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ECOLOGY

Use of artificial perches for wild birds in a degraded area in southern Brazil

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ABSTRACT. One of the major setbacks in environmental restoration is how to promote the arrival of propagules in degraded areas, and this issue is intensified at sites without vegetation, where natural dispersal is limited. To overcome this issue, one of the methods employed is the use of artificial perches, intended for attracting seed-dispersing birds, providing perching sites, and thus, facilitating the formation of vegetation nuclei from the seeds that are excreted, regurgitated, or accidentally dropped. The aim of this study was to quantify and identify the birds that used the artificial perches in a degraded area on the margins of the Forqueta River, RS, Brazil, in order to evaluate their effectiveness as an ecological restoration method. Over one year, 11 bird species were observed to use the perches. Despite the presence of birds, there was no significant seed germination at the base of the perches. Absence of frugivorous species and adverse conditions of the soil might have contributed to this result. Previous studies showed diverging results on the effectiveness of artificial perches, indicating the need for considering several factors, such as availability of food resources and the presence of invasive species. The present study highlights the complexity of ecological processes involved in the restoration of degraded areas and the importance of adaptive approaches to reach effective results.

Keywords: Avifauna; Seed rain; Seed dispersal; Nucleation; Ecological restoration.

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Introduction

Propagule dispersal is an essential process for maintaining plant species in forest systems, since it allows successful germination at sites that are favorable to the growth of these propagules, mitigating risks of competition and the action of pathogens (Jordano, Galetti, Pizo & Silva, 2006; González-Varo et al, 2021). Many trees in tropical forests produce fruits adapted to dispersal by animals (Sekercioglu & Sodhi, 2007; Bello et al, 2017), a mutualistic process in which the fauna uses the resources offered in plant reproductive structures, and in exchange, plants have their seeds dispersed (Christianini & Martins, 2015).

Among vertebrates, frugivorous birds and/or birds with omnivorous habits comprise the most effective group of dispersers, given their easy locomotion around the environment, ingesting fruits and seeds and taking them to areas that are farther from the parent plants (Sick, 1997; Azpiroz, 2001; Christianini & Oliveira, 2009; Carlo & Morales, 2016). This process corresponds to 51% of the ecology of endozoochorous woody species dispersal in the Atlantic Forest (Almeida-Neto, Campassi, Galetti, Jordano & Oliveira-Filho, 2008; Bello et al, 2017), leading to the maintenance of the biotic integrity of tropical communities (Lira-Filho & Medeiros, 2006; Fedriani, Wiegand, Garrote, Leiva, & Ayllon, 2018).

Guevara and Laborde (1993) and Athiê and Dias (2016) emphasize that after consuming the fruits, the birds naturally use the remaining trees in pastures for protection, for resting during flight between fragments, as food, or as latrine sites. Therefore, these trees play an important role in the formation of highly diversified regeneration nuclei during the early stages of natural succession. This occurs due to the significant propagation of seeds that are excreted, regurgitated, or accidentally dropped by the birds (Reis, Bechara & Tres, 2010; Carlo & Morales, 2016).

This behavior might be explored as a methodology for restoring degraded areas, by introducing and maintaining artificial perches that imitate bare or dead trees in the landscape (Reis et al., 2010; Athiê & Dias (2016), attracting functionally important birds, such as frugivores. Restoration strategies such as these are low cost, as they do not require production and planting of seedlings (Bechara et al., 2007; Reis et al., 2010;

Fedriani et al, 2018), because they use neighboring forests as source of seeds, inducing the arrival of external propagules, resulting in higher plant density than those based only on the resilience of the area (Tres & Reis, 2009; Reis et al., 2010; Almeida, 2016). Thus, they lead to increased rain and local seed bank, thus facilitating the re-establishment of ecological processes associated to stability, succession, and system resilience (Tres et al., 2007; Fedriani et al, 2018).

In addition, according to Reis et al. (2010), Corbin and Holl (2012) and Arroyo-Rodríguez et al (2017), conserved fragments near degraded areas work as a source of biotic and abiotic diversity, providing new populations within the communities being restored, as well as regeneration or colonization niches. The presence or absence of these sites might have a profound influence on seed dispersal (Pausas, Bonetb, Maestre & Climent, 2006; Cavallero, Raffaele & Aizen, 2013; Brancalion, & Chazdon, 2017). Therefore, degraded communities are redirected, integrating them with the forest remnants nearby through an ecological flow that prioritizes ecosystem biofunctionality (Bengtsson et al., 2003; Tres & Reis, 2009; Reis et al., 2010; Almeida, 2016).

Understanding the propagation of plant species and the ecological processes involved is of the utmost importance to render feasible an effective preservation and restoration of degraded areas. Therefore, studies that aim to understand seed dispersal of the native flora and the interactions between plants and animals are instrumental.

Therefore, we seek to understand the relationship between the use of artificial perches by native birds with the germination of plant species in a degraded area, close to a large forest remnant. We hypothesized that the existence of a large forest remnant near the study area would favor the arrival of seeds through birds that would occupy the artificial perches when they flew to other fragments, or even to isolated trees nearby. Considering this, the aim of the present study is to quantify and identify the birds that used the artificial perches in the degraded area, in order to evaluate the effectiveness of this ecological restoration method.

Material and methods

Study area

The study was conducted in a degraded permanent preservation area on the margins of the Forqueta River (29°16’37.28”S and 52°08’04.03”W), Taquati-Antas River Basin, in the municipality of Travesseiro, Rio Grande do Sul (RS), Brazil. The area is inserted in a phytoecological region of the Seasonal Deciduous Forest, within the Atlantic Forest (Instituto Brasileiro de Geografia e Estatística [IBGE], 2021). Climate in the region is considered as subtropical, with hot summer and mild winter. Mean annual temperature can vary between 20 °C and 22 °C and mean rainfall ranges from 1900 to 2200 mm (Alvares, Stape, Sentelhas, Gonçalves & Sparovek, 2013).

The area used in the study is, on average, 25 m wide and 150 m long (Figure 1). In addition to having sandy soil, the vegetation present is dominated by exotic species, especially grass with high invasive potential, such as *Cynodon dactylon* (L.) Pers., *Cenchrus purpureus* (Schumach.) Morrone, and *Urochloa* sp. P. Beauv. Around the study area, soil is occupied by agricultural plantations and pastures, and there is a preserved forest remnant on the opposite margin of the river.

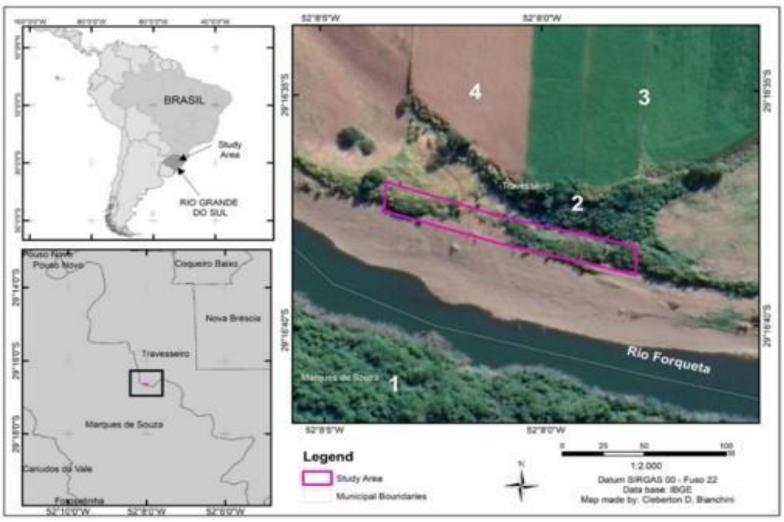

Figure 1. Limits of the study area located in the municipality of Travesseiro/RS, with indication of use and soil in the vicinities.1: Forest remnant; 2: Area with altered vegetation at an early stage and dominated by invasive exotic plants; 3: Pasture grazing area; 4: Agricultural area.

Samplings

The study area was initially cleaned, and then, herbicide was applied to eliminate invasive exotic plants. To apply the restoration techniques, the study area was divided into 15 parts, here designated plots, which were all of the same size (250 m^2) (Figure 2). Different ecological restoration techniques were designed in each plot; one of them was artificial perches.

The study was conducted by installing 18 artificial perches in 6 plots (three perches in each), built from eucalyptus wood with four meters height and two branches on the upper part at different heights (3 m and 4 m) for birds to perch, in a completely randomized experimental design. At the base of the perches, one-meter plots (1 m^2) were delimited to evaluate monthly seed germination (Figure 3).

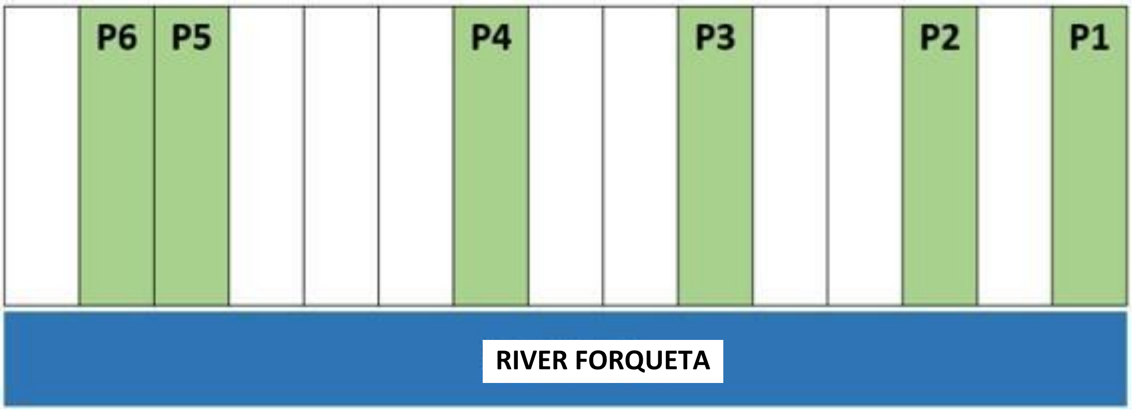

Figure 2. Division of the study area, with distribution and identification of plots with installed perches. P = Plot.

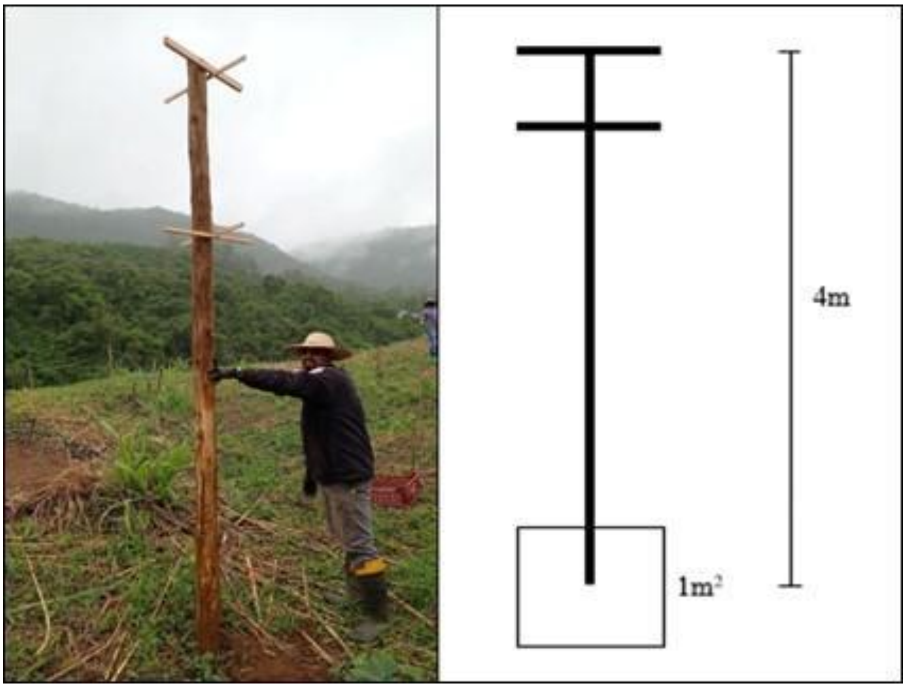

Figure 3. Image and model of the artificial perches that were installed in the study area.

To qualify and quantify the use of perches by the birds, monthly samplings were performed from February, 2022, to February, 2023. For data collection the fixed-point method was used, in which researchers remain for 20 minutes in each sampling area, observing (Bibby, Jones & Marsden, 2000). All visual records were performed with the help of Nautika 8x40 and 10x50 binoculars and Alpha a3000 digital camera with 18-55mm lenses, by two observers, positioned at a distance of approximately 100 m from the perches, so that there was no interference on the birds. The birds were identified with the help of specific bibliographies (Sick, 1997; Jacobs & Fenalti, 2020). The germination of tree or shrub species at the base of the perches was also monitored monthly, in order to evaluate the effectiveness of the perches as an ecological restoration method.

Data analysis

In order to describe the bird diversity that used the perches, richness and diversity were estimated using DivEs v. 4.2 software. Species abundance was interpreted based on Berger-Parker's dominance, Shannon-Wiener's diversity Index, and J equity (Shannon-Wiener). Exponential functions were also obtained for species accumulation curve. To quantify the trophic position of the birds recorded at the perches, we used the guilds proposed by Sick (1997) and Azpiroz (2001).

Results and discussion

Thirty-two records were obtained of 11 bird species (Figure 4), belonging to 6 families, with a Shannon-Wiener's Diversity Index of 8.2257. Thraupidae was the family with the highest number of species (with four species represented), followed by Columbidae (2), Passerellidae (2), Tyrannidae (1), Troglodytidae (1) and Rhinocryptidae (1). Overall, the birds sampled were typical of anthropized environments, as they were omnivores (18.18%), as well as granivores (63.63%) and insectivores (18.18%), which can have their trophic needs met in degraded areas.

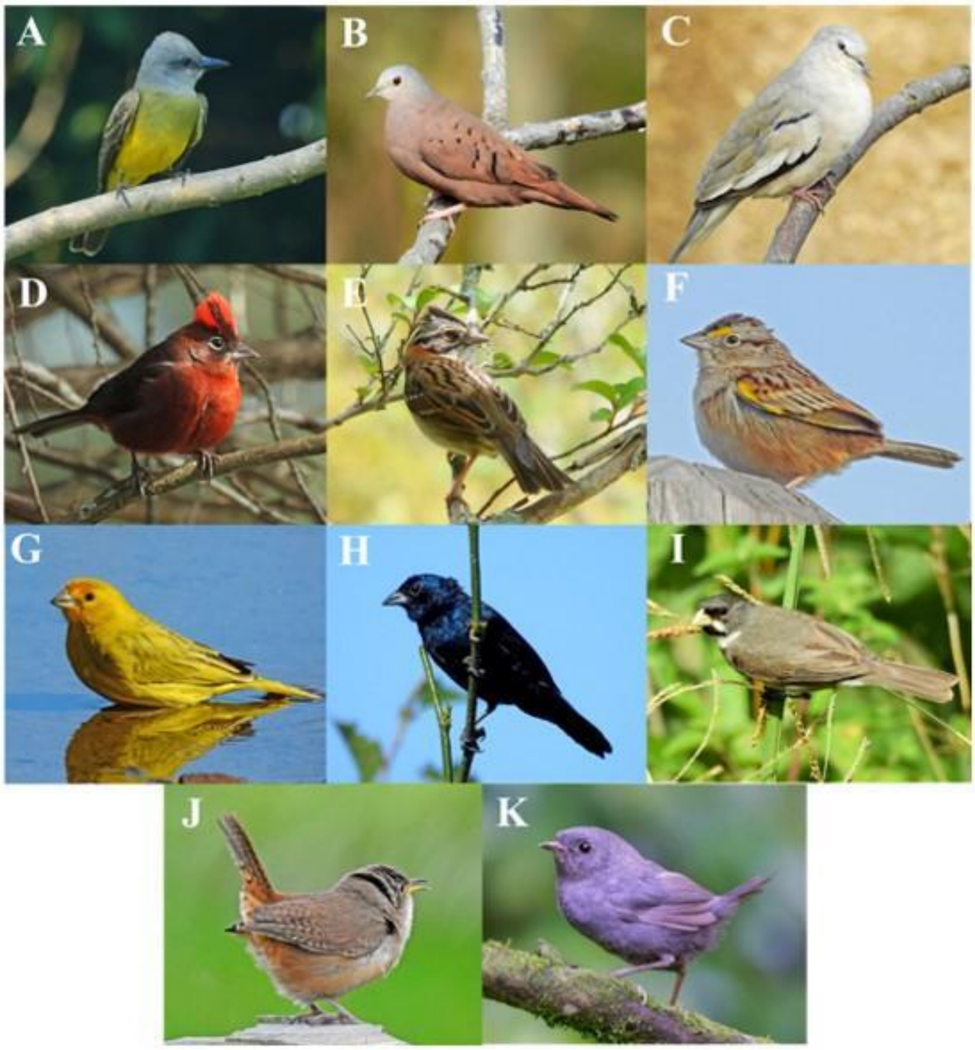

Figure 4. Bird species sampled for one year using the artificial perches in the degraded area at the margins of the Forqueta River in the municipality of Travesseiro, Rio Grande do Sul: (A) *Tyrannus melancholicus* Vieillot, 1819; (B) *Columbina talpacoti* (Temminck, 1810); (C) *Columbina picui* Temminck, 1813; (D) *Coryphospingus cucullatus* (Müller, 1776); (E) *Zonotrichia capensis* (Muller, 1776); (F) *Ammodramus humeralis* (Bosc, 1792); (G) *Sicalis flaveola* (Linnaeus, 1766); (H) *Volatinia jacarina* (Linnaeus, 1766); (I) *Sporophila caerulescens* (Vieillot, 1823); (J) *Troglodytes musculus* Vieillot, 1809; (K) *Scytalopus speluncae* (Ménétries, 1835)

Valeria Vieira (Figures 4A to 4J); Eduardo Dal Pont Morisso - Wikiaves (Figure 4K).

Among all birds sampled, only *Coryphospingus cucullatus* (Statius Muller, 1776) and *Tyrannus melancholicus* Vieillot, 1819, have omnivorous behavior; however, only *T. melancholicus* plays a recognized role in seed dispersal, as documented by Francisco and Galetti (2001), Pascotto (2006), Machado and Rosa (2005) and Jacobs and Fenalti (2020). This species is typical of either anthropic or natural areas, and it occurs in dense forest environments, especially on the edges of forests and clearings (Sigrist, 2006; Jacobs & Fenalti, 2020), a fact that helps with the inflow of propagules derived from nearby preserved fragments. However, as it is a generalist bird and has a quite varied feeding habit, we cannot be certain that the sampled individuals were ingesting fruits.

The most abundant species was *Sicalis flaveola* (Linnaeus, 1766), with eight sampled individuals. However, grass seeds predominate in their diet, which includes vegetables, insects, and rests of domestic animal feed, when they are found nearby (Sick, 1997; Azpiroz 2001; Favretto, 2023). This fact would explain the frequency of this species in the area (dominated by species of the Poaceae family, which provides food for the birds), not its potential to form forest regeneration nuclei around the perches.

February 2022 was the month with the highest abundance, having eleven individuals from seven species using the perches; it was also the month with the highest richness. Throughout the study, no type of standardization was found regarding seasonality (Figure 5).

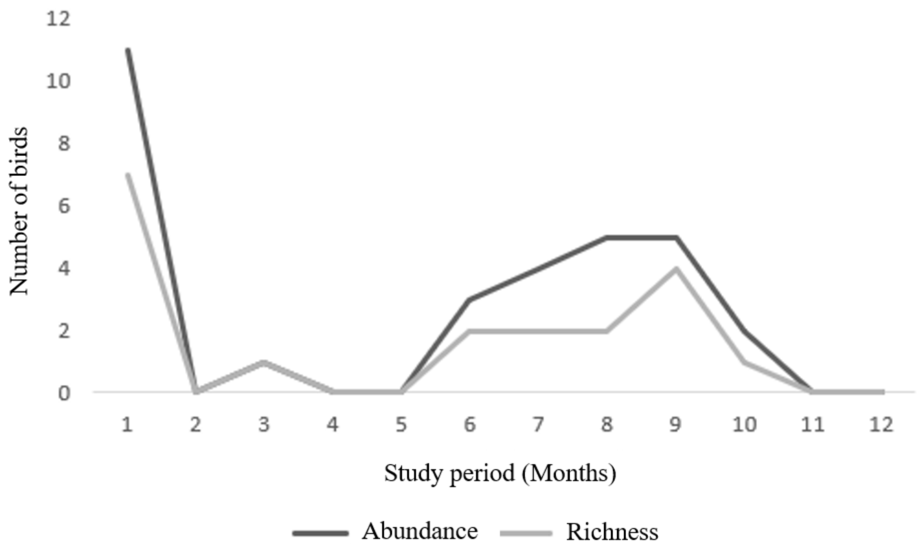

Figure 5. Abundance and richness of species sampled monthly using the artificial perches in a degraded area in the municipality of Travesseiro, Rio Grande do Sul.

Plots 4 and 5 were the most frequently visited by birds, both with eight individuals (Table 1). However, the latter had higher richness, with seven species, and higher Shannon-Wiener diversity index (H' = 2.75). Berger-Parker's dominance was the same in both plots (0.25). Plot number 6 was the only one with no record of birds throughout the

Table 1. Number of samplings of each species in each plot throughout the study. P = plot.

FAMILY	SPECIES	P1	P2	P3	P4	P5	P6
Columbidae	*Columbina picui* Temminck, 1813	0	1	0	0	0	0
	Columbina talpacoti (Temminck, 1810)	0	2	1	1	0	0
Passerellidae	*Ammodramus humeralis* (Bosc, 1792)	0	0	0	0	1	0
	Zonotrichia capensis (Muller, 1776)	3	2	0	0	1	0
Rhinocryptidae	*Scytalopus speluncae* (Ménétries, 1835)	0	0	0	1	0	0
Thraupidae	*Coryphospingus cucullatus* (Müller, 1776)	0	0	0	0	1	0
	Sicalis flaveola (Linnaeus, 1766)	1	2	1	2	2	0
	Sporophila caerulescens (Vieillot, 1823)	0	0	0	0	1	0
	Volatinia jacarina (Linnaeus, 1766)	1	0	1	1	1	0
Troglodytidae	*Troglodytes musculus* Vieillot, 1809	0	0	0	1	1	0
Tyrannidae	*Tyrannus melancholicus* Vieillot, 1819	0	0	1	2	0	0
	Richness	3	4	4	6	7	0
	Abundance	5	7	4	8	8	0
	Shannon diversity Index	1.31	1.918	2	2.5	2.75	0
	Berger-Parker's Dominance Index	0.6	0.333	0.5	0.25	2.75	0
	J equity Index (Shannon-Wiener)	0.85	0.951	1	0.961	0.9196	0

No plant germination was recorded from plants of zoochorous species at the base of the perches. However, another study carried out in a degraded area near a Riparian Forest in Pelotas, Rio Grande do Sul, by Freitas et al. (2022) showed that artificial perches were effective structures in attracting seed dispersers, increasing richness and abundance of seed species, at least as far as 50 m away from the forest fragment. Nevertheless, the authors emphasize that the positive results might be related to landscape characteristics, which provide several food resources to birds with omnivore habit, which used the perches to travel through the landscape, as these perches were elements that were distinct from the landscape, like isolated trees, which were not present in our study.

Similarly, Dias, Umetsu and Breier (2014), who carried out a study in the Environmental Protection Area Morro do Governo in the State of Rio de Janeiro, showed that inserting artificial perches had a remarkable impact on the transport of forest seeds to the degraded area. It was evident that the absolute quantity of seeds collected in the presence of artificial perches (305) was significantly higher than that found in the absence of these perches (70). However, the authors did not perform any monitoring of the avifauna that used the structures.

Among the reasons that might have contributed with the scarcity of forest seeds in the degraded area of our study is the limited opportunities frugivorous birds had to visit these areas, due to scarcity of food items available. In addition, there is a significant increase in the risk of predation for these animals when they are outside the fragments (Duncan & Chapman, 2002; Dirzo et al, 2014). In our study, for instance, one individual of *Heterospizias meridionalis* (Latham, 1790) was recorded using the perches outside the samplings, which represents a threat to the birds. Menq (2018) emphasizes that predation at perches (either natural or artificial) is the most frequently used method by birds of prey worldwide, as it requires minimum effort.

Another important factor that might have affected the formation of nuclei at the base of the perches is the occurrence of invasive exotic species in the study site, especially zoochorous species. The establishment of invasive plants might interfere and change ecological processes, e.g. causing changes in nutrient cycling, biomass decomposition rates, plant community structure, in pollination, seed dispersal, in the aesthetic value of landscapes, and loss of biodiversity due to species extinction (Lourenço, Medeiros, Gil & Silva, 2011; Pyšek et al., 2020).

Conclusion

Despite the preserved fragment located on the other margin of the river, the scarce presence of frugivorous birds in the area corroborates the findings of other studies, which indicate that degraded areas do not offer enough protection or food resources for wildlife. This fact results from the decreased presence of animals and contributes to ecological unbalance (Faxina & Schlemmermeyer, 2010). In addition, adverse soil conditions is a factor that potentially inhibits propagule germination (Parrotta, 1993).

We suggest that future studies consider a more encompassing approach, including an evaluation of soil conditions as well as food resources available in the area, and implement additional strategies to stimulate seed germination. This study highlights the complexity of ecological processes involved in the restoration of degraded areas and emphasizes the importance of more integrative and adaptive approaches to reach effective results.

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