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METROPOLITAN MAMMALS: UNDERSTANDING THE THREATS INSIDE AN URBAN PROTECTED AREA

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Abstract: Protected areas (PA) are widely recognized as conservation cornerstones. However, we still lack information about PA effectiveness in conserving biodiversity. With the accelerating process of urbanization, urban PAs have gained increasing importance. Thus, evaluating their effectiveness is particularly urgent, especially when located in a biodiversity hotspot. The aim of this study was to describe the large and medium-sized mammalian community within Tijuca National Park (TNP) – an urban PA located in the Atlantic Forest biodiversity hotspot – and to investigate if it is affected by proximity to the park border and by potential threats that occur inside the park such as roads, hiking trails, tourism infrastructure, domestic dogs and hunting. A camera-trap survey was conducted in a grid with 42 sampling units from April to September 2016. Each sampling unit was categorized as park border or interior and according to the aforementioned potential threats. A model selection framework was employed to evaluate the effects of threats on species richness and abundance. Our findings suggest that TNP harbors an impoverished fauna of large and medium-sized mammals when compared with larger and more well-preserved Atlantic Forest PAs. Furthermore, our results highlight that the mammalian abundance was affected by edge effects, presence of roads and tourism infrastructure and abundance of domestic dogs. We highlight some management actions to properly control and minimize those threats and increase the effectiveness of TNP in conserving biodiversity.

Keywords: Atlantic Forest; Brazil; Human-induced disturbances; Large and medium-sized mammals; Urban Ecology.

INTRODUCTION

Protected areas (PAs) are recognized as the main strategy for biodiversity conservation. The current global PA system covers nearly 15 % of the Earth (UNEP-WCMC & IUCN 2016) but we still lack detailed information to evaluate their effectiveness, which is particularly urgent in biodiversity hotspots (Le Saout *et al.* 2013). Despite their biodiversity value, those PAs are immersed in highly human-modified landscapes and, thus, subjected to a myriad of threats such as edge effects (e.g. changes in microclimate and vegetation structure) and human-induced disturbances (e.g. illegal hunting and exotic species) that can negatively affect biodiversity conservation inside them (e.g. Geldmann *et al.* 2013). Another potential threat for biodiversity conservation inside PAs is tourism, as intensive human presence can be detrimental for biodiversity (Zhou *et al.* 2013).

Large and medium-sized mammals are indicators for assessing the impact of those threats on biodiversity. They are sensitive to edge effects (Villaseñor *et al.* 2014), are among the preferred hunted species (Jerozolimski & Peres 2003), are negatively impacted by exotic species and avoid proximity to areas with intensive human presence such as roads and tourism infrastructure (Xavier da Silva *et al.* 2018). As a result, few areas in the world harbor intact mammal faunas (Morrison *et al.* 2007).

Hunting affects mammal communities both outside and inside PAs by reducing abundance and biomass where hunting pressure is high (Galetti *et al.* 2009, 2017, Xavier da Silva *et al.* 2018). Hunting can also be perpetrated by exotic species like domestic dogs which negatively affect native mammal species by chasing and killing individuals (Rangel *et al.* 2013) but also by competing for resources (Vanak & Gomper 2010) and transmitting diseases (Garcia *et al.* 2012). The presence and abundance of domestic dogs have been shown to be the main driver of native mammal population decline in Atlantic Forest fragments (Cassano *et al.* 2014). Unfortunately, domestic and feral dogs are found in and around many PAs in Brazil (Lacerda *et al.* 2009, Silva *et al.* 2018) and are especially found in small PAs with high housing density (Paschoal *et al.* 2018).

In PAs where tourism is allowed, the presence of roads, hiking trails and tourism infrastructure (e.g. playgrounds, barbecue areas and restaurants) are potential threats to biodiversity conservation as they increase and concentrate human presence. Tourism facilitates hunting by familiarizing species to human presence and turning them more susceptible to being hunted (Ménard *et al.* 2014). Roads present risk of roadkill, alter species behavior, cause habitat fragmentation and facilitate the dispersal of exotic species (e.g. Forman & Alexander 1998). Studies in the Atlantic Forest showed the detrimental effects of roads on mammal communities either directly by roadkill (e.g. Cáceres *et al.* 2010) or indirectly through hunting caused by human accessibility (e.g. Paviolo *et al.* 2018).

Brazil stands out both for its biodiversity but also for its investment in establishing PAs, harboring today the largest (~ 30 % of its territory) terrestrial PA system in the world (UNEP-WCMC & IUCN 2016) largely due to extensive protected areas in the Amazon. On the other hand, despite being considered a biodiversity hotspot (Myers *et al.* 2000), only 30 % of what is left of the Atlantic Forest is within PAs, of which 9 % are strictly protected (IUCN Categories I-IV; Rezende *et al.* 2018). Studies have evaluated the effectiveness of Brazilian PAs, but they mostly considered PAs located in pristine regions and focused on the role of PAs in reducing rates of habitat loss (e.g. Carranza *et al.* 2014). We know little about the effectiveness of Atlantic Forest PAs which are immersed in highly human-modified landscapes. Xavier da Silva *et al.* (2018) investigated the effectiveness of the largest National Park within the Atlantic Forest – the Iguaçú National Park (185,200 ha) – and found that although the park still harbors a rich mammalian fauna, the spatial distribution of many species is affected by threats inside the park.

The objective of this study was to describe the large and medium-sized mammalian community within Tijuca National Park (TNP) and investigate if it is affected by proximity to the park border and by potential threats that occur inside the park such as paved roads, hiking trails, tourism infrastructure, domestic dogs and hunting. We expect that threats associated with TNP boundaries (edge effects and/or human-induced disturbances) may cause a reduction in species richness and abundance at TNP's border when compared with its' interior (e.g. Villaseñor *et al.* 2014). We expect that roads, hiking trails and tourism infrastructure may have a negative impact on species richness and abundance (Benítez-López *et al.* 2010, Cáceres *et al.* 2010) since TNP is the most visited PA in Brazil. As domestic dogs are widespread inside TNP (Silva *et al.* 2018), we expect to find low species richness and abundance where dogs are abundant (Galetti & Sazima 2006, Lessa *et al.* 2016). Furthermore, as hunting seems not to be a major concern in TNP (ICMBio 2008), we expect no significant influence on mammals.

MATERIAL AND METHODS

Study area

Tijuca National Park (TNP; Figure 1), located in Rio de Janeiro city, southeast Brazil, is one of the world's largest urban forests (3,953 ha) and it is also the most visited PA in Brazil (~ 3 million visitors/year) generating a considerable yearly income (e.g. more than U$10 million in 2017; ICMBio 2017).

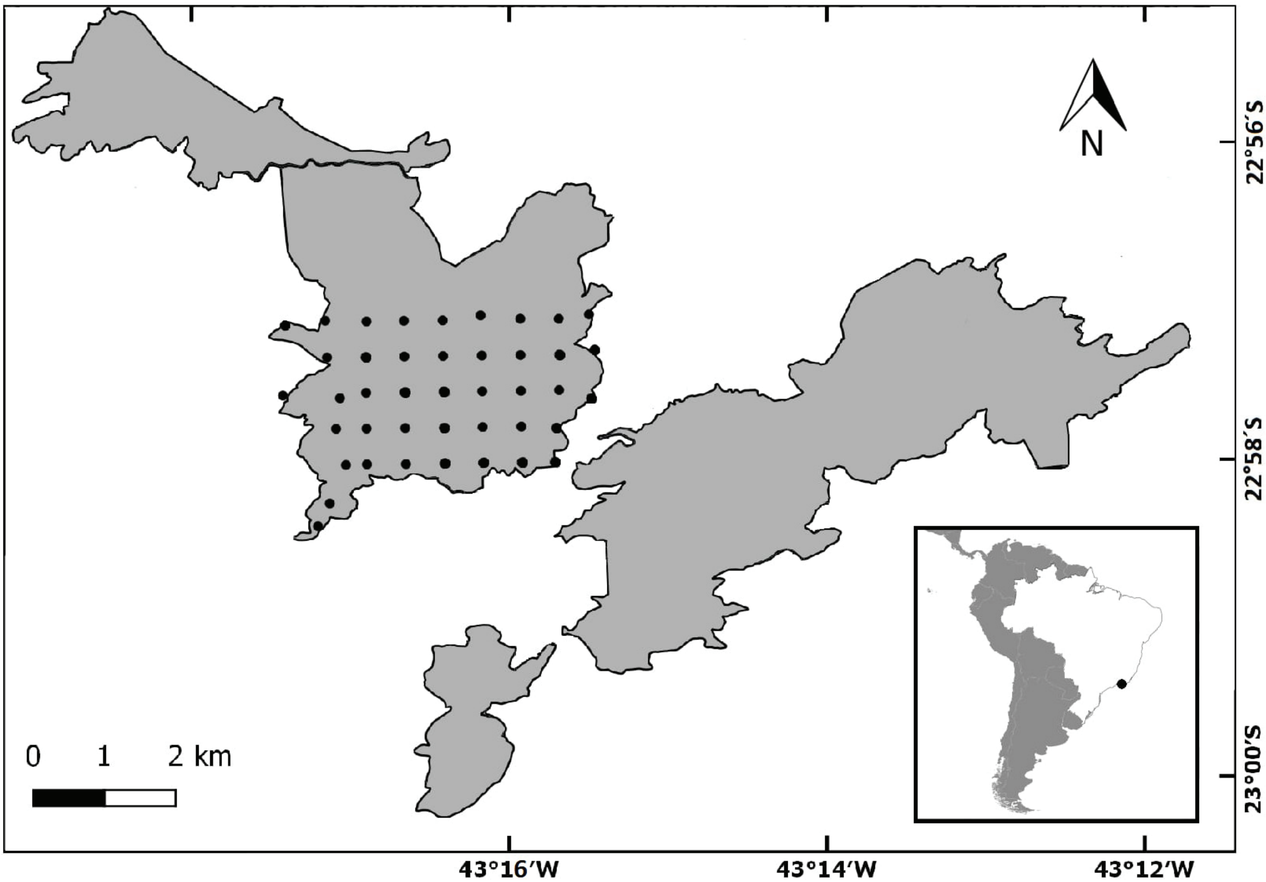

Figure 1. The location of Tijuca National Park (TNP) in Brazil is shown by a black dot on the smaller map. TNP protects four Atlantic Forest fragments which are shown in grey on the bigger map. The black dots indicate the position of the 42 camera-traps that were installed in the southern portion of Floresta da Tijuca sector.

TNP's altitude varies from sea level to 1,021 m. Annual rainfall in TNP exceeds 1,200 mm and the mean monthly temperatures vary between 18 °C and 26 °C (ICMBio 2008).

TNP protects four Atlantic Forest fragments which are separated from each other by paved roads. This study was carried out in Floresta da Tijuca sector (1,488 ha; Figure 1) which is the most visited part of TNP excluding the visits to the monument Christ the Redeemer located in Serra da Carioca sector. The vegetation of TNP is composed by typical dense ombrophilous forest species but also by some exotic species (e.g. jackfruit *Artocarpus heterophyllus*, eucalyptus *Eucalyptus* spp. and corn-plant *Dracaena fragrans*; ICMBio 2008) which are, in part, the result of a 19th century reforestation project. This initiative aimed to reverse the deforestation that occurred in the area and was causing undesirable consequences for Rio de Janeiro city such as water shortages.

Data collection

A grid with 42 sampling units, each representing a square of 500 m X 500 m, was established in the southern portion of Floresta da Tijuca sector covering an area of about 1,050 ha (~ 70 % of the sector). In the center of each sampling unit, we installed a Bushnell™ camera-trap in a tree trunk about 40 cm high (Figure 1) and sampling occurred uninterrupted from April to September 2016.

Photographs were visually analyzed, and the species recorded were identified down to the lowest taxonomic level following the taxonomic nomenclature of IUCN (2020), however, for *Guerlinguetus brasiliensis* we followed Percequillo (2020). All mammal species over 500 g that were possible to identify using photographs were considered. Photographs of each species obtained on the same day by the same camera-trap were considered independent records when there was at least an hour interval among them (Yasuda 2004). Total species richness and abundance (total number of independent records) for the entire community and total and relative abundance (number of independent records per 100 trap-days) for each individual species were estimated for each sampling unit.

Sampling units were categorized as park border or interior and according to presence of roads (paved roads with vehicles in transit during TNP's opening hours), presence of hiking trails, presence of tourism infrastructure (such as playgrounds, barbecue areas and restaurants), domestic dog abundance and presence of hunting pressure. We considered each sampling unit and verified if (1) the park border was passing through; if so, the sampling unit was considered as park border and, if not, park interior; and if (2) roads, hiking trails and tourism infrastructure were present or absent. The abundance of domestic dogs in each sampling unit was estimated as the number of independent records. The presence or absence of hunting pressure at each sampling unit was determined through an interview-based survey with 26 park rangers. As park rangers regularly hike through the trails in their daily activities, we asked them to point out on a map where they had encountered hunters or signs of hunting activity, such as traps or firearms. Prior to the interviews, park rangers were informed about the research aims, that their participation was voluntary, that they could withdraw at any time and that the information provided would be used anonymously. We obtained a written consent from each park ranger willing to participate. The committee of research ethics at the Pontifical Catholic University of Rio de Janeiro provided approval (number 2017-62).

Statistical analysis

To evaluate the effects of the aforementioned threats (proximity to the park border, roads, hiking trails, tourism infrastructure, domestic dogs and hunting pressure) on total community richness and abundance and on total abundance of the five most recorded species (response variables), we employed an information-theoretic model selection framework (Burnham & Anderson 2002). The seven candidate models encompassed a null hypothesis considering no effect of the threats on species richness or abundance and a set of six simple generalized linear models with species richness or abundance as a function of each threat. Species richness and abundance were modeled as a negative binomial variable.

The Akaike Information Criterion corrected for small samples (AICc) was calculated for each model from their log-likelihoods, number of parameters and sample sizes, and the model with the lowest AICc was considered the most plausible. The plausibility of alternative models was estimated by the differences in their AICc values in relation to the AICc of the most plausible model (ΔAIC), where a value of $\Delta AIC \leq 2$ indicates equally plausible models. If the null model was among those plausible models, an absence of threat effects on the response variable was considered. The Akaike weights (wi) express the relative likelihood of each model, in a scale of 0 to 1. All analyses were performed in R (R Core Team 2018) with the package bbmle (Bolker & R Development Core Team 2017) and mass (Venables & Ripley 2002).

RESULTS

With a total effort of 4,302 camera trap-days we obtained 1,434 independent records of 16 large and medium-sized mammal species belonging to seven orders and 13 families (Figure 2). Thirteen of the 16 identified species are native to the Atlantic Forest of Rio de Janeiro while the other three are exotic – domestic dog (*Canis lupus familiaris* Linnaeus 1758), domestic cat (*Felis catus* Linnaeus, 1758) and marmoset (*Callithrix* sp.). The species with the highest number of independent records and, therefore, the highest relative abundance (number of independent records per 100 trap-days) were: *Nasua nasua* (Linnaeus, 1766) (28 % of all independent records), *Didelphis aurita* (Wied-Neuwied, 1826) (21 %), *Cuniculus paca* (Linnaeus, 1766) (17 %), *Dasypus novemcinctus* Linnaeus, 1758 (9 %) and *Dasyprocta leporina* (Linnaeus, 1758) (7 %; Figure 2).

None of the considered threats were important in explaining richness of large and medium-sized mammals since the null model was among the selected models. In contrast, total abundance was higher in the park interior than in its border. *Nasua nasua* abundance was higher in the park interior than in its border and was also higher in areas with no tourism infrastructure. *Didelphis aurita* abundance was higher where hiking trails and roads were present than in areas where they were absent.

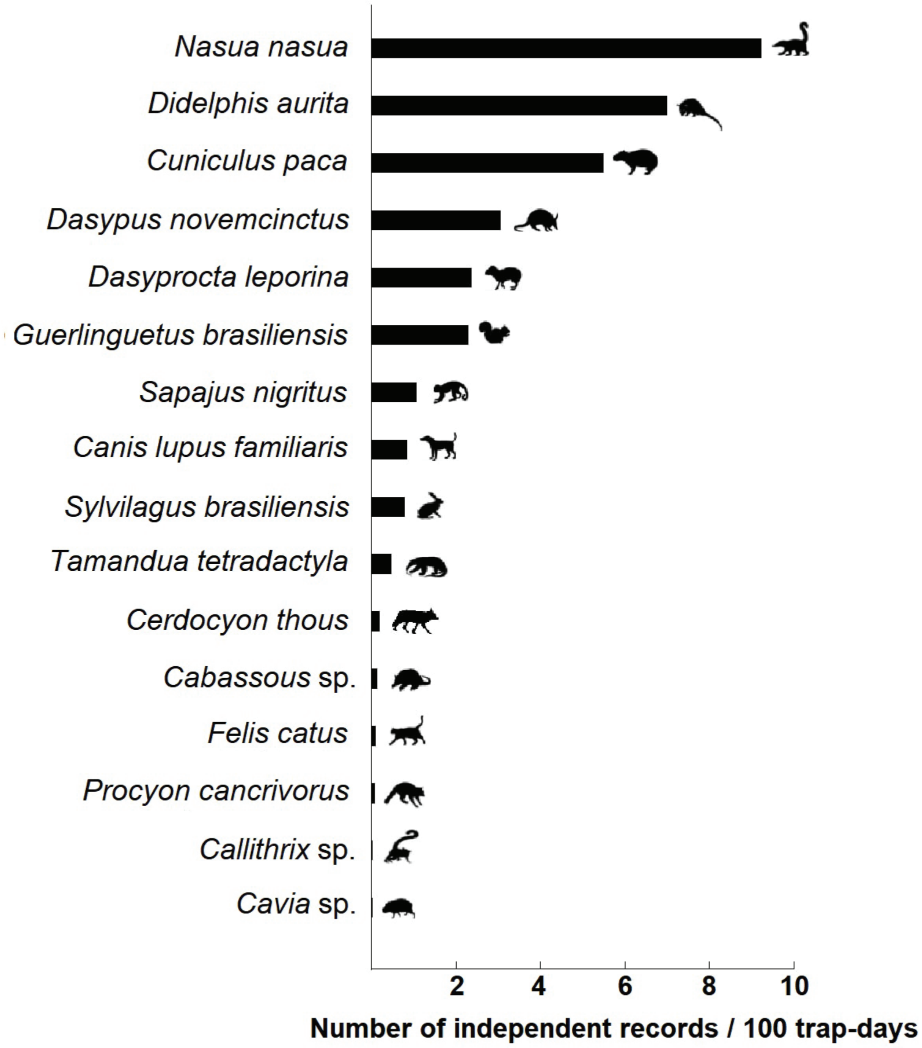

Figure 2. Number of independent records per 100 trap-days (relative abundance) for each species of large and medium-sized mammal recorded at Tijuca National Park, Rio de Janeiro, Brazil.

Cuniculus paca abundance was not explained by the threats considered since the null model was among the selected models. Four models were considered equally plausible to explain *D. novemcinctus* abundance indicating that this species is more abundant (1) where there are no roads, (2) where the abundance of domestic dogs is higher, (3) in the park interior than in its border and (4) where there is tourism infrastructure. Finally, abundance of *D. leporina* is higher in areas with roads than in areas without roads (Table 1, Appendix 1, Figure 3).

DISCUSSION

Tijuca National Park (TNP) harbors 21 species of large and medium-sized mammals. Sixteen species were recorded by this study; two of them – the naked-tailed armadillo (*Cabassous* sp.; Monteiro *et al.* 2019) and the Guinea pig (*Cavia* sp.) – had not been recorded previously at TNP (Freitas *et al.* 2006, ICMBio 2008). This study, however, failed to record four species that were previously recorded in TNP (Freitas *et al.* 2006, ICMBio 2008) – the capybara *Hydrochoerus hydrochaeris* (Linnaeus, 1766), brown-throated three-toed sloth *Bradypus variegatus* Schinz, 1825, porcupine (*Coendou* sp.), the exotic squirrel monkey *Saimiri sciureus* (Linnaeus, 1758) – and the recently reintroduced howler monkey *Alouatta guariba* (Humboldt, 1812) (Fernandez *et al.* 2017). This probably occurred because our camera-traps were all set inside the forest at ground level and *B. variegatus, S. sciureus, Coendou* sp. and *A. guariba* have arboreal habits (Fleagle *et al.* 1981, Reis *et al.* 2014) while

Table 1. Most plausible models (AICc ≤ 2) describing species richness, total abundance and abundance of individual species of large and medium-sized mammals in 42 sampling sites at Floresta da Tijuca sector within Tijuca National Park, Rio de Janeiro, south-eastern Brazil. If the null model was among the most plausible models, it was assumed that none of the explanatory variables affect the response variable. K: number of estimated parameters; AICc: Akaike Information Criterion corrected for small samples; ∆AICc: difference between the AICc of a given model and the best model; Wi: Akaike weights (based on AICc). Figure 3 show how the explanatory variable affected the response variable.

Response variable	Explanatory variable	K	AICc	∆AICc	Wi
Species richness	Domestic dogs	3	182.8	0.0	0.33
	None	2	183.8	1.0	0.20
	Park border	3	184.0	1.2	0.19
Total abundance	Park border	3	364.4	0.0	0.64
Nasua nasua	Park border	3	274.9	0.0	0.40
	Tourism infrastructure	3	275.2	0.3	0.34
Didelphis aurita	Hiking trails	3	257.6	0.0	0.43
	Roads	3	259.5	1.8	0.17
Cuniculus paca	Park border	3	218.3	0.0	0.24
	None	2	218.5	0.2	0.21
	Hunting pressure	3	219.0	0.7	0.17
	Roads	3	219.2	0.9	0.15
	Hiking trails	3	220.3	2.0	0.09
Dasypus novemcinctus	Roads	3	191.3	0.0	0.30
	Domestic dogs	3	191.6	0.3	0.26
	Park border	3	192.6	1.3	0.15
	Tourism infrastructure	3	193.3	2.0	0.11
Dasyprocta leporina	Roads	3	119.7	0.0	0.96

H. hydrochaeris have semi-aquatic habits and an association with open areas (Ferraz *et al.* 2007). Most of the large and medium-sized mammals present in TNP are not considered threatened to extinction but *Sapajus nigritus* Goldfuss, 1809 is considered "Near threatened" (NT) by the IUCN Red List of Threatened Species (Martins *et al.* 2019) and the Brazilian Red Book of Threatened Species of Fauna (ICMBio 2018) and *A. guariba* is considered as "Critically Endangered" (CR) by the Brazilian Red Book (ICMBio 2018).

Species richness of large and medium-sized mammals in TNP is lower than in two other larger and more well-preserved Atlantic Forest protected areas (PAs) in Rio de Janeiro state – Itatiaia National Park harbors 34 species (Aximoff *et al.* 2015) and Serra dos Órgãos National Park harbors 39 species (Cronemberger *et al.* 2019). The absence of apex predators in TNP is the main reason for that difference. Additionally, this absence of apex predators in TNP may be causing a mesopredator release effect and, consequently, an increase in mesopredator and prey abundance (Crooks & Soulé 1999). This might explain the higher abundance of *N. nasua*, *D. aurita* and *C. paca* in TNP than in forested areas with more species-rich mammal communities and with the presence of apex predators such as pumas *Puma concolor* (Linnaeus, 1771) and jaguars *Panthera onca* (Linnaeus, 1758) (Norris *et al.* 2012, Tobler *et al.* 2008). The mesopredator release effect may cause a trophic cascade resulting in an increase in predation pressure on smaller prey species and higher rates of herbivory (Terborgh *et al.* 2001) which are still to be confirmed at TNP. These highlight the importance of large and more pristine areas of Atlantic Forest for the conservation of more species-rich mammal communities with the presence of apex predators.

In addition to indicating that TNP harbors an impoverished large and medium-sized mammalian fauna, which are probably under a mesopredator release effect, our results also suggest that the

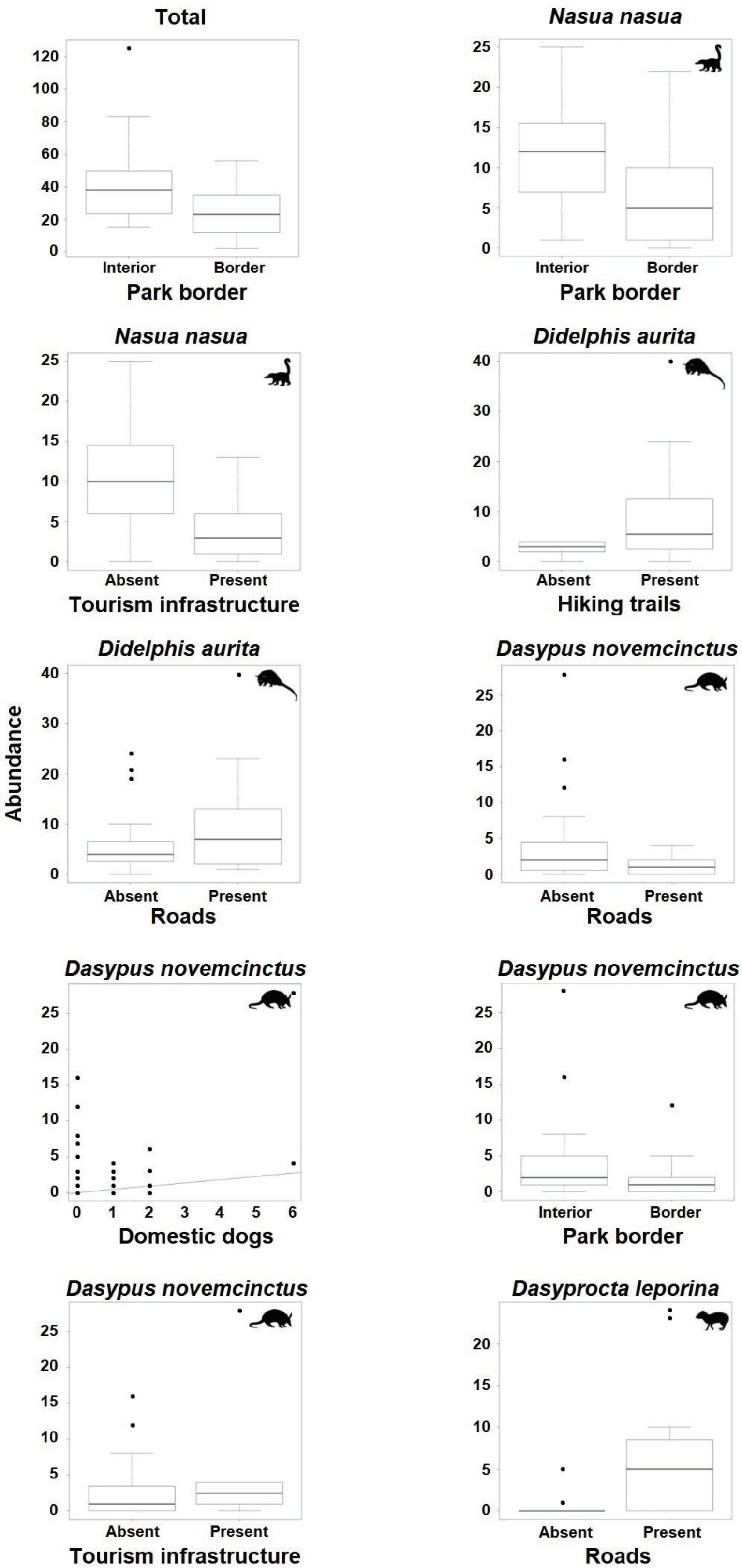

Figure 3. Graphic representation of the most plausible models describing total abundance of large and medium-sized mammal species as well as the abundance of four individual species in Tijuca National Park, Rio de Janeiro, Brazil. The main horizontal line shows the median, boxes represent quartiles and whiskers depict either the maximum or 1.5 times the interquartile range of the data (whichever is smaller). Points are outliers.

mammalian fauna is affected by threats inside the park. Domestic dog abundance and hunting pressure are, in some cases, higher close to the border of PAs and/or of habitat fragments (Grignolio *et al.* 2011, Lessa *et al.* 2016). However, in TNP, either domestic dog abundance and hunting pressure were not different between park border and interior (Wilcoxon test: W = 186, p = 0.41; W = 222, p = 0.85; respectively). On the other hand, the boundary of Floresta da Tijuca sector, our study area, mostly coincides with the border of the forest fragment. Thus, the lower abundance of the entire mammalian community and of *N. nasua* and *D. novemcinctus* in TNP's border is probably a consequence of edge effects. A significant change in both air and soil temperature close to the edge of TNP has been documented (Figueiró & Coelho-Netto 2007) and these microclimatic changes can potentially impact vegetation structure and composition which consequently impact the fauna. Some mammal species avoid forest edges and, consequently, abundance and species diversity are lower at forest edges than in forest interiors (e.g. Xavier da Silva *et al.* 2018). This edge effect can have a greater impact on mammal species if the matrix surrounding the forest fragment is densely human populated (Villaseñor *et al.* 2014) – which is the case for the urban matrix that surrounds TNP. A better understanding of how edge effects impact the mammalian fauna in TNP is crucial to identify potential management actions to mitigate them.

The abundance of *D. novemcinctus* was higher where there were no roads, indicating that roads are possibly a source of disturbance (e.g. roadkill, edge effects) for this species. On contrary, the abundance of *D. leporina* was higher where roads are present. This species was recently reintroduced at TNP; from 2010 to 2014, individuals of *D. leporina* were first released into an enclosure inside Floresta da Tijuca sector which was next to roads (Fernandez *et al.* 2017). As the animals left the enclosure, individuals established their home ranges in nearby areas (Cid *et al.* 2014) which may explain the higher *D. leporina* abundance close to roads. In addition, the abundance of *D. aurita* was higher next to roads and hiking trails. Harmsen *et al.* (2010) found that a similar species (*Didelphis marsupialis*) tends to move through trails, albeit for short distances. Apex predators which prefer to move through roads and hiking trails (Harmsen *et al.* 2010) are absent at TNP and this might have reinforced the tendency of *D. aurita* to move through these spatial features.

At TNP, the presence of tourism infrastructure affected differently the abundance of *N. nasua* and *D. novemcinctus*. We have found a higher abundance of *N. nasua* in areas without tourism infrastructure. However, Allevato (2013) found that some *N. nasua* individuals in TNP established their home ranges around areas with tourism infrastructure (e.g. areas with trash cans and restaurants) probably to use anthropogenic resources as a source of food. As some of the individuals monitored by Allevato (2013) were captured and fitted with radio-collar transmitters close to tourism infrastructure, it is possible that only some individuals or groups became accustomed to foraging around these human-made structures and that those individuals and groups that do not regularly use these anthropogenic resources actively avoid tourism infrastructure. In Iguaçu National Park, some groups of *N. nasua* have become accustomed to foraging around tourist attractions, eating trash and attacking tourists in search of food (Santos 2010); in contrast, groups of *N. nasua* outside the tourist area avoided human presence (MCM Monteiro, personal observation). Thus, it is possible that, although some individuals and groups may be associated with anthropogenic resources at TNP, the rest of the population of *N. nasua* avoids tourism infrastructure and human presence in general. The fact that *D. novemcinctus*' abundance in TNP was higher next to tourism infrastructure indicates that tourism activity is apparently affecting this species, acting as a source of attraction.

The presence of roads, hiking trails and tourism infrastructure are having an impact on some mammal species as discussed above. Therefore, reducing the number of vehicles that transit through the park and amplifying the measures used to reduce their speed could be an effective effort to make the forest next to roads more suitable for *D. novemcinctus* and reduce the risk of vehicle collision with *D. aurita* and *D. leporina*. Identifying the most frequently used tourist attractions and establishing a maximum number of tourists over a period of time could also reduce the impact generated from this activity, turning the areas next to them more suitable for *N. nasua* and avoiding a concentration of *D. novemcinctus*.

Regarding the presence of exotic mammal

species, domestic dogs are widespread throughout TNP (Silva *et al.* 2018) and can transmit diseases and chase and kill native animals (Galetti & Sazima 2006). However, the only effect of domestic dog abundance on native mammals that we identified in TNP was unexpected: the abundance of *D. novemcinctus* is higher where domestic dog abundance is also higher. Domestic dogs prey upon *D. novemcinctus* in the Atlantic Forest, in one case making up ~ 12 % of the estimated biomass consumed (Campos *et al.* 2007, Galetti & Sazima 2006). Therefore, this may indicate that domestic dogs are concentrated where one of their prey, *D. novemcinctus*, is more abundant. Although scarcely recorded in this study, the presence of the domestic cat (*Felis catus*) and the marmoset (*Callithrix* sp.) in TNP raises concern as both can have a negative impact on native species. The domestic cat can cause or contribute to the local extinction of native species (Loss *et al.* 2013). The marmoset has negatively affected vertebrate and especially primate communities in other Atlantic Forest fragments by transmitting diseases, preying on small vertebrates and competing for resources (e.g. Oliveira & Grelle 2012). To avoid the potential negative effects of domestic animals on the native fauna of TNP, environmental education actions and a better control of the public access to TNP should be promoted as already suggested by Silva *et al.* (2018).

The present-day impoverished large and medium-sized mammalian fauna in TNP is a legacy of its history. TNP suffered with deforestation due to agriculture from the 17th to the 18th century but also with hunting pressure. After a great effort of reforestation in the 19th century, TNP's forest cover was restored but as it is surrounded by an urban matrix, most species could not naturally recolonize the area and the fauna remained impoverished. Since 2010 there is an ongoing refaunation project in TNP (Refauna project) and until now, as already mentioned above, two mammal species have been successfully reintroduced – *D. leporina* and *A. guariba* (Fernandez *et al.* 2017). The success of Refauna project could contribute in the long-term to the effectiveness of TNP in representing the mammalian fauna. Our findings suggest that edge effects, exotic species and tourism-associated threats do affect the mammalian fauna inside TNP. Thus, our study suggests that not all TNP's area is effective in maintaining even its impoverished mammalian fauna. However, we believe that the implementation of conservation measures such as environmental education actions and tourism regulation could properly control and minimize threats affecting the fauna inside the park and increase the effectiveness of TNP in maintaining biodiversity.

TNP's value is undeniable, even without considering the potential success of the Refauna project in enriching TNP's mammalian fauna in the long-term and of the management actions in controlling and reducing the threats affecting the mammalian fauna inside the park. Although PAs are a mainstay of biodiversity conservation, we cannot forget that they also contribute to people's livelihoods, particularly at the local level. Urban PAs such as TNP play an important role in providing ecosystem services and in improving public health (e.g. Volenec & Dobson 2019). Furthermore, TNP is a small and isolated PA which is the case of most PAs within the Atlantic Forest biodiversity hotspot (Ribeiro *et al.* 2009). Because of this, the fact that TNP harbors an impoverished mammalian fauna and that some cryptic threats do affect the fauna inside the park may not come as a surprise, but it is a clear alert message that Atlantic Forest PAs have to be properly managed to accomplish biodiversity conservation.

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Appendix 1: Models describing species richness, total abundance and abundance of individual species of large and medium-sized mammals in 42 sampling sites at Floresta da Tijuca sector within Tijuca National Park, Rio de Janeiro, south-eastern Brazil. K: number of estimated parameters; AICc: Akaike Information Criterion corrected for small samples; ∆AICc: difference between the AICc of a given model and the best model; Wi: Akaike weights (based on AICc).

Response variable	Explanatory variable	K	AICc	∆AICc	Wi
	Domestic dogs	3	182.8	0.0	0.33
	None	2	183.8	1.0	0.20
	Park border	3	184.0	1.2	0.19
Species richness	Hiking trails	3	185.6	2.9	0.08
	Hunting pressure	3	185.7	2.9	0.08
	Roads	3	186.0	3.2	0.07
	Tourism infrastructure	3	186.1	3.3	0.06
	Park border	3	364.4	0.0	0.64
	Hiking trails	3	367.7	3.3	0.12
	Roads	3	368.2	3.8	0.10
Total abundance	Domestic dogs	3	369.7	5.3	0.05
	Hunting pressure	3	369.9	5.5	0.04
	None	2	369.9	5.5	0.04
	Tourism infrastructure	3	371.1	6.7	0.02
	Park border	3	274.9	0.0	0.40
	Tourism infrastructure	3	275.2	0.3	0.34
	None	2	277.8	2.9	0.10
Nasua nasua	Domestic dogs	3	278.9	4.0	0.06
	Hiking trails	3	279.6	4.7	0.04
	Hunting pressure	3	280.0	5.1	0.03
	Roads	3	280.0	5.2	0.03
	Hiking trails	3	257.6	0.0	0.43
	Roads	3	259.5	1.8	0.17
	None	2	259.9	2.3	0.14
Didelphis aurita	Hunting pressure	3	260.6	3.0	0.10
	Domestic dogs	3	261.6	4.0	0.06
	Tourism infrastructure	3	261.9	4.3	0.05
	Park border	3	261.9	4.3	0.05
	Park border	3	218.3	0.0	0.24
	None	2	218.5	0.2	0.21
	Hunting pressure	3	219.0	0.7	0.17
Cuniculus paca	Roads	3	219.2	0.9	0.15
	Hiking trails	3	220.3	2.0	0.09
	Tourism infrastructure	3	220.6	2.3	0.08
	Domestic dogs	3	220.8	2.5	0.07

Appendix 1: Continued on next page...

Appendix 1: ...Continued

Response variable	Explanatory variable	K	AICc	∆AICc	Wi
	Roads	3	191.3	0.0	0.30
	Domestic dogs	3	191.6	0.3	0.26
	Park border	3	192.6	1.3	0.15
Dasypus novemcinctus	Tourism infrastructure	3	193.3	2.0	0.11
	None	2	193.7	2.3	0.09
	Hunting pressure	3	194.5	3.2	0.06
	Hiking trails	3	195.8	4.5	0.03
	Roads	3	119.7	0.0	0.96
	Hiking trails	3	126.7	6.9	0.03
	Park border	3	130.5	10.8	0.00
Dasyprocta leporina	Tourism infrastructure	3	132.1	12.3	0.00
	None	2	132.8	13.0	0.00
	Hunting pressure	3	134.8	15.1	0.00
	Domestic dogs	3	134.9	15.2	0.00