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Effects of structural and functional connectivity and patch size on the abundance of seven Atlantic Forest bird species

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Abstract

We studied the importance of fragment size and structural and functional connectivity on the occurrence and abundance of seven Atlantic Forest bird species in 13 patches (13–275 ha) and three sites within a continuous forest (10,000 ha). We sampled birds with point counts and evaluated structural connectivity considering the presence of corridors and the degree of isolation. We defined functional connectivity by analyzing species movements using playbacks in forest corridors between fragments and in the surrounding matrix. Species differed in their responses to fragmentation. For the frugivorous species, *Trogon surrucura*, *Carpornis cucullatus* and *Triclaria malachitacea*, patch size was the main factor determining abundance. Two understory insectivorous species, *Basileuterus leucoblepharus* and *Pyriglena leucoptera*, were more affected by the degree of patch connectivity, the former by the presence of corridors and the latter by the distance between patches. The capacity of *P. leucoptera* to use corridors and open areas (i.e. functional connectivity) shaped its abundance pattern. Fragmentation had no effect on the abundance of *Chiroxiphia caudata* and had a positive effect on *Batara cinerea*. This study emphasizes the importance of considering species' perceptions of landscape, especially functional connectivity, in understanding the effects of habitat fragmentation.

Keywords: Habitat fragmentation; Birds; Corridors; Patch size; Functional connectivity

1. Introduction

Connectivity and patch size are important parameters for the persistence of species in fragmented landscapes (Karr, 1982; Blake and Karr, 1987; Bierregaard and Stouffer, 1997; Stratford and Stouffer, 1999; Crooks et al., 2000). While connectivity is associated with migration rates, and thus with the (re)colonization probability and the rescue effect, patch size is mainly related to the probability of local extinction (Levins, 1970; Hanski and Gilpin, 1997).

Connectivity can be defined as the capacity of the landscape to facilitate biological fluxes (Taylor et al., 1993; Tischendorf and Fahrig, 2000). In structural terms, it can be evaluated by measuring landscape patterns, such as density and complexity of corridors (Beier and Noss, 1998), distance between patches, and inter-habitat matrix permeability (Metzger and Décamps, 1997; Gascon et al., 1999; Antongiovanni and Metzger, 2005). Functional connectivity is more complex. It depends not only on the landscape pattern, but also on the interactions between this pattern and the biological characteristics of the target species, such as their ability to move in areas of non-habitat (Greenberg, 1989; Sieving et al., 1996). For example, understory insectivorous birds, which are able to use more intensively deforested countryside, are less affected by fragmentation and have

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lower extinction risk (Sekercioglu et al., 2002). Interest in how species use different landscape elements to disperse is increasing (Tischendorf and Fahrig, 2000; Graham, 2001; Bélisle and Desrochers, 2002; Adriaensen et al., 2003) as it is linked with the probability of an individual finding patches of habitat that are spread across the landscape and, therefore, is related with species' capacity to persist in such environments.

In the present study, we evaluated the abundance of seven Atlantic rainforest bird species in relation to patch size and connectivity, considering not only structural characteristics of the landscape but also movement behavior of species.

The Brazilian Atlantic rainforest has one of the highest levels of biodiversity and rates of endemism in the world, and is among the world's top five threatened hotspots (Myers et al., 2000; Mittermeier et al., 1999). Despite strict environmental legislation, today less than 8% of the forest remains and deforestation persists (Dean, 1996; Fundação SOS Mata Atlântica/INPE, 2002). Due to habitat loss and the consequent fragmentation, populations are becoming isolated in small forest patches and many species, especially endemics (Ribon et al., 2003), are locally disappearing. For example, the Atlantic Forest has 188 endemic bird species (Pacheco and Bauer, 2000) and among them 102 are considered threatened (Pacheco and Bauer, 2000; IUCN, 2003).

There is a growing literature concerning the effects of deforestation and fragmentation on bird communities in this biome (Willis, 1979; Aleixo and Vielliard, 1995; Christiensen and Pitter, 1997; Anjos and Boçon, 1999; Brooks et al., 1999a; Maldonado-Coelho and Marini, 2000; Ribon et al., 2003), but few authors have considered aspects of connectivity. Since the response to fragmentation depends on the interaction between spatial characteristics of the landscape and the species' behavior (Tischendorf and Fahrig, 2000), we analyzed connectivity in structural and functional terms. Structurally, we considered the presence or absence of connections (corridors) between small and larger patches in the land-

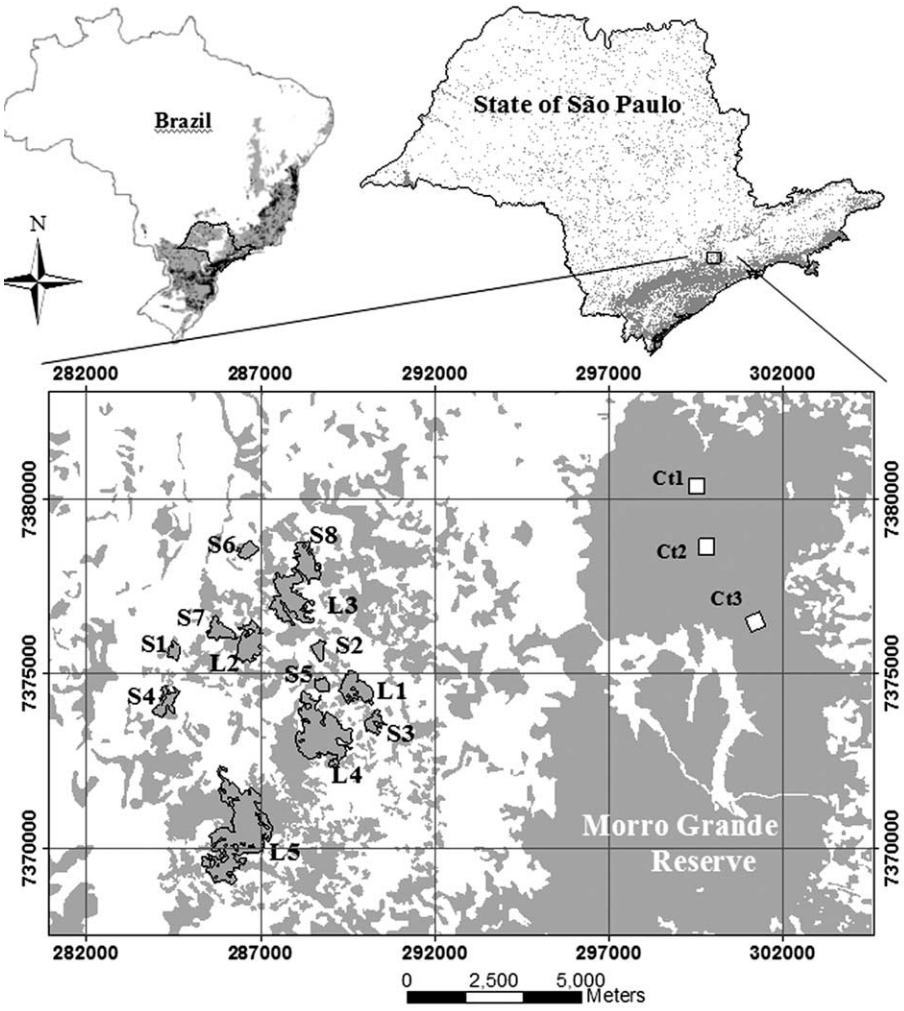

Fig. 1. Location of the study region in São Paulo State, Brazil. The more detailed map shows the continuous forest (Morro Grande Reserve) and the adjacent fragmented landscape, with the 16 study sites (patch codes and spatial characteristics in Table 1).