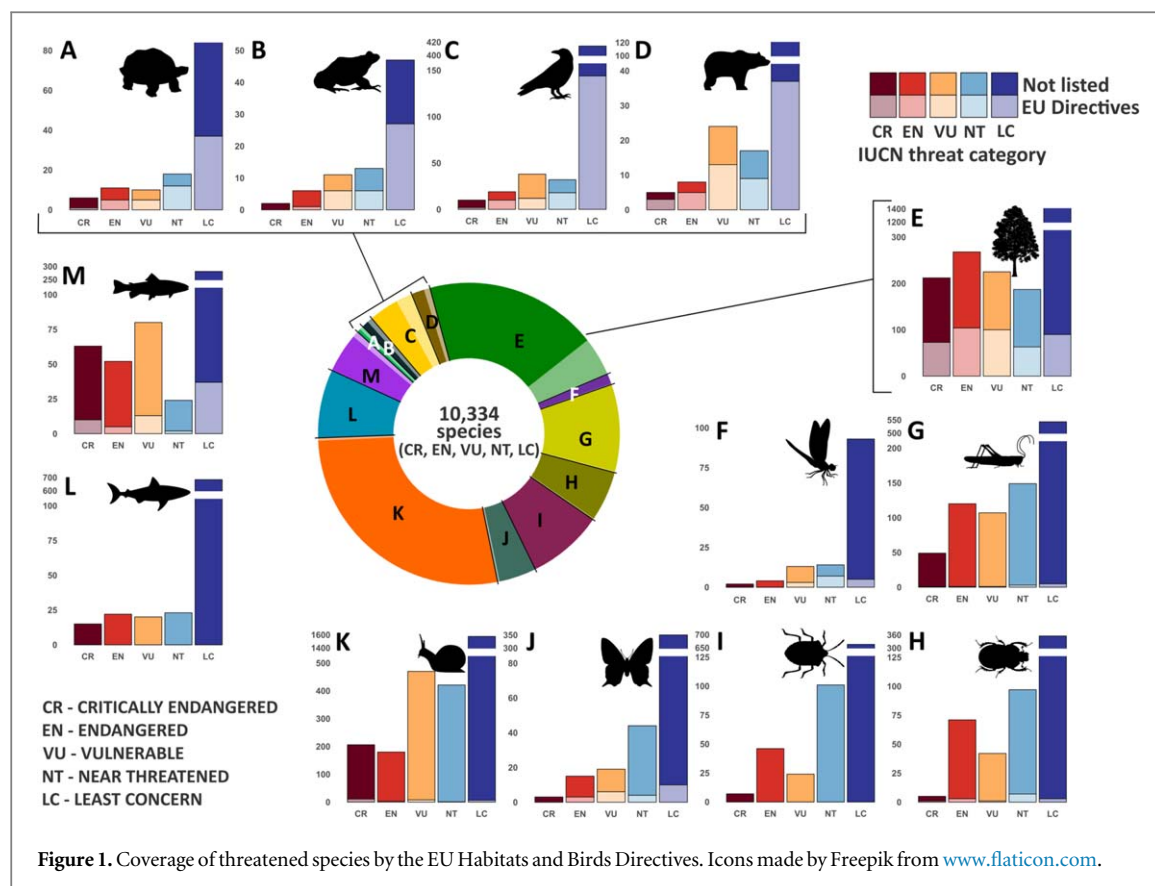
The European Union (EU) committed to halt the loss of biodiversity in its 2020 Biodiversity Strategy. However, all reports show conservation efforts are falling short of their objectives and the status of biodiversity in the EU continues to decline. Here, we propose four key avenues for the next Strategy, currently under discussion, to make EU conservation efforts more effective. First, we suggest the next Biodiversity Strategy should ensure legal coverage for threatened species not listed in the EU Habitats and Birds Directives, which currently cover only 16.4% of all threatened species. Second, halting biodiversity loss requires threatened species to be adequately managed. To this end, the potential of the extant Natura 2000 should be fully released. Already designated protected areas (PAs) hold more species than currently declared as target for management, leaving an opportunity to further manage more threatened species. Third, to address dynamism associated to climate and land use change, conservation management should be expanded outside PAs, using the planned network of Green Infrastructure. Fourth, while more funding is required to properly implement the Biodiversity Strategy, the improvements we suggest can be made more cost-effective by using systematic planning approaches and better integration of conservation policy in other sectorial policies, such as the Common Agriculture Policy. While existing policy mechanisms can already be used to implement some of these recommendations, revised policies should seek better integration of conservation into other sectorial policies, as well as efficient allocation and use of funds to increase the efficiency of conservation efforts.

1. Introduction

Biodiversity is declining globally: the Earth's natural capital must be protected now (IPBES 2019). The European Union (EU) has long recognized this need. In its Biodiversity Strategy, the EU committed to halt biodiversity loss by 2020 (EC 2011). EU member states have implemented substantial conservation efforts, including the establishment of the world's largest network of Protected Areas (PAs), the Natura 2000 network. However biodiversity loss in the EU continues: the recent assessment on the status and trends on biodiversity across Europe and Central Asia (IPBES 2019) shows a generalized decline of species populations and habitats, driven by multiple processes

such as land use and climate change). Currently, only 23% of species and 16% of habitats listed in the Habitats Directive and 52% of species listed in the Birds Directive are under no foreseeable risk of extinction (EEA 2015). These values fall short of the targets set by the Biodiversity Strategy when it was signed (EC 2011), namely improving the conservation status of 100% of habitats and 50% of species compared to 2011 levels (Target 1 in EC 2011 p 5).

Even more worryingly, those figures underestimate the magnitude of the problem, because EU reports focus exclusively on species listed in the annexes of the Directives. These lists have been questioned because they reflect poorly the true conservation needs across the continent (Hochkirch *et al* 2013).



Compared against the IUCN Red List of Threatened Species (IUCN 2018), the Annexes include only 17.4% of Red-List Critically Endangered, 16.9% of Endangered and 15.4% of Vulnerable Red List species present in the EU, while including many non-threatened species in least need of conservation action (figure 1). The Annexes also reflect poorly the taxonomic distribution of conservation needs (figure 1). Of all Red List-threatened species, the Annexes cover 57% of mammals and between 36% and 41% of birds, reptiles, amphibians and plants, but only 14% of fish, 3% of non-marine molluscs, 1% of orthopterans and no hemipterans, although the number of threatened species in the later groups exceeds five-fold those of all vertebrates together.

The central pie shows the total number of species in Europe under different IUCN threat categories (10 334 species); different colors indicate the proportion represented by each taxonomic group (within each group, the light color is the number of species covered in the Annexes of the Directives, the dark color is the number of species not listed in the Annexes of the Directives). Bar plots break down the number of species within each taxonomic group (indicated with the respective letter in the central pie chart) across their corresponding IUCN red list categories. A: Reptiles ($N = 138$); B: Amphibians ($N = 79$ species); C: Birds ($N = 513$); D: Mammals ($N = 205$); E: Plants ($N = 2346$); F: Odonates ($N = 126$); G: Orthopterans ($N = 968$); H: Saprophytic beetles ($N = 570$); I: Hemipterans ($N = 841$); J: Butterflies ($N = 431$); K:

Non-marine molluscs ($N = 2852$); L: Marine fish ($N = 764$); M: Freshwater fish ($N = 500$). Note that the bars for the LC category in some cases were truncated to improve visualization of the remaining categories in the plot.

A large proportion of the EU's threatened biodiversity, particularly insects and other invertebrates vital to many ecosystem services (IPBES 2016), is thus left without adequate legal coverage from the continental policy. These gaps severely limit the EU's capacity to respond effectively to current and future conservation challenges. National or regional efforts might partially cover local gaps, but those are hard to track and evaluate in relation to continental targets.

The EU's environmental policy needs to improve rapidly if it is to halt biodiversity loss and secure human wellbeing. A new Biodiversity Strategy is being discussed as the 2020 landmark approaches, so this is the right time to revisit its successes and failures to date and inform the next policy. We suggest four avenues to address the current gaps highlighted by recent EU reports (EC 2015, EEA 2015). These avenues are: (i) to improve the representation of threatened species by relying more directly on scientific evidence; (ii) to ensure that those species are covered by adequate management plans, not necessarily by adding more PAs, but by updating management of Natura 2000 sites to support threatened species currently not present in the Annexes; (iii) to integrate management of species and habitats outside PAs using complementary strategies such as the Green Infrastructure framework;

and (iv) to increase the resources allocated to conservation management.

2. Policy recommendations for the next EU biodiversity strategy

2.1. Improve policy coverage of threatened biodiversity

Legal and management coverage of species with unfavorable conservation status in the EU must become more ambitious and better reflect conservation needs. The Birds and Habitats Directives already define clear criteria for designating species and habitats of community interest, which include consideration of the conservation status of endangered or vulnerable species and habitats. The IUCN Red List Assessment is the most comprehensive global source of information on species extinction risk (Rodrigues *et al* 2006) and represents a central information resource to set conservation priorities (Stuart *et al* 2010). The Red List already contains information about >13 300 European species, which should be used more directly to inform conservation priorities at the continental scale.

Ideally, Annexes should be revised to cover more or all of the Red List-threatened species. However, bureaucratic and political complications probably make such a revision unrealistic for the next Strategy (not least because it would require consensus among member States). Other approaches to extending policy and management to threatened species outside the Annexes could be taken instead. For example, species not listed in the Directives but classified as threatened in the Red List could be allowed to access conservation funding through the LIFE program (the main financial tool for conservation action in the EU; Hermoso *et al* 2017). Alternatively, they could be included in Prioritized Action Frameworks, strategic multiannual planning tools that review species conservation actions and financing needs across the Natura 2000, directing them to the corresponding EU funding programs. Both programs are currently only restricted to species listed in the Directives.

2.2. Revisit management plans of natura 2000 sites

Covering all threatened species (about 20% of all assessed species; figure 1) and habitats across the EU is a necessary goal, but also a daunting task. Simply adding PAs might be the most intuitive response but, while doubtlessly beneficial for conservation, might be socially, politically and economically challenging in a densely populated territory under large pressure from other uses (Maiorano *et al* 2015). Indeed, the rate of new additions to the Natura 2000 network is slowing down (Kukkala *et al* 2016).

However, the current network already provides a great opportunity for enhancing conservation effectiveness in the EU. The geographic ranges of many

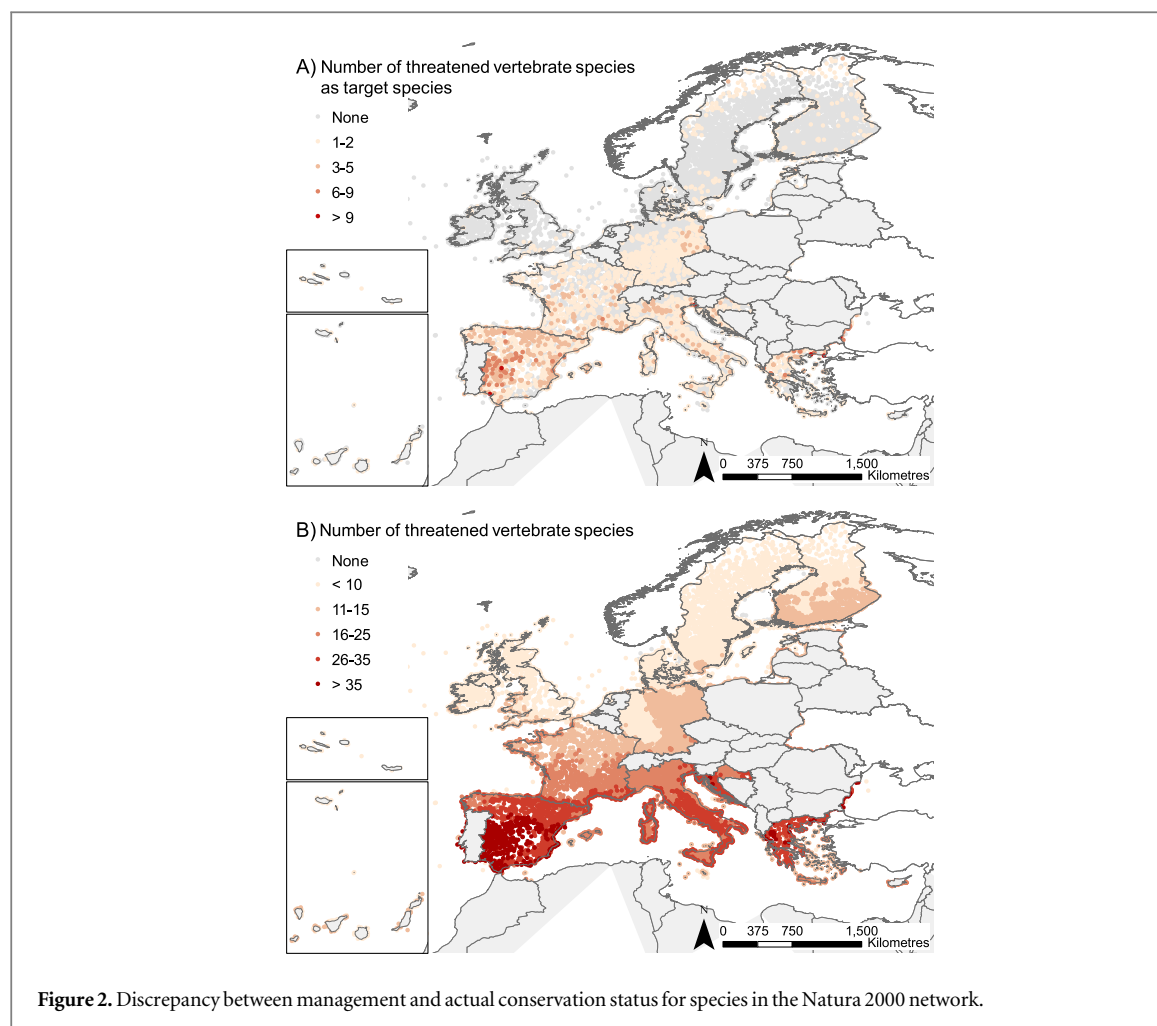
threatened vertebrate species in Europe, assessed in the IUCN Red List (IUCN 2018), potentially overlap with Natura 2000 network sites (figure 2). However, currently only 20% of Natura 2000 sites have at least one threatened vertebrate species declared as target species. These target species are the focus of management attention within each Natura 2000 site, including the species for which each site was initially designated. The list of species currently managed at each Natura 2000 site could be updated to incorporate non-listed, co-occurring threatened species. As an indication of the untapped potential of this approach, each Natura 2000 PAs contains on average 15 threatened vertebrate species. To optimize resource allocation and maximize synergies, this update process should prioritize sites with the greatest potential to encompass multiple threatened species and those where including new species requires the smallest additional effort (e.g. species that could benefit from management already being carried out in a given Natura 2000 site).

Number of threatened vertebrate species per Natura 2000 site declared as target species ($N = 68$ species) (A) and number of threatened vertebrate species occurring within each Natura 2000 site ($N = 230$ species) (B) per Natura 2000 site. All threatened vertebrates occurred in at least one Natura 2000 site (i.e. according to the spatial overlap of IUCN red list maps and N2000 sites; Median = 27 sites per threatened species). The distribution of the Natura 2000 sites is represented by the centroid of its extent for mapping purposes.

2.3. Expand management of biodiversity and ecosystem services beyond PAs

Conservation goals cannot be achieved by exclusively focusing management inside PAs, especially given the dynamic conditions dictated by ongoing global change (Dudley *et al* 2018) and the limited opportunities to designate new PAs. In 2013, the EU developed a Strategy for designing a network of Green Infrastructure across the EU (EC 2013). The aims of this strategy are (i) to enhance connectivity between PAs to allow species to thrive across their entire natural habitat and adapt to effects of climate change, and (ii) to contribute to the maintenance of ecosystem services for society. The network of Green Infrastructure is considered a key step towards achieving Target 2 of the Biodiversity Strategy (EC 2011 p 5), allowing management of biodiversity and ecosystem services outside the current PA network. The design and implementation of this network are still in the early stages, so an assessment of its consequences is premature (EC 2015); our suggestions focus on the planning process.

Management areas that become part of the network of Green Infrastructure should be located where they maximize benefits for biodiversity conservation and ecosystem service provision while minimizing



potential conflicts with competing land uses. Such planning should be coordinated across the EU members to achieve a Trans-European Network for Green Infrastructure, as demanded by the EU Action Plan for Nature, People and the Economy (European Parliament 2017). Moreover, extant policy must be adapted or extended to ensure sufficient funding for implementation and management of the Green Infrastructure network. Potentially suitable frameworks already exist, such as Structural and Cohesion funds, European Agricultural Fund for Rural Development, or the European Fund for Strategic Investment. For example, the Common Agriculture Policy includes the designation of Ecological Focus Areas in agricultural land, that contribute to provision of ESS like pollination, or soil erosion prevention and the conservation of biodiversity (Bommarco *et al* 2013). These Ecological Focus Areas could contribute as part of the network of Green Infrastructure.

2.4. Improve earmarking of funds for conservation

Finally, conservation efforts must be funded adequately and managed efficiently. Kettunen *et al* (2011) estimated that in the period 2007–2013 the EU

budget allocated between €550 and €1150 million annually to the Natura 2000 network, which only covered between 9% and 19% of its financing needs. Moreover, with the exception of the LIFE Program, conservation funds from other sources are not earmarked for conservation actions (European Court of Auditors 2017). This is especially important given that these other sources of funding conservation actions (e.g. European Agricultural Fund for Rural Development or Structural and Cohesion Funds) account for up to 90% of the overall contribution to the overall conservation budget. The lack of transparency on reporting precisely which conservation actions were supported by these funds makes it hard to evaluate whether or not money has been efficiently invested in the species or habitats that would contribute the most to achieving continental conservation goals. Even the LIFE program has left large gaps in conservation action over its nearly 3-decades of existence (Hermoso *et al* 2017). The next Biodiversity Strategy must integrate better with other sectorial policies to ensure conservation is adequately funded and balanced fairly against other interests. Finally, strategic planning of investment is key to maximize the impact of the limited resources available and avoid misuse of funds.

3. Conclusions

It is time to evaluate the failures and the lessons learned from the design and implementation of current EU Biodiversity Strategy to make the most of the new post-2020 strategy, currently under discussion. The Convention on Biological Diversity is also initiating the same process (Mace *et al* 2018). The current Natura 2000 network and EU legal framework provide an ideal foundation to build on. Representativeness, coverage and allocation of resources must all be improved: we suggest adequate planning is needed to improve integration of current and future conservation efforts, ensuring the location of new areas and the upgrade of current ones are chosen to maximize conservation returns. In the face of global change, which will amplify the variable dynamics of natural systems, conservation policy must become more flexible, for example by allowing more fluid revisiting of priority species, while remaining transparent and evidence-based. Adequate planning is thus vital for policy to adapt to changing challenges and needs, increasing its effectiveness and its chances of better fulfilling post-2020 conservation goals.

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Data availability statement

The data that support the findings of this study are openly available at <https://eea.europa.eu/data-and-maps/data/natura-10> and <https://iucnredlist.org/>.

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