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Original Research Article

Evidence of cross-taxon congruence in Neotropical wetlands: Importance of environmental and spatial factors

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A B S T R A C T

Surrogate groups have been used as a useful tool for biodiversity conservation. The occurrence and distribution of a taxon can be predicted based on the occurrence of other biological species or groups. Consequently, the current study sought to determine the presence of one or more surrogate groups in a seasonally flooded region in the South American Pantanal wetlands. Data on the occurrence and distribution of species were collected at Pantanal Long-Term Sampling Sites (PLTSS). We assayed for congruence between woody plants, herbaceous plants, spiders, anurans, birds and small mammals using Mantel tests. We also evaluated the effect of selected environmental and spatial factors on each biological group, using variance partitioning. Based on the average correlation between groups, the group with the highest congruence was woody plants, and it was therefore considered the best surrogate group for the PLTSS area. The soil texture (percentage of silt, sand and clay) are not important in defining plant group distributions. However, plants were distributed as a function of flood intensity and hydroperiod. The effect of flooding and vegetation structure differed between the analyzed zoological taxa. Additionally, spatial factors, here represented by Moran Eigenvector Maps, were important for all evaluated biological groups.

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1. Introduction

Biodiversity loss has been attributed to several factors, including habitat fragmentation, introduction of exotic species, overexploitation and, more recently, climate change (Kareiva and Marvier, 2012). These factors, separately or together, can result in population decline, and hence, in the imbalance of biological communities (Soulé, 1985; Pimm and Ravesn, 2000; Loyola and Lewinsohn, 2009; Kareiva and Marvier, 2012). Knowledge of local biodiversity is an important tool for conservation, since it allows planning of realistic management actions and strategies aimed at preserving ecosystem integrity. However, gaining information on the fauna and flora of an area, especially in the tropics, requires much time and money, often making such a task unachievable in the short and medium term (Lawton et al., 1998).

Estimates of the number of species on Earth are still far from being in agreement, and, indeed may even be contradictory (Caley et al., 2014). Recent estimates were around 8.5 million species, of which nearly 1.5 million were already formally described (Mora et al., 2011; Costello et al., 2012). While biodiversity in the tropics is generally much higher than in temperate regions (e.g., Slik et al., 2015), the assessment of such biodiversity is usually expensive and time-consuming, as well as requires appropriate technical expertise (Lawton et al., 1998; Gardner et al., 2008). A solution for the problem of insufficient information concerning species distribution and natural history and the difficulty of monitoring tropical biodiversity has been the use of surrogate groups (Lindenmayer et al., 2002; Westgate et al., 2014). The concept of surrogate groups proposes that the abundance and richness of species in a particular biological group can be used to represent the species distribution of the other groups from the same area (Margules and Pressey, 2000).

To function well a surrogate group should be easy to sample and identify, and must have congruent patterns (biological concordance) with those groups that it will represent, i.e., those occurring in both spatial distributions and in response to the same environmental gradients (Gaston and Williams, 1996; Paavola et al., 2003; Heino, 2003; Bini et al., 2007; Landeiro et al., 2012). Moreover, to be considered viable, a surrogate group must be less expensive and less time-consuming to inventory or monitor when compared to other potential target groups.

The advantage of using surrogate groups is that, when congruence is found, distribution patterns obtained for a biological group can be extrapolated to the other groups in the same geographical area (Heino and Mikra, 2006), thus reducing the time and financial resources required for planning and implementing conservation (Howard et al., 1998; Lamoreux et al., 2006; Trindade-Filho and Loyola, 2011). Because congruence implies that groups respond in similar ways to environmental factors, it should be possible to evaluate the effects of various potential impacts (e.g., deforestation, hydroelectric power generation, mining) on different biological groups simultaneously by monitoring the group selected as surrogate, as well as indirectly preserving unsampled taxa simply by encouraging the conservation of the surrogate group (Gaston and Williams, 1996).

Despite criticism on the effectiveness of the use of surrogate groups in biodiversity conservation and monitoring plans (e.g., Grantham et al., 2010; Padial et al., 2012; Westgate et al., 2014), studies conducted in a variety of ecosystems have successfully evaluated taxonomic groups as potential surrogates. In the Neotropics, Pinto et al. (2008) evaluated the congruence between different orders and families of birds in Central Brazilian Cerrado, and concluded that the family Thamnophilidae could be used as a surrogate group for the evaluated taxa. Landeiro et al. (2012) analyzed congruence between 22 taxonomic groups of both plants and animal in an area of Amazon rainforest and found that lianas (all from the Bignoniaceae family) were the best surrogate group.

Wetlands are among the most diverse, productive and threatened natural systems on the planet (Tockner et al., 2000). The integrity and biodiversity of the South American Pantanal, one of the world's largest wetlands, are threatened by activities such as cattle ranching and agriculture (Seidl et al., 2001; Fernandes et al., 2015), and it has therefore been the subject of intense research and conservation focus (Junk et al., 2014). Successfully protecting the ecological integrity of such wetlands requires the conservation of the various ecosystem services contributed by biodiversity, such as storage and treatment of water, ground water recharge, sediment retention, microclimate regulation and the refuges provided for migratory species.

A wide variety of studies have shown that seasonal migration, reproductive behavior and animal and plant species distributions and densities in the Pantanal floodplain are linked to the flood regime (e.g., Mourão et al., 2000; Rebellato and Cunha, 2005; Junk et al., 2006; Arieira et al., 2016; Valerio et al., 2016). However, information concerning the distribution patterns of local biological communities is still scanty (Pott and Pott, 2004; Fernandes et al., 2014), with few studies seeking to integrate existing acquired knowledge and understand how biological communities interact with one another (Junk et al., 2006). To cover this knowledge gap, the aim of this study was to evaluate congruence between different biological groups in a seasonally flooded environment of the Pantanal, and identify the group (or groups) that best represent the distribution of the sampled community (i.e., surrogate groups).

Starting from the selection of the surrogate group, we sought to test the effects of environmental factors (soil, flood and vegetation) and spatial factors on all the biological groups analyzed. We predicted that the groups whose distribution patterns are most strongly associated with each other would respond to the same environmental factors, in accordance with the assumptions of niche theory or environmental filters, while groups with weakly convergent distribution patterns would be influenced by neutral processes such as those associated with dispersal.