REVISTA FLORESTA Engenharia Florestal

ISSN 1982-4688
Edição 54
Universidade Federal do Paraná
Setor de Ciências Agrárias

NATURAL REGENERATION IN EDGE AND INTERIOR OF A FOREST FRAGMENT AT THE CATARINENSE PLATEAU

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Received for publication: 01/08/2023 – Accepted for publication: 02/04/2024

Resumo

Regeneração natural na borda e interior de um fragmento florestal no planalto catarinense. A fragmentação florestal é um dos maiores desafios para a conservação das florestas na região do Planalto Catarinense. Desta forma, este trabalho objetivou avaliar o efeito de borda sobre a estrutura e florística da regeneração natural arbórea em um fragmento de Floresta Ombrófila Mista em São José do Cerrito, Santa Catarina. A regeneração natural do componente arbóreo no sub-bosque foi amostrada em quatro transectos alocados perpendiculares à borda do fragmento. Foram instaladas oito parcelas de 20 m² na borda (contato com a matriz do entorno) e interior (100 m da borda) do fragmento, subdivididas em parcelas menores de acordo com a classe dos regenerantes. Os regenerantes foram identificados, mensurados em altura e classificados de acordo com o seu grupo sucessional, status de conservação, endemismo e calculado o índice de regeneração para cada classe de altura e total. Para análise estatística utilizou-se a análise de Escalonamento Multidimensional Não-Métrico (NMDS). Os resultados demostraram diferença significativa entre interior e borda do fragmento, sendo a comunidade regenerante na borda expressivamente mais abundante e mais diversa que o interior. As espécies com o maior índice de regeneração total para o interior foram *Myrcia hatschbachii* (RNT=12,1%) e *Banara tomentosa* (RNT=11,1%), e para a borda foi *Myrcia oblongata* (RNT=15,1%). Conclui-se que o efeito de borda parece ter sido um fator determinante para a alteração na estrutura e composição florística dos regenerantes.
Palavras-chave: Efeito de borda, Floresta Ombrófila Mista, Fragmentação de habitats.

Abstract

Forest fragmentation is one of the greatest challenges for forest conservation in the Catarinense Plateau region. Thus, this work aimed to evaluate the edge effect on the structure and floristics of natural tree regeneration in a fragment of Mixed Ombrophylous Forest in São José do Cerrito, Santa Catarina. The natural regeneration of the tree component in the understory was sampled in four transects placed perpendicular to the edge of the fragment. Eight plots of 20 m² were installed on the edge (contact with the surrounding matrix) and inside (100 m from the edge) of the fragment, subdivided into smaller plots according to the class of regenerants. The regenerants were identified, measured in height and classified according to their successional group, conservation status, endemism and calculated the regeneration index for each class of height and total. For statistical analysis, Non-Metric Multidimensional Scaling (NMDS) analysis was used. The results showed a significant difference between the interior and edge of the fragment, with the regenerating community on the edge being significantly more abundant and more diverse than the interior. The species with the highest rate of total regeneration towards the interior were *Myrcia hatschbachii* (TNR=12.1%) and *Banara tomentosa* (TNR=11.1%), and towards the edge it was *Myrcia oblongata* (TNR=15.1%). It is concluded that the edge effect appears to have been a determining factor for the alteration in the structure and floristic composition of the regenerants.
Keywords: Edge Effect, Mixed Ombrophylous Forest, Habitat Fragmentation.

INTRODUCTION

The Atlantic Rainforest is classified as the third global natural hotspot due to its high biodiversity, endemism, endangered species and intense anthropogenic pressure in its natural environment, from which it is estimated that, on average, 24% of the area has forest coverage, from which 12,4% is considered well-preserved areas (PINTO; HIROTA, 2022). Within this biome, the Mixed Ombrophylous Forest (MOF) presents considerable ecological importance for being the habitat of several animal and plant species, highlighting the need to invest on strategies for conservation of the Araucaria Subtropical Forest, as stated by Gomes *et al.* (2020a)

The forest fragmentation consists of a process of native vegetation conversion due to land use (such as farming, livestock, and logging expansions) and it results on negative consequences to the habitat, affecting local flora and fauna (FERNANDES; FERNANDES, 2017). These consequences modify the vegetal community structure, and, according to the level of fragment isolation, determines the gene movement, so that the activities such as farming and livestock raising are one of the main causes to said fragmentation (SOUZA *et al.*, 2014).

After the habitat fragmentation, a few influences from the environment outside of its limits occur, and this action varies according to its shape, size, and level of forest isolation, resulting in reducing the size and biological diversity within the remaining fragment. That is to say, it increases the edge effect, exposing organisms to much higher air temperature and to a deficit on the air steam, influencing up to sixty meters within the fragment from the edge (SILVA; SOUZA, 2014). The edge effect can be different within forest fragments with diverse history of disturbance, where the intensifying of the edge effect depends on the type of impact. (PSCHEIDT *et al.*, 2018).

The forest fragment of which the most external area is in interface with livestock areas, for instance, presents a functional and structural variation according to its distancing from the edge, it is, amongst other reasons, the advancement of livestock over the fragment that makes the natural regeneration process more difficult. The variation on illuminance, higher on the edge and lower in the interior, triggers the start of secondary succession, demonstrating the edge effect in the environment (PSCHEIDT *et al.*, 2018). The light heterogeneity for the seedling is a critical factor, affecting its development, being responsible for the successional and structural dynamics in the forest (TURCHETTO *et al.*, 2015).

Seedling bank is an important regeneration technique, once many species present this mechanism as the main strategy to maintain population, which provides the necessary propagules to environment regeneration (FERREIRA *et al.*, 2016). According to Avila *et al.* (2013), said bank encompasses late secondary, early secondary and pioneer species, in a way that allows responses to different environmental conditions, proving to be an essential mechanism to colonizing ecosystems with tree and bush species.

From that, the scientifical knowledge about MOF is indispensable to direct conservation and maintenance strategies for biodiversity, as well as the understanding on how these species are affected by the edge effect. Therefore, the present paper aimed on assessing the edge effect on the structural and vegetational composition of tree species natural regeneration in a fragment of Mixed Ombrophylous Forest and on listing the species contained within the area of study, determining their successional groups, conservation status, endemism, and regeneration index by height class. The hypotheses are: there are floristic differences amidst the natural regeneration on the different distance sectors from the edge, with more early succession species on the edge when compared to the interior; a higher diversity and abundance occur on the edge with more early succession species when compared to the interior, denoting self-regeneration; livestock influences the floristic and structural composition in the fragment's seedling bank, showing environmental degradation, and; rare and endangered species occur alongside exotic species, indicating a threat to biodiversity and an increase on the fragment's isolation, thus an increase on the fragmentation degree.

MATERIALS AND METHODS

Area characteristics

During April and May 2022, the natural regeneration of tree species was studied in a fragment located in the municipality of São José do Cerrito, SC (Figure 1). The study area geographic coordinates are 27º44'16,13" S and 50º28'51,35" O. The elevation is of about 900m above sea level. The matrix of the fragment's surrounding the segment is characterized by the presence of farming and livestock activities, with free access for cattle to the interior of the forest that, especially during winter, roams the fragments interior in search of food and shelter.

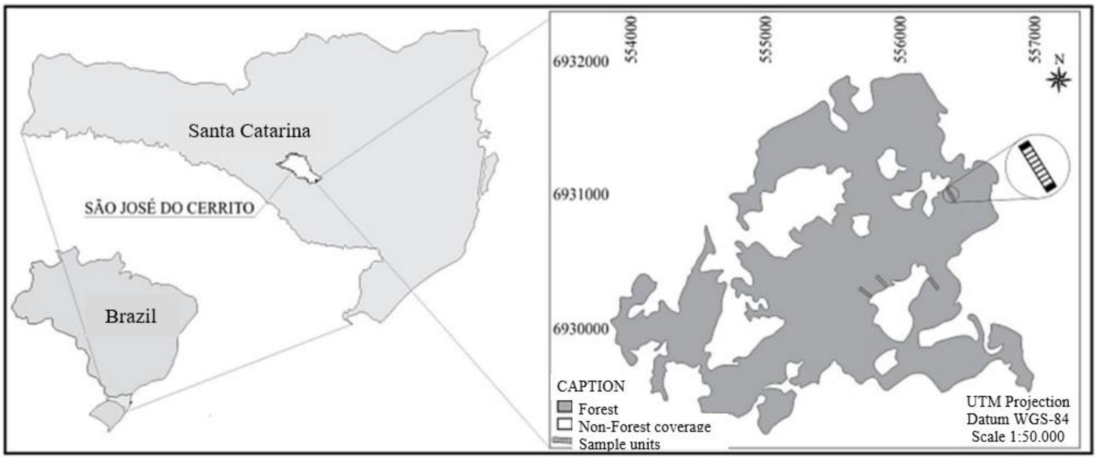

Figure 1. Map with the geographic location of the forest fragment in São José do Cerrito (SC) and distribution of plots along an edge-interior gradient, where the studied natural regeneration plots are represented in

black, one at the beginning of the fragment (edge sector) and another 100m inland (interior sector). Source adapted: Gross *et al.* (2020).

Figura 1. Mapa com a localização geográfica do fragmento florestal em São José do Cerrito (SC) e distribuição das parcelas ao longo de um gradiente borda-interior, onde as parcelas estudadas para regeneração natural estão representadas em preto, uma no início do fragmento (setor borda) e outra 100 m adentro (setor interior). Fonte adaptada: Gross *et al.* (2020).

The area's natural vegetation is classified as Mixed Ombrophylous Forest. The predominant climate is Cfb type, as of Koppen's classification. The soils in the fragment are, predominantly, cambisoils. The municipality of São José do Cerrito is located at the Lages Plateau, in the river basins from rivers Canoas and Pelotas, with terrain, mostly, hilly (ANTUNES; CONSTANTE, 2016).

Data collection and analysis

For sampling natural regeneration (arboreal individuals with diameter at breast height less than 5cm and height bigger than 20cm), plots were traced at different distances from the edge and in areas with and without the presence of cattle, through four transects. These transects, already pre-established on field for the study of adult arboreal individuals, were divided in subplots for sampling natural regeneration. As the cattle has free access to the forest, these transects, currently, are found divided in half, while half of them has been surrounded with a fence to avoid cattle entrance. This fencing has been done about a year before the study took place.

Each transect, with 100m in length, located perpendicular to the fragment's edge, has been divided into edge sector (forest in contact with edge) and fragment interior (100 m from the edge) (Figure 2a). In each transect subplots of 1m x 20m were allocated (20 m²), with its respective subplots (Figure 2b), one of each parcel being in each of those considering the edge distance (edge sector and interior sector). This has made a total of eight parcels with 160 m² sampled. From the 20m² of each parcel, 10m² are areas with cattle, and the remaining 10 m² are cattle free area.

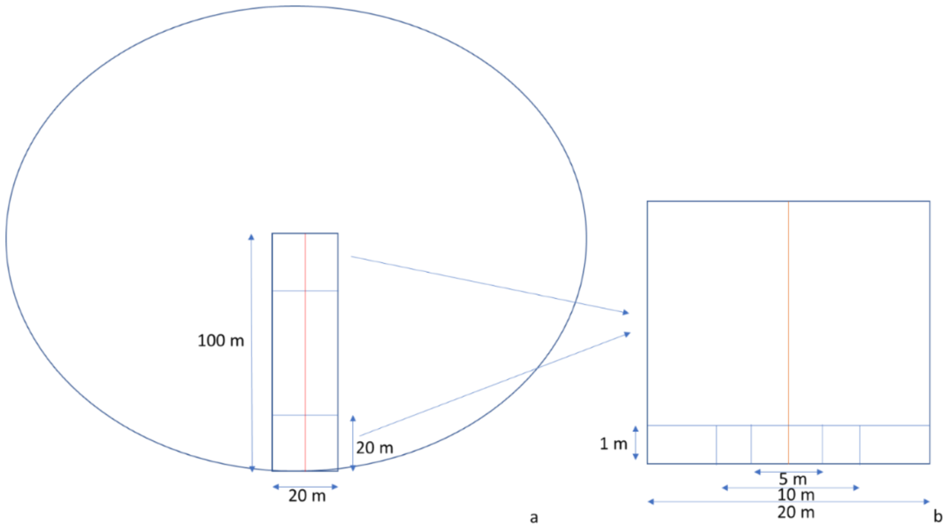

Figure 2. Schematic sketch of one of the transects of the study area, measuring 20 m x 100 m (a). The border plot and the interior plot of each of the four transects studied were subdivided into subplots for natural regeneration sampling (b). The red line crossing the transect represents the division of areas with and without cattle.

Figura 2. Croqui esquemático de um dos transectos da área de estudo, de 20 m x 100 m (a). A parcela da borda e a parcela do interior de cada um dos quatro transectos estudados foi subdividida em sub-parcelas para a amostragem da regeneração natural (b). A linha vermelha cortando o transecto representa a divisão das áreas com e sem gado.

The subplots were dimensioned according to their regeneration class, following methodology used by Santos *et al.* (2018). This way, each of the 20 m² parcels was subdivided in smaller parcels, according to i) class 1 of regenerants: plants with height over 20 cm and less than 1m were assessed in subplots of 5 m²; ii) class 2 of regenerants: plants with height over 1m and less than 3m were assessed in subplots of 10 m² and iii) class 3 of regenerants: plants with height over 3 m and breast height diameter lesser than 5 cm, were assessed in the 20m² parcels.

All the assessed arboreal regenerating individuals inside the plots and subplots were identified and had their class height registered. The identification of species was executed on field or, when not possible, were collected and registered in pictures from the botanical material for later identification in the laboratory, based on specialized bibliography, with the scientific names being based on the List of Species of Flora and Fungai in Brazil. Platforms such as The International Union for Conservation of Nature Red List of Threatened Species (IUCN Red List) were also used to know the preservation status of found species, Stehmann (2009) to acknowledge their endemism and Ferreira *et al.* (2013) to determine the successional group of species. The concept of endemism used in this paper determines if the occurrence and geographical distribution of species is restricted to the Atlantic Rainforest level, according to its ecology and biogeographical evolution.

The sample sufficiency has been determined to the sampled species in the area through species accumulation curve, using the rarefaction method, based on the methodology proposed by Hsieh and Chao (2016).

To each sector of edge distance, the early/late succession of individuals was classified, also the presence or not of species threatened by extinction and endemic ones. Furthermore, for each sector, edge and interior, the natural regeneration index by class and total have been calculated, according to methodology used by Vieira and May (2020). This calculation (TNR) ponders the frequency and density of each regenerant class (CNR) and aims to evaluate the potential of species regeneration in each size.

In order to verify the existence of floristic-structural groups related to the distance from the edge and the impact caused by the presence of cattle, the ordinance of plots in the edge and interior sectors within the fragment was applied to connect to the structural (abundance) and floristic characteristics, from a matrix of quantitative data, using the technique of multivariate analysis called Non-Metric Multidimensional Scaling (MINCHIN, 1987). The ordinance suitability for interpretation has been assessed by the value of Standard Residuals Sum of Squares (STRESS).

The data analyses have been achieved via electronic tables and the statistic software R, using the Vegan package.

RESULTS

It has been identified and put in an inventory 224 individuals from 52 species and 24 families (Figure 3), with one unidentified individual (UI) and one from which it has been possible to identify only its genus (*Schinus* sp.) due to a lack of vegetational and/or reproduction structures for identification.

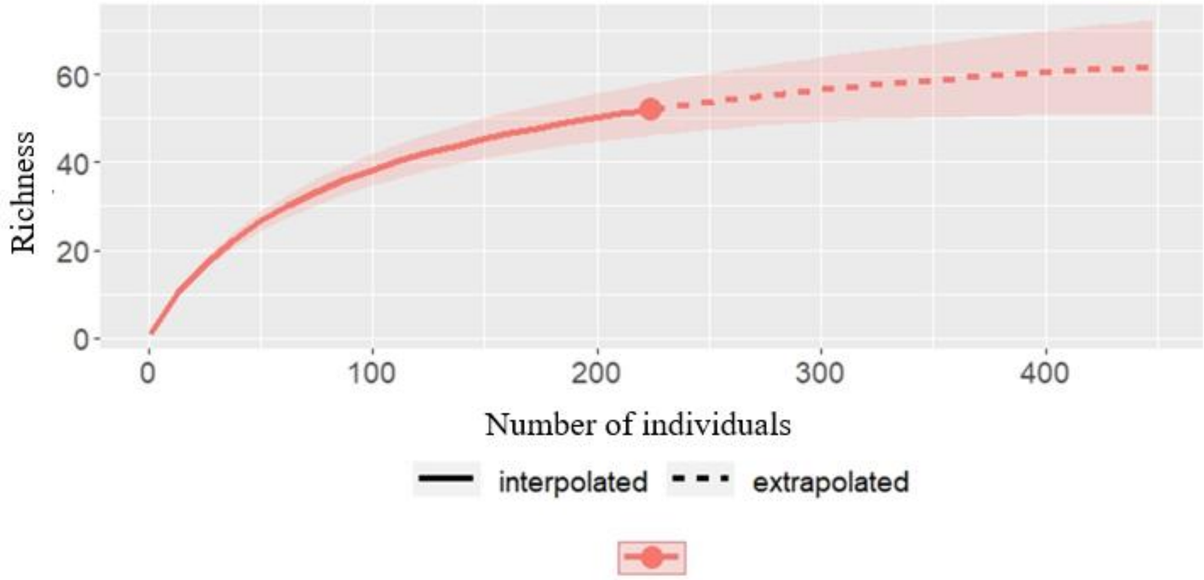

Figure 3. Rarefaction curve for richness (52 species) as a function of the number of individuals sampled (224 individuals). The solid line represents the interpolated richness and the dotted line the extrapolated richness up to twice the sample size (448 individuals). The red band indicates the confidence interval for the estimated richness.

Figura 3. Curva de rarefação para a riqueza (52 espécies) em função do número de indivíduos amostrados (224 indivíduos). A linha continua representa a riqueza interpolada e a linha pontilhada a riqueza extrapolada até o dobro da amostragem (448 indivíduos). A faixa em vermelho indica o intervalo de confiança para a riqueza estimada.

Observing the NMDS (Figure 4), it is possible to see that the floristic-structural composition differed between edge and interior of the fragment on axis I, with plots on the edge concentrated on the left side of the analysis and the interior plots on the right side.

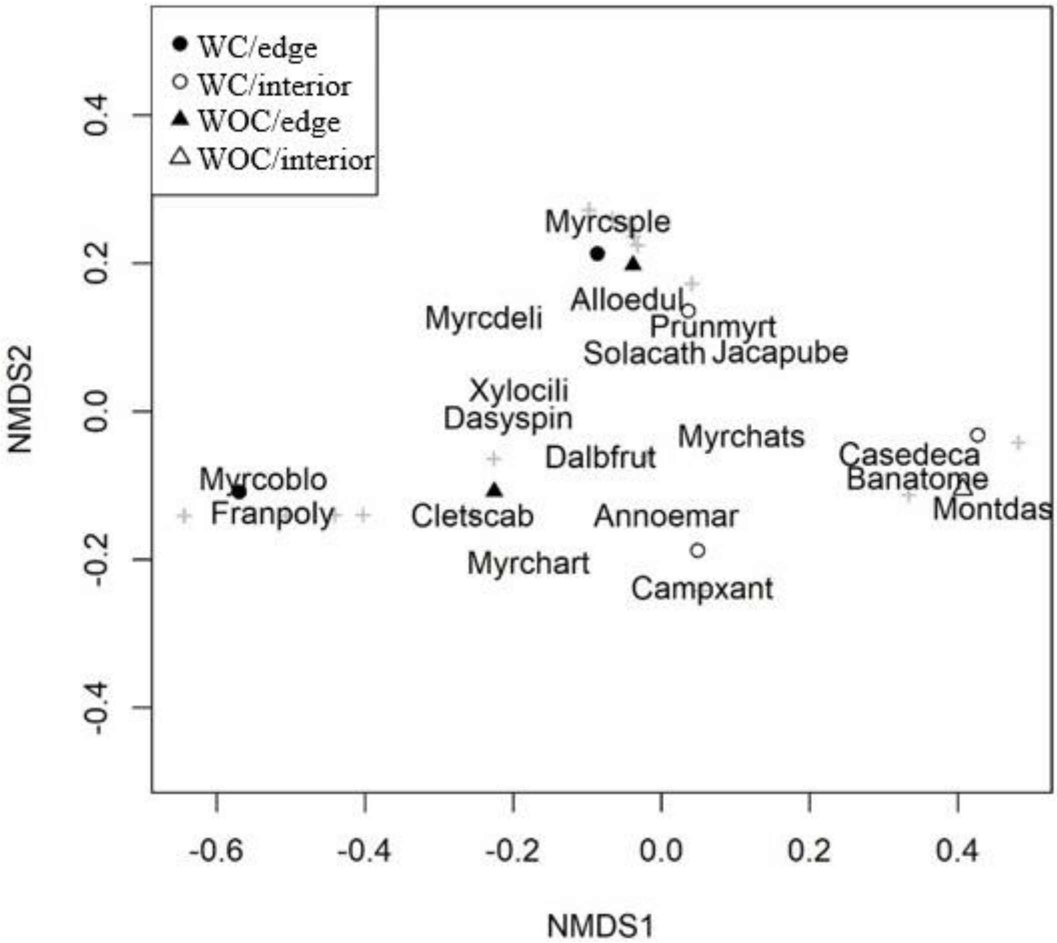

Figure 4. Ordination produced by NMDS analysis (STRESS = 0.0744, k = 2) for plots and regenerating species. Unfilled symbols indicate interior parcels and filled symbols indicate border parcels. Circles indicate the area with cattle and triangle the area without cattle.

Figura 4. Ordenação produzido pela análise NMDS (STRESS = 0,0744, k = 2) para as parcelas e as espécies regenerantes. Símbolos sem preenchimento indicam parcelas de interior e símbolos com preenchimento indicam as parcelas de borda. Círculos indicam a área com gado e triângulo a área sem gado.

The percentage of the successional groups (Table 1) for the edge was of 37,5% for pioneers, 32,5% for early secondaries, 25% for late secondaries e 5% for climax. Whereas for the interior, the percentage of the successional groups was of 12% for pioneers, 44% for early secondaries, 40% for late secondaries e 4% for climax.

The total values of the Natural Regeneration Index by Class (NRC) (Table 1) for the edge were of 56,1% for class 1, 27% for class 2 and 16,8% for class 3. As for the interior, the total values were of 62,9% for class 1, 15,6% for class 2 and 21,5% for class 3.

The abundance of species on the edge was of 144 individuals whereas in the interior it was of 80 individuals.

Table 1. Table of floristic composition, endemism, conservation status, successional group and natural regeneration index by class and total in the interior-edge of regenerating tree species.

Tabela 1. Tabela de composição florística, endemismo, status de conservação, grupo sucessional e índice de regeneração natural por classe e total interior-borda das espécies arbóreas regenerantes.

Species	EN	SG	CS	Edge				Interior			
				NRC1	NRC2	NRC3	TNR	NRC1	NRC2	NRC3	TNR
Aiouea amoena (Nees & Mart.) R.Rohde	N	Ls	Lc	1,3	0,9	0,0	2,2	0,0	0,0	0,0	0,0
Allophylus edulis (A.St.-Hil. *et al.*) Hieron. ex Niederl.	Y	Es	Lc	3,9	0,9	0,0	4,8	6,2	0,0	0,0	6,2
Allophylus guaraniticus (A. St.-Hil.) Radlk.	Y	Ls	NE	0,0	0,0	0,0	0,0	4,9	0,0	1,8	6,7
Annona emarginata (Schltdl.) H.Rainer	Y	Es	Lc	1,9	0,0	0,0	1,9	1,8	3,0	0,0	4,8
Araucaria angustifolia (Bertol.) Kuntze	Y	Ls	Cr	0,0	0,0	0,0	0,0	1,8	1,8	6,0	9,6
Baccharis montana DC.	N	Pi	NE	0,0	1,3	0,9	2,2	0,0	0,0	0,0	0,0
Banara tomentosa Clos	Y	Ls	Lc	2,8	1,3	0,0	4,1	11,1	0,0	0,0	11,1
Berberis laurina Billb.	Y	Pi	NE	1,3	0,9	0,0	2,2	0,0	0,0	0,0	0,0
Blepharocalyx salicifolius (Kunth) O.Berg	Y	Es	NE	0,0	0,0	0,0	0,0	1,8	0,0	0,0	1,8
Campomanesia xanthocarpa (Mart.) O.Berg	Y	Es	NE	0,0	0,0	0,0	0,0	0,0	0,0	1,8	1,8
Casearia decandra Jacq.	Y	Ls	NE	0,9	0,0	0,0	0,9	1,8	3,6	0,0	5,4
Clethra scabra Pers.	Y	Pi	Lc	0,0	1,3	0,9	2,2	0,0	0,0	0,0	0,0
Cupania vernalis Cambess.	Y	Ls	Lc	0,9	0,9	0,0	1,9	1,8	0,0	0,0	1,8
Dalbergia frutescens (Vell.) Britton	Y	Ls	Lc	4,0	0,0	0,0	4,0	4,2	0,0	1,8	6,0
Dasyphyllum spinescens (Less.) Cabrera	Y	Pi	Lc	2,2	0,9	0,0	3,2	0,0	0,0	0,0	0,0
Feijoa sellowiana (O.Berg) O.Berg	Y	Es	Lc	0,0	0,0	0,9	0,9	0,0	0,0	0,0	0,0
Frangula polymorpha Reissek	N	Pi	NE	0,9	2,3	0,9	4,2	0,0	0,0	0,0	0,0
Ilex brevicuspis Reissek	Y	Es	NE	0,0	0,0	0,0	0,0	1,8	0,0	0,0	1,8
Ilex theezans Mart. ex Reissek	Y	Es	NE	0,0	0,9	0,0	0,9	0,0	0,0	0,0	0,0
Jacaranda puberula Cham.	Y	Es	Lc	2,2	0,0	0,0	2,2	1,8	0,0	0,0	1,8
Leandra regnellii (Triana) Cogn.	Y	Pi	NE	1,9	0,0	0,0	1,9	4,2	0,0	0,0	4,2
Ligustrum sinense Lour.	N	Pi	NE	0,0	0,9	0,0	0,9	0,0	0,0	0,0	0,0
Lithraea brasiliensis Marchand	Y	Pi	NE	0,0	1,3	0,0	1,3	0,0	0,0	0,0	0,0
Matayba elaeagnoides Radlk.	Y	Ls	Lc	1,3	0,0	0,0	1,3	2,4	0,0	0,0	2,4
Maytenus boaria Molina	Y	Ci	Lc	0,0	1,3	0,0	1,3	0,0	0,0	0,0	0,0
Miconia cinerascens Miq.	Y	Es	NE	1,9	0,9	0,0	2,8	0,0	0,0	0,0	0,0
Monteverdia dasyclada (Mart.) Biral	Y	Es	NE	0,0	0,0	0,0	0,0	1,8	0,0	0,0	1,8
Myrceugenia mesomischa (Burret) D.Legrand & Kausel	Y	Pi	Lc	0,0	0,0	0,0	0,0	0,0	1,8	1,8	3,6
Myrceugenia oxysepala (Burret) D.Legrand & Kausel	Y	Ls	NE	0,0	0,0	0,0	0,0	0,0	0,0	1,8	1,8
Myrcia guianensis (Aubl.) DC.	Y	Es	Lc	1,9	0,0	0,0	1,9	0,0	0,0	0,0	0,0
Myrcia hartwegiana (O.Berg) Kiaersk.	Y	Es	NE	0,9	0,0	0,0	0,9	0,0	1,8	0,0	1,8
Myrcia hatschbachii D.Legrand	Y	Ci	NE	0,9	0,0	0,0	0,9	3,7	1,8	6,6	12,1
Myrcia oblongata DC.	Y	Pi	NE	9,2	3,6	2,2	15,1	0,0	0,0	0,0	0,0
Myrcia palustris DC.	Y	Pi	Lc	0,0	0,9	0,0	0,9	0,0	0,0	0,0	0,0
Myrcia splendens (Sw.) DC.	Y	Ls	Lc	2,0	0,0	0,9	2,9	0,0	1,8	0,0	1,8
Myrciaria delicatula (DC.) O.Berg	Y	Ls	Lc	0,0	0,9	0,0	0,9	0,0	0,0	0,0	0,0
Myrrhinium atropurpureum Schott	Y	Ls	Lc	0,9	0,0	0,0	0,9	0,0	0,0	0,0	0,0
Myrsine parvula (Mez) Otegui	Y	Es	Lc	0,9	0,9	0,0	1,9	2,4	0,0	0,0	2,4
Nectandra lanceolata Nees	Y	Ls	Lc	0,0	0,0	0,9	0,9	0,0	0,0	0,0	0,0
Nectandra megapotamica (Spreng.) Mez	Y	Ls	Lc	0,0	0,0	0,0	0,0	1,8	0,0	0,0	1,8
Ni	N	-	NE	0,9	0,0	0,0	0,9	0,0	0,0	0,0	0,0
Podocarpus lambertii Klotzsch ex Endl.	Y	Ls	Nt	0,0	0,0	0,9	0,9	0,0	0,0	0,0	0,0
Prunus myrtifolia (L.) Urb.	Y	Es	Lc	3,5	0,0	0,0	3,5	4,2	0,0	0,0	4,2
Schinus sp. L.	N	-	NE	0,9	0,0	0,9	1,9	0,0	0,0	0,0	0,0
Schinus terebinthifolia Raddi	Y	Pi	NE	0,0	0,0	1,9	1,9	0,0	0,0	0,0	0,0
Solanum sanctae-catharinae Dunal	Y	Pi	NE	0,9	0,9	0,0	1,9	1,8	0,0	0,0	1,8
Styrax leprosus Hook. & Arn.	Y	Ls	Lc	0,0	0,0	0,0	0,0	1,8	0,0	0,0	1,8
Symphyopappus itatiayensis (Hieron.) R.M.King & H.Rob.	Y	Pi	NE	0,9	0,0	0,0	0,9	0,0	0,0	0,0	0,0
Symplocos tenuifolia Brand	Y	Pi	NE	1,3	0,0	0,0	1,3	0,0	0,0	0,0	0,0
Symplocos uniflora (Pohl) Benth.	Y	Es	Lc	0,0	1,3	2,2	3,5	0,0	0,0	0,0	0,0
Xylosma ciliatifolia (Clos) Eichler	Y	Es	Lc	0,9	0,9	0,9	2,8	0,0	0,0	0,0	0,0
Zanthoxylum rhoifolium Lam.	Y	Pi	Lc	2,0	0,9	1,9	4,8	0,0	0,0	0,0	0,0

It reads: EN= Endemic to Brazil; Y= Yes; N= No; SG= Successional group; Pi= Pioneer; Es= Early secondary; Ls= Late secondary; Ci= Climax; CS = Conservation status; Lc= Low concern; Nt= Nearly threatened; Cr= Critical danger; NE= Non-evaluated species as to its threat; NRC= Natural Regeneration Index by class (%); e TNR= Total Natural Regeneration Index (%).

Only one species has been classified under critical situation (*Araucaria angustifolia*) and one as nearly threatened (*Podocarpus lambertii*) (Table 1). Also, it was quantified one invasive exotic species (*Ligustrum sinense*) on the edge of the forest fragment. As a field observation, it is highlightable the high presence of *taquara* (*Merostachys multiramea* Hack.), especially in the sector located in the interior of the fragment.

The number of species for each family is: 13 Myrtaceae (*Blepharocalyx salicifolius*, *Campomanesia xanthocarpa*, *Feijoa sellowiana*, *Myrceugenia mesomischa*, *Myrceugenia oxysepala*, *Myrcia guianensis*, *Myrcia hartwegiana*, *Myrcia hatschbachii*, *Myrcia oblongata*, *Myrcia palustris*, *Myrcia splendens*, *Myrciaria delicatula* and *Myrrhinium atropurpureum*), three Anacardiaceae (*Lithraea brasiliensis*, *Schinus* sp. and *Schinus terebinthifolia*), three Asteraceae (*Baccharis montana*, *Dasyphyllum spinescens* and *Symphyopappus itatiayensis*), three Lauraceae (*Aiouea amoena*, *Nectandra lanceolata* and *Nectandra megapotamica*), three Salicaceae (*Banara tomentosa*, *Casearia decandra* and *Xylosma ciliatifolia*), three Sapindaceae (*Allophylus guaraniticus*, *Cupania vernalis* and *Matayba elaeagnoides*), two Aquifoliaceae (*Ilex brevicuspis* and *Ilex theezans*), two Celastraceae (*Maytenus boaria* and *Monteverdia dasyclada*), two Melastomataceae (*Leandra regnellii* and *Miconia cinerascens*), two Symplocaceae (*Symplocos tenuifolia* and *Symplocos uniflora*) and only one species from the family Annonaceae (*Annona emarginata*), Araucariaceae (*Araucaria angustifolia*), Berberidaceae (*Berberis laurina*), Bignoniaceae (*Jacaranda puberula*), Clethraceae (*Clethra scabra*), Fabaceae (*Dalbergia frutescens*), Myrsinaceae (*Myrsine parvula*), Oleaceae (*Ligustrum sinense*), Podocarpaceae (*Podocarpus lambertii*), Rhamnaceae (*Frangula polymorpha*), Rosaceae (*Prunus myrtifolia*), Rutaceae (*Zanthoxylum rhoifolium*), Solanaceae (*Solanum sanctae-catharinae*) and Styracaceae (*Styrax leprosus*). From there, the non-endemic species present in the inventory were only *Ligustrum sinense*, *Frangula Polymorpha*, *Baccharis montana* and *Aiouea amoena*.

DISCUSSION

The sampling effort (Figure 3) has been suited for the characterization of the area's floristic composition, because as the sampling effort has been increased by 10% there was an increment of 3.85% of new species in total, that is, less than 5%, assuring the population minimal representativity. (KERSTEN; GALVÃO, 2011).

The absence of differentiation between the areas with and without access for cattle (Figure 4) has probably occurred due to the plot fencing to avoid access being implemented one year before this study, not offering enough time for this action to reflect on the structure and composition of vegetation.

The expressive representativity from the family Myrtaceae (13 species) is a characteristic pattern from the Mixed Ombrophylous Forest (e.g. FERREIRA *et al.* 2016, VIBRANS *et al.*, 2011), as it is the family with the most endemic species richness in the present inventory, denoting the conservation priority of forest fragments as a mechanism for maintaining biodiversity and endemic species protection, as pointed by Gomes *et al.* (2020a).

Many of the sampled species are not evaluated as to their level of threat (Table 1), which is a concerning point due to the invisibility of the situation. This problem is intensified with the presence of the invading exotic species *Ligustrum sinense,* because of its capability to develop in the forest understory, being able to alter the floristic structure and composition of native species (CORDEIRO *et al.*, 2014). This has occurred in other studies with the Mixed Ombrophylous Forest, in which the species *Ligustrum sinense* is present in the inventories (e.g. NUNES *et al.*, 2018).

The scenario worsens regarding the species of restricted occurrence and endemic ones, as for instance *Myrceugenia mesomischa* and *Myrciaria delicatula*, and for species in critical danger, such as *Araucaria angustifólia*, and nearly threatened, as *Podocarpus lambertii*. This way, the presence of invading exotic species such as *Ligustrum sinense* could affect these species and alter the forest successional dynamics, influencing the biological flow, the species dispersion and the fragment's floristic-structural composition.

The values null of importance on the indexes of total natural regeneration (TNR = 0) from the fragment's edge and interior (Table 1) show an absence of one species in one of the sectors. This way, the counting of these values has exposed that, the number of species present only on the edge, 27 species in total, is higher than the number of species only in the interior, 10 species in total, pointing towards a higher richness on the fragments edge. Moreover, the number of individuals is also smaller in the interior (80) than on the edge (144), indicating a more intense abundance on the edge of the fragment. This has occurred because species such as *Myrcia oblongata*, *Symplocos tenuifolia*, *Symplocos uniflora*, *Frangula polymorpha*, *Clethra scabra*, *Myrcia guianensis* and *Dasyphyllum spinescens*, for example, benefited from the light entrance on the edge to regenerate more in this sector. On the Other hand, *Allophylus guaraniticus*, *Myrceugenia oxysepala*, *Nectandra megapotamica*, *Araucaria angustifolia* and *Styrax leprosus*, for instance, have been more present in the interior, showing a bigger tolerance to shading. This diversity can be explained by the higher expression of pioneers (37,5%) on the edge and of secondaries (late=40% and early=44%) in the interior and it characterizes a response to the changes in microclimate between the edge and the interior of the fragment (PSCHEIDT *et al.*, 2018).

Another factor that may be influencing this scenario, as the smaller abundance and richness in the interior compared to the edge, is the presence of *taquara* in the interior of the fragment. Even presuming that, probably, *taquara* is affecting these values, it is to be stated that, in literature, it is registered (e.g. SAMPAIO; SCARIOT, 2011), generally, a higher number of individuals on the edge that in the interior of fragments, due to an easier regeneration provided by highest illuminance on the edge.

The analysis of natural regeneration by height class (Table 1) has shown bigger numbers of species on regenerant class 1, as much for the edge (56,1%) as for the interior (62.9%). The bigger density of individuals on classes of smaller size is common in forest natural regeneration for native forests, because, at first, there is a high production of propagules that, through time, pass through environmental filters (for instance, herbivory), which reduces the density of individuals at the same pace they grow in size (SCCOTI *et al.*, 2011).

The two species with most importance for the interior of the fragment have been *Myrcia hatschbachii* (TNR=12,1%) and *Banara tomentosa* (TNR=11,1%). The former is a climax species with representativity in all height classes, especially in the one with the most height (NRC3=6,6%); and the latter, is a late secondary species with considerable representativity in the class of lower height (NRC1=11,1%). Whereas, for the edge of the fragment, the most important species was *Myrcia oblongata* (TNR=15,1%), characterized as pioneer and with representativity in all height classes, especially the one with smaller height (NRC1=9,2%). These species present enormous potential to establish in the forest, mainly *Myrcia hatschbachii* and *Myrcia oblongata*, what becomes evident due to the fact they have representativity in all height classes (SILVA *et al.*, 2007). Beyond that, *Myrcia oblongata* is a bioindication species for dystrophic soils in the Mixed Ombrophylous Forest, demonstrating its potential of regeneration in places with limiting edaphic filters (GOMES *et al.*, 2020b), and *Myrcia hatschbachii* is quoted in other studies (e.g. VIEIRA; MAY, 2020) as an important species for natural regeneration in MOF. Still, in a paper from Vibrans *et al.* (2011), *Myrcia oblongata* was the species with most density of natural regeneration in Santa Catarina's Floristic and Forest Inventory (IFFSC), showing, as well as the aforementioned ones, great importance for MOF, being able to be referred for restoring altered areas.

In a study of regenerations guilds of arboreal components, Salami *et al.* (2017) reported that *Banara tomentosa* is one of the species that presented a high recruitment rate, however, its representativity happens only in the classes of lower height in the fragment interior (NRC1=11,1%), demonstrating that there may be a filter making it difficult for part of the individuals to enter the adult forest.

The considerable differentiation between the edge and interior sector (Figure 4), the expressive amount of species richness and abundance, mostly, of pioneers on the edge and low amount of the same species value, as predominantly, secondaries in the interior, as well as species of higher pioneer importance on the edge and secondary/climax in the interior, points that, possibly, the edge effect is acting on the floristic structural composition within the fragment.

CONCLUSION

The analyses of the structure and floristic compositions from the regenerants in the edge and interior sectors of the fragment allow us to conclude that:

- The edge effect seems to have been a key factor for the altering on the floristic structural composition of regenerating arboreal species within the studied fragment;
- The species *Myrcia hatschbachii* and *Myrcia oblongata* are the species with the highest index of total natural regeneration and its representativity in all regeneration classes indicates high potential for nuclear and for forest establishment, these being, respectively, a climax species present in the fragment interior and the other a pioneer present on the edge;
- It can be seen a higher percentage of individuals in the first class (plants with height over 20cm and less than 1m) in both sectors, however the species *Banara tomentosa*, third most important among the fragment regenerants, is found mainly in the interior and only in the class of lower height, indicating possible filter for the establishment of this species;
- There is a higher number of species occurring only on the edge than in the fragment interior, besides that the edge is more diverse and abundant than the interior;
- It is recommended to follow up on the area in the following year to analyze the impact of cattle alongside the edge effect on the floristic structural composition of the forest fragment.

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