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ORIGINAL PAPER

Determination of conservation priorities in regions with multiple political jurisdictions

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Abstract Red lists serve as the most prominent tool for priority setting in applied conservation, even though they were not originally designed for this task. Hence, threat status does not always reflect actual conservation needs and can be very different from actual conservation priorities. Therefore, red lists may at best be a suboptimal tool for setting conservation priorities in a country or region. As a response, a range of alternative or complementary tools have been developed, with approaches, methods, and parameters such as population decline, population center etc. used, differing widely among countries. One recent development is the combination of conservation status with a measure of the international importance of a population in a focal region for the global survival of a species. Here, we provide a new method that integrates the two concepts while keeping

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them conceptually separate. The main benefit of this method is that it can be applied across variable geographical scales such as regions, countries, and even continents. Furthermore, it allows for better recommendations for applied conservation and conservation policy development than the two concepts in isolation. Our method, if applied internationally, would allow for a standardized priority setting in species conservation, would be highly comparable between countries, and would lead to a more efficient use of the limited financial and human resources for monitoring and conservation of biodiversity.

Keywords Species conservation · Conservation priorities · National responsibility · Threat status in Europe · Conservation policy support

Introduction

Red lists have been commonly used to prioritize conservation efforts across the globe, making them a centerpiece for conservation assessment. Red lists explain the complex phenomenon "endangerment" in a simple way (The Nature Conservancy 1988; IUCN 1996, 2001), leading to high public acceptance (Schnittler and Günther 1999). However, red lists were not primarily designed to set conservation priorities (The Nature Conservancy 1988; IUCN 1996, 2001), and therefore not surprisingly have some shortcomings for such an application (e.g. Mehlman et al. 2004; Eaton et al. 2005). For example, in national red lists a species endemic to a small region may receive the same threat status as others that are widely distributed but represented in a particular country by only a few populations (Rabinowitz 1981; Mehlman et al. 2004). The latter populations, however, play no important role for the overall survival probability of the species. Hence, using red lists for earmarking resources for conservation management and biodiversity monitoring may at best be suboptimal for setting conservation priorities (Gärdenfors 2000, 2001). As a consequence, different countries have developed novel priority setting tools (Brooks et al. 2006), e.g. South Africa (Freitag and Jaarsveld 1997), Australia (Coates and Atkins 2001), the United States of America (Beissinger et al. 2000; Carter et al. 2000), Canada (Couturier 1999), and several European Countries (Schmeller et al. 2008a). These methods of conservation prioritization, however, differ vastly among countries, despite the same basic notion to base prioritization on the international importance of a population for the global survival of a species (Schmeller et al. 2008a).

A major difficulty of all the methods is lack of data on past and future population development, which are currently available for a small fraction of species only (birds, mammals, amphibians; Baillie et al. 2004). Population decline is only quantified in well studied species (e.g. Baillie et al. 2004), and the consideration of the distribution center for setting national responsibilities and conservation priorities is only possible in uniformly distributed species, but not for species with a disjunctive distribution, such as some alpine species (Sagarin et al. 2006; see also Schmeller et al. 2008b). Thus, methods for setting conservation priorities should be applicable with minimum data requirements.

Lack of data about rare and threatened species as well as inconsistencies of conservation policy development are important causes of the gap between the scientific approach to conservation prioritization and practical conservation implementation (e.g. Mace et al. 2000; Knight 2006). This is particularly the case for methods of systematic reserve site selection (Margules and Pressey 2000; Knight and Cowling 2007) and the identification of priority species and habitats and actions needed for their conservation (i.e. Gärdenfors

2001; Samways 2003). Clearly, conservation is in need of a method for the assessment of conservation priorities with small data demands, which combines the advantages of red lists and the assessment of international importance of a population (e.g. Keller and Bollmann 2004; Schmeller et al. 2008a, b) by integrating the most promising approaches of both. A standardized method should allow scaling from regional to global scales to match the size of the assessed area, should comprise few and easily assessable criteria, and should be applicable in principle to any species. Such a method would allow the strategic allocation of flexible, but limited resources in global conservation planning.

Here, we report on a method for setting conservation priorities that can fulfill these requirements. The method is insofar innovative as it includes the concept of national responsibilities (see Schmeller et al. 2008b) in a scoring system. We will discuss the application of our method in regard to data availability and future biodiversity monitoring needs.

Setting conservation priorities

We developed a method basing on national responsibilities (Schmeller et al. 2008b) and the threat status of a species, strictly separating the two concepts. The determination of national responsibilities is based on the size of the distribution area of a species as well as on its distribution pattern. Three distribution patterns were distinguished: local (patchy distribution within a biogeographical region), regional (distribution limited to one biogeographic region), and wide (distribution across two or more biogeographic regions). The method on national responsibilities takes further into account the relation of a species' global distribution to its distribution in the focal area and hence the international importance of a population in regard to its global distribution (for more details see Schmeller et al. 2008b). Previous methods, while incorporating parameters of the international importance of a population for the global survival of a species (its irreplaceability), did not succeed to distinguish clearly between these two concepts (see e.g. Schmeller et al. 2008a).

We decided to base our assessment on a scoring system, as e.g. used in Canada (National Recovery Working Group 2005). Such a scoring system with a clear number of action categories is sufficient to sensibly combine conservation status and national responsibility to ranks for conservation priority. We allocated scores to the categories of national responsibilities as defined by Schmeller et al. (2008b) and to those of the international IUCN Red List, the Annexes of the Habitats (Council Directive 92/43/EEC) and Birds Directives (Council Directive 79/409/EEC). These annexes are supplementary conservation tools in Europe, and comprise lists of species and habitats for which EU member states need to create reserve sites in the frame of the Natura 2000 network (e.g. Evans 2005). Such supplementary systems, usually species lists, aim to aid conservation on different political scales and exist also in other countries (e.g. Ontario, Canada, Couturier 1999). If no red list data or annex listings were available, we assigned scores to the categories of the national red list of the focal nation. Further, it is important to notice that for species extinct in the wild, national responsibilities cannot be assessed based on current distribution in the wild. For these species, we suggest to assess the distribution of potential habitat across countries where the species formerly occurred. Such an approach facilitates the derivation of conservation actions (see below). For our ranking system, we summed the scores for national responsibility and threat status, weighting both criteria equally, assuming that both parts of the evaluation, national responsibility and conservation status, are equally important for the assessment of conservation needs of a species (Fig. 1). These

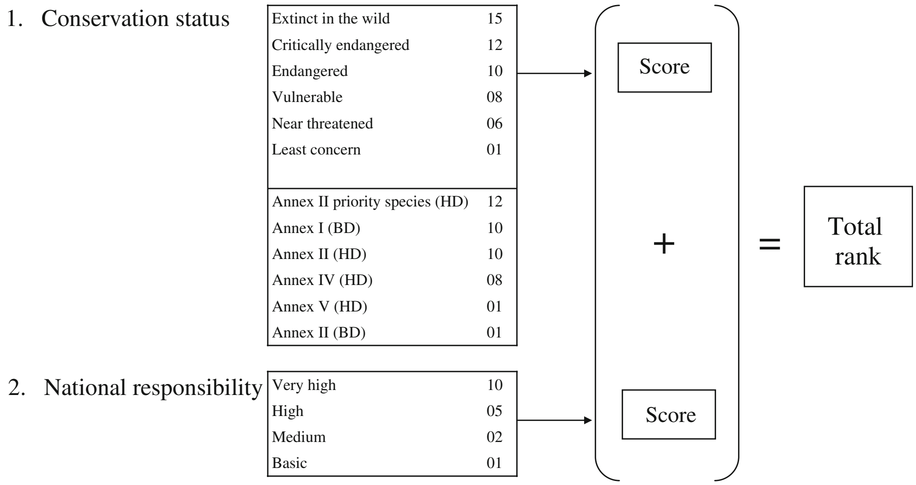

Fig. 1 Determination of conservation priorities based on category scores. National responsibilities and the threat measure (IUCN Red List, National Red List or Annexes of the Habitat and Birds Directives) of species are strictly separated. The highest score from either the Annex category or the Red List category will be taken to calculate the priority rank

Table 1 Score table for the determination of conservation priority ranks

	Very high	High	Medium	Basic
Extinct in the Wild	25	20	17	16
Critically Endangered Annex II priority species (HD)	22	17	14	13
Endangered Annex II (HD) Annex I (BD)	20	15	12	11
Vulnerable Annex IV (HD)	18	13	10	**9**
Near Threatened	16	11	**8**	**7**
Least Concern Annex V (HD) Annex II (BD)	11	**6**	**3**	**2**

The top row gives the level of national responsibility (Schmeller et al. 2008b) and the first columns the conservation status resulting from red lists and/or the Annexes of the Habitats (HD) or Birds Directives (BD). The different grey shading represents the ranks 1 (dark grey—immediate action), 2 (white—high priority), 3 (light grey—priority) and 5 (bold numbers—under observation). Rank 4 (data deficiency) is not displayed and comprises species with a local or regional distribution and too sparse data to assess national responsibilities and/or conservation status (IUCN categories DD and NE)

scores were assigned to five conservation priority categories (Table 1), comprising ranks of “immediate action”, “high priority”, “priority”, “improvement of knowledge” and “under observation”. Only the highest score from either the annex category or the red list category were considered, following a conservative approach. For example, if a species is an annex IV species (8 points) but categorized as endangered in the IUCN Red List (10 points), the conservation status was given a score of 10 points. Such a procedure assures that the conservation status is not underestimated in our method.

The rationale between the different categories is as follows. In the case of the highest rank, "*immediate action*" (rank 1), the loss of the focal nation's population would lead to the global extinction of the species since the main distribution area lies within the countries borders and the species is highly threatened. The country has to undertake immediate conservation actions and needs to allocate considerable resources to the conservation of such species to increase populations in space and numbers. In the case of species extinct in the wild, the country or countries that have high responsibility for still suitable habitat should undertake priority measures to protect that habitat and take the lead for programs to re-establish populations in the wild.

Species in the *high priority* rank (rank 2) would become globally extinct in the case of the loss of the focal nation's population as a high proportion of the distribution area lies within a nation's or region's borders and the species is threatened or nearly threatened. The country has to give conservation action a high priority and has to set up a long-term conservation plan to improve the conditions for the species. The *priority* rank (rank 3) comprises species, for which the loss of the focal nation's population may lead to global extinction in the long-term. The population of such species in the focal area is either small compared to the total distribution range or the threat status is low. However, populations at the periphery of the distribution are often evolutionary significant units (Moritz 1994) and thus important for evolutionary processes and essential for the maintenance of genetic diversity and should be placed in this category. A nation's conservation actions are necessary to be started with priority.

Species with a regional or local distribution or no available distribution data and without entries in either the international or the national red lists were assigned to a *data deficiency* rank (rank 4). Here, we follow the rationale that widely distributed species usually are not considered endangered in national or the IUCN Red List with very few exceptions (e.g. *Zootoca vivipara pannonica, Triturus carnifex*), while regional and local species usually have small population sizes and have at least an increased risk of extinction. Therefore, we argue that the knowledge on the latter species needs to be improved to allow for an assessment of conservation status and priority. The lowest priority rank "*under observation*" (rank 5), comprises species which are distributed mainly outside the focal nation's area and/or the global survival is not endangered. The country needs to undertake monitoring activities in longer intervals to be able to assess the status of its populations over time, but does not need to undertake any other conservation actions.

Discussion

We are currently experiencing a global biodiversity crisis and conservation actions need to be set up in the most efficient way possible to optimally use limited conservation resources. Unfortunately, none of the currently available methods of conservation priority setting are widely accepted as their data requirements are too stringent, are considered scientifically unsound, or are too complex for the usage by decision makers (e.g. Fitzpatrick et al. 2007; Miller et al. 2007; Schmeller et al. 2008a).

Here, we have presented a new method to determine conservation priorities at various geographical scales. Our method combines national responsibilities through a measure of irreplaceability (see Schmeller et al. 2008b) with the threat status of a species and has few and well defined priority ranks. We weight these two parameters equally, as in our opinion both parameters are of substantial importance for the conservation of a species. Our method, therefore, should be easily comprehensible and may allow an automated assessment, allowing conservation priority setting on a large number of species. The assessment of our method, however, is solely intended to support practitioners in their decisions. Decision making in conservation is not only a monetary or scientific issue and nonetheless is obliged to consider other relevant factors as i.e. societal or cultural aspects, and knowledge on effective conservation measures. Thus, the prioritization following from the method proposed here should be taken with a pinch of salt and final conservation measures need to be considered in view of the conservation circumstances in each region and in regard to the species.

The ranks in our method readily indicate species monitoring needs in a first step. Our method demands close monitoring of species in rank 1 (in addition to concrete conservation actions) and 2, frequent monitoring for species in rank 3, and the set up of new monitoring programs for species in rank 4, which are needed to improve the knowledge on such species. In case a species falls in rank 5, practitioners could redirect resources from such monitoring programs to others in more urgent need. In a second step, the proposed scoring process could be followed by a risk assessment that optimizes the trade-offs between chance-of-success, money required, actors involved, and management actions needed across all species for which priorities are set. However, risk assessment is data-demanding and labour-intensive and therefore is not frequently applied even to a single species. Therefore, we consider it unrealistic for a large set of species, even if done only within one of the high priority categories. Nevertheless, with a growing amount of good quality data on distribution and demography and the improvement of monitoring systems the reliability of our method will further improve (see also Schmeller et al. 2008a).

Generally, besides the broad assessment of a species' threat status, data availability is a major issue in global biodiversity conservation (Brooks et al. 2001, 2006). It is imperative to improve this problem by centralizing data and by setting up more effective monitoring networks. Furthermore, collected data or at least derivates of them (such as indicators) need to be made widely available to the public, so that analyses on population development can be done (e.g. Guralnick et al. 2007).

We believe that our method is superior to methods that try to catch all aspects of a species (i.e. Miller et al. 2007), because it leaves little room for debate but is based on sound scientific reasoning. Furthermore, our method considers all factors contributing to the assessment of conservation status. These comprise biological and distributional factors and extinction risk due to the consideration of the IUCN Red List. However, we avoid double consideration of these factors by stringently separating the concepts of national responsibilities and threat status (see also Schmeller et al. 2008a). Our method of priority setting would further be readily applicable to any revision of an international red list. This makes our method sustainable, granting comparability of priority lists over long time periods. An alternative method basing on many factors, such as proposed by Miller et al. (2007), would be highly complex and difficult to implement. Application of such a complex method, considering distributional factors, extinction risk on different geographic scales, biological, societal, logistical and economic factors (Miller et al. 2007), to a large number or even all taxa, on different geographic scales and across the globe is impossible due to data limitations and incomparability of several of the mentioned factors (e.g. Fitzpatrick et al. 2007; Schmeller et al. 2008a). Further, societal and economic factors especially will be subject to extensive debates with little hope of clear agreements between different interest groups on national, regional or continental level, which drastically reduces the value of such a method.

Our method was mainly developed for the use in Europe. Therefore, we also considered supplementary conservation tools for setting priorities, namely the Annexes of the European Habitats and Birds Directive. These directives are among the most powerful instruments in applied conservation in Europe and have equivalents in other countries (e.g. Couturier 1999). Such complementary tools may be considered in adjustments of our method to circumstances in other countries. Though, the usage of such species lists is problematic, as they are incomplete and politically influenced. Generally, it may be preferable to assess the threat status by an international red list only. Such an approach would increase the comparability of the results from different countries or regions and would also clearly show for which species more data needs to be collected. The application of red lists in setting conservation priorities, however, also needs to take into consideration known biases (Koomen and van Helsdingen 1996), for example the bias by (i) selection criteria, (ii) unrepresentativeness of red lists, (iii) inclusion of island endemics, (iv) (micro-) biotope differences, and biases due to (v) the discovery of new species. Further, the major groups of invertebrates are very differently represented in the global, European, and national red lists. In European red lists the molluscs, dragonflies, and butterflies are clearly overrepresented (Baillie et al. 2004). In contrast, hymenoptera and diptera are under-represented.

Despite our focus on the development of a concept applicable to the European case, our method can be easily applied to different locations. In the case of an international application, our method could potentially become a standardized system for priority setting in species conservation, highly comparable among countries. We believe that our method can lead to a more efficient use of the limited financial and human resources in conservation and biodiversity monitoring.

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