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Biodiversity and forestry: relative abundance of *Nothura maculosa* in eucalyptus plantations and native grasslands in southern Brazil

Biodiversidade e silvicultura: abundância relativa de *Nothura maculosa* em plantações de eucalipto e campos nativos no Sul do Brasil

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ABSTRACT

Over the last decades, agribusiness has shown a great expansion in the Pampa Biome. Forestry, mainly with eucalyptus, has expanded its planting in the Rio Grande do Sul state, southern Brazil. The objective of this study was to contribute to the understanding of the impact of planted forests on Brazilian Pampa biodiversity, through the comparison of the relative abundance of *Nothura maculosa* in areas of native field and areas with young (aged 6–12 months) eucalyptus. Pointing dogs were used to define the relative abundance (individuals per hour) of *N. maculosa* on 16 farms and ten eucalyptus plantations. A total of 307 individuals of *N. maculosa* were recorded on the 26 sampled properties, of which 188 were found in grasslands (average of 12.6 ind.h^{-1}) and 119 in eucalyptus plantings (average of 13.5 ind.h^{-1}). No statistically significant differences were found between the sampled areas ($p = 0.18$; $\alpha = 0.05$). The main conclusion of this study is that when the landscape spatial-temporal mosaic is considered, the term “green desert” become quite limited.

Keywords: green deserts; pampa biome; spotted *Nothura*; planted forests.

RESUMO

Nas últimas décadas, o agronegócio tem apresentado grande expansão no bioma Pampa. A silvicultura, principalmente com eucalipto, expandiu seu plantio no estado do Rio Grande do Sul (RS), sul do Brasil. O objetivo deste estudo é contribuir para o entendimento do impacto das florestas plantadas na biodiversidade do Pampa brasileiro, através da comparação da abundância relativa de *Nothura maculosa* em áreas de campo nativo e áreas com plantios jovens (6–12 meses) de eucalipto. Cães de aponte foram utilizados para definir a abundância relativa (indivíduos por hora) de *N. maculosa* em 16 fazendas e dez plantações de eucalipto. O total de 307 indivíduos de *N. maculosa* foi registrado nas 26 propriedades amostradas, sendo 188 em pastagens (média de 12,6 ind.h^{-1}) e 119 em plantios de eucalipto (média de 13,5 ind.h^{-1}). Não foram encontradas diferenças estatisticamente significantes entre as áreas amostradas ($p = 0,18$; $\alpha = 0,05$). A principal conclusão deste estudo é que quando o mosaico espaço-temporal de paisagem é considerado, o termo “deserto verde” fica bastante limitado.

Palavras-chave: desertos verdes; Bioma Pampa; codorna-amarela; Florestas Plantadas.

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Introduction

In the last decades, there has been a great expansion of agribusiness in the Pampa (Bilenca and Miñarro, 2004; Thompson and Carroll, 2006; Carvalho et al., 2008; Cravino and Brazeiro, 2021). In southern Brazil, we highlight summer crops such as soybeans, corn, and rice associated or not with winter pastures, such as ryegrass (Carvalho et al., 2008). Converting the grasslands to agricultural or silvicultural use affects some ecosystem functions for many years, even after reconversion (Leidinger et al., 2017). The latest estimates indicate that about 48.7% of the Brazilian Pampa may have changed due to human actions (Cordeiro and Hasecack, 2009).

Recently, the silviculture has extended its planting in southern Brazil, especially in the Pampa, occupying an approximate area of 1.03 million hectares in Rio Grande do Sul (RS) in 2019, with 67.7% being eucalyptus (AGEFLOR, 2020). Despite the small area (only 2.9% of the state) comparing to agriculture, there is a prospect of expanding tree plantations in the coming decades, which makes the biodiversity monitoring a basic premise for good forest management (FSC, 2015) that should be thought out from the local reality (Hartley, 2002; Carnus et al., 2006).

Nothura maculosa (Telmminck, 1815) is a common species in natural pastures and agroecosystems in the Pampa (Bump and Bump, 1969; Thompson and Carroll, 2006) and is the diet of several reptiles, birds, and mammals. Therefore, it is an important hunting species in southern Brazil, Uruguay, and Argentina (Bump and Bump, 1969; Menegheti, 1985; Crego and Macri, 2009). This study aimed to contribute to the understanding of the impact of planted forests on biodiversity, through the comparison of the relative abundance of *N. maculosa* in areas of native field and areas with young eucalyptus (aged 6–12 months) in properties located in cities of the southern half of RS, Brazil.

Material and Methods

Study area

The present study was conducted in 26 properties distributed in the cities of São Gabriel, Rosário do Sul, Cacequi, and Santana do Livramento (SAG core); and Cerrito, Pedro Osório, Arroio Grande, Jaguarão, Herval, and Pinheiro Machado (PEL core) (Figure 1); all in RS.

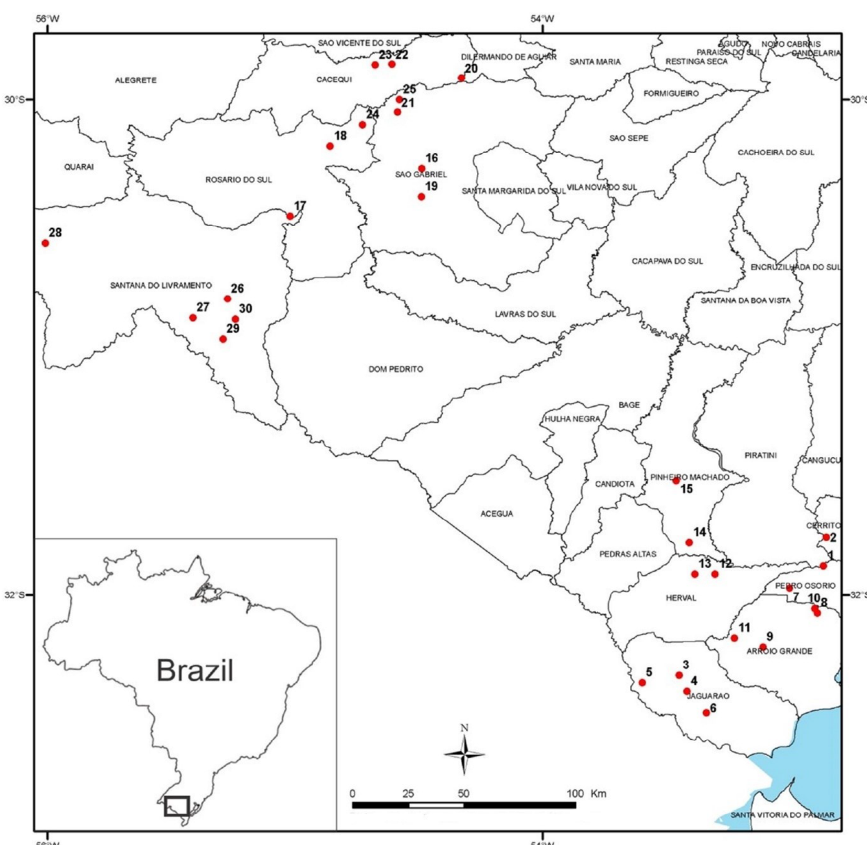

Figure 1 – Map with the location of the sampled rural properties: 1. FARM-01 (22J 323603/ 6471042); 2. FARM-02 (22J 324433/ 6483670); 3. EUC-03 (22H 269580/ 6420954); 4. FARM-04 (22H 272754/ 6413752); 5. FARM-05 (22H 255645/ 6417303); 6. FARM-06 (22H 280271/ 6404412); 7. EUC-07 (22J 310762/ 6461001); 8. EUC-08 (22H 321658/ 6449773); 9. EUC-09 (22H 301173/ 6434243); 10. FARM-10 (22H 320587/ 6451868); 11. FARM-11 (22H 290178/ 6438013); 12. FARM-12 (22J 282;265/ 6466651); 13. FARM-13 (22J 274465/ 6466489); 14. EUC-14 (22J 272133/ 6480419); 15. FARM-15 (22J 266477/ 6508141); 16. FARM-16 (21J 741441/ 6647728); 17. FARM-17 (21J 690008/ 6627559); 18. FARM-18 (21J 706108/ 6658576); 19. FARM-19 (21J 741035/ 6635105); 20. EUC-20 (21J 757930/ 6688071); 21. EUC-21 (21J 732648/ 6673250); 22. FARM-22 (21J 730879/ 6694771); 23. FARM-23 (21J 724394/ 6694538); 24. EUC-24 (21J 718889/ 6667799); 25. EUC-25 (21J 733525/ 6678744); 26. FARM-26 (21J 665142/ 6590862); 27. EUC-27 (21J 651747/ 6582624); 28. FARM-28 (21J 594981/ 6616663); 29. EUC-29 (21J 663107/ 6572865); 30. EUC-30 (21J 668076/ 658170). The properties FARM-5 and FARM-11, EUC-8 and EUC-29, were not used in this work due to technical problems in the field.
Source: Brazilian Institute of Geography and Statistics (IBGE, 1997).

Figure 2 – Pointing dog performing red-spotted tinamous (*Nothura maculosa*) scanning work on a rural property (FARM-06). In the background: the dog handler (right) and an observer (left). Jaguarão (RS), Brazil.

Figure 3 – Eucalyptus planting area on EUC-03 property. Jaguarão (RS), Brazil.

For each city, rural properties with at least 400 ha of field were selected (Figure 2), and areas where eucalyptus planting occurred between the final months of 2008 and the beginning of 2009 (Figure 3). All properties were sampled between May 12–20 (PEL core) and July 04–13 (SAG core) in 2009, totaling 21 days of field activities.

Methodology

In each of the sampled properties, the following initial procedures were adopted: (a) approximate determination of wind directions, to define the alignment axis of the scanning; (b) measurement of wind speed with an anemometer ($m.s^{-1}$), to control the quality of the dogs' work; (c) measurement of air temperature, to control the quality of the dogs' work; (d) Universal transverse Mercator (UTM) coordinates at the beginning and end of the scan, to obtain the total distance, azimuth, and geographical positioning of the scanning; and (e) expeditious description of the geomorphology, vegetation physiognomy, and the surrounding landscape. Three pointing dogs were used to sample the red-spotted tinamous (*N. maculosa*) (Menegheti et al., 1981; Pinheiro and Lopez, 1999; Crego and Macri, 2009) in a relay system, not all working on the same properties. In each sampled area, there was a dog handler to control the activities of the dog – Pointer breed with pedigree and trained to this type of activity. In addition, there was an observer to record information about the red-spotted tinamou sampled, a time control, and an expeditious description of the microhabitat, and a technician with a support vehicle.

After reading the coordinates, the observer determined the handler to start the activity with the dog. This consisted of progressive zigzagging displacement, perpendicular to the axis of the alignment of the area to be scanned (Figure 2). As they were trained dogs, the scan width could be considered, on average, constant. Once the dog perceived the emanations of each red-spotted tinamou and assumed the pointing position, the time of the recording was noted and, after the bird was raised, also the number of the present individuals, the development stage (nestling/young/adult), and the characteristics of the microhabitat. Additionally, it was recorded the initial and final times of activities interruption for resting, watering, and replacing the dog, or changing the location of the scan on the same property.

Further to the red-spotted tinamous sampled after the pointing position, those that were eventually run over by the dog were also considered since it is not possible to affirm that the dog did not perceive their emanations. However, all individuals that were raised by the displacement of the dog handler or the observer and, therefore, not perceived by the dog, were recorded separately to be used as an indicator of the dog's work quality in each sector scanned. Sector is understood to be each one of the units of the scanned area per property.

The samples were preferably performed in the early morning and late afternoon to have the best climate conditions for the effective perception of the red-spotted tinamous by the dogs, and lower temperatures to obtain a better performance in their activity (Menegheti et al., 1981). For each property, it was established a minimal sampling time of 50 minutes and a maximum of 60 minutes.

On a property scale, the sampling effort developed was determined, the sampled individuals were totaled, and the red-spotted tinamou abundance index obtained on each property, in terms of individuals per hour ($ind.h^{-1}$), was calculated.

A General Linear Model (GLM) with Statistical Package for Social Sciences (SPSS v. 26) and Statistica v. 12 was applied to the field data considering *N. maculosa* as a dependent variable ($ind.h^{-1}$).

Results

A total of 307 red-spotted tinamous were recorded on the 26 sampled properties, of which 188 were found in the grasslands of 16 properties (average of 12.6 $ind.h^{-1}$; Table 1) and 119 in ten eucalyptus plantings (average of 13.5 $ind.h^{-1}$, Table 2).

Table 1 – Farms sampled through scanning with the pointing dogs. Rio Grande do Sul, Brazil.

Property	City	Date	N	T	Ind.h^{-1}
FARM-01	Pedro Osório	May/2009	13	55	14.2
FARM-02	Cerrito	May/2009	17	51	20.0
FARM-04	Jaguarão	May/2009	6	60	6.0
FARM-06	Jaguarão	May/2009	14	55	15.3
FARM-10	Arroio Grande	May/2009	5	60	5.0
FARM-12	Herval	May/2009	9	50	10.8
FARM-13	Herval	May/2009	17	60	17.0
FARM-15	Pinheiro Machado	May/2009	13	60	13.0
FARM-16	São Gabriel	Jul/2009	6	53	6.8
FARM-17	Rosário do Sul	Jul/2009	16	53	18.1
FARM-18	Rosário do Sul	Jul/2009	7	59	7.1
FARM-19	São Gabriel	Jul/2009	25	57	26.3
FARM-22	Cacequi	Jul/2009	10	57	10.5
FARM-23	Cacequi	Jul/2009	8	57	8.4
FARM-26	Santana do Livramento	Jul/2009	12	53	13.6
FARM-28	Santana do Livramento	Jul/2009	10	53	11.3
Farms/Total			188	893	
Farms/Average			11.75	55.8	12.6

N: number of red-spotted tinamous (*Nothura maculosa*); T: time of the scan in minutes; Ind.h^{-1}: red-spotted tinamous per hour.

Table 2 – Plantations of eucalyptus sampled through scanning with the pointing dogs. Rio Grande do Sul, Brazil.

Property	City	Date	N	T	Ind.h^{-1}
EUC-03	Jaguarão	May/2009	24	50	28.8
EUC-07	Pedro Osório	May/2009	8	55	8.7
EUC-09	Arroio Grande	May/2009	21	54	23.3
EUC-14	Pinheiro Machado	May/2009	14	50	16.8
EUC-20	Cacequi	Jul/2009	5	55	5.5
EUC-21	São Gabriel	Jul/2009	18	50	21.6
EUC-24	Rosário do Sul	Jul/2009	5	53	5.7
EUC-25	São Gabriel	Jul/2009	4(2)	50	4.8
EUC-27	Santana do Livramento	Jul/2009	11	54	12.2
EUC-30	Santana do Livramento	Jul/2009	9	56	9.6
Eucalyptus/Total			119	527	
Eucalyptus/Average			11.9	52.7	13.5

N: number of red-spotted tinamous (*Nothura maculosa*); T: time of the scan in minutes; Ind.h^{-1}: red-spotted tinamous per hour.

Only on three occasions, in three different field areas, did red-spotted tinamous take off after the dogs' scanning, being these three individuals dismissed in the present analysis. Considering only the 12 properties in PEL core, the average was 14.5 ind.h^{-1}, and in 14 properties of SAG core, the average was 11.7 ind.h^{-1}. In the PEL core, the average in the grassland areas was 12.7 ind.h^{-1}, and in the eucalyptus plantings, 18.2 ind.h^{-1}. In the SAG core, the average in the grassland areas was 12.9 ind.h^{-1}, and in the eucalyptus plantings, 10.0 ind.h^{-1}. Statistically significant differences were not found in the relative abundance of *N. maculosa* between all comparisons (Figure 4, Table 3).

Notice that there are five general p-values. The first for the general model, the second for the intercept, the third for comparing means between SAG and PEL groups, a fourth for comparing plantations and farms, and a fifth for the interaction between group and type factors. None of them were statistically significant. ($\alpha = 0.05$)

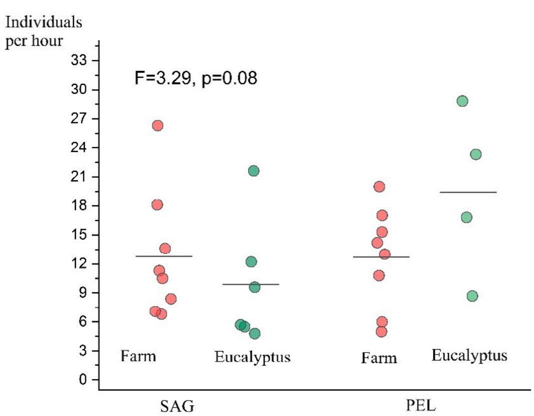

Figure 4 – General Linear Model (SPSS v. 26; Statistica v. 12) between treatments. Individuals of *Nothura maculosa* per hour on farms and eucalyptus plantations in the SAG and PEL cores (α = 0.05).

Discussion

The monitoring of *N. maculosa* populations in the Pampa biome in recent decades as a cinegetic species has provided the development of a reliable methodology, which can be adapted to different monitoring objectives. The relative densities obtained in the present study, both in the plantings and in the adjacent fields, are similar to those of previous studies for hunting censuses (Menegheti et al., 1981). This fact indicates that this species, common in the Pampa biome and present in the diet of various animals (reptiles, birds, mammals), seems to adapt to planting areas in the initial phase. Even in these areas more protected from illegal hunting, they are common in native grasslands and "remnants" of agricultural plantings on rural properties in the region.

N. maculosa is adapted to a wide variety of environments in the Pampa. The greatest abundance tends to occur in fields with ground cover between 10–50 cm high, preferably with clumps of grasses and herbs (Bump and Bump, 1969), as these environments provide shelter, food, and nesting sites. In the present study, areas with early-stage eucalyptus plantings appear as favorable habitats for *N. maculosa*, since no significant differences were found between planting and grassland areas of neighboring properties.

The habitat created by the wider spacing between rows of trees lines (5 m), therefore, with less number of trees per hectare in the forestry project under study, made the young eucalyptus individuals (0–1 year) play artificially the role of clumps, offering some protection to *N. maculosa.* Besides, this habitat favored its escape behavior, which consists of walking to hide among the vegetation of clumps and then remain motionless, taking a short, noisy, and parabolic flight when threatened (Bump and Bump, 1969; Crego and Macri, 2009).

According to Timo et al. (2015), the age of the eucalyptus stands determines different compositions of the mammalian fauna. In the early stages (0–1 year), when stands still resemble open

Table 3 – General Linear Model (SPSS v. 26; Statistica v. 12).

Dependent Variable: Red-spotted tinamou per hour (ind.h^{-1})					
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**p**
Corrected Model	222.64	3.00	74.21	1.76	0.180
Intercept	4,492.24	1.00	4,492.24	106.83	< 0.001
Group	132.54	1.00	132.54	3.15	0.090
Type	22.52	1.00	22.52	0.54	0.470
Grupo * Type	138.24	1.00	138.24	3.29	0.080
Error	925.12	22.00	42.05		
Total	5,604.38	26.00			
Correct Total	1,147.76	25.00			

Df: degrees of freedom; F: F-test; p: p-value (α = 0.05).

savannah, plants look like bushes and herbivores are abundant. Later (2–5 years), omnivores and insectivores become more numerous. In the final stages (6–7 years), there is a drastic decrease in the number of species and frequency of all trophic categories (Timo et al., 2015).

The presence of *N. maculosa* in fields in the early stages of planting indicates that in addition to public policies on size and distance between fragments (FEPAM, 2010), other variables must be considered (Hartley, 2002; Lindenmayer and Hobbs, 2004; Timo et al., 2015). Depending on the ecologic context in which they are located, forest plantations may have a negative or a positive impact on diversity at landscape level, regional landscape fragments or on individual species (Carnus et al., 2006; Cravino and Brazeiro, 2021).

The silvicultural plantations that have a mosaic of associated areas of preserved native habitats or in recovering process, either as permanent preservation areas (*Área de Preservação Permanente* — APP) or legal reserves (*Reserva Legal* — RL) (Brasil, 2012), may play a positive role in the conservation of local biodiversity (Mazzolli, 2010; Bonilla-Sánchez et al., 2012; Pinto and Duarte, 2013; Campos et al., 2018). According to Lindenmayer et al. (2009), patches of native forest fragments and riparian forests suffer a lower impact on their biologic diversity when the adjacent area is forest plantations. Eucalyptus plantations can thus be potentially beneficial for landscape connectivity (Sapucci et al., 2022). The wetlands and wet fields, associated with the extensive network of riparian forests and grasslands, where it is assumed that most of the Pampa's biodiversity is concentrated (Bencke, 2010; Costella et al., 2013), need today a huge conservation effort involving, in most cases, effective restoration and recovery projects.

The record of maned wolf (*Chrysocyon brachyurus*) and several felines (*Leopardus geoffroyi, Leopardus wiedii, Leopardus colocolo, Leopardus yagouaroundi*), among other mammals in areas of forestry consorted with cattle ranching in the Pampa biome (Pinto and Duarte, 2013) indicates that studies on species diversity should also consider the edge and interior species of gallery forests, generally very threatened in areas with other agricultural activities, due to the destructuring of these forests (Costella et al., 2013; Kliger and Ginzburg, 2022).

In the design of forest plantations, fauna corridors, riparian forests, and a mosaic of different ages and rotation periods must be considered (FSC, 2015; Timo et al., 2015). Plantations can thus ensure landscape management, maintaining or restoring a varied mosaic (sizes, ages, species, etc.) that contributes to the environmental and economic resilience of the activity (FSC, 2015).

Eucalyptus plantations of different ages, and the numerous ecological corridors formed by the APP+RL areas of forest plantings, as well as internal roads and firebreaks (Cravino and Brazeiro, 2021) can be more effective than the measures already mentioned, such as the definition of the maximum allowed size of a fragment, or the minimum distances between plantings, which do not consider the varying adjacent crops (mainly soybeans, rice, and ryegrass) and their impacts. Maintaining the diversity of this mosaic (different planting ages and habitat types, including crops and native grasslands) may help minimize the risk of biodiversity loss, since the mosaic provides suitable conditions for most species (Kneeshaw et al., 2000; Hartley, 2002; Lindenmayer and Hobbs, 2004; Alves et al., 2012; Campos et al., 2018).

At the regional landscape level, on all rural properties, all crops and extensive cattle raising, should conserve their APP+RL (Campos et al., 2018), as imposed by the Brazilian Native Vegetation Protection Law (Brasil, 2012). The extensive cattle raising, often with overgrazing, can be considered one of the main threats to the soil fragility (Roesch et al., 2009), besides the invasion of alien species (Bettega and Trevisan, 2022) of the Pampa biome and its riparian forests (Costella et al., 2013), and the annual crops and their cocktail of poisons.

There is a discussion about the forestry impacts on grasslands, mainly because of soil acidification, salinization, carbon sequestration, water yield (Jobbágy and Jackson, 2004; Farley et al., 2005; Jackson et al., 2005; Berthrong et al., 2012), and biodiversity losses (Carnus et al., 2006; Brockerhoff et al., 2008). That is why the use of the term "green deserts" is so common (Bremer and Farley, 2010; Viani et al., 2010; Pozo and Säumel, 2018; Horák et al., 2019).

The relative abundance of *N. maculosa* does not differ significantly between young plantations and native grasslands in this study, thus questioning the idea of a "green desert". Predators of *N. maculosa* such as hawks and medium-sized mammals (Silveira et al., 1997), certainly also hunt in this habitat (Pinto and Duarte, 2013). Several studies on different groups of fauna also question the claim that silviculture constitutes a "green desert" (Hartley, 2002; Barlow et al., 2008; Brockerhoff et al., 2008; Mazzolli, 2010; Viani et al., 2010; Bonilla-Sánchez et al., 2012; Pinto and Duarte, 2013; Hilgert-Moreira et al., 2014; Timo et al., 2015; Cravino and Brazeiro, 2021).

Conclusion

The main conclusion of this study is that when the landscape spatial-temporal mosaic is considered, the term "green desert" become quite limited. The presence of *N. maculosa* in the early stages (0–1 year) of the plantations, with relative densities like the native grasslands, suggests that another look should be given to this issue. Corroborating this statement, several studies with other animals, vertebrates and invertebrates, point to the need for a broader discussion on biodiversity and forestry. However, this approach strongly depends on good forest management by forestry companies, which must be based on effective public policies, in the seek for the sustainability of this activity.

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References

AGEFLOR, 2020. O setor de base florestal do Rio Grande do Sul 2020: ano base 2019. Associação Gaúcha de Empresas Florestais. 82 p. (Accessed January 3, 2023) at:. http://www.ageflor.com.br/noticias/wp-content/uploads/2020/12/O-Setor-de-Base-Florestal-no-Rio-Grande-do-Sul-2020-ano-base-2019.pdf.

Alves, T.R.; Fonseca, R.C.B.; Engel, V.R., 2012. Mamíferos de médio e grande porte e sua relação com o mosaico de hábitats na *Cuesta* Botucatu, Estado de São Paulo, Brasil. Iheringia, v. 102, (2), 150-158. https://doi.org/10.1590/S0073-47212012000200006.

Barlow, J.; Araujo, I.S.; Overal, W.L.; Gardner, T.A.; Mendes, F.S.; Lake, I.R.; Peres, C.A., 2008. Biodiversity and composition of fruit-feeding butterflies in tropical *Eucalyptus* plantations. Biodiversity and Conservation, v. 17, (5), 1089-1104. https://doi.org/10.1007/s10531-007-9240-0.

Bencke, G.A., 2010. Diversidade e Conservação da Fauna dos Campos do Sul do Brasil. In: Pillar, V.P.; Muller, S.C.; Castilhos, Z.M.S.; Jacques, A.V.A. (Eds.), Campos Sulinos: conservação e uso sustentável da biodiversidade. Ministério do Meio Ambiente, Brasília, pp. 101-121.

Berthrong, S.T.; Piñero, G.; Jobbágy, E.G.; Jackson, R.B., 2012. Soil C and N changes with afforestation of grasslands across gradients of precipitation and plantation age. Ecological Applications, v. 22, (1), 76-86. https://doi.org/10.1890/10-2210.1.

Bettega, R.P.; Trevisan, A.C.D., 2022. Controle da germinação de Capim-anoni (*Eragrostis plana* VEES): inovação com bioinsumos botânicos. Research, Society and Development, v. 11, (17), e267111739142. https://doi.org/10.33448/rsd-v11i17.39142.

Bilenca, D.; Miñarro, F., 2004. Identificación de Áreas Valiosas de Pastizal (AVPs) en las Pampas y Campos de Argentina, Uruguay y de sur de Brasil. Fundación Vida Silvestre. Argentina, Buenos Aires. 353 pp.

Bonilla-Sánchez, Y.M.; Serio-Silva, J.C.; Pozo-Montuy, G.; Chapman, C.A., 2012. Howlers are able to survive in *Eucalyptus* plantations where remnant and regenerating vegetation is available. International Journal of Primatology, v. 33, (1), 233-245. https://doi.org/10.1007/s10764-011-9569-9.

Brasil, 2012. Lei Federal nº 12.651/2012 (Native vegetation protection law). (Accessed December 16, 2022) at:. https://www2.camara.leg.br/legin/fed/lei/2012/lei-12651-25-maio-2012-613076-normaatualizada-pl.pdf.

Bremer, L.L.; Farley, K.A., 2010. Does plantation forestry restore biodiversity or create green deserts? A synthesis of the effects of land-use transition ns on plant species richness. Biodiversity and Conservation, v. 19, (14), 3893-3915. https://doi.org/10.1007/s10531-010-9936-4.

Brockerhoff, E.G.; Jactel, H.; Parrota, J.A.; Quine, C.P.; Sayer, J., 2008. Plantation forest and biodiversity: oxymoron or opportunity? Biodiversity and Conservation, v. 17, (5), 925-951. https://doi.org/10.1007/s10531-008-9380-x.

Bump, G.; Bump, J., 1969. A study of the spotted tinamous and the pale spotted tinamous of Argentina. US Fish and Wildlife Service Special Scientific Report – Wildlife 120, Washington, D.C. 172 pp.

Campos, B.M.; Charters, J.D.; Verdade, L.M., 2018. Diversity and distribution patterns of medium to large mammals in a silvicultural landscape in southeasten Brazil. iForest, v. 11, (6), 802-808. https://doi.org/10.3832/ifor2721-011.

Carnus, J.-M.; Parrota, J.; Brockerhoff, E.; Arbez, M.; Jactel, H.; Kremer, A.; Lamb, D.; O'Hara, K.; Walters, B., 2006. Planted Forest and Biodiversity. Journal of Forestry, v. 104, (2), 65-77. https://doi.org/10.1093/jof/104.2.65.

Carvalho, P.C.F.; Paruelo, J.; Ayala, W., 2008. La intensificación productiva en los pastizales del Río de la Plata: tendencias y consecuencias ecosistémicas. XXII Reunión del Grupo Técnico en Forrajeras del Cono Sur: Grupo Campos: 29-40.

Cordeiro, J.L.P.; Hasecack, H., 2009. Cobertura vegetal atual do Rio Grande do Sul. In: Pillar, V.P.; Muller, S.C.; Castilhos, Z.M.S.; Jacques, A.V.A. (Eds.), Campos Sulinos: conservação e uso sustentável da biodiversidade. Ministério do Meio Ambiente, Brasília, pp. 285-299.

Costella, E.; Garcia, B.A.; Costa, L.S.; Corneleo, N.S.; Schunemann, A.L.; Stefenon, V.M., 2013. Anthropogenic use of gallery in the Brazilian Pampa. Acta Scientiarum, v. 35, (2), 211-217. https://doi.org/10.4025/actascibiolsci.v35i2.13458

Cravino, A.; Brazeiro, A., 2021. Grasslands Afforestation in South America: local scale impacts of Eucalyptus plantations on uruguayan mammals. Forest Ecology and Management, v. 484, 118937. https://doi.org/10.1016/j.foreco.2021.118937.

Crego, R.D.; Macri, I.N., 2009. Una técnica para la estimación de la densidade y el monitoreo de poblaciones de inambú común (*Nothura maculosa*) em ambientes de pastizal. Hornero, v. 24, (1), 31-35.

Farley, K.A.; Jobbágy, E.G.; Jackson, R.B., 2005. Effects of afforestation on water yield: a global synthesis with implications for policy. Global Change Biology, v. 11, (10), 1565-1576. https://doi.org/10.1111/j.1365-2486.2005.01011.x.

Forest Stewardship Council (FSC), 2015. FSC Principles and Criteria for Forest Stewardship. FSC-STD-01-001 V5-2 EN. Forest Stewardship Council, A.C. 32 pp. (Accessed December 26, 2022) at:. https://my.fsc.org/my-en/forest-stewardship/fsc-principles-and-criteria-for-forest-stewardship.

Fundação Estadual de Proteção Ambiental (FEPAM), 2010. Zoneamento Ambiental da Silvicultura: estrutura, metodologia, resultados. (Accessed December 20, 2022) at:. https://fepam.rs.gov.br/zoneamento-ambiental-para-a-atividade-de-silvicultura-no-rs.

Hartley, M.J., 2002. Rationale and methods for conserving biodiversity in plantation forest. Forest Ecology and Management, v. 155, (1-3), 81-95. https://doi.org/10.1016/S0378-1127(01)00549-7.

Hilgert-Moreira, S.B.; Fernandes, M.Z.; Marchett, C.A.; Blochtein, B., 2014. Do different landscapes influence the response of native and non-native bee species in the *Eucalyptus* pollen foraging, in Southern Brazil? Forest Ecology and Management, v. 313, 152-160. https://doi.org/10.1016/j.foreco.2013.10.049.

Horák, J.; Brestovanská, T.; Mladenović, S.; Koutb, J.; Boguschc, P.; Haldac, J.P.; Zasadild, P., 2019. Green desert?: Biodiversity patterns in forest plantations. Forest Ecology and Management, v. 433, 343-348. https://doi.org/10.1016/j.foreco.2018.11.019.

Jackson, R.B.; Jobbágy, E.G.; Avissar, R.; Roy, S.B.; Barrett, D.J.; Cook, C.W.; Farley, K.A.; Maitre, D.C.; McCarl, B.A.; Murray, B.C., 2005. Trading Water for Carbon with Biological Carbon Sequestration. Science, v. 310, (5756), 1944-1947. https://doi.org/10.1126/science.1119282.

Jobbágy, E.G.; Jackson, R.B., 2004. Groundwater use and salinization with grassland afforestation. Global Change Biology, v. 10, (8), 1299-1312. https://doi.org/10.1111/j.1365-2486.2004.00806.x.

Kliger, M.; Ginzburg, R.G., 2022. Effectiveness of the obligation of keeping forest strips for native forest connectivity and conservation in the dry Chaco, Argentina. Forest Systems, v. 31, (3), e017. https://doi.org/10.5424/fs/2022313-18906.

Kneeshaw, D.; Leduc, A.; Drapeau, P.; Gauthier, S.; Paré, D.; Carignan, R.; Doucet, R.; Bouthillier, L.; Messier, C., 2000. Development of integrated ecological standards of sustainable forest management at an operational scale. Forest Chronicle, v. 76, (3), 481-493. https://doi.org/10.5558/tfc76481-3.

Leidinger, J.L.G.; Gossner, M.M.; Weisser, W.W.; Koch, C.; Cayllahua, Z.L.R.; Podgaiski, L.R.; Duarte, M.M.; Araujo, A.S.F.; Overbeck, G.E.; Hermann, J-M.; Kollmann, J.; Meyer, S.T., 2017. Historical and recent land use affects ecosystem functions in subtropical grasslands in Brazil. Ecosphere, v. 8, (12), e02032. https://doi.org/10.1002/ecs2.2032.

Lindenmayer, D.B.; Hobbs, R.J., 2004. Fauna conservation in Australian plantations forests – a review. Biology and Conservation, v. 119, (2), 159-168. https://doi.org/10.1016/j.biocon.2003.10.028.

Lindenmayer, D.B.; Wood, J.T.; Cunningham, R.B.; Crane, M.; Macgregor, C.; Michael, D.; Montague-Drake, R., 2009. Experimental evidence of the effects of a changed matrix on conserving biodiversity within patches of native forest in an industrial plantation landscape. Landscape Ecology, v. 24, (8), 1091-1103. https://doi.org/10.1007/s10980-008-9244-5.

Mazzolli, M., 2010. Mosaics of exotic forest plantation and native forest as habitat of Pumas. Environmental Management, v. 46, (2), 237-253. https://doi.org/10.1007/s00267-010-9528-9.

Menegheti, J.O., 1985. Densidade de *Nothura maculosa* Temminck 1815 (Aves, Tinamidae): variação anual. Iheringia, v. 1, 87-100.

Menegheti, J.O.; Silva, F.; Vieira, M.I.; Bretschneider, D.; Marques, M.I.B., 1981. Spatial and temporal variations of *Nothura maculosa* (Temminck, 1815) from hunting data 1977, in Rio Grande do Sul state, Brazil. Iheringia, v. 58, 23-30.

Pinheiro, R.T.; Lopez, G., 1999. Abundancia del tinamú manchado (*Nothura maculosa*) y del tinamú alirrojo (Rhynchotus rufescens) en una área cinegética del Rio Grande do Sul (Brasil). Ornitología Neotropical, v. 10, 35-41.

Pinto, L.C.; Duarte, M.M., 2013. Occurrence (new record) of maned wolf *Chrysocyon brachyurus* (Illiger, 1815) (Carnivora, Canidae) in southern Brazil. Ciência Florestal, v. 23, (1), 253-259. https://doi.org/10.5902/198050988459.

Pozo, P.; Säumel, I., 2018. How to Bloom the Green Desert: Eucalyptus Plantations and Native Forests in Uruguay beyond Black and White Perspectives. Forest, v. 9, (10), 614. https://doi.org/10.3390/f9100614.

Roesch, L.F.W.; Vieira, F.C.B.; Pereira, V.A.; Schunemann, A.L.; Teixeira, I.F.; Senna, A.J.T., Stefenon, V.M., 2009. The Brazilian Pampa: a Fragile Biome. Diversity, v. 1, (2), 182-198. https://doi.org/10.3390/d1020182.

Sapucci, G.R.; Negri, R.G.; Massi, K.G.; Alcântara, E.H., 2022. *Eucalyptus* plantation benefits to patch size and shape of forested areas in southeast atlantic forest. Revista Árvore, v. 46, e4626. https://doi.org/10.1590/1806-908820220000026.

Silveira, L.; Jácomo, A.T.A.; Rodrigues, F.H.G.; Crawshaw, P.G., 1997. Hunting association between the aplomado falcon (*Falco femoralis*) and the maned wolf (Chrysocyon brachyurus) in Emas National Park, Central Brazil. The Condor, v. 99, (1), 201-202. https://doi.org/10.2307/1370238.

Thompson, J.J.; Carroll, J.P., 2006. Habitat use and survival of the spotted tinamou (*Nothura maculosa*) in agroecosystems in the province of Buenos Aires, Argentina. In: Cederbaum, S.B.; Faircloth, B.C.; Terhune, T.M.; Thompson, J.J.; Carroll, J.P. (eds). Gamebird 2006: Quail IV and Perdix XII. Warnell School of Forestry and Natural Resources. Athens, GA, USA. 111-119 pp.

Timo, T.P.C.; Lyra-Jorge, M.C.; Gheler-Costa, C.; Verdade, L.M., 2015. Effect of the plantation age on the use of Eucalyptus stands by medium to large-sized wild mammals in south-eastern Brazil. iForest, v. 8, (2), 108-113. https://doi.org/10.3832/ifor1237-008.

Viani, R.A.G.; Durigan, G.; Melo, A.C.G., 2010. A regeneração natural sob plantações florestais: desertos verdes ou redutos de biodiversidade? Ciência Florestal, v. 20, (3), 533-552. https://doi.org/10.5902/198050982067.