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Rarity status of endemic and vulnerable fish species in a Brazilian Atlantic Forest protected area

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ABSTRACT

Rare and endemic species can be good indicators for monitoring the success of biodiversity management in protected areas. Rarity status can be checked using relatively simple quantitative methods. We used species frequency of occurrence, abundance and biomass to identify rare fish species in a Brazilian Atlantic Forest protected area. We also analyzed the abundance of a vulnerable and endemic species, *Isbrueckerichthys epakmos*, using general linear models and predictor variables related to instream environmental structures (substrate types, mesohabitats, water velocity and depth). Nine rare species were found, disregarding an exotic specimen. *I. epakmos* was endemic to PEJU, highly abundant and widely spread species. Its abundance was strongly related to higher proportions of coarse substrate, pools and riffles. The combination of biological information and rarity rates is a useful tool for indicating failures in conservation management, but also for suggesting more effective actions.

Introduction

In ecological communities, few species are common while most are rare, a consistent pattern across taxa and ecosystems (Magurran, 2004; Magurran and Handerson, 2010a). An intuitive measure of rarity is density, i.e. the number of individuals in a given area (Gaston, 1994). Even though population biomass or the spatial distribution range may equally be employed for expressing rarity, the former is linked to the amount of material and energy flow in food webs (Cohen et al., 2003), while the second is a measure of endemism (Gaston, 1994; Hercos et al., 2013).

Endemic species for example can be good indicators of unique communities, e.g. with many rare taxa (Burlakova et al., 2011). While common species can compensate, in the short term, a decline in ecological functions resulted from a decrease in rare taxa, the loss of additional functions performed by uncommon groups can contribute to further loss of species. It is worth noting that rare species, even those with only one individual in the sample, can sustain vulnerable ecosystem functions, i.e. those that can only be fulfilled by a

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small group of species with specific traits related to their function (Mouillot et al., 2013). If these keystone species disappear, vulnerable ecosystem processes are also lost, indicating that rare species can influence ecosystem resistance and resilience in the long term (Smith and Knapp, 2003).

Besides the importance for ecosystem functioning, the concept of species rarity is central to biodiversity assessment. For example, species richness estimators assume that the higher the number of species captured in only one sample (uniques) or those represented by only one individual (singletons), the higher total species richness in the community (Chao, 1984; Colwell and Coddington, 1994; Chao et al., 2009). In this sense, all information on unseen species is summarized by the rarity pattern in the samples. Once all species in the sample are represented by at least two individuals (or are presented in two sites) no more species are expected to be found in that community (Magurran, 2010).

When it comes to previously established protected areas – PAs, indicators of rarity can be used to monitor changes in biodiversity patterns over space and time, indicating failures or successes in conservation management (Santiago and Gallo, 2011), whereas for unprotected areas these and other ecological indicators allow detecting priority conservation sites (Metzger and Casatti, 2006).

Unfortunately, basic information about species occurrence and distribution, as well as rarity and endemism rates, are still scarce and unevenly distributed in Brazil (Menezes et al., 2007). Even in currently existing PAs scientific knowledge production is very low, or its content shows theoretical results, with few practical suggestions of management improvement. For the Jurupará State Park – PEJU – the situation is no different.

This Brazilian PA, located in São Paulo State, contributes to biodiversity protection in a large Atlantic Forest continuum. Despite some basic information gathered in the Management Plan,[1] current knowledge regarding biotic and abiotic conditions in PEJU is virtually null, according to Santiago and Gallo (2011) evaluation of scientific research applied to the park management. Many reasons contribute to this astounding scenario, particularly bureaucratic obstacles for researches approval and lack of partnerships among researchers and research centers.

The PEJU Management Plan lists 74 fish species distributed in a preserved area that exceeds 26,200 hectares (São Paulo, 2010). Despite activities with high potential for aquatic ecosystems degradation (e.g. housings and damming), there are signs of high levels of endemism in fish fauna. At least four fish species present in the park are listed as vulnerable in the "Fauna threatened with extinction in São Paulo State" (Bressan et al., 2009). This book, published by the State Government in partnership with research centers, used the same criteria and categories proposed by IUCN – International Union for Conservation of Nature. The vulnerable fish species listed in the book and found in PEJU were *Isbrueckerichthys duseni* (Miranda Ribeiro, 1907) (Siluriformes: Loricariidae), *Isbrueckerichthys epakmos* Pereira & Oyakawa, 2003 (Siluriformes: Loricariidae), *Pseudocorynopoma heterandria* Eigenmann, 1914 (Characiformes: Characidae) and *Scleromystax prionotos* (Nijssen & Isbrücker, 1980) (Siluriformes: Callichthyidae).

In this scenario, we present this study as a contribution to the current knowledge about PEJU fish communities. Rarity status of fish species was assessed using quantitative criteria and the abundance and distribution of the endemic and vulnerable species *I. epakmos* was analyzed according to instream environmental components.

Materials and methods

Sampled stretches

Ten sites, 75 m long stream stretches, were sampled inside Jurupará State Park and in its buffer zone between June and December 2010 (Fig. 1). This 75 m standardized distance allowed us to sample the main mesohabitats (i.e. pool, run and riffles, description in Teresa and Casatti, 2012) and microhabitats (e.g. depths, substrate types, water velocity) within the streams (Oyakawa et al., 2006). Since we aimed to understand the conservation potential of the area, we selected stream stretches in less degraded environments, e.g. with no obvious signs of substrate homogenization or suppression of the riparian vegetation.

Collection of the ichthyofauna and environmental variables

Fish were collected with electrofishing equipment, using a portable generator (Yamaha, model EF2600, 2.3 kVA, 60 Hz) connected to a voltage transformer. In each site a sweep was made following the downstream-upstream direction, without contention networks at the upper and lower limits. All collected specimens were fixed in formalin for 72 h and then preserved in 70% ethanol. Specimen vouchers were deposited in the Fish Collection of Zoology Department in São José do Rio Preto, São Paulo, Brazil.

Three transverse transects were set up at upper, middle and lower limits of each site to guide the quantification of substrate components and channel morphology. Along these transects we visually quantified the percentage of wood debris, pebbles, cobbles and boulders at every one meter (description of all categories in Cruz et al., 2013). The sum of these percentages was used as a variable, named coarse substrate (cs), which was related to bottom substrate stability and microhabitats diversity within the channel (Casatti et al., 2006). Along with substrate components, we also measured channel depth (cm) and water velocity (m/s) and combined the data to calculate a Shannon diversity index for water velocity (H'_{vel}). We added the proportions of the pools and riffles (pr) in each sampled site to create a variable that reflected the combinations of different mesohabitats, capable of housing high species diversity (Teresa and Casatti, 2012).

[1] The Management Plan is a mandatory technical document that must contain information about biotic and abiotic factors, landscape use and human activities inside the PA and its surroundings. It serves as a guide to natural resources management and governance approaches (Medeiros & Pereira, 2011).