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Selecting important areas for bryophyte conservation: Is the higher *taxa* approach an effective method?

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ABSTRACT

Surrogates have been used as a support for conservation practices, since they are easier to assess and less time consuming than collecting species-level data. One of these surrogates is the “higher *taxa* approach”, i.e., the use of data with coarser taxonomic resolution than the species level, such as genus and family levels, as a surrogate for total species richness.

The aim of this work was to test if higher *taxa* (Genera) could be used in the selection of important areas for bryophyte conservation, using three different methodological approaches: Scoring, Important Plant Areas and Complementarity-based approach. We tested these approaches in a protected area, the Peneda-Gerês National Park, one of the best studied areas in Portugal for bryophytes and one of the first areas in the country with bryophyte collections. The knowledge of bryophyte distribution in this National Park has been increasing and distribution maps and detailed species lists were recently published, so we thought it would be a good area to test if the higher *taxa* approach is an effective method for selecting important areas for bryophyte conservation.

Our results showed that localities were ranked in a similar way using species or genera data, regardless of the methodology used. The Complementarity-based approach in comparison with other methodologies protected a higher percentage of bryophyte species.

In general, the three approaches identified the same areas as important areas for bryophyte conservation. Therefore, for the studied area and independently of the approach used, genera could be used in the selection of important areas for bryophyte conservation.

1. Introduction

One of the challenges in conservation practice today consists of the lack of complete datasets with information on distribution of species, data that could be used for planning and management (Mandelik, Dayan, Chikatunov, & Kravchenko, 2007).

In recent years, surrogates (i.e., habitat, environmental, taxonomic surrogates) have been used as support for conservation practices. Recently, the higher *taxa*-approach (i.e., the use of data at a coarser taxonomic resolution than the species level, such as of genus- and family-levels, as a surrogate for species richness) has been widely studied in terrestrial ecosystems (Balmford, Jayasuriya, & Green, 1996; Bergamini et al., 2005; Mandelik et al., 2007). The advantages of using these surrogates in biodiversity inventories are: (1) higher *taxa* (i.e., genera and families) are more easily identified than species; (2) time and cost associated with sampling and *taxa* identification is reduced when adopting the higher *taxa* approach; (3) more localities can be surveyed when using higher *taxa* because it is less time-consuming (Gladstone & Alexander, 2005).

For the purposes of conservation and reserve selection and design, surrogates have been tested in different habitats, for different taxonomic groups of flora and fauna and at different spatial scales (Balmford, Lyon, & Lang, 2000; Cardoso, Silva, de Oliveira, & Serrano, 2004a; Gladstone & Alexander, 2005; Guareschi et al., 2012; Larsen & Rahbek, 2005; Mazaris, Kallimanis, Sgardelis, & Pantis, 2008; McMullan-Fisher, Kirkpatrick, May, & Pharo, 2010). Surrogate data at the finest possible geographical resolution are of

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the utmost importance for the selection of important areas, in order to provide guidance for the identification of actual reserves in the field (Larsen & Rahbek, 2005). Additionally, different underlying criteria, such as hotspots, complementarity of species or rarity (Fox & Beckley 2005; Margules, Nicholls, & Pressey, 1998; Vane-Wright, Humphries, & Williams, 1991) and irreplaceability (Carwardine et al., 2007; Ferrier, Pressey, & Barrett, 2000) have been applied to identify a set of sites which maximize the diversity of what is conserved.

Species richness is one of many measures of diversity, and is used to evaluate the biodiversity of a site. Through species richness we can study the dynamics, spatial scale and temporal distribution of biodiversity. This biological component has been widely used in the selection of important areas for conservation and for reserve network design (Mazaris et al., 2008), but, to our knowledge, bryophyte genera richness have never been used to select areas for bryophyte conservation.

The most common approaches used in prioritization of areas important for conservation are scoring and Complementarity-based approaches (Marignani & Blasi, 2012).

Scoring procedures establish one or several criteria (such as species richness, rarity or vulnerability) to rank sites in order of value or priority (Abellán, Sánchez-Fernández, Velasco, & Millán, 2005). Some studies have tested this approach in terrestrial ecosystems with spiders (Cardoso et al., 2004a), wasps (Vieira, Seneca, & Sérgio, 2012), and vertebrates (Mazaris et al., 2008).

Complementarity-based approaches also allow the selection of sites that represent all targeted biodiversity features together (Rodrigues & Brooks, 2007). This approach minimizes the number of selected sites necessary to represent the maximum number of species (Beger, Jones, & Munday, 2003). The reason for success of this approach is the fact that sites complement one another biologically (Shokri & Gladstone, 2009). Furthermore, this approach has been widely studied across aquatic ecosystems (Beger et al., 2003; Shokri & Gladstone, 2009), and terrestrial ecosystems (Cardoso et al., 2004a,b; Vieira, Oliveira, Brewster, & Gayubo, 2012).

Globally, another approach commonly identified as Important Plant Area (IPA) has been developed by Plantlife International, with the purpose of identification and protection of a network of the best sites for plant conservation worldwide (Anderson, 2002). This approach consists of three basic principles for selecting IPAs: (1) the site needs to harbor significant populations of one or more species whose conservation is of global or European interest; (2) the site has an exceptionally rich flora in the European context in relation to its biogeographical zone; and (3) the site is an outstanding example of a habitat of interest for plant conservation, and of botanical importance at the global or European level (Anderson, 2002). This approach has been previously applied to bryophytes (García-Fernández, Draper, & Ros, 2010; Sérgio et al., 2012). Other studies have been developed with bryophytes in Portugal using different approaches and methodologies for prioritization of important sites for conservation. For instance, Sergio, Araujo, and Draper (2000) proposed a first approach for selecting a network of reserves in Portugal using gap analysis. On the other hand, Draper, Rosselló-Graell, Garcia, Tauleigne Gomes, and Sérgio (2003) tested the selection of protected areas for conservation according to the habitat suitability of endangered bryophyte species.

Bryophytes can be used as structural organisms at the microhabitat-level because they establish ecological relationships with other small organisms such as arthropods or earthworms (Draper et al., 2003). Bryophytes usually go unnoticed in conservation planning because of their small size, difficulty of identification and unrecognized levels of local diversity. Furthermore, it is usually difficult or impractical to undertake bryophyte surveys in some seasons due to their ephemeral cycles. However, their role in ecosystems, contribution to overall biodiversity and potential as

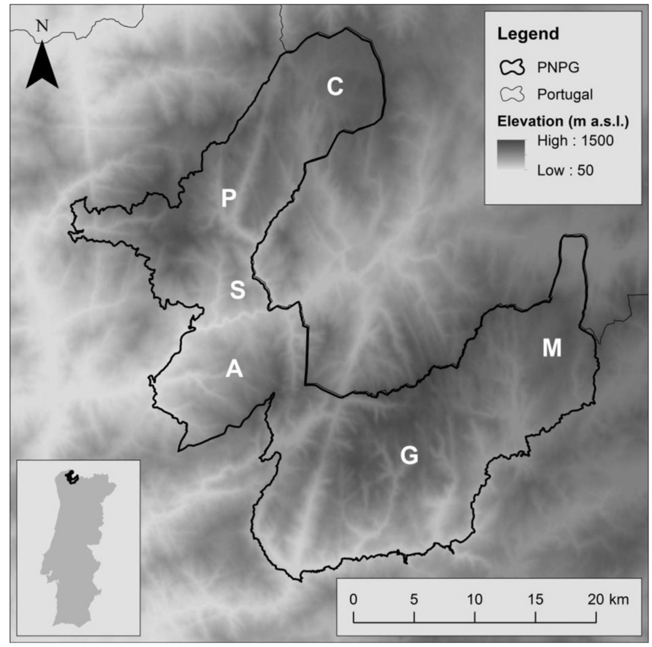

Fig. 1. Mountain areas of the Peneda-Gerês National Park (PNPG): C—Castro Laboreiro plateau; P—Peneda mountain; S—Soajo mountain; A—Amarela mountain; G—Gerês mountain; M—Mourela plateau.

biological resources highlight the need for their inclusion in conservation planning (McMullan-Fisher et al., 2010).

The aim of this study was to test if a higher *taxa* approach (at genus-level) could be used in the selection of areas for bryophyte conservation in the Peneda-Gerês National Park, using three common approaches for reserve selection: Scoring approach, Important Plant Areas, and Complementarity-based approach. The Peneda-Gerês National Park (PNPG) is the only National Park in Portugal and one of the best studied sites for bryophytes in Portugal, making this area a good case study to test the ongoing hypothesis.

2. Material and methods

2.1. Study area

The PNPG has a total area of approximately 70,000 ha, with altitudes ranging from 50 to 1500 m. The main geomorphological units in PNPG (Fig. 1) are: Castro Laboreiro plateau (C), Peneda mountain (P); Soajo mountain (S); Amarela mountain (A); Gerês mountain (G); Mourela plateau (M). Despite the overall Atlantic climate PNPG has peculiar climatic conditions, from Rio Homem valley with thermophytic and humid conditions, to the high mountains and interior with warm and heavy rainfall conditions. Geologically, PNPG is dominated mainly by granites (Sérgio et al., 2012).

2.2. Data source

A georeferenced bibliography-based dataset was prepared based on pre-existent bryophyte data from the University of Lisbon (LISU) and Oporto (PO) herbaria resulting from sporadic surveys, projects (Sérgio et al., 2012) and Ph.D. studies (Garcia, 2006; Hespanhol, Séneca, Figueira, & Sérgio, 2011; Vieira et al., 2012).

For each *taxon* a threat category was assigned, according to the Portuguese Red Data Book (Sérgio et al., 2013): critically endangered (CR); endangered (EN); vulnerable (VU); near threatened (NT); low concern species which require special attention (LC-Att); species with insufficient data (DD and DD-*n*) and species of low con-