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ARTICLE

The structure of bird communities in areas revegetated after mining in southern Brazil

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ABSTRACT: Mined areas undergo physical changes and profound alterations in the structure and composition of the vegetation. Hence, the fauna cannot return to these areas without human intervention, usually through revegetation. In the state of Paraná, southern Brazil, we assessed the structure of bird communities (species richness, composition, trophic guilds, and forest dependence) in areas of different ages (5, 10, and 20 years) that were revegetated after mining with a single species of native tree (*Mimosa scabrella*). These areas were compared with a forest area with no mining influence (control). The areas differed in species richness and species composition. Birds of some foraging guilds (*e.g.*, frugivores) were absent from 10- and 5-year-old areas. The occurrence of forest-dependent birds increased, whereas forest-independent birds decreased with increasing area age. The death of *Mimosa scabrella* trees between 10 and 20 years after planting reduced vegetation complexity and affected the bird fauna. To avoid such an effect, and to assure the presence of frugivorous birds that are important to restore the vegetation through seed dispersal, we recommend the use of a high diversity of plant species in the initial planting, including plants with fleshy fruits that attract frugivorous birds.

KEY-WORDS: Araucaria Forest, foraging guilds, forest dependence, forest restoration, mining areas, restored areas.

INTRODUCTION

An often dramatic example of human interference in the environment is mining, which frequently results in decreased habitat complexity and changes in community composition (Wray *et al.* 1982). These changes may negatively affect the fauna, leading to decreasing populations (Scott & Zimmerman 1984). In an attempt to revert those negative effects, worldwide mining companies are often obliged by law to restore the vegetation in previously mined areas.

One of the techniques used to restore previously mined areas begins with the flattening of the local topography, followed by the deposition of soil with a seed bank and the planting of pioneer exotic and/or native plants (Tischew & Kimer 2007). The planting of tree species to recover degraded mining areas has been made in Brazil since the 1970s, mainly by planting exotic species such as eucalyptus (*Eucalyptus* spp.), and native species such as *bracatinga* (*Mimosa scabrella*) (Willians 1984). This restoration strategy results in an apparently well-developed vegetation in less than a decade. Nevertheless, the real effectiveness of this type of management in promoting the return of the fauna to restored mining areas is still unknown (Barth 1989).

The return of birds to regenerating forests is important to the local or regional maintenance of bird populations and the ecological roles played by birds (*e.g.*, predation, pollination, seed dispersal, and pest control) (Sekercioglu 2006). Seed-dispersing birds, for example, contribute directly to the regeneration of degraded areas (Walker & Del Moral 2003).

In Brazil, there are no studies that evaluated the effectiveness of post-mining management for the recovery of bird communities (but see Parrotta *et al.* 1997). However, mining activities are common in Brazil, which has one of the most diverse bird faunas in the world. In this study, we assessed the structure of bird communities in areas within the Araucaria Forest domain in southern Brazil. Such areas were previously mined and began to be restored at different times. Our main objective was to evaluate the effects of post-mining management on the richness and species composition of the bird community as a whole, as well as on specific foraging guilds and forest dependence categories. Since birds are sensitive to vegetation structure (MacArthur & MacArthur 1961, Whitman *et al.* 1998), the complexity and heterogeneity of the vegetation were assessed in the studied areas and related to the occurrence of birds.

MATERIAL AND METHODS

Study areas

We carried out the present study in São Mateus do Sul, state of Paraná, Brazil (25°52'S; 50°23'W; Figure 1). This municipality is located on the Paraná Plateau at 800 m a.s.l. The regional climate is type Cfb of Köppen (1948), subtropical humid with no dry season. The average annual rainfall varies between 1,400 and 1,500 mm. The average temperature of the warmest month is below 22°C and the average temperature of the coldest month is above 10°C, with more than five frosts per year. The vegetation of the region is the Araucaria forest, characterized by the dominance of *Araucaria angustifolia* (Bertol.) Kuntze (Araucariaceae) (Veloso *et al.* 1991).

We selected four study areas forming a regeneration gradient from areas at initial successional stages to areas at advanced successional stages (Table 1). Three areas, coded based on their succession stage as A05 (recovering for five years), A10 (recovering for ten years), and A20 (recovering for 20 years) were located at the Unidade de Superintendência de Industrialização de Xisto of Petrobrás. These are mining areas under restoration. The restoration began with the topographic flattening and covering of the exposed soil with humus, and then the planting of *bracatinga* (*Mimosa scabrella* Benth, Leguminosae), an evergreen tree native from southeastern and southern Brazil that varies from 4 to 18 m in height and 20 to 30 cm in diameter at breast height. It may reach up to 30 m in height and 50 cm or more in diameter at breast height when adult. It is a fast-growing pioneer species regardless of the physical conditions of the soil, being frequently used in the restoration of degraded areas (Mattos & Mattos 1980, Lorenzi 2002).

The youngest managed area (A05) was composed exclusively of *bracatingas* and was at an initial successional stage (Table 1). The area A10 had only *bracatinga* as a tree species, and had an herbaceous understory composed of pioneer species and a high undergrowth cover. In A20 there was an input of different tree species at initial and intermediate life stages, *i.e.*, seedlings, young, and subadult individuals (Table 1). The fourth study area was a forest fragment located at the south of the managed areas that has never been mined, but underwent selective logging of *erva-mate* (*Ilex paraguariensis* St. Hil., Aquifoliaceae) in the 1960s. This area, coded as A50 (approximately 50 years of succession), corresponded to a control area in the present study (Figure 1, Table 1). The control area had a dense and continuous canopy. The emergent stratum was composed of *araucárias* (*Araucaria angustifolia*) with a developing understory, *i.e.*, composed of young and subadult trees, a herbaceous stratum of intermediate height (ca. 30 cm) compared to other areas, and a sparse undergrowth. With the exception of the urban area at the south of the restored areas, the matrix surrounding all the study areas was similar, composed of a mosaic of agricultural fields and small forest fragments (Figure 1).

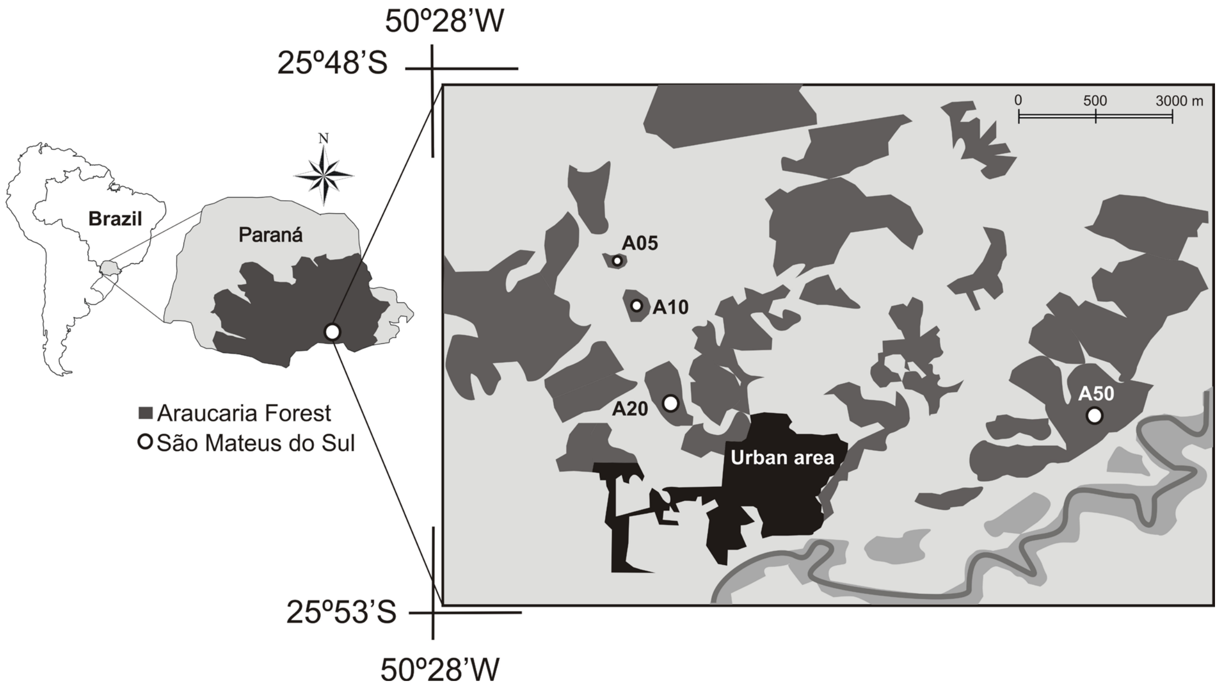

FIGURE 1. The restored mining areas (A05, A10, and A20) and control area (A50) located in São Mateus do Sul, state of Paraná, southern Brazil.

TABLE 1. Summary of the main characteristics and vegetation of the study areas in São Mateus do Sul, state of Paraná, southern Brazil. The abbreviations correspond to the years after the beginning of regeneration (*e.g.*, A20 is under regeneration for twenty years).

Area	Size (ha)	Type of exploration	Year when disturbance ceased	Most common species *
A50 (Control)	50	Extraction of mate plant (*Ilex paraguariensis*)	Has never been mined	*Lithraea brasiliensis*, *Rollinia sylvatica*, *Aspidosperma parvifolium*, *Araucaria angustifolia*, *Ocotea porosa*, *Sloanea monosperma*, *Cedrela fissilis*, *Jacaranda micrantha*, *Casearia decandra*, *Cupania vernalis*, *Campomanesia xanthocarpa*, *Podocarpus lambertii*, *Schinus terebinthifolius*, *Ilex paraguariensis*, *Psidium longipetiolatum, Syagrus romanzoffiana*, *Allophylus edulis*, and *Eugenia* cf. *Involucrata.*
A20	15	Mining	1985	*Mimosa scabrella*, *Casearia decandra*, *Cupania vernalis*, *Campomanesia xanthocarpa*, *Schinus terebinthifolius*, *Ilex paraguariensis*, *Syagrus romanzoffiana*, *Allophylus edulis*, and *Eugenia* cf. *Involucrata.*
A10	5	Mining	1995	Mainly *Mimosa scabrella* and individuals of *Baccharis* sp., Euphorbiaceae, *Bauhinia candicans*, and *Schinus terebinthifolius*.
A05	2	Mining	2001	Understory composed solely by saplings of *Mimosa.Scabrella*

* Barbieri & Heiden (2009). Plant nomenclature follows APG II - Angiosperm Phylogeny Group II (2003).

Vegetation structure

We established three plots of 10 x 30 m in each sampling area inside which we measured six structural parameters to characterize the vegetation: (i) the stem girth at breast height of all tree species with circumference ≥ 15 cm; (ii) the height of these trees measured with a 1-m graduated ruler; (iii) the undergrowth cover estimated with a 1-m^2 grid divided into 100 squares of 10 x 10 cm placed in 15 random sites within each plot; (iv) the understory height (plants > 1 m) with girth at breast height ≤ 15 cm; and (v) the absolute maximum height of the herbaceous vegetation (height < 1 m) at 15 random points in the plot. In addition, we also measured (vi) the percentage of canopy cover measured with a spherical densiometer in five points at each plot, four of which were located at the vertex and one in the center of the plot. At each of these points, we took four measurements of canopy cover to obtain an average value that characterized each point (Lemmon 1956).

Bird sampling

We sampled birds from January to December 2006 using the point count method with unlimited distance (Bibby *et al.*1992), always taking care to avoid double counting of the same bird and not counting birds outside the sampling areas. We sampled ten points at each area once in each season of the year, totaling 40 random sampling points within each study area, with a minimum distance of 100 m among sampling points. We remained for 10 min at each sampling point, moving among them at an interval shorter than 20 min to optimize the sampling time and assure independence among sampling points

(Bibby *et al.* 1992, Lynch 1995). The nomenclature followed Comitê Brasileiro de Registros Ornitológicos (CRBO 2011).

Data analysis

We tested for differences between average values of each vegetation structure parameter with a one-way analysis of variance (ANOVA). When such differences were significant, we used a Tukey post-hoc test (Zar 1996). In addition, to interpret these variables we used a principal component analysis (PCA). Through the interpretation of the PCA axis 1 (PC1), we obtained indexes of structural complexity and heterogeneity of the vegetation for each area (August 1983). We calculated the structural complexity of the areas as the average of the scores of axis 1, which concentrates all the variation of the original variables of each sample and outlines a space defined by the highest variation observed in the raw data (August 1983). Hence, structurally more complex areas were pointed out by high averages of these scores. We calculated the structural heterogeneity of the areas as the standard deviation of the scores of axis 1. Hence, heterogeneous areas were those with high variance in these scores. For these analyses, we transformed proportions to the arcsine of the square root (Zar 1996).

We analyzed sampling completeness with species accumulation curves made for each area (Krebs 1999). To compare richness between areas, we used a rarefaction analysis (Gotelli & Colwell 2001). This analysis is a non-biased way to compare areas, because it is not influenced by variations in the density of individuals per area (Colwell & Coddington 1994, Gotelli & Colwell 2001), which is expected in areas of different sizes. For building the rarefaction curve we used the program EstimateS® 7.5 (Colwell 1997).

To test for spatial autocorrelation among areas in species composition, we used a Mantel test with Bray-Curtis distances (dissimilarity) calculated based on the matrix of species records across areas and distances (m) among areas (Quinn & Keough 2002). We performed this Mantel test in the software PCord 4.20 (McCune & Mefford 1999), using 1,000 permutations.

We tested for differences in the composition of the bird fauna between areas through a clustering analysis based on the Bray-Curtis distance with the simple connection algorithm in the program MVSP (Kovach 2003). For analyzing foraging guilds, we grouped the species in six categories following Willis (1979), Sick (1997), and Sigrist (2006): CA (carnivores), FR (frugivores), NC (nectarivores), IN (insectivores), ON (omnivores), and GR (granivores). This analysis allows identifying the presence of some diet categories, so it indirectly allows assessing resource availability in the area. Forest dependence categories followed Silva (1995) with modifications based on the experience of the authors. The following forest dependence categories were considered: dependent (species found mainly in forest habitats), semi-dependent (species that occur in the forest but are frequently found in open habitats), and independent (species that occur in open vegetation such as pastures, grasslands, and marshes).

Although we are aware of a possible spatial dependence among point counts in each area (pseudo-replication *sensu* Hurlbert 1984), we assumed each point count to be an independent sample. Hence, to minimize this effect, we used a resampling statistic calculated in the program Resampling Stats® for Excel (Simon 1997, Blank *et al.* 2001), with 10,000 randomizations, in order to test for differences among areas in rarefied richness, number of records of each species (*i.e.*, abundances), and Bray-Curtis index. When the variances were significantly different ($\alpha \leq 0.05$), we adjusted them *a posteriori* to avoid the error type I due to the multiple interactions between average values, thus following the correction proposed by Holm (1979).

RESULTS

Vegetation structure

The study areas differed in several parameters of vegetation structure (Table 2). We observed an increase in tree girth and canopy cover with area age, but this gradient was not observed for other parameters, such as tree height (Table 2). Area A10 was more similar to A50 in tree height than to A20 due to the death of *bracatingas* that occurred 10 to 20 years after planting. Hence, A10 was broadly dominated by high individuals of *bracatinga*, whereas A20 had a low canopy with other tree species at initial and intermediate life stages. As a result, A50 had the highest complexity and heterogeneity of vegetation, followed by A10 and not by A20, as we expected (Table 2).

The youngest area (A05) had no well-developed canopy stratum; it presented an understory with average height higher than other managed areas, but formed only by *bracatingas* at initial life stage, with high herbaceous vegetation. This area had a homogeneous and less complex vegetation structure when compared to the other areas (Table 2).

Bird communities

We obtained a total of 3,454 records of 120 bird species (34 families, 12 orders) during 1,600 min of sampling (Appendix). The species accumulation curves for the four study areas stabilized at the end of the study soon after an increase in early spring (Figure 2). We had a higher absolute richness in A50 with 81 species, followed by A10 with 66 species, A20 with 54 species, and A05 with 39 species. The average rarefied species richness differed between A50 (mean ± 95% confidence interval = 52.1 ± 3,89 species) and A20 (41.4 ± 3,02 species), whereas A10 (46.6 ± 3,34 species) did not differ significantly from A50 or A20. The lowest richness was estimated for A05 (27.3 species), which differed significantly from all other areas (Table 3).

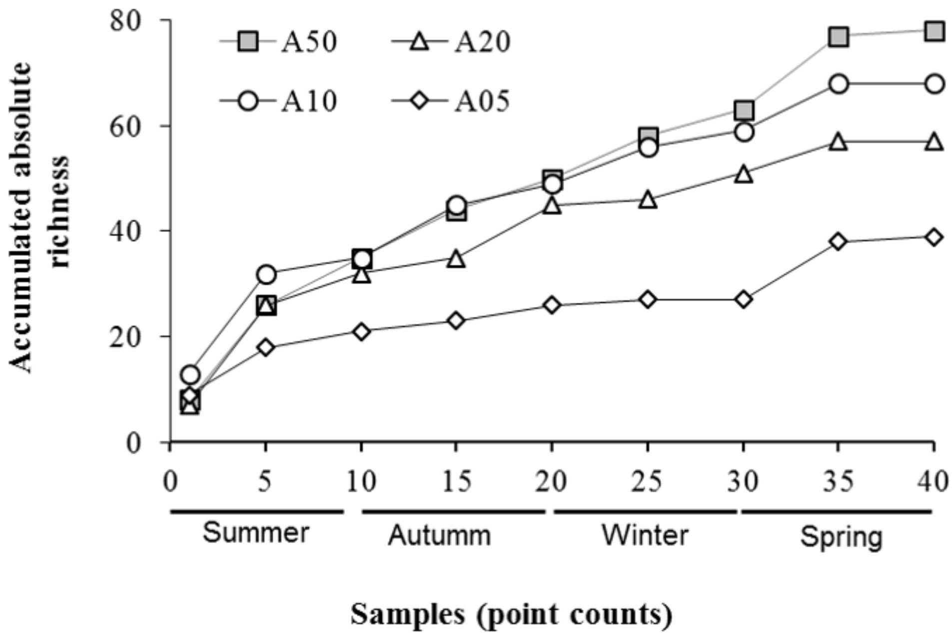

FIGURE 2. Species accumulation curves of the restored mining areas (A05, A10, and A20) and the non-mined control area (A50) at different seasons. Sampling dates were Summer (4-19 January 2006); Autumm (15-25 April 2006); Winter (16-29 July 2006); and Spring (10-18 November 2006).

TABLE 2. Vegetation structure parameters in three restored mining areas (A05, A10, and A20) and one non-mined control area (A50). We present average values and standard errors based on three 10 x 30 m plots sampled in each area. The same letters indicate similar variances among areas. The indexes of vegetation complexity and heterogeneity correspond, respectively, to the average and standard deviation of the scores of the axis 1 obtained from a PCA calculated with the structural parameters listed in the table (see text for details about this analysis).

Vegetation parameters	A50	A20	A10	A05
Girth at breast height (m)	0.43 ± 0.07[a]	0.38 ± 0.02[a,b]	0.30 ± 0.01[b]	0.00 ± 0.00[c]
Tree height (m)	10.62 ± 0.64[a]	4.91 ± 0.16[b]	10.00 ± 0.14[a]	0.00 ± 0.00[c]
Height of herbaceous vegetation (m)	0.30 ± 0.02[a]	0.19 ± 0.02[b]	0.29 ± 0.04[a]	0.38 ± 0.02[c]
Undergrowth cover (%)	24.10 ± 5.10[a]	88.97 ± 3.58[b]	88.47 ± 5.31[b]	59.50 ± 6.80[c]
Understory height (m)	3.36 ± 0.16[a]	1.59 ± 0.22[b]	1.39 ± 0.16[b]	2.93 ± 0.17[c]
Canopy cover (%)	96.10 ± 0.46[a]	91.24 ± 1.68[b]	73.16 ± 2.73[c]	0.00 ± 0,00[d]
Complexity	0.80	0.18	0.43	-1.40
Heterogeneity	0.90	0.36	0.45	0.23

TABLE 3. Average differences in rarefied species richness and corrections of the significance level (following the method proposed by Holm, 1979) between pairs of study areas.

Areas	Average differences	P-value	Adjusted P 0.05/(N+1-1)	Significant
A50 x A20	10.79	0.001	0.008	Yes
A50 x A05	24.86	0.001	0.010	Yes
A20 x A05	14.06	0.001	0.013	Yes
A10 x A05	19.29	0.001	0.017	Yes
A50 x A10	5.56	0.036	0.025	No
A20 x A10	-5.23	0.066	0.050	No

The compositions of the avifauna were significantly different for all between-area comparisons, but the control (A50) and the youngest (A05) areas had the most dissimilar avifaunas, while A20 and A10 had 70% of similarity (Table 4). There was no spatial autocorrelation in species occurrence among areas (Mantel r = 0.298; P = 0.173),

Overall, most bird species were insectivorous or omnivorous. Only the older areas (A50 and A20) had members of all six foraging guilds, while A05 had the lowest number of such guilds: only granivores, omnivores, and insectivores with the noteworthy absences of frugivorous and nectarivorous species (Figure 3A). There were more granivores in the youngest areas, A10 and A05. (Figure 3A).

There was a decrease in the proportion of forest-dependent species from the control to younger areas, whereas the opposite pattern was observed for forest-independent birds (Figure 3B). Semi-dependent species were more evenly distributed among areas, varying from 27.5% to 33.3% of all species recorded in each area (Figure 3B).

TABLE 4. Bray-Curtis dissimilarity indexes and corrections of the significance level (following the method proposed by Holm, 1979) used to compare species composition between study areas.

Areas	Bray-Curtis dissimilarity index	P value	Adjusted P 0.05/(N+1-1)	Significant
A20 x A10	0.315	0.000	0.008	Yes
A50 x A10	0.684	0.000	0.010	Yes
A20 x A05	0.670	0.001	0.013	Yes
A50 x A05	0.926	0.007	0.017	Yes
A50 x A20	0.695	0.011	0.025	Yes
A10 x A05	0.588	0.015	0.050	Yes

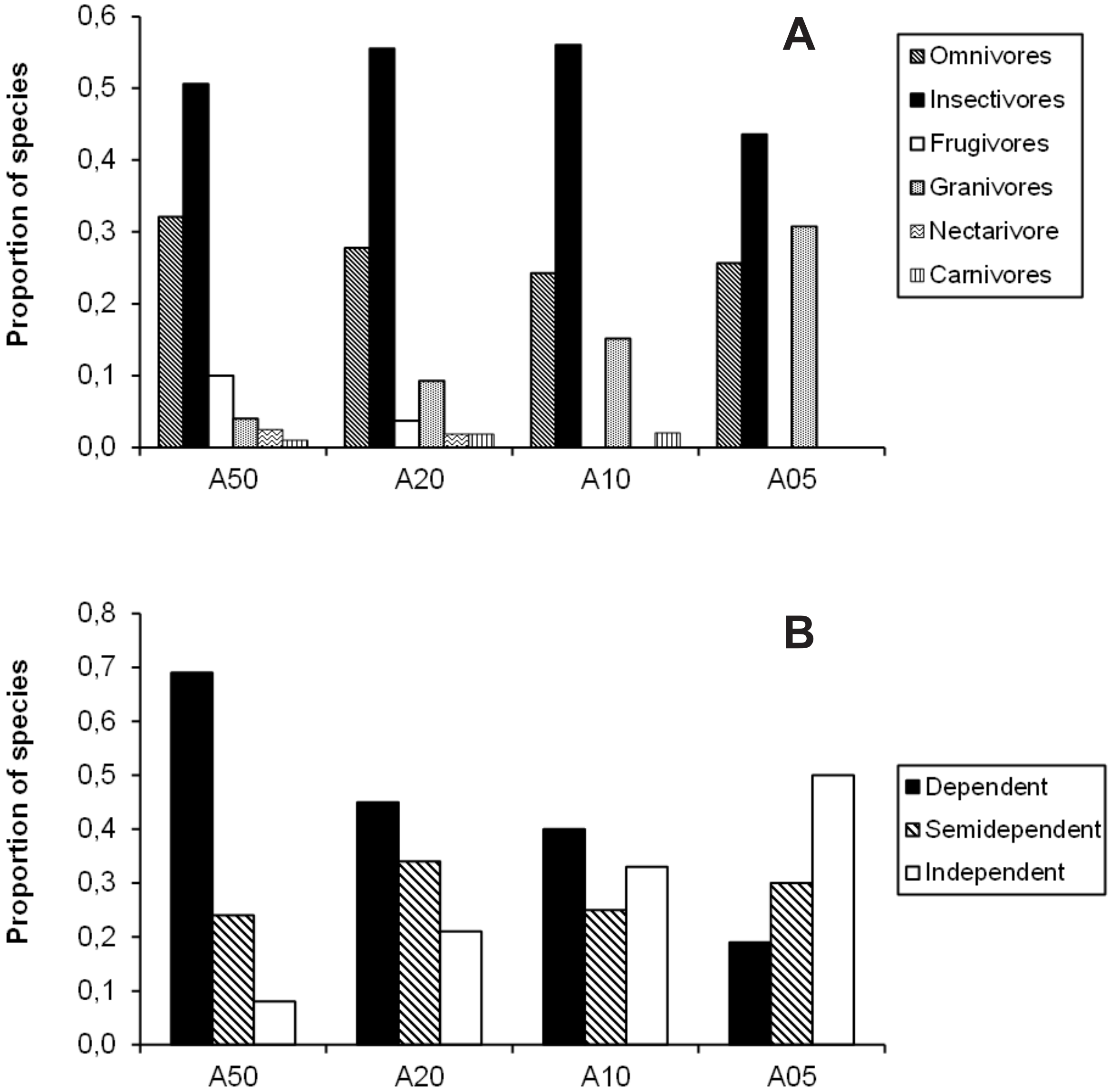

FIGURE 3. Percentage of species in each diet (A) and forest dependence (B) categories recorded in restored mining areas (A05, A10, and A20) and in a non-mined control area (A50). The numbers of bird species recorded in A05, A10, A20, and A50 were 39, 66, 54, and 80, respectively.

DISCUSSION

We observed a significant change in bird species richness and composition a few years after post-mining management, a result that corroborates with other studies in restored mined areas in forest environments (Brewer 1958, Krementz & Sauer 1982, Armstrong & Nichols 2000, Passell 2000, Nichols & Nichols 2003). It should be noted, however, that in the present study we lack replicates of age categories for the areas sampled, which call for caution in the interpretation and generalization of results. Notwithstanding, we believe that some results are good indicatives of the effects of the restoration strategy adopted upon the bird community.

Based on the species-area relationship (reviewed by Rosenzweig 1995), we expected a decreasing gradient of species richness from the older and larger to the smaller and younger area. Such gradient, however, did not exactly occurred because areas A10 and A20 did not differed from each other in species richness, likely because the death of *bracatingas* 10 to 20 years after planting reduced the complexity and heterogeneity of the vegetation at A20. Moreover, the area A10 showed similar species richness to the control area. The presence of forest-independent granivores species (such as *Zonotrichia capensis, Sicalis flaveola,* and *Lanio cucullatus*) together with forest-dependent species (such as *Trogon surrucura* and *Crypturellus obsoletus*) likely contributed to increase the species richness in A10, making it similar to the richness observed in the control area. However, differently from A10, the control area harbors species that are more sensitive to human disturbance, such as some Dendrocolaptidae and Formicariidae (Stotz *et al.* 1996), which were not recorded in the managed areas. Therefore, although the species richness of a 10-yr old area is comparable to an area that has never been mined, it has less disturbance-sensitive species, regardless of their dependence on forested habitats.

We did not record frugivorous or nectarivorous species at A05 but only insectivorous, omnivorous, and granivores species. This functional composition probably reflects the initial stage of regeneration of the vegetation at A05. Motta-Júnior (1990) reported that in degraded habitats there is a larger number of omnivorous birds, and possibly less specialized insectivorous birds. Indeed, likely as a result of the low structural complexity of A05, which was typical of initial successional stages (D'Angelo Neto *et al.* 1998), we did not record top predators (*e.g.*, Accipitridae and Falconidae), intermediate and large frugivores (*e.g.*, families Tinamidae, Trogonidae, and Ramphastidae), soil insectivores (species of the family Formicariidae), large bark insectivores (*e.g.*,Dendrocolaptidae), and several other frugivores (*e.g.*,Thraupidae). It is important to note that the flowers of *bracatinga*, the dominant species in A05, are pollinated by bees (Catharino *et al.* 1982), thus not attracting nectarivorous birds. Likewise, it does not produce fleshy fruits and, hence, does not represent a food source for frugivores. Therefore, if the objective is to speed up forest succession and quickly restore a mining area, it is important to include plants with fleshy fruits at the initial planting to attract frugivorous birds (Parrotta *et al.* 1997, Barbosa & Pizo 2006).

In conclusion, for the purpose of avifauna recovery we suggest that it is undesirable to adopt uniform plantations of *Mimosa scabrella* as a restoration strategy in mined areas because forest specialists and frugivorous birds lose suitable refuges for several decades until the planted forest regenerates and can thus disappear from the area. The initial planting of a high diversity of species is important not only to ensure the persistence of the restored forest (Rodrigues *et al.* 2010) but also to speed up the recovery of the bird fauna.

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APPENDIX.

Number of records of bird species in each of the study areas in São Mateus do Sul, state of Paraná, Brazil. Abbreviations: A50 (area with no mining history, at least 50 years with no disturbances), A20 (mined area under recovery for 20 years), A10 (mined area under recovery for 10 years), and A05 (mined area under recovery for 5 years). Diet categories: C (carnivores), F (frugivores), N (nectarivores), I (insectivores), O (omnivores), and G (granivores). Forest dependence categories: D (dependent), S (semi-dependent), I (independent). See text for definition of categories.

Families/species	**Diet**	**Forest dependence**	**Areas**			
			A50	**A20**	**A10**	**A05**
Tinamidae						
Crypturellus obsoletus (Temminck, 1815)	F	D	4	7	0	0
Crypturellus tataupa (Temminck, 1815)	F	D	3	0	0	0
Nothura maculosa (Temminck, 1815)	I	I	0	0	0	9
Cracidae						
Penelope obscura Temminck, 1815	F	D	4	0	0	0
Odontophoridae						
Odontophorus capueira (Spix, 1825)	I	D	4	0	0	0
Accipitridae						
Rupornis magnirostris (Gmelin, 1788)	C	I	0	1	1	0
Falconidae						
Micrastur semitorquatus (Vieillot, 1817)	C	S	2	0	0	0
Rallidae						
Aramides saracura (Spix, 1825)	I	S	2	0	1	2
Columbidae						
Columbina talpacoti (Temminck, 1811)	G	I	0	0	6	0
Columbina picui (Temminck, 1813)	G	I	0	0	7	9
Columbina squammata (Lesson, 1831)	G	I	0	0	3	0
Zenaida auriculata (Des Murs, 1847)	G	I	0	0	1	1
Leptotila verreauxi Bonaparte, 1855	G	S	18	3	8	1
Leptotila rufaxilla (Richard e Bernard, 1792)	G	D	6	0	5	0
Patagioenas picazuro (Temminck, 1813)	G	S	19	0	2	0
Psittacidae						
Pyrrhura frontalis (Vieillot, 1817)	F	D	15	0	0	0
Triclaria malachitacea (Spix, 1824)	F	D	2	0	0	0
Cuculidae						
Coccyzus melacoryphus Vieillot, 1817	I	D	0	0	1	0
Piaya cayana (Linnaeus, 1766)	I	S	0	4	7	0

Families/species	**Diet**	**Forest dependence**	**Areas**			
			A50	**A20**	**A10**	**A05**
Guira guira (Gmelin, 1788)	I	I	0	0	3	9
Tapera naevia (Linnaeus, 1766)	I	S	0	1	0	0
Trochilidae						
Chlorostilbon lucidus (Shaw, 1812)	NC	S	1	3	0	0
Leucochloris albicollis (Vieillot, 1818)	NC	D	1	0	0	0
Trogonidae						
Trogon surrucura Vieillot, 1817	O	D	36	1	18	0
Ramphastidae						
Ramphastos dicolorus Linnaeus, 1766	F	D	4	0	0	0
Picidae						
Picumnus temminckii Lafresnaye, 1845	I	D	0	1	6	0
Colaptes melanochloros (Gmelin, 1788)	I	S	1	1	4	0
Colaptes campestris (Vieillot, 1818)	I	I	0	0	0	10
Veniliornis spilogaster (Wagler, 1827)	I	S	9	5	21	2
Piculus aurulentus (Temminck, 1821)	I	D	4	2	1	0
Dryocopus lineatus (Linnaeus, 1766)	I	S	1	0	0	0
Campephilus robustus (Lichtenstein, 1818)	I	D	4	0	0	0
Thamnophilidae						
Thamnophilus caerulescens Vieillot, 1816	I	D	2	3	12	1
Thamnophilus ruficapillus Vieillot, 1816	I	I	0	3	1	26
Dysithamnus mentalis (Temminck, 1823)	I	D	22	0	0	0
Drymophila malura (Temminck, 1825)	I	D	0	0	4	0
Conopophagidae						
Conopophaga lineata (Wied, 1831)	I	D	13	0	0	0
Grallariidae						
Hylopezus nattereri (Pinto, 1937)	I	D	1	0	0	0
Formicariidae						
Chamaeza campanisona (Lichtenstein, 1823)	I	D	115	0	0	0
Scleruridae						
Sclerurus scansor (Menetries, 1835)	I	D	36	0	0	0
Dendrocolaptidae						
Sittasomus griseicapillus (Vieillot, 1818)	I	D	31	0	3	0
Xiphocolaptes albicollis (Vieillot, 1818)	I	D	2	1	5	0
Dendrocolaptes platyrostris Spix, 1825	I	D	3	0	3	0

Families/species	**Diet**	**Forest dependence**	**Areas**			
			A50	**A20**	**A10**	**A05**
Xiphorhynchus fuscus (Vieillot, 1818)	I	D	3	0	0	0
Lepidocolaptes falcinellus (Cabanis& Heine, 1859)	I	D	6	0	1	0
Furnariidae						
Leptasthenura setaria (Temminck, 1824)	I	D	26	0	0	0
Synallaxis ruficapilla Vieillot, 1819	I	D	0	12	0	0
Synallaxis cinerascens Temminck, 1823	I	D	7	13	13	1
Synallaxis spixi Sclater, 1856	I	S	0	20	25	10
Cranioleuca obsoleta (Reichenbach, 1853)	I	D	2	0	0	0
Syndactyla rufosuperciliata (Lafresnaye, 1832)	I	D	1	20	5	1
Heliobletus contaminates Berlepsch, 1885	I	D	20	0	0	0
Furnarius rufus (Gmelin, 1788)	I	I	0	0	4	5
Incertae sedis						
Xenops rutilans Temminck, 1821	I	D	0	1	0	0
Rhynchocyclidae						
Mionectes rufiventris Cabanis, 1846	I	D	3	0	0	0
Phylloscartes ventralis (Temminck, 1824)	I	D	15	0	2	0
Tolmomyias sulphurescens (Spix, 1825)	I	D	25	0	1	0
Poecilotriccus plumbeiceps (Lafresnaye, 1846)	I	D	0	1	4	9
Incertaesedis						
*Platyrinchus mystaceus*Vieillot, 1819	I	D	12	0	0	0
Tyrannidae						
Phyllomyias fasciatus (Thunberg, 1822)	I	S	0	0	0	0
Elaenia sp,	O		3	0	0	0
Elaenia flavogaster (Thunberg, 1822)	O	S	2	0	0	0
Elaenia spectabilis Pelzeln, 1868	O	D	2	0	0	0
Elaenia parvirostris Pelzeln, 1868	O	I	0	0	1	0
Elaenia mesoleuca (Deppe, 1830)	O	D	8	1	0	0
Camptostoma obsoletum (Temminck, 1824)	O	I	2	28	34	21
Serpophaga subcristata (Vieillot, 1817)	I	S	0	9	10	48
Euscarthmus meloryphus Wied, 1831	I	S	0	2	34	16
Myiophobus fasciatus (Statius Muller, 1776)	I	I	0	1	0	1
Lathrotriccus euleri (Cabanis, 1868)	I	D	4	0	3	0
Machetornis rixosa (Vieillot, 1819)	I	I	0	0	1	0
Legatus leucophaius (Vieillot, 1818)	I	S	6	2	0	0

Families/species	**Diet**	**Forest dependence**	**Areas**			
			A50	**A20**	**A10**	**A05**
Pitangus sulphuratus (Linnaeus, 1766)	O	I	24	29	49	21
Myiodynastes maculatus (Statius Muller, 1776)	O	S	7	9	3	0
Megarynchus pitangua (Linnaeus, 1766)	O	S	0	2	0	0
Empidonomus varius (Vieillot, 1818)	I	S	4	2	0	0
Tyrannus melancholicus Vieillot, 1821	I	I	2	2	7	0
Myiarchus swainsoni Cabanis e Heine, 1859	I	I	8	0	2	0
Attila phoenicurus Pelzeln, 1868	I	D	49	0	0	0
Pipridae						
Chiroxiphia caudata (Shaw e Nodder, 1793)	O	D	36	1	18	0
Tityridae						
Schiffornis virescens (Lafresnaye, 1838)	F	D	16	0	0	0
Pachyramphus polychopterus (Vieillot, 1818)	I	D	15	3	2	1
Vireonidae						
Cyclarhis gujanensis (Gmelin, 1789)	I	S	9	13	27	1
Vireo olivaceus (Linnaeus, 1766)	I	D	0	9	0	0
Corvidae						
Cyanocorax caeruleus (Vieillot, 1818)	O	D	12	0	0	0
Cyanocorax chrysops (Vieillot, 1818)	O	S	43	5	19	3
Troglodytidae						
Troglodytes musculus Naumann, 1823	I	I	2	35	25	30
Turdidae						
*Turdus rufiventri*s Vieillot, 1818	O	S	75	16	25	12
Turdus leucomelas Vieillot, 1818	O	S	4	0	0	0
Turdus amaurochalinus Cabanis, 1850	O	S	36	0	5	1
*Turdus subalari*s (Seebohm, 1887)	O	D	3	0	0	0
Turdus albicollis Vieillot, 1818	O	D	11	0	0	0
Thraupidae						
Saltator similis d'Orbigny e Lafresnaye, 1837	O	D	12	26	47	2
Lanio melanops (Vieillot, 1818)	O	D	6	0	0	0
Tachyphonus coronatus (Vieillot, 1822)	O	D	1	3	0	0
Tangara sayaca (Linnaeus, 1766)	O	S	4	23	22	0
Pyrrhocoma ruficeps (Strickland, 1844)	I	D	4	3	11	0
Pipraeidea melanonota (Vieillot, 1819)	O	D	3	2	0	0
Conirostrum speciosum (Temminck, 1824)	I	S	3	41	42	0

Families/species	Diet	Forest dependence	Areas			
			A50	A20	A10	A05
Emberizidae						
Zonotrichia capensis (Statius Muller, 1776)	G	I	10	91	130	212
Ammodramus humeralis (Bosc, 1792)	G	I	0	0	0	37
Poospiza cabanisi (Bonaparte, 1850)	O	D	4	20	5	0
Sicalis flaveola (Linnaeus, 1766)	G	I	0	0	2	5
Lanio cucullatus (Statius Muller, 1776)	G	I	0	18	48	133
Sporophila caerulescens (Vieillot, 1823)	G	I	0	2	7	42
Volatinia jacarina (Linnaeus, 1766)	G	I	0	1	0	110
Cardinalidae						
Cyanoloxia glaucocaerulea (d'Orbigny&Lafresnaye, 1837)	G	S	0	0	0	12
Cyanoloxia brissonii (Lichtenstein, 1823)	G	S	0	0	9	1
Parulidae						
Parula pitiayumi (Vieillot, 1817)	I	D	23	9	20	6
Geothlypis aequinoctialis (Gmelin, 1789)	I	I	0	0	11	14
Basileuterus culicivorus (Deppe, 1830)	I	D	53	41	38	0
Basileuterus leucoblepharus (Vieillot, 1817)	I	D	68	60	54	0
Icteridae						
Cacicus chrysopterus (Vigors, 1825)	O	D	3	2	7	0
Cacicus haemorrhous (Linnaeus, 1766)	O	D	6	17	6	0
Gnorimopsar chopi (Vieillot, 1819)	O	I	0	0	6	0
Pseudoleistes guirahuro (Vieillot, 1819)	O	I	0	0	1	0
Molothrus bonariensis (Gmelin, 1789)	O	I	0	0	0	1
Fringillidae						
Sporagra magellanica (Vieillot, 1805)	G	I	0	0	0	4
Euphonia pectoralis (Latham, 1801)	O	D	9	0	0	0
Euphonia chalybea (Mikan, 1825)	O	D	7	0	0	0