Forest Ecology and Management 424 (2018) 216–227

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Tree monocultures in a biodiversity hotspot: Impact of pine plantations on mammal and bird assemblages in the Atlantic Forest

M.E. Iezzi[a,b,*], P. Cruz[a,b], D. Varela[a,b], C. De Angelo[a,b], M.S. Di Bitetti[a,b,c]

[a] Instituto de Biología Subtropical (IBS), Universidad Nacional de Misiones (UNaM) – CONICET, Bertoni 85, Puerto Iguazú, Misiones, Argentina
[b] Asociación Civil Centro de Investigaciones del Bosque Atlántico (CeIBA), Bertoni 85, Puerto Iguazú, Misiones, Argentina
[c] Facultad de Ciencias Forestales, UNaM, Eldorado, Misiones, Argentina

ARTICLE INFO

Keywords:
Productive landscape
Tree plantations
Species richness
Species composition
Human access
Forest fragments

ABSTRACT

Forest plantations of fast-growing exotic species constitute an important economic activity in tropical and temperate regions of developing countries. Large areas of native forests and grasslands are being turned into tree plantations without assessing their impacts on natural communities. We evaluated the effects of replacing native forests by non-native pine (*Pinus taeda*) plantations on the diversity and composition of assemblages of terrestrial mammals and ground-dwelling and understory birds, in a forest productive landscape of the Upper Paraná Atlantic Forest of Misiones, Argentina. Camera-trap stations were deployed in three different "environments": 53 in a continuous forest, 69 in forest fragments, and 62 in tree plantations. The evaluation focused on the effect of the environment, the structural complexity of the vegetation, the cost-distance (distance weighted by connectivity) to the continuous forest, the percentage of native forest within different radii, and the cost of human access (as a proxy for hunting pressure) on both mean species richness per station and species composition. Alpha diversity of the assemblages of each environment was estimated using Hill numbers (effective number of species): q_0 = richness, q_1 = number of common species and q_2 = number of dominant species. Changes in community composition were evaluated by comparing the assemblages of the three environments using three similarity indices: Sorensen (q0 = similarity in species identity), Horn (q1 = similarity in common species), and Morisita-Horn (q2 = similarity in dominant species). For mammals and birds, richness was significantly higher in forest stations (both continuous and fragmented) than in those located in plantations. For both taxa, it also decreased with the distance to the continuous forest (but with a negative quadratic term in birds). Tree plantation stands contained biased and impoverished subsets of the original assemblages. Mammal composition was affected by the environment, the distance to the continuous forest, the proportion of native forest in the landscape, and human access. The bird assemblages of plantations were seriously affected, and their composition was also influenced by changes in vegetation structure. Alternative management practices (e.g. pruning, thinning) and landscape features can partially mitigate the negative effect of tree plantations on mammal and bird assemblages. Large areas of forest that function as population sources and forest fragments immersed in the matrix of plantations are strictly necessary to preserve the original native mammal and bird assemblages in the productive landscape. Promoting connectivity and improving hunting controls will also support their conservation.

1. Introduction

Tropical and subtropical forests contain a large share of the terrestrial biodiversity (Myers et al., 2000). Worldwide, these forests are increasingly being replaced by monoculture plantations (Kremen and Miles, 2012), including tree plantations (Keenan et al., 2015), which results in the simplification of the vegetation structure and composition, and in the loss of a large portion of the native species (Barlow et al., 2007; Brockerhoff et al., 2008). Therefore, species richness is often lower in tree plantations than in natural forests (Bergner et al., 2015; Lantschner et al., 2011; Zurita et al., 2006), but the extent of this decline varies considerably across a range of management intensities and taxa (Bergner et al., 2015; Brockerhoff et al., 2013, 2008; Trentini et al., 2017).

Species well adapted to mature, climax-forest communities and with narrow niche breadths are usually the most affected in agro-forested landscapes (Newbold et al., 2014; Pryde et al., 2016; Zurita et al., 2017) that usually retain the generalist species which sometimes thrive in human-modified environments (Azhar et al., 2013; Estavillo et al., 2013; Lindenmayer et al., 2008). Particularly, mammals and birds are

* Corresponding author at: Instituto de Biología Subtropical (IBS), Universidad Nacional de Misiones (UNaM) – CONICET, Bertoni 85, Puerto Iguazú, Misiones, Argentina.
E-mail address: maru.iezzi@gmail.com (M.E. Iezzi).

https://doi.org/10.1016/j.foreco.2018.04.049
Received 6 December 2017; Received in revised form 24 April 2018; Accepted 26 April 2018

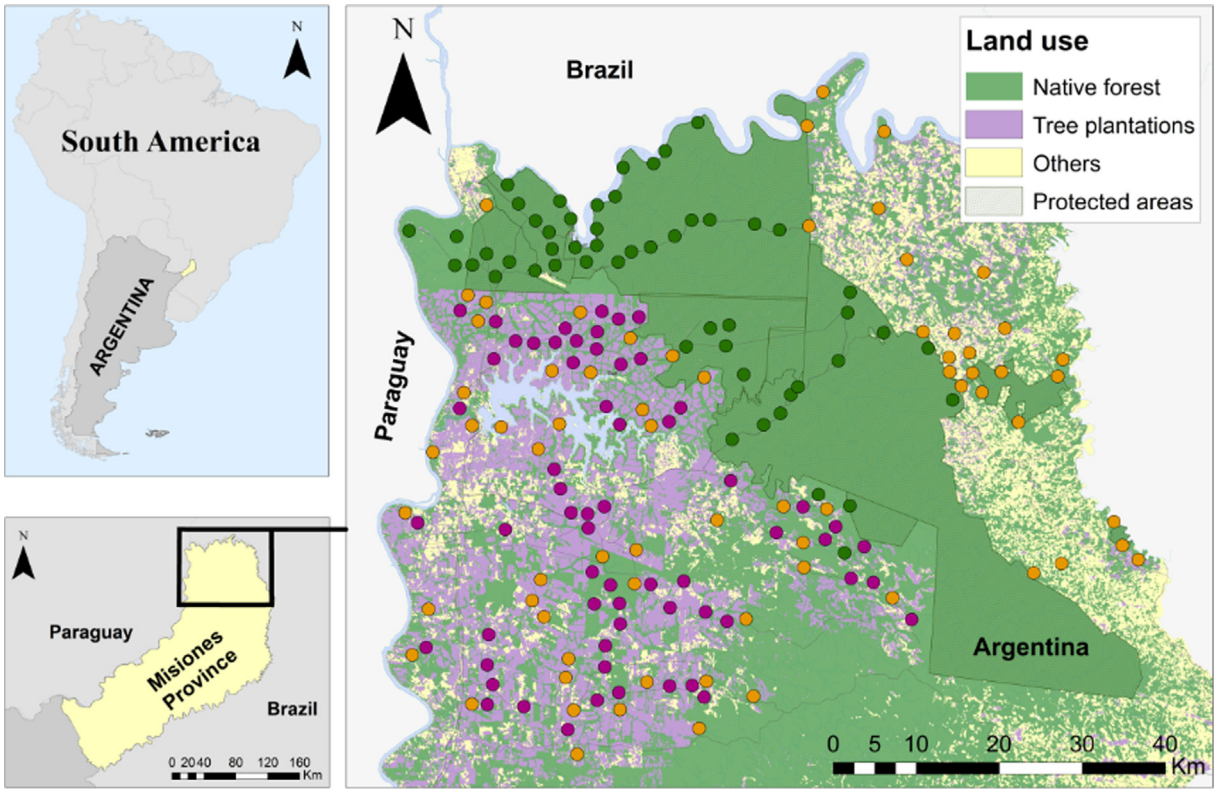

Fig. 1. Location of the study site and camera-trap stations in the Atlantic Forest of Misiones province, Argentina. Green points correspond to continuous forest stations (53), orange points to native forest fragments (69), and violet points to tree plantations (62).

sensitive to human-modified ecosystems (Barlow et al., 2007), and the richness and composition of their assemblages are negatively affected by the replacement of forests with commercial tree plantations (Barlow et al., 2007; Irwin et al., 2014; Mortelliti and Lindenmayer, 2015; Zurita et al., 2017, 2006).

However, there are several features of productive landscapes that can mitigate the negative impacts of plantations on biodiversity. For instance, planted forest stands may become alternative, albeit not optimal, habitats for native species through specific management practices (Brockerhoff et al., 2013, 2008; Fonseca et al., 2009; Pietrek and Branch, 2011). Tree plantations that promote the growth of understory vegetation, for example, can provide food and shelter for birds and mammals, supporting higher levels of biodiversity (Azhar et al., 2013; Bergner et al., 2015; Simonetti et al., 2013). However, the native species that use productive stands as alternative or temporal habitats usually depend on patches of natural habitat that serve as population sources (Lindenmayer and Hobbs, 2004).

Very large forest patches of natural habitat are critical as population sources of mammal and bird species in productive landscapes (Núñez-Regueiro et al., 2015; Yue et al., 2015). The conservation and restoration of wide areas of forest immersed or buffered by the productive landscape are essential for the persistence and resilience of the original assemblages in the landscape (Brockerhoff et al., 2013; Lindenmayer and Hobbs, 2004). Consequently, the richness and occupancy of some species decline as the distance to the native forest increases (Edwards et al., 2010; Sunarto et al., 2012; Yue et al., 2015). Moreover, mammal and bird species abundances are usually higher in connected forest fragments compared to isolated ones (e.g. Magioli et al., 2016; Mortelliti et al., 2014; Pardini et al., 2005). Therefore, ensuring the connectivity of the forest remnants with large expanses of well-preserved habitat can constitute an important mechanism for native species conservation in productive landscapes.

Besides their contribution for maintaining habitat connectivity, relatively small remnants of native forest immersed in the productive areas can contribute to landscape heterogeneity (Brockerhoff et al., 2013; Lindenmayer et al., 2008) and may create the conditions for the existence of population sources of species with low spatial requirements, thus maintaining the richness and composition of the native assemblages (e.g. Beca et al., 2017; Felton et al., 2010; Lindenmayer et al., 2008, 1999; Zurita and Bellocq, 2009). Native vegetation patches and strips of riparian vegetation, even those relatively small or narrow, may be critically important, since they could be used by many native animals to traverse productive areas (Di Bitetti et al., 2011; Heer et al., 2015; Pietrek and Branch, 2011).

Although the form of tree plantation stands and landscape management practices affect biodiversity conservation, they may interact with other anthropic pressures associated with landscape transformation. For example, the conversion of forests to plantations usually implies the deploy of a network of roads that facilitate the access of people to previously remote areas, which in turn may increase extractive activities, such as hunting, on previously inaccessible forests. Poaching can have strong effects on the abundance of some particular species (Benítez-López et al., 2017), causing changes in the composition of mammal and bird assemblages (Peres and Palacios, 2007). In tropical forests, large mammals such as ungulates and big carnivores are the most negatively affected species by poaching (Di Bitetti et al., 2008; Jerozolimski and Peres, 2003; Paviolo et al., 2009; Peres and Palacios, 2007), and these are the species with the biggest impact on ecological processes and biodiversity through top-down regulation (Estes et al., 2011).

The Atlantic Forest is not only considered a hotspot of biodiversity (Mittermeier et al., 1998; Myers et al., 2000), but also one of the most threatened forests in the world with only 11–16% of its original cover remaining (Ribeiro et al., 2009). One of the larger portions of continuous Atlantic Forest persists in Misiones province, Argentina (Ribeiro et al., 2009), where forest loss has been mainly caused by its conversion to crop and extensive non-native tree plantations for fiber production (Izquierdo et al. 2008). In northern Misiones province, the matrix of