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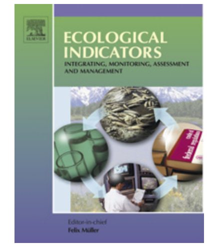

Does higher taxon diversity reflect richness of conservation interest species? The case for birds, mammals, amphibians, and reptiles in Greek protected areas

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ABSTRACT

A critical issue in conservation biology is the establishment of a strong relationship between species richness and a surrogate index. Such a relationship could provide the basis for the establishment of cost effective and easy to monitor methods for measuring biodiversity, providing an alternative for the prioritization of sites for conservation. We found that richness of species of conservation interest could reliably be predicted from the richness of higher order taxa, such as genus and family, in amphibians, reptiles, birds and mammals. Furthermore, the networks of reserve sites selected based upon the richness of genera or families were as effective in including species diversity, as the ones selected based upon species richness.

1. Introduction

Efficient environmental planning depends upon the identification of reliable measures of biodiversity (Groomsbridge, 1992) and the ability to detect the status and changes in ecological conditions at various spatial scales and ecosystems (O'Connor et al., 1998; O'Connell et al., 2000). Species richness, as a standard biological component, provides information on the biodiversity value of a site, while fluctuating trends of species richness allow the study of the dynamics, threats, spatial and temporal distribution of biodiversity. In this sense, species richness has been widely used for prioritizing areas for conservation and for designing reserve networks (Prendergast et al., 1993; Howard et al., 1998).

However collection of detailed data on species richness and distribution are both money and time consuming (Williams and Gaston, 1994; Balmford et al., 1996b; Lawton et al., 1998) and demand the arduous contribution of specialists. On the other hand, the quality and type of data collected at the different sites of interest are likely to contain gaps (Polasky and Solow, 2001), which could have a negative effect on reliable representation of flora and fauna leading that way to erroneous conclusions on the conservation value of a site.

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To overcome such limitations, conservation biologists have concentrated on the development of effective approaches that would allow accurate predictions of species richness. Several such methods have focused on the identification of surrogate variables (Noss, 1990; Roberge and Angelstam, 2004; Niemi and McDonald, 2004). These surrogacy methods rely on the identification of a close relationship between species richness and predictors such as environmental variables (Shafer et al., 2001; Jetz and Rahbek, 2002; Taplin and Lovett, 2003) or indicator groups of species (Gaston, 2000; Lawler et al., 2003; Fleishman et al., 2004).

Taxonomic surrogacy is based on the use of higher taxonomic level data (i.e. genera, families, orders) to predict patterns of species richness (Gaston and Williams, 1993). The underlying hypothesis for a successful application of the method is that the number of species in a given site under study is higher than the number of the superspecific taxa at the same site, while all taxa could be correctly categorized.

An efficient application of the method would reduce time, money and resources during monitoring and systematic arrangement of species (Balmford et al., 1996a), and it would help to better understand spatial patterns of diversity (Gaston et al., 1995). Higher taxon approach was applied at both local and regional scales (Gaston et al., 1995; La Ferla et al., 2002; Larsen and Rahbek, 2005), which could be highly demanding in terms of performing direct species measurements. Recently, application of the higher taxon approach has been extended to evaluate effects of environmental changes, such as burning (Brennan et al., 2006) and has been used to study the association between plant richness and climatic based variation in water-energy dynamics (O'Brien et al., 1998).

A series of studies, both faunistic and floristic applied to fauna and flora, have demonstrated good congruence between species richness patterns and higher-taxon richness, indicating that the approach could be a promising tool in conservation biology for rapid estimation of species richness (Gaston and Williams, 1993; Williams and Gaston, 1994; Gaston and Blackburn, 1995; Roy et al., 1996; Balmford et al., 1996b, 2000; Hodge and Frampton, 2001). However, other studies showed only weak relationships between lower and higher ranked taxa, raising questions on the efficiency of higher taxon approach (Andersen, 1995; Prance, 1994; Fjeldså, 2000).

Despite the promising results obtained by some of the studies using the higher taxon approach, caution should be given when applying the method and interpreting results since the method is subject to a series of limitations such as sampling effort, data quality and spatial autocorrelation (Grelle, 2002; Cardoso et al., 2004). Similarly, encouraging evidence exists to support higher taxon approach as a promising shortcut in the identification and categorization of areas for conservation (Balmford et al., 2000; Larsen and Rahbek, 2005). However, the efficiency of the method to be used for prioritization of conservation areas needs to be demonstrated for different groups of taxa in different biomes and in different biogeographical areas (Balmford et al., 2000).

A potential criticism in the efficiency of higher taxon approach arises from the area effect on the analytical process (Andersen, 1995; Gaston, 2000). A positive relationship between species richness and habitat area is rather expected, although the extent to which species—area relationships are reflected to higher ranked taxa is unclear. Another potential limitation on the efficiency of the method could arise because of variation in environmental conditions. Spatial heterogeneity is related to ecological process and variability and could act as a determinant of species richness and composition by favoring specific organisms and eliminating the distribution of others. However, to the best of our knowledge the potential influence of spatial heterogeneity on the performance of the higher taxon approach has not been studied so far.

In the present study we test the efficiency of the higher taxon approach as a tool for conservation policy, for four different vertebrate classes (mammals, birds, amphibians and reptiles) in Greece. This is the first test of this approach undertaken for a detailed data set of amphibians and reptiles in the Mediterranean region, which is characterized by high diversity and environmental heterogeneity. We are based on data collected from several sites dispersed throughout Greece, covering 16% of the national territory. We investigated the reliability of higher taxon approach to predict species richness for four vertebrate classes. We further, examined if spatial autocorrelation or area or habitat diversity of the study sites affect the relationship between species richness and higher order (family and genus) richness. Finally, we assessed the efficiency of higher taxon to rank sites for conservation, by comparing ranking order of the sites produced based on species, family and genera.

2. Methods

2.1. *Data set*

In the European Union, the Habitats Directive (92/43 EEC) and the directive on bird conservation (79/409 EEC) underpin the establishment of a European network of protected areas known as Natura2000. In Greece, sites included in this network are dispersed all over the country covering approximately 16% of the national territory (Dimopoulos et al., 2005). The selection of sites eligible to be included in the Natura 2000 network has been carried in all Member States of the European Union since 1992. A site was included if it contained either a habitat type of Annex I or a plant or animal species of Annex II of the Habitat's Directive or Birds Directive. Towards implementing the Habitats Directive and the Bird Directive in Greece, the project 'Identification and Description of Habitat Types in Areas of Interest for the Conservation of Nature, 1999–2001' was carried out under the responsibility of the Hellenic Ministry for the Environment, Physical Planning and Public Works and the project covered 254 sites, which were initially proposed to be included to the Natura 2000 network. Within this project various terrestrial or aquatic habitats were syntaxonomically identified to detail, described, and delineated through fieldwork and sample collection at each site. According to its geographic, abiotic and biotic features a habitat was characterized as a specific habitat type or subtype of Annex I of the Habitats Directive 92/43/EEC or as a national habitat type (characteristic or important for Greece). For each site, based on literature review, expert knowledge and field trips, the presence of species of Annex II of the Habitats Directive and/or of Bird Directive was recorded. A significant