




Nota Técnica

Effect of artificial perches and the avifauna involved in the ecological restoration of a mined area in the south of Brazil

Efeito de poleiros artificiais e a avifauna envolvida na restauração ecológica de área minerada no sul do Brasil

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ABSTRACT

The present study analyzed the effect of artificial perches in the supply of vegetal propagules and in the avifauna attraction in degraded area due to mining, in Rio Grande do Sul, Southern Brazil. The seed rain was sampled monthly from December, 2014 to April, 2015, in four collector tables arranged under artificial perches and in four control collector tables (without perches). We compared the seeds number by the Mann-Whitney U test (5% probability level) and used the Spearman correlation to calculate the association degree among the visitor birds on perches and the seeds number sampled in the collectors under perches. The avifauna monitoring was performed during the same period by fixed point method, totaling 40 hours of sampled effort. The treatments differed statistically, with registration of 1588 seeds in the tables under perches and 237 seeds in the tables without perches. The sampling of seed rain in the perches followed the pattern of avifauna visitation, presenting high value to coefficient of association degree (0.975). We observed nine species of birds in the study area, and the Tyrannidae family was predominant. The species observed visiting the artificial perches were *Knipolegus lophotes* and *Tyrannus melancholicus*, both from Tyrannidae family. The number of sampled seeds demonstrates that artificial perches were efficient to return seed rain in the mined areas. The Tyrannidae family demonstrates to be the most effective group of birds to dispersion of seeds in the local of study.

Keywords: Nucleation; Dispersion; Seeds



RESUMO

O presente estudo analisou o efeito de poleiros artificiais no aporte de propágulos vegetais e na atração da avifauna em área degradada pela mineração, no Rio Grande do Sul, Sul do Brasil. A chuva de sementes foi amostrada mensalmente de dezembro de 2014 a abril de 2015, em quatro mesas coletoras dispostas sob poleiros artificiais e em quatro mesas coletoras testemunhas (sem poleiros). Comparamos o número de sementes pelo teste U de Mann-Whitney (nível de probabilidade de 5%) e usamos a correlação de Spearman para calcular o grau de associação entre as aves visitantes nos poleiros e o número de sementes amostradas nos coletores sob poleiros. O monitoramento da avifauna foi realizado no mesmo período pelo método de ponto fixo, totalizando 40 horas de esforço amostral. Os tratamentos diferiram estatisticamente, com registro de 1588 sementes nas mesas sob poleiros e 237 sementes nas mesas testemunhas. A amostragem da chuva de sementes nos poleiros seguiu o padrão de visitação da avifauna, apresentando alto valor para o coeficiente de grau de associação (0,975). Observamos nove espécies de aves na área de estudo, sendo a família Tyrannidae predominante. As espécies observadas visitando os poleiros artificiais foram *Knipolegus lophotes* e *Tyrannus melancholicus*, ambos da família Tyrannidae. O número de sementes amostradas demonstra que os poleiros artificiais foram eficientes para o retorno da chuva de sementes nas áreas mineradas. A família Tyrannidae demonstra ser o grupo de aves mais eficaz para dispersão de sementes no local de estudo.

Palavras-chave: Nucleação; Dispersão; Sementes

1 INTRODUCTION

Mined areas become susceptible to serious environmental alterations, which can cause degradation. In degraded areas by mining, the resiliency degree of ecosystems depends on degradation intensity and may prevent the re-establishment of ecological functions (Martins, 2013), demanding ecological restoration strategies. The ecological restoration can be understood as a practice that begins or accelerates the recovering of an ecosystem that was degraded, damaged or destroyed, having as main objective the re-establishment of self-regulation potential (SER, 2004).

In ecological restoration, we apply different nucleation techniques to help the natural process to restore degraded areas. A viable alternative is the use of perches to attract bird dispersers. Artificial perches are an effective strategy to increase seed rain, because birds, when using these structures, defecate and/or regurgitate the seeds, performing nucleation function and collaborating with restoration process (Tomazzi; Castellani, 2016).



The avifauna has a fundamental role in the maintenance of the dynamical balance and in the increase of ecological interactions (Campos; Miranda Neto; Peixoto; Godinho; Silva, 2012; Rocha; Silva; Martins; Volpato, 2015). This way, it is important to consolidate the knowledge about fauna and flora interactions, aiming to restore degraded areas more efficiently and more compatible with the natural characteristics of the Brazilian ecosystems (Martins; Miranda Neto; Ribeiro, 2015).

Several studies about artificial perches evaluate the seed rain, but do not describe the avifaunal groups that use them (Dias; Umetsu; Breier, 2014; Tomazi; Castellani, 2016; Iguatemy; Vilarinhos; Oda; Conde; Zaú, 2020). In degraded areas by mining, this perspective is even more innovating, since the perception that the low degree of resiliency, common in these areas, would not be compatible with the perches technique. However, there is lack of scientific results that prove this hypothesis. Therefore, the present study aimed to evaluate the efficiency of artificial perches to attract avifauna and restore seed rain in degraded area by mining with exposed saprolite, improving the understanding about artificial perches contribution in ecological restoration projects.

2 MATERIAL AND METHODS

The present study was carried out in degraded area due to mining, in the metropolitan region of Porto Alegre city, Rio Grande do Sul, Southern Brazil.

The region of study presents elements of Deciduous Seasonal Forest and Semideciduous Seasonal Forest. The natural vegetation occurs like forest disjunctions, presenting the dominant stratum predominantly deciduous, with more than 50% of the specimens without leaves in the cold period (IBGE, 2012). The climate is Humid subtropical with dry summer (ST UMc) (Alvares, 2013). The annual average temperature is 18.5°C and the annual precipitation is 1.335 mm (MDA, 2007).

The area presents abandoned mining pits with exposed saprolite that was not colonized by vegetation for 15 years after the end of mining activities, which demonstrates the low degree of local resiliency. The saprolite is from granitic origin, with



quartzite predominance. The particle size analysis by the pipette method (EMBRAPA, 2017) presented 56% of coarse sand, 8% of fine sand, 16% of silt and 20% of clay.

Table 1 – Floristic inventory of forest fragments in the surrounding of mined area, Southern Brazil

Species	Botanical Family
<i>Actinostemon concolor</i> (Spreng.) Müll.Arg.	Euphorbiaceae
<i>Allophylus edulis</i> (A. St-Hil., Cambess. & A. Juss.) Radlk. ex Warm.	Sapindaceae
<i>Blepharocalyx salicifolius</i> (Kunth) O.Berg	Myrtaceae
<i>Campomanesia rhombea</i> O.Berg	Myrtaceae
<i>Casearia decandra</i> Jacq.	Salicaceae
<i>Chrysophyllum marginatum</i> (Hook. & Arn.) Radlk	Sapotaceae
<i>Daphnopsis fasciculata</i> (Meisn.) Nevling	Thymelaeaceae
<i>Erythroxylum deciduum</i> A.St.-Hil.	Erythroxylaceae
<i>Eugenia uruguayensis</i> Cambess.	Myrtaceae
<i>Ficus cestrifolia</i> Schott	Moraceae
<i>Gochnatia polymorpha</i> (Less.) Cabr.	Asteraceae
<i>Lithraea brasiliensis</i> Marchand	Anacardiaceae
<i>Miconia sellowiana</i> Naudin	Melastomataceae
<i>Myrcia multiflora</i> (Lam.) DC.	Myrtaceae
<i>Myrcia palustris</i> DC.	Myrtaceae
<i>Myrcianthes gigantea</i> (D. Legrand) D. Legrand	Myrtaceae
<i>Myrsine umbellata</i> Mart.	Primulaceae
<i>Nectandra lanceolata</i> Nees	Lauraceae
<i>Nectandra megapotamica</i> (Spreng.) Mez	Lauraceae
<i>Ocotea pulchella</i> (Nees) Mez	Lauraceae
<i>Psychotria</i> sp.	Rubiaceae
<i>Scutia buxifolia</i> Reissek	Rhamnaceae
<i>Sebastiania brasiliensis</i> Spreng.	Euphorbiaceae
<i>Sebastiania commersoniana</i> (Baill.) L.B. Sm. & Downs	Euphorbiaceae
<i>Styrax leprosus</i> Hook. & Arn.	Styracaceae
<i>Symplocos uniflora</i> (Pohl) Benth.	Symplocaceae
<i>Trichilia elegans</i> A. Juss.	Meliaceae
<i>Xylosma prockia</i> (Turcz.) Turcz.	Salicaceae
<i>Zanthoxylum rhoifolium</i> Lam.	Rutaceae

Source: Authors (2015)

We used artificial perches of dry type, constituted by four bamboo sticks, buried and



tied among them, and being left free superior lateral branches for the landing of the birds. Four perches were installed, with average height of four meters, arranged at random. Based on the perches collector tables of seeds were installed with dimensions of 1m², one meter high from the ground and with sombrite at background for draining water. As control treatment, four collector tables without perches were arranged, also at random.

The monitoring of avifauna occurred from December, 2014 to April, 2015. During this period, the observations were performed monthly, during the morning and afternoon shifts, totalizing 40h of observation. The method chosen for monitoring the avifauna was of direct observation by fixed point with simultaneous observation of the four perches. This method is widely used in projects of monitoring of birds worldwide, besides that, presents better characteristics of cost-benefit when compared to other methods (Bispo; Aguiar; Nobre; Machado; Cohn-Haft; Develey; Laranjeiras; Lemos; Uehara-Prado, 2016). For the monitoring of birds it was used a binocular, audio recorder and photographic camera with optical zoom of 26x. Besides the monitoring of avifauna in the artificial perches it was also registered the avifauna species that have interacted with the area.

The seeds deposited were collected with the help of tweezers, allocated in plastic bags and they passed by screening in the Núcleo de Estudos e Pesquisas em Recuperação de Áreas Degradadas - NEPRADE, of Universidade Federal de Santa Maria (UFSM).

The individuals of avifauna observed in the place of study were identified and classified in relation to the species, family, and trophic group (Willis, 1979; Telino-Júnior, 2005).

For the data analysis of supply of propagules it was performed the normality test of Anderson-Darling, which demonstrated that data base did not present normality. The treatments were compared by the Mann-Whitney U test to the level of 5% of probability by trough Assistat 7.7 software (Silva; Azevedo, 2016).

To calculate the association degree among the visiting birds of the artificial perches and the seeds number sampled in the collectors under the perches, it was performed the Spearman correlation through the SPSS 22.0 software.

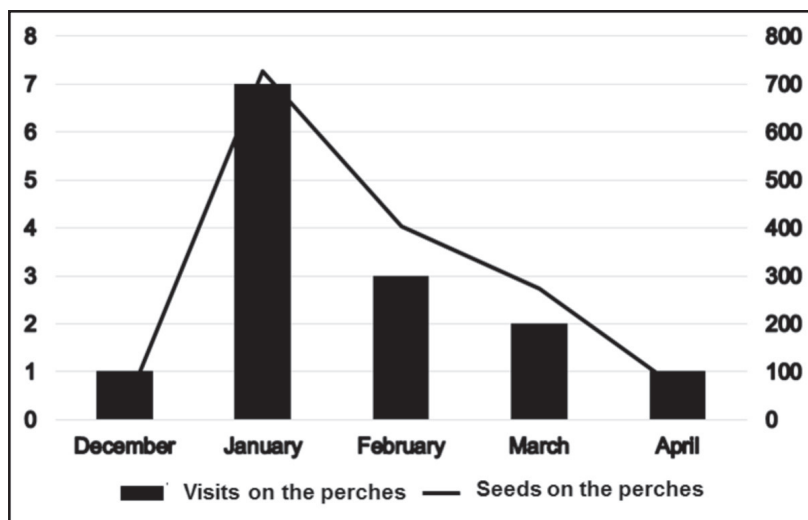


3 RESULTS AND DISCUSSIONS

The total number of seeds sampled in the collectors was of 1825, being 1588 seeds (87.01%) sampled in the perches and 237 seeds (12.99%) in the collector tables without perches, with significant difference by the Mann-Whitney test, to the level of 5% of significance.

Sampling of seed rain in the artificial perches accompanied the pattern of avifauna visitation, presenting a high coefficient value by the Spearman correlation (0.975) for association between the propagules number and the observation of the perches use by avifauna (Figure 1).

Figure 1 - Correlation between avifauna visitation in the perches and seed number sampled under the perches in degraded area by mining in Southern Brazil



Source: Authors (2015)

The study area presented exposed saprolite during 15 years without demonstrating process of re-colonization. Considering this scenery, the results with artificial perches show efficiency to re-establish seed rain by avifauna. The technique appears to be a potential strategy for ecological restoration of the study area, when implemented in conjunction with other nucleation strategies (Silva, 2015), that become tools of great magnitude to attract several species of fauna, helping in the acceleration



of ecological restoration, besides that, they are strategies of low cost (Martins, 2013).

In research with artificial perches in the Southeast of Brazil, Dias, Umetsu and Breier (2014) obtained 81.33% of the seeds sampled in the collectors under the perches and 18.67% of the seeds sampled in the collectors without perches. It is possible that the two forest fragments, although small and with elevated edge effect, are acting as sources of propagules. However, the most important fact that evinces is that, even with the fragments of the surrounding, probably, there was not supply of propagules in the area before the installation of the perches, once that there was not vegetal cover over the saprolitic ground for 15 years. It is to be assumed that, although the inhospitable condition of the exposed saprolite, if there was a constant supply of propagules as the registered in the perches, there would be vegetation in the area, even though incipient.

Nine species of birds belonging to seven families were observed in the area, being differentiated by the trophic group, as shown in Table 2. The most representative family in the visitation of the area was Tyrannidae, counting 33.33%, while the families Cathartidae, Columbidae, Ardeidae, Turdidae, Thraupidae and Passerellidae counted 11.11% each.

Table 2 – Avifauna sampled in degraded area by mining during the ecological restoration initial process, in Southern Brazil. Trophic group: D (Detritivore), I (insectivore), G (granivore), O (omnivore)

Species	Family	Trophic group
<i>Butorides striata</i> (Linnaeus, 1758)	Ardeidae	O
<i>Cathartes aura</i> (Linnaeus, 1758)	Cathartidae	D
<i>Coereba flaveola</i> (Linnaeus, 1758)	Thraupidae	O
<i>Knipolegus lophotes</i> (Boie, 1828)	Tyrannidae	I
<i>Patagioenas picazuro</i> (Temminck, 1813)	Columbidae	O
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Tyrannidae	O
<i>Turdus rufiventris</i> (Vieillot, 1818)	Turdidae	O
<i>Tyrannus melancholicus</i> (Vieillot, 1819)	Tyrannidae	I
<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Passerellidae	G

Source: Authors (2015)



During the 40 hours monitoring, we observed a total of 14 visits in the artificial perches, performed by *Knipolegus lophotes* and *Tyrannus melancholicus*, both of Tyrannidae family (Figure 2).

Figure 2 – Avifauna visiting the artificial perches during ecological restoration in mining area in Southern Brazil: *Tyrannus melancholicus* (a) and *Knipolegus lophotes* (b)



Source: Authors (2015)

The avifauna presented a seasonal behavior in the use of artificial perches. The greatest number of observations occurred in January (50%), followed by February (21.43%), March (14.29%) and April (7.14%). December presented low value for avifaunal visitation, due to installation the artificial perches occurred noise pollution and inhibited the avifauna approximation (Figure 1).

The low species number can be explained for the eucalyptus plantings surrounding the area, that probably can be acting as a filter, preventing that the specialist frugivorous species remain in the place. Marsden, Whiffin and Galetti (2001) explain that due to the eucalyptus stands not having a sparse low story, usually, they can serve as barrier for that several bird species. On the other hand, for birds with forest habits, eucalyptus stands can be useful for their displacement, as they simulate their natural habitat (Biz; Cornelius; Metzger, 2017), favoring the gene flow of species with zoochoric dispersion. Dispersal is considered one of the most complex ecological processes, involving the interaction between disperser behavior and landscape



structure. Fragmented landscapes can alter the dispersal behavior of avifauna. Cornelius, Awade, Cândia-Gallardo, Sievingc and Metzger (2017) demonstrated that birds adapted to fragmented landscapes are slower and more thorough in exploring this type of habitat when compared to continuous habitats, which may influence the interest in artificial perches in open areas, such as the one in the present study. Behavioral plasticity may favor birds adapted to fragmented landscapes. intensive use of artificial perches can express adaptability.

Five species of birds are classified as omnivorous, among the nine identified. According to Francisco and Galetti, (2002) omnivore species guarantee high frequencies of visits and high consumption rates, developing an important role in the dispersion of seeds in altered environments.

The behavioral plasticity, as in the Tyrannidae family, favors the survival, even in altered environments (Martins-Oliveira, 2012). The artificial perches, allied to the opened aspect of the study area, attracted the Tyrannidae species, contributing to the seed rain results. Study performed by Padovezi, Rodriguez and Horbach (2014) relates Tyrannidae species as more representative in study areas with diverse degradation levels, in the Southeast Brazil. Brodt, (2009) also in the Southern Brazil, found great predominance of Tyrannidae family in visits to artificial perches, reaching 94.6% of the total observed, being *Tyrannus melancholicus* the most observed species. Rlbeiro, Goulart and Marini (2002) showed that *Knipolegus lophotes* besides feeding with insects, also feeds with small fruit, evincing its generalist habit what is appreciated in restoration projects.

The relation between Tyrannidae family and degraded areas demonstrates that strategies to attract these species must considered in restoration projects. Even in lower ecosystem resilience, these strategies can accelerate de ecological process, like secondary succession, an aim of the effective ecological restoration.

Species that use perches present frequent returning to these structures (Silveira; Souto; Damasceno; Mucida; Pereira, 2015), increasing the probability of seed rain. This



fact makes that, even being few species, the frequency that individuals are attracted by the perches guarantees its efficiency.

The decrease of bird visits throughout the months was due to Tyrannidae are considered the greatest representatives inside the category of intra-continental migrants, migrating with the arrival of the cold season (Chesser, 1994). Brazil has 133 bird families; 37 of those with at least one species migratory or partially migratory. Among these families, Tyrannidae presents the most number of migratory species (33 spp.) (Somenzari; Whitney, 2018). We can expect that after the winter, the representatives of species return to the place of study, taking up its contribution to the seed rain and consequently to the restoration of the degraded area.

4 CONCLUSIONS

Tyrannidae family is the most effective birds group in the seed dispersion in the study areas.

The seed rain in the perches demonstrates the relevance to attract the birds in ecological restoration projects.

The use of artificial perches was efficient to supply of vegetal propagules in the study area. We suggest using of these perches, even in areas with elevated levels of degradation and low levels of ecosystem resiliency.

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