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Evaluating the potential of protected areas to preserve biodiversity at large scales

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Abstract

The conservation value of protected areas can be measured in many ways. Here, we propose a concept that estimates the potential of large-scale protected area networks to preserve biodiversity. Our metrics of conservation value include species richness, rarity, the effect of area on species occurrence and differentiation diversity. With this approach we aim to improve protected area networks in terms of future conservation needs.

Key Words

Biodiversity, differentiation diversity, protected area, species rarity, species richness

Introduction

Environmental change leads to biodiversity loss at local to global scales. Protected areas are major conservation tools to prevent such loss. But most research on the performance of protected areas focus on local to regional scales (Orlikowska et al. 2016). In addition, the performance of PA networks depends on its large-scale configuration in space (Montesino Pouzols et al. 2014). Therefore, large-scale approaches are urgently needed to identify strengths and weaknesses of PA networks to efficiently protect biodiversity at all scales (Watson et al. 2014, Hermoso et al. 2016).

We suggest to assess the conservation value of PAs in different ways such as in terms of inventory diversity, differentiation diversity, species rarity and the species–area relationship. The methodological approach we propose is applicable for large-extent conservation assessments. Consequently, it is possible to identify PAs of high and low uniqueness values to evaluate current conservation efficiency and guide future conservation effort. Thereby, large scale management priorities can be defined.

Methods and Results

Since distribution data of species are variable in quality and mostly have coarse spatial resolution, we built a probabilistic approach for assigning each reported species to each PA (see also Araújo et al. 2011) by using chain rule probability theory. Based on that, we can estimate the uniqueness of PAs in terms of species rarity and differentiation diversity, and also calculate inventory diversity both directly and accounting for the species–area relationship (SAR). To measure conservation value in these ways, we propose to calculate about seven uniqueness indices (reported species richness, area-controlled surplus of reported species, rarity-weighted richness, average rarity, total dissimilarity, turnover dissimilarity, nestedness dissimilarity).

Discussion

A macroscopic perspective is necessary to guide effective conservation strategies (Araújo et al. 2011, Le Saout et al. 2013, Montesino Pouzols et al. 2014, Maiorano et al. 2015). Research effort has barely aimed to understand the potential of PA networks at international scale (Orlikowska et al. 2016), and most nature conservation funding has not been addressed to high conservation priorities (Hermoso et al. 2016). With our study, we propose a new perspective and simple analytical tools for decision-making and conservation prioritization at large scales. Funding strategies require transparent instruments to set conservation priorities for the spatial distribution of conservation effort (Hochkirch et al. 2013a, b; Maes et al. 2013, Kati et al. 2014, Linnell et al. 2015). Our novel approach allows PAs to be ranked, with respect to biodiversity components of conservation concern, and can be easily adopted for any data and PA type, and for other components of biodiversity.

Our method supports international conservation planning by demonstrating strengths and weaknesses of PA networks. We developed, for the first time, a range of measures of conservation value for PAs that include both richness metrics and dissimilarity values. Compositional dissimilarity is a crucial dimension of conservation performance of PA networks (Chiarucci et al. 2008) that is often neglected (Socolar et al. 2016). It is just another fundamental component of biodiversity that informs about complementarity, and is therefore highly relevant to multi-site considerations, such as to PA networks.

Conclusion

Biodiversity knows no country limits. Nature conservation needs international guidance. The uniqueness indices we propose can evaluate the performance of PAs with respect to species conservation. They can be easily adapted for other data from gene to ecosystem level. We encourage to apply these conservation tools at the international scope to also encourage national authorities to cooperate and support funding beyond national boundaries to improve nature conservation in future.

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