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**FOREST AMOUNT INFLUENCES ON CARNIVORE  
MAMMAL OCCURRENCE WITHIN BRAZILIAN  
ATLANTIC FOREST**

**DISSERTAÇÃO DE MESTRADO**

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**Santa Maria, RS, Brasil**

**2016**

**FOREST AMOUNT INFLUENCES ON CARNIVORE  
MAMMAL OCCURRENCE WITHIN BRAZILIAN ATLANTIC  
FOREST**

**André Luis Regolin**

Dissertação apresentada ao Curso de Mestrado do Programa de Pós-Graduação em Biodiversidade Animal, da Universidade Federal de Santa Maria (UFSM, RS), como requisito parcial para obtenção do grau de **Mestre em Ciências Biológicas.**

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**FOREST AMOUNT INFLUENCES ON CARNIVORE MAMMAL  
OCCURRENCE WITHIN BRAZILIAN ATLANTIC FOREST**

elaborada por  
**André Luis Regolin**

como requisito parcial para obtenção do grau de  
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"Todo mundo deveria ter um pandeiro..."

Antônio Nóbrega



## **RESUMO**

Dissertação de Mestrado  
Programa de Pós-Graduação em Biodiversidade Animal  
Universidade Federal de Santa Maria

### **INFLUÊNCIA DA QUANTIDADE DE FLORESTA SOBRE A OCORRÊNCIA DE MAMÍFEROS CARNÍVOROS NA MATA ATLÂNTICA BRASILEIRA**

ORIENTADOR: NILTON CARLOS CÁCERES

CO-ORIENTADOR: MILTON CÉZAR RIBEIRO

Local da Defesa: Santa Maria, 18 de fevereiro de 2016.

O processo de fragmentação de habitat é a principal ameaça à conservação de mamíferos terrestres em nível global. Apesar da importância da compreensão do grau de sensibilidade das espécies aos efeitos do processo de fragmentação do habitat, existem poucos trabalhos que buscam avaliar a relação da fragmentação de florestas tropicais com a ocorrência de mamíferos carnívoros. Nós investigamos como as métricas de estrutura da paisagem - quantidade de floresta, densidade de manchas, quantidade de borda, relação perímetro-área e heterogeneidade espacial - afetam a diversidade de mamíferos em múltiplas extensões em 22 paisagens da Mata Atlântica. Nos orientamos pelas seguintes hipóteses: a) a riqueza de carnívoros é relacionada positivamente com a quantidade de floresta; b) a ocorrência das espécies varia de acordo com a sua sensibilidade à perda de floresta e à preferência por florestas ou áreas abertas. Riqueza e composição de espécies foram relacionadas com várias métricas da paisagem. Devido a alta correlação entre as métricas, adotamos a quantidade de floresta como principal variável preditora. Utilizando o método de seleção de modelos (AICc), verificamos que a quantidade de floresta influencia positivamente a riqueza e que as respostas a estrutura da paisagem diferem entre espécies, possivelmente devido as diferenças no uso de habitat. Reiteramos a importância da proteção de remanescentes florestais para a manutenção da alta quantidade de floresta no Neotrópico, particularmente onde as paisagens eram cobertas por florestas.

**Palavras-chave:** armadilha fotográfica, *Cerdocyon thous*, conservation, *Eira barbara*, *Galictis cuja*, fragmentação de habitat, *Leopardus spp.*, *Nasua nasua*, *Puma spp.*, *Procyon cancrivorus*.

## **ABSTRACT**

Master Course Dissertation  
Animal Biodiversity Postgrad Program  
Universidade Federal de Santa Maria

### **FOREST AMOUNT INFLUENCES ON CARNIVORE MAMMALS OCCURRENCE WITHIN BRAZILIAN ATLANTIC FOREST**

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**CO-ADVISER: MILTON CÉZAR RIBEIRO**

**Defense Place and Date: Santa Maria, January 18<sup>nd</sup>, 2016.**

Habitat fragmentation process is the main threat to the conservation of terrestrial mammals at the global level. Despite the importance of understanding the degree which species are sensitive to the effects of habitat fragmentation, there are few studies that assess the relationship between tropical forest fragmentation and the occurrence of carnivore mammals. We investigated how landscape structure — forest amount, patch density, edge amount, perimeter-area ratio and spatial heterogeneity — affects the diversity of carnivore mammals at multiple extents within 22 Atlantic Forest landscapes. We hypothesized that (a) carnivore richness is positively related to forest amount; and (b) the occurrence of species will vary according to its sensitivity to forest loss and its preference for forest or open areas. Species richness and composition were correlated with several landscape structure metrics. Due to a high correlation among the metrics, we adopted forest amount as the principal predictor variable. Using the model selection method (*AICc*), we confirmed that forest amount positively influenced species richness, and we verified that the responses to landscape structure differed among species, possibly due to the differences in their habitat use. Our results reiterate the importance of protecting forest remnants to maintain the high quantity of forest within Neotropics, particularly where originally landscapes was covered by forests.

**Key words:** camera trap, *Cerdocyon thous*, conservation, *Eira barbara*, *Galictis cuja*, habitat fragmentation, *Leopardus* spp., *Nasua nasua*, *Puma* spp., *Procyon cancrivorus*.

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## INTRODUÇÃO

Busco compreender nesta dissertação a influência de características da paisagem sobre a diversidade de mamíferos carnívoros neotropicais em um gradiente de cobertura florestal e em múltiplas extensões de análise da paisagem. Adotei este tema pelo fato da perda de habitat ser a principal ameaçada a mamíferos terrestres (Schipper et al. 2008). A dissertação é composta por um artigo científico intitulado "*Forest amount influences on carnivore mammal occurrence within Brazilian Atlantic Forest*", o qual está formatado para submissão ao periódico *Journal of Mammalogy* (ISSN 0022-2372).

Para esta finalidade, utilizei dados de armadilhamento fotográfico coletados por mim e por colaboradores em unidades de conservação e áreas sujeitas a implantação de empreendimentos dos setores energético e portuário em Santa Catarina e Rio Grande do Sul, no sul da Mata Atlântica brasileira. Apesar das limitações metodológicas impostas pela diferença do desenho amostral entre as áreas de estudo, os dados reunidos contém informações apuradas sobre a ocorrência de espécies de mamíferos carnívoros de médio e grande porte em um conjunto de paisagens que representa um gradiente de perda de cobertura florestal nativa. Busquei analisar a paisagem adotando as métricas que refletem os principais efeitos da perda de habitat (Fahrig 2003, 2013) sobre mamíferos (Virgós et al. 2002; Lyra-Jorge et al. 2010; Brady et al. 2011; Brodie et al. 2015) e considerando a importância das múltiplas extensões espaciais (Boscolo & Metzger 2009; Lyra-Jorge et al. 2010; Jackson & Fahrig 2012, 2014).

Selecionei os carnívoros em virtude de sua importância para o funcionamento dos ecossistemas (Crooks & Soulé 1999; Roemer et al. 2009; Jorge et al. 2013), pela efetividade da fotografia remota em levantar dados sobre espécies deste grupo em ambientes florestais (Tobler et al. 2008; Mccallum 2013) e pelo fato de as respostas dessas espécies quanto às modificações da paisagem ao longo de suas distribuições permanecem pouco exploradas.

1 ARTIGO CIENTÍFICO

2

3 Running heading: Forest amount influences carnivore mammal

4

5 **Forest amount influences on carnivore mammal occurrence within Brazilian Atlantic**

6 **Forest**

7

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34 Key words: camera trap, *Cerdocyon thous*, conservation, *Eira barbara*, *Galictis cuja*, habitat

35 loss, *Leopardus* spp., *Nasua nasua*, *Puma* spp., *Procyon cancrivorus*.

36

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38

### 39 **Abstract**

40 Habitat fragmentation process is the main threat to the conservation of terrestrial mammals at

41 the global level. Despite the importance of understanding the degree which species are

42 sensitive to the effects of habitat fragmentation, there are few studies that assess the

43 relationship between tropical forest fragmentation and the occurrence of carnivore mammals.

44 We investigated how landscape structure — forest amount, patch density, edge

45 amount, perimeter-area ratio and spatial heterogeneity — affects the diversity of carnivore

46 mammals at multiple extents within 22 Atlantic Forest landscapes. We hypothesized that (a)

47 carnivore richness is positively related to forest amount; and (b) the occurrence of species will

48 vary according to its sensitivity to forest loss and its preference for forest or open areas.

49 Species richness and composition were correlated with several landscape structure metrics.

50 Due to a high correlation among the metrics, we adopted forest amount as the principal



51 predictor variable. Using the model selection method (*AICc*), we confirmed that forest amount  
52 positively influenced species richness, and we verified that the responses to landscape  
53 structure differed among species, possibly due to the differences in their habitat use. Our  
54 results reiterate the importance of protecting forest remnants to maintain the high quantity of  
55 forest within Neotropics, particularly where originally landscapes was covered by forests.

56

## 57 **Introduction**

58 Habitat fragmentation process is the main threat to the conservation of terrestrial mammals at  
59 the global level (Schipper et al. 2008). The process modifies the landscape through the loss  
60 and subdivision of habitat, reducing the quantity of available habitat and increasing the  
61 isolation of the patches, the area under edge effect (Fahrig 2003), and the heterogeneity of the  
62 habitat mosaic (Brady et al. 2011). The effects of fragmentation can cause changes in the  
63 richness, composition, abundance, distribution, and genetic diversity of species; these changes  
64 affect a variety of ecological processes (Fahrig 2003; Valiente-Banuet et al. 2015). An  
65 understanding of the degree to which species are sensitive to the effects of habitat  
66 fragmentation is necessary to guide strategies for the conservation of biodiversity and  
67 ecosystem services. Nonetheless, there are few studies that have assessed the relationship  
68 between tropical forest fragmentation and the diversity of carnivorous mammals.

69 For decades, the island biogeography model (MacArthur and Wilson 1967) was adopted to  
70 explain the population and community patterns in remnants of natural areas in terrestrial  
71 ecosystems, which supports the definition of conservation actions such as the planning of  
72 protected areas (Fahrig 2013). In this context, an exaggerated importance was attributed to the  
73 size of, and distance between , patches to explain the patterns of richness, abundance and  
74 occurrence of mammal species (Chiarello 1999; Virgós et al. 2002; Michalski and Peres 2005,  
75 2007; Silva-Jr and Pontes 2008). However, animals are not isolated in habitat patches; rather,

76 they can move through the mosaic of landscape units and can obtain resources in the matrix  
77 (Umetsu et al. 2008; Brady et al. 2011; Magioli et al. 2014). Therefore, the patch must not be  
78 used as the natural unit of measurement (Fahrig 2013). The analysis of the effects of  
79 fragmentation must occur at the landscape level. A landscape can be defined as the area  
80 delimited by distances that are biologically relevant to the sampling point (spatial extents),  
81 and it encompasses areas of different types and proportions, of different habitats (Fahrig  
82 2003, 2013; Jackson and Fahrig 2014).

83 One of the challenges of landscape-level studies is to determine the best spatial extent to be  
84 considered in the analysis (Boscolo and Metzger 2009). Following Jackson and Fahrig (2014),  
85 the spatial extent at which the metrics are measured is fundamental to the correct evaluation  
86 of the relationship between species and landscape. Although the scale of effect — the spatial  
87 extent of analysis at which the relationship is strongest — is theoretically associated with the  
88 biological characteristics of a species, there is still little empirical evidence of this (Jackson  
89 and Fahrig 2012). To deal with this issue, landscape analysis can occur at multiple spatial  
90 extents to define the scale of effect *a posteriori* (Jackson and Fahrig 2012, 2014; Fahrig  
91 2013).

92 In addition to assessing the quantity and disposition of the habitat patches at multiple extents  
93 of the landscape, studies on the effects of habitat fragmentation need to consider the  
94 heterogeneity of altered habitats in the matrix, which generally contains a high proportion of  
95 landscapes dominated by human use (Umetsu et al. 2008). For example, Brady et al. (2011)  
96 verified that attributes of the matrix are more important than patch and landscape variables for  
97 explaining mammal richness in the subtropical southeast of Queensland, Australia. These  
98 authors proposed that, under the evaluated conditions, the matrix should be the primary  
99 measure of isolation because it functions as a filter for dispersion, a source of disturbances by  
100 feral animals and humans, and a supplementary source of resources.

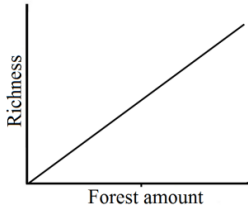
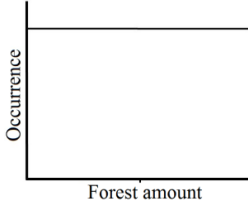
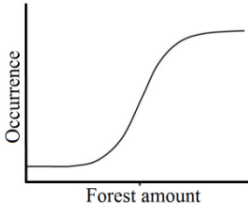
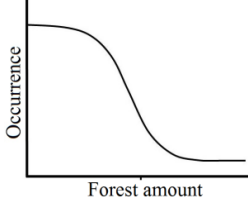
101 Responses to the fragmentation process can vary among species due to the differences in their  
102 use of habitat, in their acquisition of resources, and in their capacity for movement through  
103 the landscape (Virgós et al. 2002). For example, Lyra-Jorge et al. (2010) observed that the  
104 best explanatory models for the frequency of occurrence differed among three carnivore  
105 species in southeastern Brazil. The authors reported that the ocelot (*Leopardus pardalis*)  
106 occurrence was better explained by the quantity of Cerrado woodland ("cerradão") formations  
107 at a narrow extent (250 m). Conversely, they found that the models of edge amount at a wide  
108 extent (2000 m) best explained the occurrences of the mountain lion (*Puma concolor*) and the  
109 maned wolf (*Chrysocyon brachyurus*). Brodie et al. (2015) also ascertained the differences in  
110 mammal responses to the fragmentation of tropical forests in Borneo. In that area, the clouded  
111 leopard *Neofelis diardi*, the Malay civet *Viverra zibetha*, and the leopard cat *Prionailurus*  
112 *bengalensis* composed the group most negatively affected by landscape modifications, as they  
113 were much more abundant in primary forests, where their responses to edge effect differed.  
114 Given that the species' responses can differ according to the structure and composition of the  
115 landscape (Virgós et al. 2002; Lyra-Jorge et al. 2010, Brodie et al. 2015), it is important that  
116 studies on the effect of habitat fragmentation include species-specific approaches.

117 We used carnivore mammals as the study object because this group includes species that are  
118 affected by landscape changes and that perform essential ecosystem functions (Crooks and  
119 Soulé 1999; Roemer et al. 2009; Oliveira et al. 2010; Jorge et al. 2013). Furthermore,  
120 carnivores can be monitored by camera trap, which is an efficient tool to generate data about  
121 species occurrence in forest environments, including those that are elusive and have low  
122 population density (Tobler et al. 2008; Mccallum 2013). Methodological advances that  
123 reduced the cost of camera traps have led to an increase in the number of studies about  
124 carnivore ecology (Mccallum 2013). However, there are gaps of information about the

125 ecology of carnivores in many regions, and the responses of these species to the modification  
126 of the landscape throughout their distributions remain scarcely explored.

127 Although the Atlantic Forest is a hotspot for the conservation of biodiversity (Myers et al.  
128 2000), it has been intensely degraded and currently reduced to 12% of its original vegetation  
129 cover, which is generally distributed in small, isolated remnants (<50 hectares) that are  
130 commonly not protected as Units of Conservation (Ribeiro et al. 2009). Therefore, the  
131 objective of this study was to assess the effects of the process of forest habitat fragmentation  
132 on richness, composition, and occurrence of carnivores in the Atlantic Forest at multiple  
133 extents of landscape analysis. We hypothesized that (a) carnivore richness are positively  
134 correlated to forest amount; and (b) the occurrence of species will vary according to its  
135 sensitivity to forest loss and its preference for forest or open areas. To organize and facilitate  
136 the analyses, we gathered the species into three groups according to expected patterns of  
137 response to forest fragmentation: i) habitat generalist species, ii) forest-preferring species; and  
138 iii) forest species tolerant of habitat degradation. These expected patterns are based on the  
139 knowledge of the species' natural history, available in the scientific literature, and are  
140 presented Table 1.

141 **Table 1.** — Working predictions for carnivore mammals' occurrence and richness by forest amount in 22 landscapes within the southern part of  
 142 the Brazilian Atlantic Forest.

Response variables	References for expected responses	Expected responses	Visual representation
Species richness	Chiarello (1999), Silva-Jr. and Pontes (2008)	Species richness is positively related to forest amount.	
Occurrence of habitat generalist species (group 1) <i>Cerdocyon thous</i> (Linnaeus, 1766) <i>Puma yagouaroundi</i> (Geoffroy, 1803)	Berta (1982), Michalski et al. (2006), Di Bitetti et al. (2009) Oliveira (1998a), Michalski et al. (2006), Giordano (2015)	The occurrences of these species have no relation to the forest amount.	
Occurrence of forest-preferring species (group 2) <i>Leopardus guttulus</i> (Hensel, 1872) <i>Leopardus wiedii</i> (Schinz, 1821) <i>Eira barbara</i> (Linnaeus, 1758) <i>Leopardus pardalis</i> (Linnaeus, 1758)	Goulart et al. (2009) Oliveira et al. (1998b) Presley (2000) Murray and Gardner (1997), Harveson et al. (2004), Goulart et al. (2009)	The probability of occurrence of these species is positively related to forest amount.	
Occurrence of forest species tolerant of habitat degradation (group 3) <i>Galictis cuja</i> (Molina, 1782) <i>Nasua nasua</i> (Linnaeus, 1766) <i>Procyon cancrivorus</i> (Cuvier, 1798)	Yensen and Tarifa (2003) Gompper and Decker (1998), Beisiegel and Mantovani (2006) Emmons and Feer (1997), Cáceres et al. (2007)	The probability of occurrence of these species is negatively related to forest amount.	

## 143 **Material and Methods**

### 144 *Study landscapes*

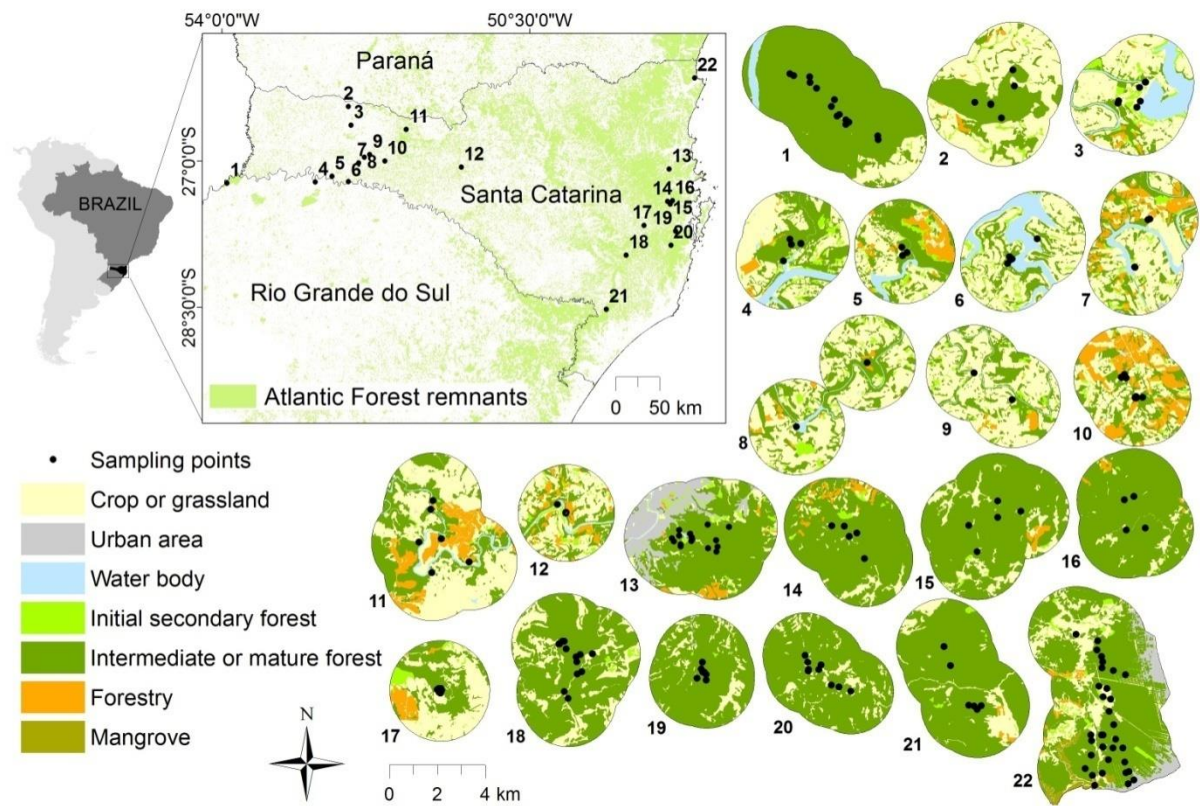
145 The present study took place in 22 landscapes in the states of Santa Catarina and Rio Grande  
146 do Sul, southern Brazil (Figure 1). The study landscapes are situated in the Atlantic Forest  
147 biome (IBGE 2004) and present different degrees of anthropogenic intervention. The amount  
148 of forest cover varies from 19% to 98% among the landscapes, with an average of 61%. Their  
149 vegetation includes remnants of Seasonal Deciduous Forest, Mixed Ombrophilous Forest,  
150 Dense Ombrophilous Forest, and small portions in transition with Natural Fields (Vibrans et  
151 al. 2012; see Supporting Information S1). By virtue of a sampling system with multiple  
152 collection stations in each landscape (see text below), the size of the landscapes varies from  
153 1,256.6 ha to 4,074.4 ha. However, we do not consider this as compromising our analyses,  
154 because the landscape metrics are not influenced by the landscape extents; furthermore, we  
155 explored the effect of the sampling effort on the estimation of species occurrences (see text  
156 below).

157

### 158 *Sampling of the mammals*

159 Sampling of the mammals in all landscapes was accomplished through remote photography.  
160 The samplings occurred in different periods between 2005 and 2012. Camera traps were  
161 installed within forest fragments, positioned on trails and paths used naturally by carnivore  
162 mammals, and affixed to tree trunks at a height of 30–40 cm to maximize the chance of  
163 recording the local fauna. The traps remained operative for 24 hours per day and were  
164 serviced to download the photos and to perform maintenance when necessary. The sampling  
165 effort totaled 10,544 trap-nights, varying between 180 and 910 trap-nights per landscape (see  
166 Supporting Information S2). We verified graphically whether the difference in the sampling  
167 effort between landscapes affected the results of the species occurrence analyzes.

168



169

170 **Figure 1.** — Location of 22 study landscapes and the land use and occupation maps of the

171 areas where carnivore occurrences were recorded, within the southern part of Brazilian

172 Atlantic Forest. Legend: 1) Turvo State Park; 2) Araucárias State Park; 3) Quebra Queixo

173 Hydropower plant; 4, 5, and 6) Foz do Chapecó Hydropower plant; 7) Arvoredo Small

174 Hydropower; 8) Plano Alto Small Hydropower; 9) Alto Irani Small Hydropower; 10)

175 Ipumirim; 11) Passos Maia Small Hydropower; 12) Salto Góes Small Hydropower; 13)

176 Private Natural Reserve (RPPN) Chácara Edith; 14, 15 and 16) RPPN Caraguatá; 17) RPPN

177 Rio das Furnas; 18) RPPN Leão da Montanha; 19 and 20) Serra do Tabuleiro State Park; 21)

178 Aguai State Biological Reserve; 22) Itapoá Port.

179

180 *Landscape metrics at multiple spatial extents*

181 First, we inserted the geographic coordinates of the sample points into a geographic  
182 information system (GIS), using the UTM projection, Zone 22S, Datum WGS 84. Next, we  
183 generated buffers of different sizes around these points to represent the various extents of  
184 analysis. The buffer sizes were 250 m, 500 m, 1000 m, 1500 m and 2000 m, and they  
185 corresponded to similar values that have been used in a previous study that also assessed the  
186 relationship between the landscape variables and the occurrence of medium- and large-size  
187 carnivores (Lyra-Jorge et al. 2010).

188 To calculate the landscape metrics, we performed a photo-interpretation from high-resolution  
189 images available in the applications "Online World Imagery" in the software ArcGIS 10.2.1  
190 (ESRI 2011) and "Google Earth" in the "Open Layer plug-in" in the software QGIS 1.8.0  
191 (QGIS Development Team 2014). We mapped the area of each landscape on a 1:2,500 scale,  
192 covering the largest extent of the analysis, the 2000 m buffer. The source of the images for  
193 each landscape was selected based on the quality and the date of the images. We mapped the  
194 vegetation cover, land use and land occupation according to the following classes: (i) water  
195 bodies; (ii) urban and construction areas; (iii) silviculture; (iv) field, pasture, agriculture and  
196 exposed soil; (v) mangrove forest; (vi) forest in initial stage; (vii) forest in medium, advanced  
197 or primary stage. We converted the entry maps into the matrix format before calculating the  
198 metrics. We calculated the landscape metrics at multiple spatial extents, using the software  
199 GRASS 6.4.3 (GRASS Development Team 2014) and some functions in ArcGIS 10.2.1  
200 (ESRI 2011); in both cases, we used scripts in the Python language. For each landscape and  
201 spatial extent, we calculated the following metrics: forest amount (area of forest in medium,  
202 advanced or primary stage, in ha, divided by the landscape area); edge amount (area of edge,  
203 in ha, considering a depth of 50 m, divided by the landscape area); patch density (relationship  
204 between the number of patches and the area of the landscape); perimeter-area ratio



205 (relationship between the perimeter of the forest edge and the relative area of forest); and the  
206 Simpson diversity index for landscape.

207

### 208 *Data analysis*

209 First, we checked for spatial autocorrelation between our data through the Mantel test (Dale  
210 and Fortin 2005). The results ( $r=0.068$ ;  $P=0.17$ ) showed no spatial autocorrelation between  
211 the occurrence of mammals and the spatial location of the centroids of our 22 landscapes.

212 Next, we checked for multicollinearity of the predictor variables through the Pearson's  
213 correlation test, finding a high correlation between the five extents for all of the landscape  
214 metrics (see Supporting Information S3, S4, S5, S6 and S7). We then selected from each  
215 metric the extent that best represented a gradient (the extent with the most homogeneous  
216 frequency distribution): 500 m for heterogeneity; 1000 m for the relative amount of forest;  
217 2000 m for the relative area of edge; 2000 m for the perimeter-area ratio; and 2000 m for  
218 patch density. We used the Pearson's correlation analysis to assess the correlation between  
219 these five metrics in their respective spatial extents. We found a high correlation among them  
220 (see Supporting Information S8), and based on Fahrig (2013), we selected the 'forest amount'  
221 metric as the principal measure of the forest habitat fragmentation process.

222 Subsequently, we adopted a redundancy analysis (RDA) to check whether the species  
223 composition is explained by the landscape variables (Borcard et al. 2011; Legendre and  
224 Legendre 2012).

225 Finally, we used generalized linear models (GLM) to relate the carnivore species richness and  
226 the occurrence of each species to the relative amount of forest in the landscape. We adopted a  
227 normal distribution for richness and a binomial distribution for occurrence (Zuur et al. 2009).

228 For each response variables (species richness or occurrence of each species), we contrasted  
229 the model  $Y \sim \text{forest amount (\%)}$  against the null model (representing the absence of effect).

230 Corrected Akaike Information Criterion (*AICc*) values were used to select the best models.  
 231 We considered all models with  $\Delta AIC < 2$  to be equally plausible (Burnham and Anderson  
 232 2002). We reported the *AICc* weights (*wAICc*) for both the ‘forest amount’ and the null  
 233 models. We used the software R version 3.1.1 for the analyses (R Development Team 2014).

234

## 235 **Results**

### 236 *Species richness and forest amount*

237 The results partially corroborate our predictions (Table 2). We recorded 10 terrestrial  
 238 carnivore mammal species associated with forest formations in the 22 studied Atlantic Forest  
 239 landscapes. We did not analyze the jaguar [*Panthera onca* (Linnaeus, 1758)] records, because  
 240 it was detected only in the Turvo State Park landscape. We confirmed that the carnivore  
 241 species richness is positively related to the forest amount of the 22 studied landscapes (Table  
 242 3, Figure 2).

243

244 **Table 2.** — Comparison between expected responses and responses obtained from the  
 245 analyzes to explain the species richness and the carnivore occurrence in 22 landscapes within  
 246 the southern part of the Brazilian Atlantic Forest.

Response variables	Expected responses	Obtained responses
Species richness	positive	positive
Species occurrence		
Habitat generalist species (group 1)		
<i>Cerdocyon thous</i> (Linnaeus, 1766)	null	null
<i>Puma yagouaroundi</i> (Geoffroy, 1803)	null	null
Forest-preferring species (group 2)		
<i>Leopardus guttulus</i> (Hensel, 1872)	positive	null
<i>Leopardus wiedii</i> (Schinz, 1821)	positive	null
<i>Eira barbara</i> (Linnaeus, 1758)	positive	null
<i>Leopardus pardalis</i> (Linnaeus, 1758)	positive	positive

Response variables	Expected responses	Obtained responses
<i>Puma concolor</i> (Linnaeus, 1771)	positive	positive
Forest species tolerant to habitat degradation (group 3)		
<i>Galictis cuja</i> (Molina, 1782)	negative	negative
<i>Nasua nasua</i> (Linnaeus, 1766)	negative	null
<i>Procyon cancrivorus</i> (Cuvier, 1798)	negative	null

247

248 **Table 3.** — Eleven pairs of concurrent models analyzed to explain the species richness and  
 249 the carnivore occurrence in 22 landscapes within the southern part of the Brazilian Atlantic  
 250 Forest.

Response variables	Model*	$AIC_c^{**}$	$\Delta AIC_c$	$DF^{***}$	$wAIC_c^{****}$
Richness	Forest amount	80.1	0.0	3	0.82
	Null	83.2	3.1	2	0.18
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Null	19.7	0.0	1	0.72
	Forest amount	21.7	1.9	2	0.28
<i>Puma yagouaroundi</i> (Geoffroy, 1803)	Null	25.8	0.0	1	0.77
	Forest amount	28.2	2.4	2	0.23
<i>Leopardus guttulus</i> (Hensel, 1872)	Null	23.1	0.0	1	0.77
	Forest amount	25.4	2.4	2	0.23
<i>Leopardus wiedii</i> (Schinz, 1821)	Null	25.8	0.0	1	0.59
	Forest amount	26.5	0.7	2	0.41
<i>Eira barbara</i> (Linnaeus, 1758)	Forest amount	29.5	0.0	2	0.68
	Null	31.0	1.5	1	0.32
<i>Leopardus pardalis</i> (Linnaeus, 1758)	Forest amount	12.8	0.0	2	1.00
	Null	25.8	12.9	1	0.00
<i>Puma concolor</i> (Linnaeus, 1771)	Forest amount	23.0	0.0	2	0.80
	Null	25.8	2.8	1	0.20
<i>Galictis cuja</i> (Molina, 1782)	Forest amount	28.1	0.0	2	0.90
	Null	32.5	4.4	1	0.10
<i>Nasua nasua</i> (Linnaeus, 1766)	Null	23.1	0.0	1	0.69
	Forest amount	24.7	1.6	2	0.31
<i>Procyon cancrivorus</i> (Cuvier, 1798)	Null	25.8	0.0	1	0.76
	Forest amount	28.1	2.3	2	0.24

251 \*Null model –relates the species occurrence or species richness with a random value. Forest

252 amount–relates the species occurrence or species richness with the relative amount of forest in

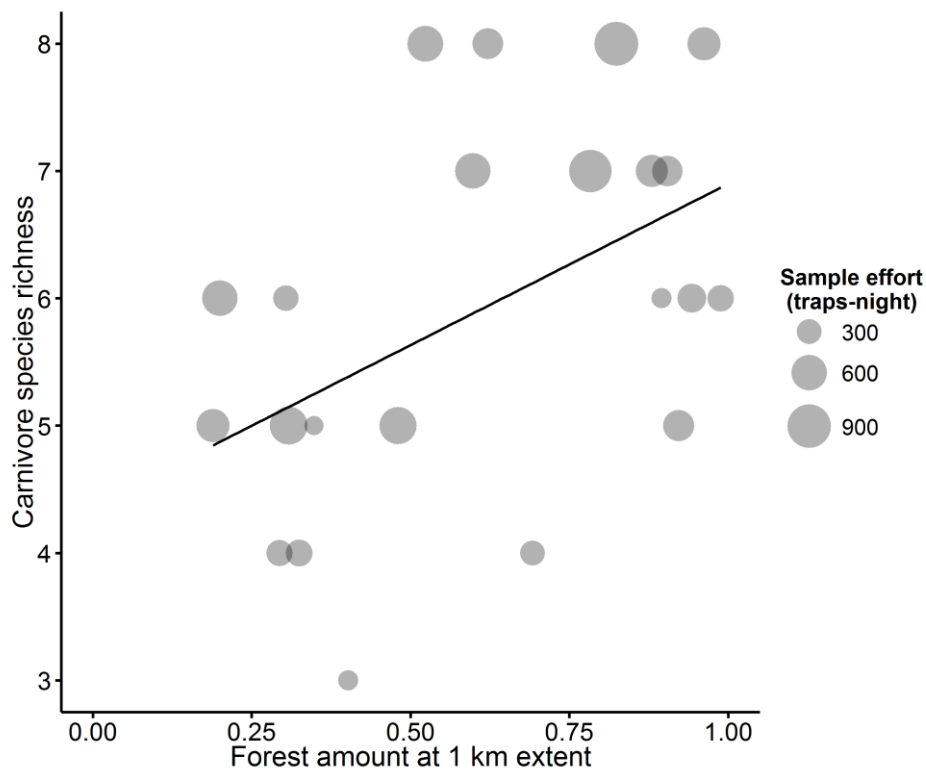
253 the landscape.

254 \*\*Corrected Akaike Information Criterion

255 \*\*\*Degrees of freedom

256 \*\*\**AICc* weight

257



258

259 **Figure 2.** — Linear relation between carnivore species richness and a gradient of forest

260 amount (%) at the 1 km extent for 22 landscapes in the southern part of the Brazilian Atlantic

261 Forest.

262

263 *Carnivores species composition and landscape metrics*

264 The RDA demonstrated a relationship between species composition and the landscape

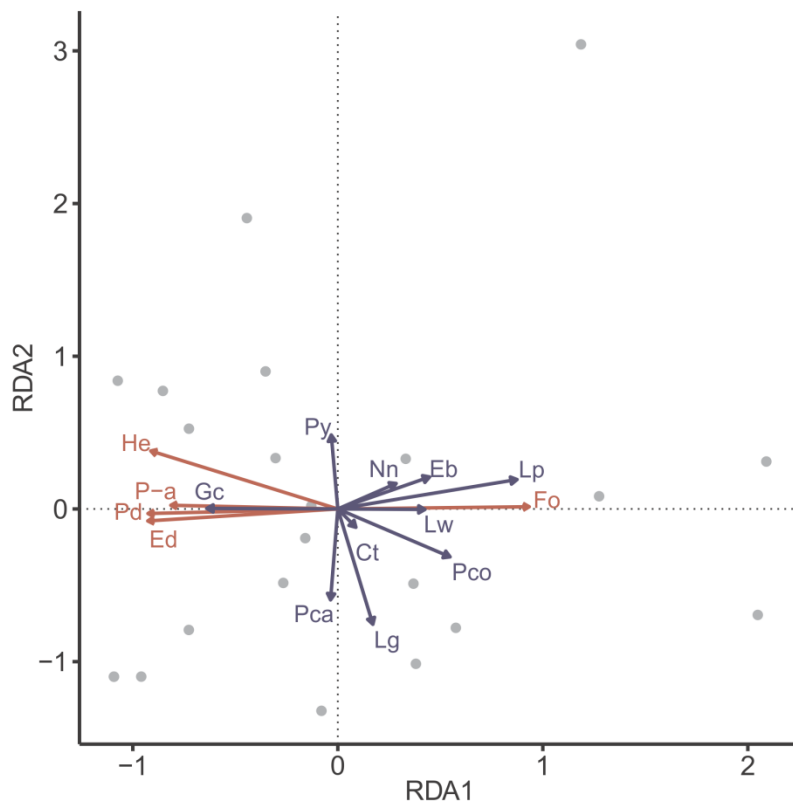
265 structure metrics ( $R^2 = 0.34$ ;  $P < 0.001$ ). The relationships observed in the RDA (Figure 3) are

266 explained mainly by the *RDA 1* axis (39.9%), which represents the amount of forest on the

267 landscapes. The *RDA 2* axis, with a lower contribution (28.0%), is best explained by the

268 landscape heterogeneity.

269 The analysis of the first axis (*RDA 1*) indicates a strong relationship of *Leopardus pardalis*  
 270 (Linnaeus, 1758) and *Puma concolor* (Linnaeus, 1771) to highly forested landscapes.  
 271 *Leopardus wiedii* (Schinz, 1821) was slightly associated to forest amount. On the other hand,  
 272 *Galictis cuja* (Molina, 1782) mainly occupies fragmented landscapes.  
 273 The analysis of the second axis (*RDA 2*) suggests that *Puma yagouaroundi* (Geoffroy, 1803)  
 274 tends to occur in heterogeneous landscapes while *Procyon cancrivorus* (Cuvier, 1798) and  
 275 *Leopardus guttulus* (Hensel, 1872) are associated with landscape with lower heterogeneity, as  
 276 also observed to *P. concolor*. Finally, the *RDA 2* reveals that *Nasua nasua* (Linnaeus, 1766),  
 277 *Eira barbara* (Linnaeus, 1758), and *Cerdocyon thous* (Linnaeus, 1766) is very weakly related  
 278 to both axes and, therefore, does not present an strong association with the landscape  
 279 variables.  
 280



281  
 282 **Figure 3.** — Redundancy analysis diagram of carnivore occurrence and landscape metrics.  
 283 Legends to species: *Ct* — *Cerdocyon thous*, *Py* — *Puma yagouaroundi*, *Pco* — *Puma*

284 *concolor*, *Lg* — *Leopardus guttulus*, *Lw* — *Leopardus wiedii*, *Lp* — *Leopardus pardalis*, *Eb*  
285 — *Eira barbara*, *Gc* — *Galictis cuja*, *Nn* — *Nasua nasua*, and *Pca* — *Procyon cancrivorus*.

286 Legends to landscape metrics: *He* — Simpson Heterogeneity Index, *P-a* — Perimeter-area  
287 ratio, *Pd* — Patch density, *Ed* — Edge amount, and *Fo* — Forest amount.

288

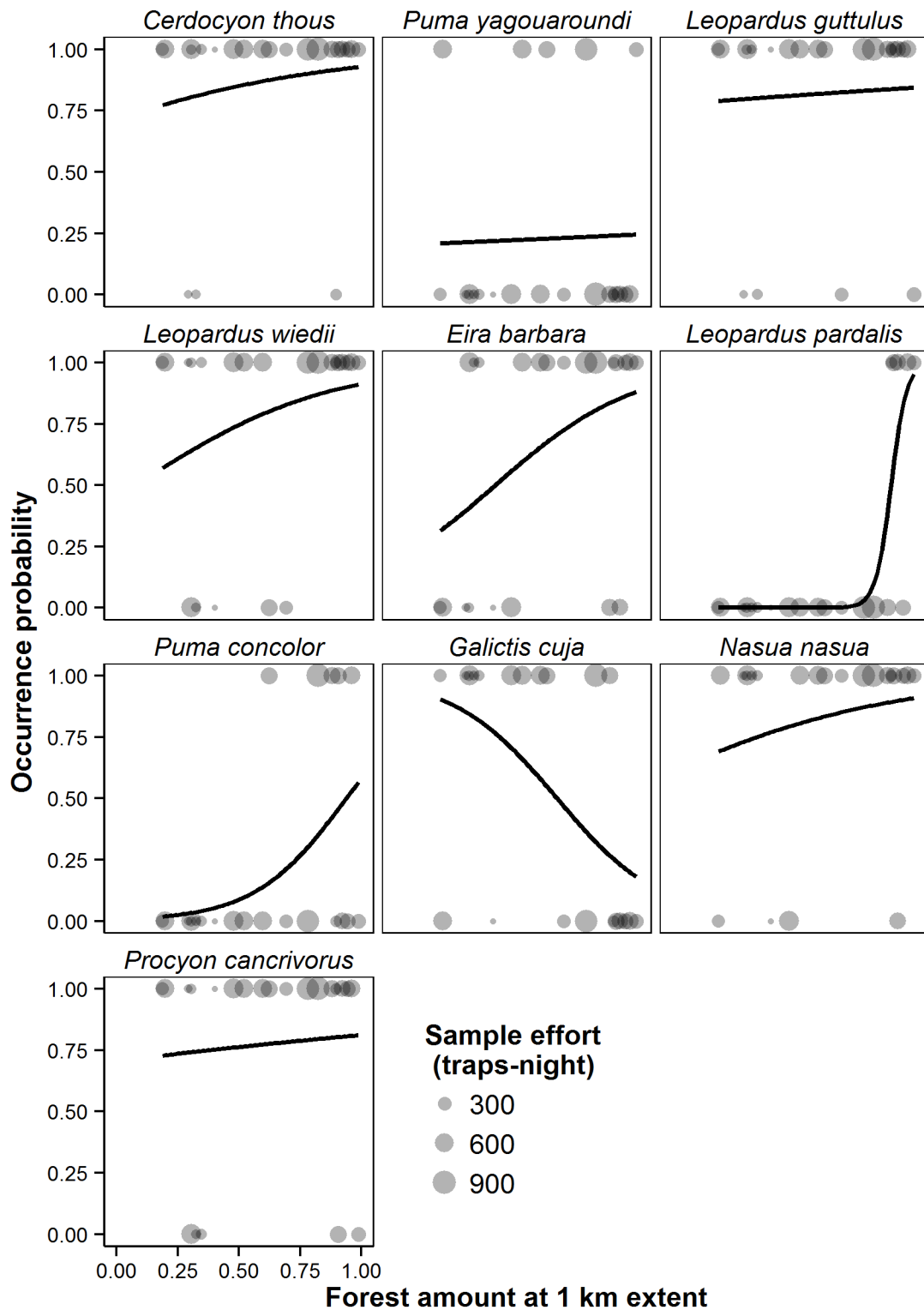
289 *Occurrence of carnivore species and forest amount*

290 The pattern of occurrence as a function of the forest amount on the landscape differed among  
291 the 10 analyzed species, as verified by the GLM. As predicted, we found that forest amount  
292 did not contributed to the occurrence of the habitat generalist species (group 1), *C. thous* and  
293 *P. yagouaroundi* (Table 3, Figure 4).

294 With respect to the forest-preffering species (group 2), we determined that the occurrences of  
295 the small felines, *L. guttulus* and *L. wiedii*, and of the tayra, *E. barbara*, are explained as  
296 much by the ‘forest amount’ model as by the null model (Table 3, Figure 4), which suggests  
297 that the occurrence of these species is independent of the amount of forest on the studied  
298 landscapes. On the other hand, the large felines, *L. pardalis* and *P. concolor*, mainly occupied  
299 landscapes with a high percentage of forest cover (Table 3, Figure 4).

300 With reference to forest species that are tolerant of habitat degradation (group 3), we  
301 ascertained that the occurrence of *G. cuja* is negatively related to the forest amount (Table 3,  
302 Figure 4). Finally, both of the Procyonidae, *N. nasua* and *P. cancrivorus*, demonstrate an  
303 occurrence that is unrelated to the forest amount on the landscape (Table 3, Figure 4), ‘forest  
304 amount’ models and the null models being equally plausible to explain the patterns.

305



306

307 **Figure 4.** — Logistic regression plots of ten carnivore species' occurrences across a gradient  
 308 of forest amount (%) at the 1 km extent for 22 landscapes in the southern part of the Brazilian  
 309 Atlantic Forest.

310

311 **Discussion**312 *Species richness and forest amount*

313 We observed a positive influence of the forest amount on the richness of carnivore species in  
314 the Atlantic Forest, which reinforces the "Habitat amount hypothesis" proposed by Fahrig  
315 (2013). According with Fahrig (2003, 2013), the analysis of the effect of fragmentation must  
316 occur at the landscape-level, avoiding the use of the patch as the natural unit of measure and  
317 thus weakening the power of patch size to explain species richness on medium- and large-size  
318 mammals (as seen in Chiarello 1999; Virgós et al. 2002; Michalski and Peres 2005, 2007;  
319 Silva-Jr and Pontes 2008). Recent landscape-level studies have revealed the important  
320 influence of other landscape elements on the richness of medium- and large-size mammal  
321 species. For example, Lyra-Jorge et al. (2010) showed that species richness is affected mainly  
322 by the area of the landscape under the influence of edge effects in areas of Cerrado in  
323 southeastern Brazil. Brady et al. (2011) revealed the relevance of matrix attributes to explain  
324 the richness of mammal species in the subtropical southeast of Queensland, Australia.

325

326 *Occurrence of carnivore species and forest amount*

327 In agreement with our predictions, the occurrences of *C. thous* and *P. yagouaroundi* (group 1  
328 — habitat generalist species) are not related to the amount of forest on the landscape. This is  
329 due to the fact that both species are generalists in terms of their use of habitat (Berta 1982;  
330 Oliveira 1998a; Michalski et al. 2006; Di Bitetti et al. 2009).

331 The GLM did not reveal a relationship between the occurrences of *L. guttulus* and *L. wiedii*  
332 (group 2 — forest-preferring species) and the forest amount, contrary to our predictions.

333 Although *L. guttulus* can occur in areas of predominantly open vegetation such as restinga  
334 (Tortato and Oliveira 2005), Goulart et al. (2009) suggested that this species is associated



335 with dense forest vegetation. For *L. wiedii*, we expected greater dependence on forest cover,  
336 given that it is considered essentially a forest species, though not exclusively (Oliveira  
337 1998b). Nonetheless, our results corroborates a study demonstrating that *L. guttulus* and *L.*  
338 *wiedii* forage in agricultural matrices (corn and/or soybean crops) of Atlantic Forest  
339 landscapes (Rinaldi et al. 2015). When examining the diets of these species, the authors found  
340 the occurrence of synanthropic prey in 44% of the fecal samples of *L. guttulus* and in 32% of  
341 those for *L. wiedii*. These findings by Rinaldi et al. (2015), together with our results show the  
342 necessity of investigating the natural history of these small felines, particularly with respect to  
343 habitat use.

344 Contradicting our predictions, *E. barbara* (group 2 — forest-preferring species) showed a  
345 tolerance for forest fragmentation. Despite the proposal by Presley (2000) that *E. barbara* is  
346 rarely found outside of forest environments, Michalski et al. (2006) reported that a tayra  
347 monitored by radio-tracking did not show a preference for any habitat type available within its  
348 home range in southeastern Brazil. This species was also observed in highly disturbed and  
349 fragmented forest landscapes of southern and eastern Brazilian Amazonia (Michalski and  
350 Peres 2005). The pattern found by the last authors possibly explains the results we found in  
351 this study for *E. barbara*.

352 The occurrence of *L. pardalis* (group 2 — forest-preferring species) is limited to landscapes  
353 with a high percentage of forest cover. This result corroborates our prediction for the  
354 occurrence of this species, which mainly occupies densely forested areas (Murray and  
355 Gardner 1997, Goulart et al. 2009). Patterns similar to those we identified in the Atlantic  
356 Forest were found through radio telemetry in Texas, where *L. pardalis* almost exclusively  
357 chose areas with high forest cover (>95%) (Harveson et al. 2004). Lyra-Jorge et al. (2010)  
358 found that the frequency of *L. pardalis* explained by the amount of "cerradão" woodland in

359 southeastern Brazil. Thus, we verified that *L. pardalis* is highly sensitive to the loss of forest  
360 cover in the Atlantic Forest.

361 Regarding *P. concolor* (group 2 — forest-preferring species), despite the indication of low  
362 habitat selectivity (Lyra-Jorge et al. 2010; Magioli et al. 2014), we observed that its  
363 occurrence is strongly associated with forest cover in the Atlantic Forest landscapes of  
364 southern Brazil, as previously determined by Mazzolli (1993). This is possibly due to the  
365 pressure of illegal hunting on the species in non-protected areas (with lower percentage of  
366 forest cover) by ranchers who seek to minimize the damages this species causes to livestock  
367 production (Mazzolli et al. 2000).

368 *Galictis cuja*'s (group 3 — forest species tolerant of habitat degradation) occurrence in  
369 relation to forest fragmentation is in agreement with our prediction. As a species that can  
370 inhabit open areas (Yensen and Tarifa 2003) and the edges of forest formations, the  
371 probability of its occurrence diminishes as a function of the increment of forest on the  
372 landscape.

373 The patterns of occurrence observed for *N. nasua* and *P. cancrivorus* (group 3 — forest  
374 species tolerant of habitat degradation) contradict our predictions, since the GLM reveals an  
375 absence of relationship between these species' occurrences and the amount of forest on the  
376 landscape. Although *N. nasua* is a species that occupies mainly forested areas (Gompper and  
377 Decker 1998) and that forages predominantly in the canopy (Beisiegel and Mantovani 2006),  
378 it can also obtain resources in cultivated, degraded and urbanized areas surrounding forest  
379 fragments, which likely explains the pattern that we found. The relationship between the  
380 occurrence of *P. cancrivorus* and forest patch density is justified by its selectivity in terms of  
381 habitat use—its occurrence is commonly associated with water courses, where they catch  
382 their prey—and it rarely occupies the deep forest interior (Emmons and Feer 1997). The

383 forest patches where we recorded *P. cancrivorus* were associated with water courses and  
384 represent the ideal conditions for its occupation.

385 It is important to mention that the sampled landscapes consisted of more than 19% forest  
386 cover. Consequently, for cases where we found an absence of relationship between species  
387 occurrence and forest amount (*i.e.* when the null model is more or equally plausible compared  
388 to the model  $Y \sim$  forest amount), minimum limit of 19% forest cover may be above the  
389 fragmentation threshold for the analyzed species.

390

### 391 *Landscape changes, carnivore species composition and ecological consequences*

392 Except for Turvo State Park, all of the studied landscapes are possible subject to the effects of  
393 trophic cascade caused by the absence of the primary apex predator of the Atlantic Forest, the  
394 jaguar (*P. onca*), as proposed by Jorge et al. (2013). The condition of apex predator absence is  
395 aggravated by the fact that *P. concolor* and *L. pardalis* — second and third largest predators,  
396 respectively, in terms of biomass (Paglia et al. 2012) — are absent from a majority of the  
397 studied landscapes. Under these conditions, we can expect an increase in the abundance of  
398 herbivores and a consequent increase in the rate of herbivory, which affects plant  
399 communities (Roemer et al. 2009). For example, Chiarello (1999) found an elevated  
400 abundance of herbivores in landscapes with low forest cover in southeastern Brazil. The  
401 negative consequences of the increase in herbivore abundance can be even more grievous in  
402 the case of invasive exotic species, the main ones in the region being the wild boar (*Sus scrofa*  
403 Linnaeus, 1758) and the hare (*Lepus europaeus* Pallas, 1778). In addition to herbivory,  
404 invasive exotic species can negatively affect native animal species through competition and  
405 the transmission of diseases and parasites (Mack et al. 2000).

406 Furthermore, we determined that seven mesocarnivore species (*C. thous*, *P. yagouaroundi*, *L.*  
407 *guttulus*, *L. wiedii*, *E. barbara*, *N. nasua* and *P. cancrivorus*) occur in landscapes with varying

408 degrees of fragmentation and, therefore, occupy the majority of landscapes free from the  
409 direct and/or indirect influence of apex and/or top predators. Under these conditions, it is  
410 expected that mesocarnivores compound the potential negative effects of increased herbivore  
411 abundance, as they exert a strong influence on the dynamics and structure of the communities  
412 of their main prey (Crooks and Soulé 1999, Oliveira et al. 2010), which includes small  
413 mammals, birds and reptiles. The impacts on these prey may cause the local extinction of  
414 species and the loss of their ecological functions (Roemer et al. 2009).

415

#### 416 *Conclusion*

417 We verified that (a) carnivore species richness is positively related to forest amount and  
418 negatively associated to fragmentation, (b) landscape configuration is important for explain  
419 carnivore species composition, and (c) forest amount can explain some carnivore species  
420 occurrence. Our results reiterate the importance of protecting forest remnants to maintain the  
421 high quantity of forest within Neotropics, particularly where originally landscapes was  
422 covered by forests. This action is fundamental for the conservation of carnivore species,  
423 ecosystems, and the ecological processes in which they participate. We also recognize the  
424 importance of complementary actions, such as the restoration of degraded areas and livestock  
425 management aimed at reducing hutting as retaliation for livestock predation (*e.g.* Mazzolli et  
426 al. 2000).

427 Additionally we suggest that future researches could analyze landscape in larger spatial  
428 extensions for better understand the scale effect. Furthermore, they could include landscapes  
429 with very small percentage of forest cover (*i.e.* <20%), aiming to explore all gradient of forest  
430 loss. In respect of the animal database, its import for upcoming works to adopt a standardized  
431 sample design, and to analyze data through models that incorporate the imperfect detection,  
432 *e.g.* MacKenzie et al. (2002). Finally, is necessary more details about habitat use by the

433 species to assessment the consequences of fragmentation on biodiversity, ecological processes  
434 and ecosystem services.

435

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445

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588 **Supporting Information**

589 **Supporting Information S1.** — Vegetation type, centroid geographic coordinates (UTM Zone 22S, datum WGS84), and landscape metrics of  
 590 the study areas. Legend: 1) TurvoState Park; 2) AraucáriasState Park; 3) QuebraQueixo Hydropower plant; 4, 5, and 6) Foz do Chapecó  
 591 Hydropower plant; 7) Arvoredo Small Hydropower; 8) Plano Alto Small Hydropower; 9) Alto Irani Small Hydropower; 10) Ipumirim; 11)  
 592 Passos Maia Small Hydropower; 12) Salto Góes Small Hydropower; 13) Private Natural Reserve (RPPN) Chácara Edith; 14, 15and 16) RPPN  
 593 Caraguatá; 17) RPPN Rio das Furnas; 18) RPPN Leão da Montanha; 19 and 20) Serra do TabuleiroState Park; 21) AguaíState Biological  
 594 Reserve;22) Itapoá Port. DF - Deciduous Forest; MOF - Mixed Ombrophilous Forest, DOF - Dense Ombrophilous Forest; NF - Natural Fields.

Code	Area	Longitude	Latitude	Vegetation type	Landscapearea (ha)	Forest amount	Edge amount	Patch density	Perimeter- area ratio	Heterogeneity
1	PET	204632	6984513	DF	3235.4	0.988	0.39	4.60E-07	0.004	0.499
2	PEA	342891	7071760	DF/MOF	2473.4	0.598	4.38	2.97E-06	0.077	0.499
3	QQ	345870	7050390	DF/MOF	1977.3	0.200	10.02	9.11E-06	0.443	0.696
4	FZ3	305248	6985635	DF/MOF	1771.4	0.308	10.57	7.25E-06	0.460	0.674
5	FZ2	324093	6992101	DF/MOF	1438.3	0.480	8.15	9.84E-06	0.171	0.652
6	FZ1	342830	6986312	DF/MOF	1919.8	0.523	9.23	7.63E-06	0.192	0.616
7	ARV	354587	7007473	DF/MOF	2078.3	0.189	9.09	1.46E-05	0.559	0.655

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8	AI	361167	7013980	DF/MOF	2513.2	0.402	9.91	8.59E-06	0.360	0.560
9	PA	367382	7016804	DF/MOF	2002.0	0.304	11.40	1.09E-05	0.507	0.512
10	IPU	384558	7009381	DF/MOF	1821.3	0.348	10.72	9.17E-06	0.414	0.669
11	PPM	409132	7045771	DF/MOF/NF	3046.7	0.325	7.28	7.66E-06	0.276	0.669
12	PSG	471906	7002660	DF/MOF	1277.5	0.294	13.33	9.24E-06	0.550	0.731
13	CE	709185	7000667	DOF	2576.4	0.783	4.44	2.87E-06	0.058	0.364
14	CA1	707501	6963624	DOF/MOF	2129.8	0.922	2.73	9.24E-07	0.030	0.147
15	CA2	710230	6960353	DOF/MOF	2659.4	0.904	2.83	6.70E-07	0.032	0.174
16	CA3	712830	6964595	DOF/MOF	2100.5	0.962	2.29	1.32E-07	0.024	0.073
17	RF	680596	6936370	DOF/MOF	1374.9	0.622	8.19	2.94E-06	0.150	0.474
18	LM	659963	6902205	MOF/NF	2599.3	0.824	5.77	1.66E-06	0.075	0.292
19	TH	716277	6929478	DOF/MOF	1645.9	0.943	3.00	9.71E-07	0.033	0.107
20	TSB	711092	6913605	DOF/MOF	2483.5	0.880	4.25	4.23E-07	0.051	0.211
21	RA	637469	6840735	DOF	2513.8	0.895	2.49	5.55E-07	0.029	0.188
22	PI	738128	7104411	DOF	4074.4	0.692	6.67	8.73E-06	0.102	0.480

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596 **Supporting Information S2.** — Sampling details of mammals in the 22 studied landscapes.

Code	Area	Trap model	# sampling points	Sampling effort (trap-nights)	Period	Mean distance between traps (meters)
1	PET	Tigrinus 6.0D	14	336	May 2009–Nov 2009	1,748
2	PEA	Tigrinus 6.0C	6	606	Apr 2006–Oct 2007	1,204
3	QQ	Tigrinus 6.0C	8	600	Apr 2006–Oct 2007 and Feb 2012–Oct 2012	832
4	FZ3	Tigrinus 6.0C	6	681	Jan 2008–Mar 2010	590
5	FZ2	Tigrinus 6.0C	3	661	Jan 2008–Mar 2010	297
6	FZ1	Tigrinus 6.0C	5	615	Jan 2008–Mar 2010	581
7	ARV	Tigrinus 6.0C	4	529	Mar 2009–Nov 2009 and May 2011–Aug 2011	1,401
8	AI	Tigrinus 6.0C	2	196	Mar 2009–May 2009 and Aug 2009–Oct 2009	3,965
9	PA	Tigrinus 6.0C	2	317	Jan 2009–Nov 2009 and Sep–Oct/2009	1,943

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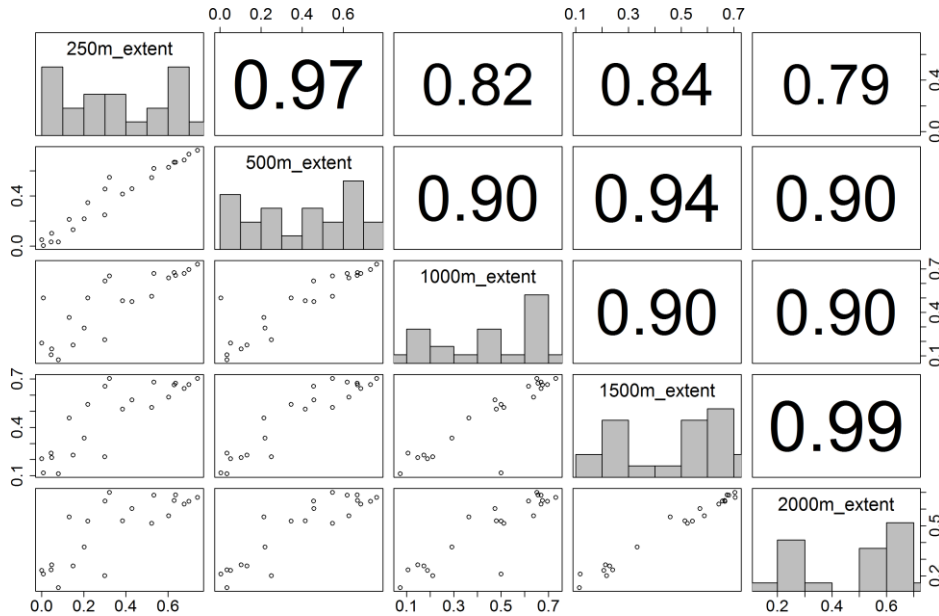
10	IPU	Tigrinus 6.0D	11	180	Oct 2010–Jul 2011	618
11	PPM	Tigrinus 6.0C	6	345	Jun 2010–Feb 2012	1,804
12	PSG	Tigrinus 6.0C	3	333	Sep 2010–Nov 2012	266
13	CE	Tigrinus 6.0C	16	862	Aug 2008–Jun 2010	1,008
14	CA1	Tigrinus 6.0C	5	467	Aug2005–Dec 2006	966
15	CA2	Tigrinus 6.0C	5	444	Aug 2005–Dec 2006	1,533
16	CA3	Tigrinus 6.0C	4	523	Aug 2005–Dec 2006	1,130
17	RF	Bushnell HD	11	455	May 2011–Jul 2013	116
18	LM	Bushnell HD	13	910	Sep 2006–Oct2007	1,088
10	TH	Tigrinus 6.0C	7	401	Nov 2005–Jul 2006	362
20	TSB	Tigrinus 6.0C	9	495	Jan 2005–Nov 2006	1,150
21	RA	Tigrinus 6.0D	6	200	Mar 2007–Apr 2008	1,468
22	PI	Bushnell HD	35	298	Dec 2010–Aug 2011	2,390

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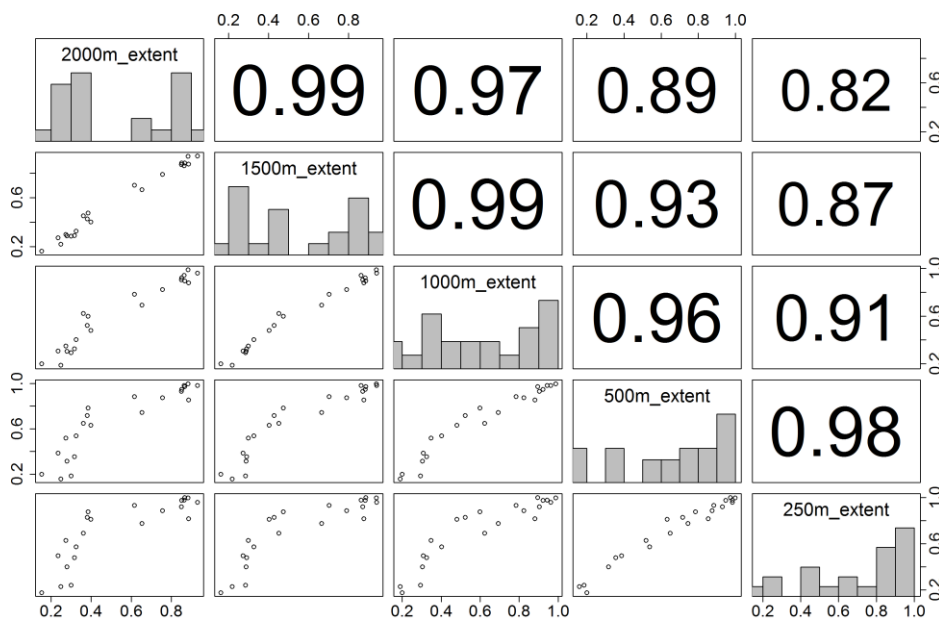
599 **Supporting Information S3.** — Scatter plot matrices of the correlation of Simpson landscape  
 600 heterogeneity index among five extents.



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603 **Supporting Information S4.** — Scatter plot matrices of the correlation of forest amount  
 604 among five extents.

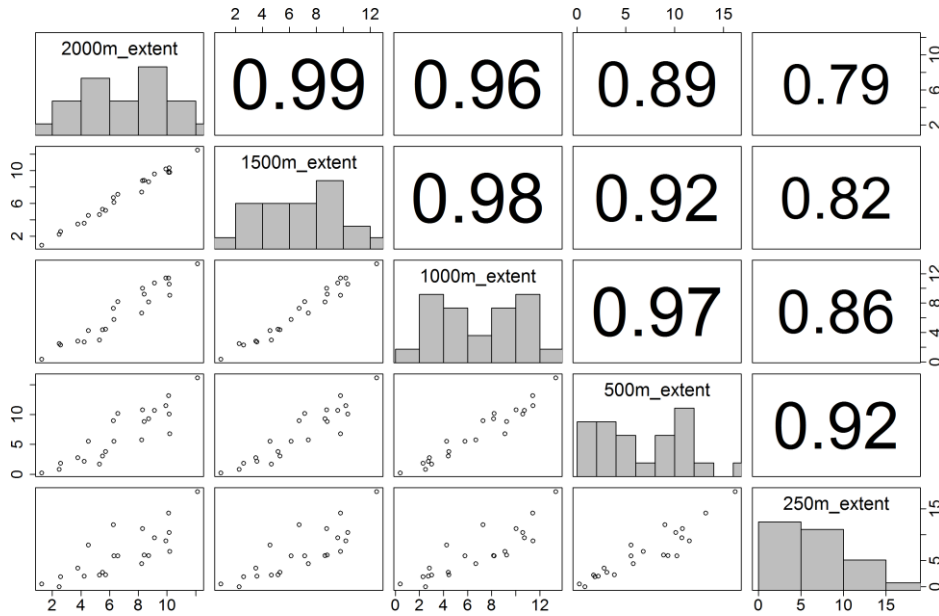


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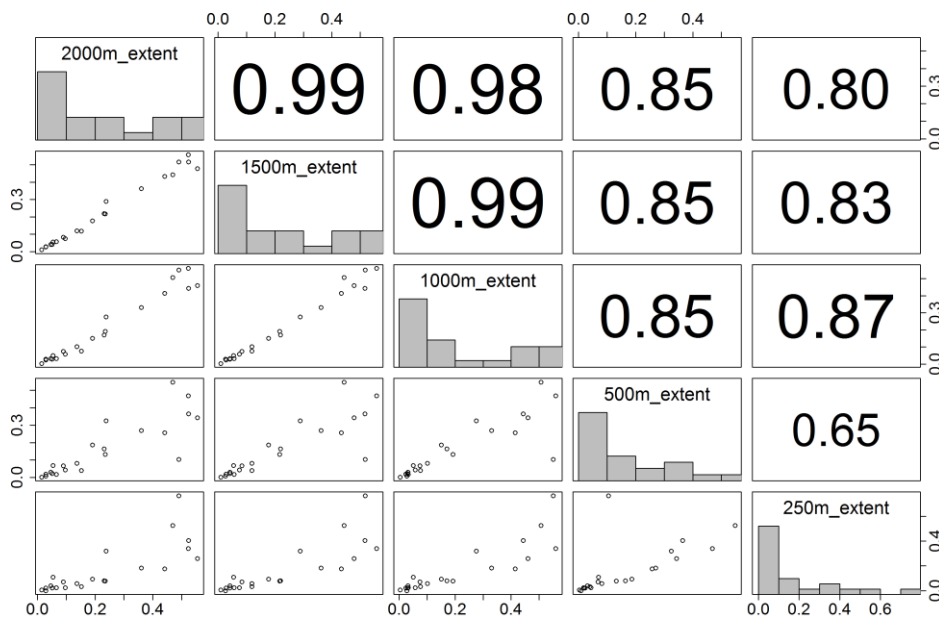
607 **Supporting Information S5.** — Scatter plot matrices of the correlation of relative edge  
 608 amount among five extents.



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610

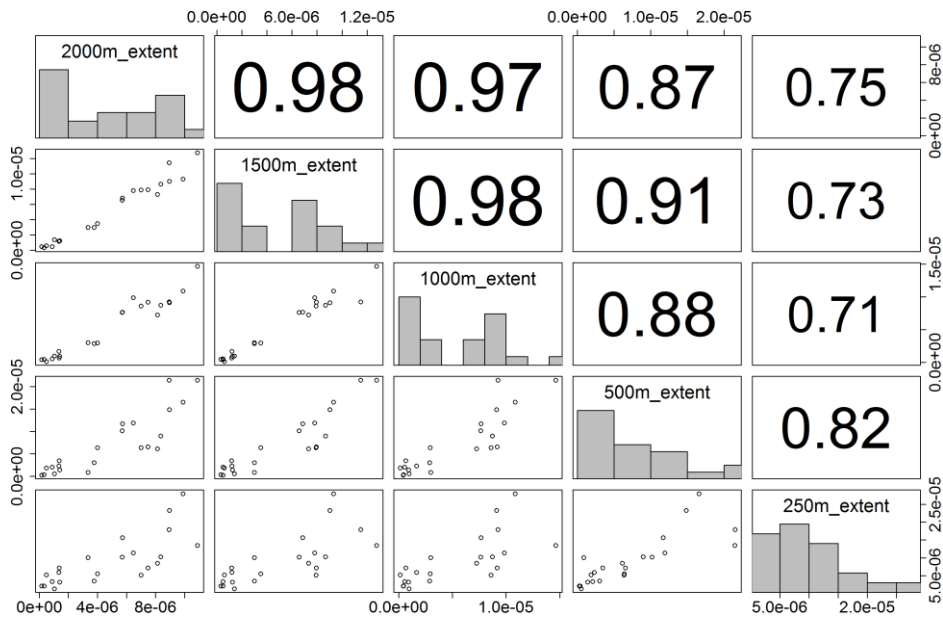
611 **Supporting Information S6.** — Scatter plot matrices of the correlation of perimeter-area  
 612 ratio among five extents.



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614

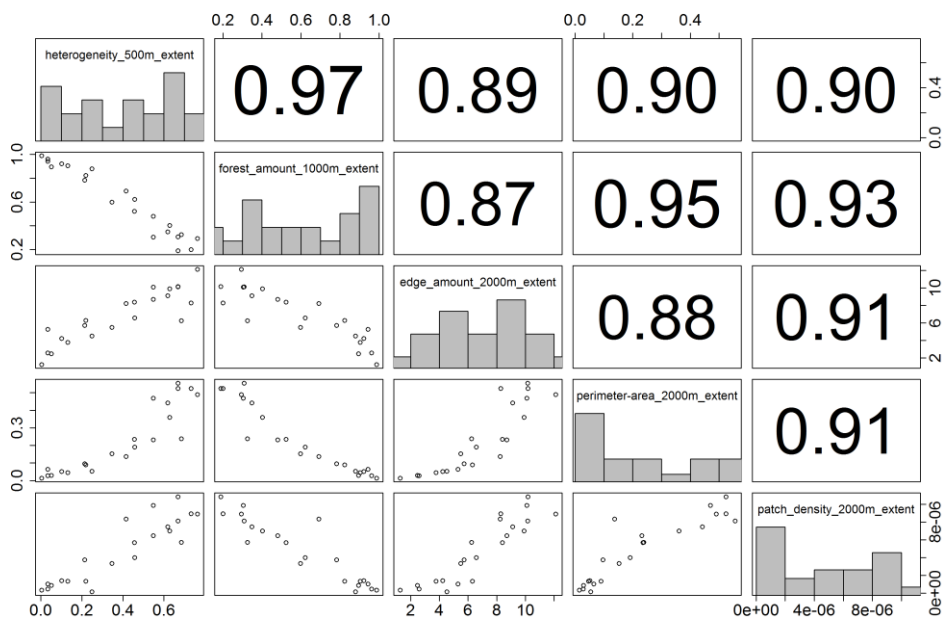
615 **Supporting Information S7.** — Scatter plot matrices of the correlation of patch density  
 616 among five extents.



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619 **Supporting Information S8.** — Scatter plot matrices of the correlation of Simpson landscape  
 620 heterogeneity index (at 500 m extent), relative forest amount (at 1000 m extent), relative edge  
 621 area (at 2000 m extent), perimeter-area ratio (at 2000 m extent), and patch density (at 2000 m  
 622 extent).



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## 624 CONCLUSÃO

625

626 Verifiquei neste trabalho a importância de características da paisagem sobre a diversidade de  
627 mamíferos carnívoros na Mata Atlântica utilizando armadilhamento fotográfico e sistemas de  
628 informações geográficas. Observei que a riqueza de carnívoros está relacionada  
629 positivamente com a quantidade de floresta e é negativamente afetada por outras métricas da  
630 paisagem. Além disso, verifiquei que a ocorrência das espécies varia de acordo com a sua  
631 sensibilidade à perda de floresta, possivelmente devido ao uso de habitat. Deste modo, nossos  
632 resultados corroboram a Hipótese da Quantidade de Habitat (Fahrig 2013).

633 Ainda, os resultados reiteram a importância de proteção de remanescentes florestais para a  
634 manutenção da alta quantidade de floresta em paisagens da Mata Atlântica. Esta ação é  
635 fundamental para a conservação de espécies de carnívoros, ecossistemas e processos  
636 ecológicos nos quais elas estão envolvidas.

637 Apesar do contínuo aumento da quantidade de dados levantados em campo sobre as espécies,  
638 principalmente para estudos de avaliação de impacto ambiental, poucos esforços tem sido  
639 investidos na integração das informações. Verifiquei que, apesar das diferenças nos métodos  
640 de amostragem, integrar informações podem auxiliar na compreensão das respostas dos  
641 animais a alterações na paisagem e contribuir para o conhecimento sobre a ecologia de  
642 espécies pouco estudadas.

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