# Factors affecting big cat hunting in Brazilian Protected areas

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**Short communication**

# Factors affecting big cat hunting in Brazilian protected areas

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**Abstract**

We surveyed Brazilian protected areas to assess the scale of big cat hunting within the National Protected Areas System. A questionnaire was emailed to managers of 297 reserves, with a response rate of 33.7%. One-third of respondents reported that jaguars (*Panthera onca*) and/or pumas (*Puma concolor*) have been hunted recently (i.e., within the last two years) in their reserves, resulting in the deaths of at least 60 cats. Hierarchical partitioning analysis revealed that degree of restriction to human use in the reserve (as a four-level rank variable) was the most important factor affecting the probability of a manager reporting big cat hunting, with hunting reported three times more frequently in the less restrictive reserves than in the more restrictive ones. Though our study represents only a small fraction of the problem, it confirms that hunting is widespread and represents a threat to carnivore conservation within Brazilian protected areas.

*Keywords*: Protected areas, hunting, *Panthera onca*, *Puma concolor***sumo**

**Resumo**

Nós pesquisamos as áreas protegidas do Brasil para avaliar a dimensão da caça de grandes felinos dentro do Sistema Nacional de Áreas Protegidas. Um questionário foi enviado por email para os gestores de 297 reservas, com uma taxa de resposta de 33.7%. Um terço dos respondentes relatou que onças-pintadas (*Panthera onca*) e pumas (*Puma concolor*) foram caçados recentemente (i.e., nos últimos dois anos) em suas reservas, resultando na morte de pelo menos 60 felinos. Uma análise de partição hierárquica revelou que o grau de restrição ao uso humano na reserva (na forma de uma variável ordinal de quatro níveis) foi o fator mais importante a afetar a probabilidade de os gestores relatarem a caça de grandes felinos, com a caça sendo relatada com o triplo da frequência nas reservas menos restritivas do que nas mais restritivas. Apesar de nossos dados representarem apenas uma pequena fração do problema, eles confirmam que a caça é muito difundida e representa uma ameaça à conservação de carnívoros dentro das áreas protegidas brasileiras.

Keywords: Áreas protegidas, caça, *Panthera onca*, *Puma concolor*

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## Introduction

Hunting of jaguars (*Panthera onca*) and pumas (*Puma concolor*) is widely recognized as one of the main threats to their conservation [1]. Despite its importance, the impact of hunting remains virtually invisible, and few cases of hunting are reported, investigated or punished. For example, in a survey of all (n=2360) notifications for crimes against wildlife issued by the Brazilian Environmental Protection Agency (IBAMA) at the national level between 2005 and 2010, Destro [2] found that only five (0.02%) were related to hunting of big cats. Even when cases are reported, they are rarely systematized or followed through. As a result, the magnitude of the problem and its impact on wild populations remain unknown or, at best, only inferred. To make things worse, hunting also occurs inside protected areas [3-5], compromising their objectives and the long-term persistence of the species in these areas. More information is urgently required on this issue. Here, we present the results of a survey on big cat hunting in federally protected areas in Brazil, based on their managers' knowledge

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## Methods

Brazilian protected areas are regulated by the National Protected Areas System (SNUC, Law 9.985 19 July 2000).  There are currently *c.* 300 federal protected areas in Brazil, belonging to two main categories: strictly protected areas, which have biodiversity conservation as the main objective, and sustainable use areas that allow for different levels of human use. These basic types are further divided in 12 sub-categories (Table 1, Rylands & Brandon [6]).

Between January and July 2011, we emailed a questionnaire to managers of federal protected areas in Brazil asking about reserve management, human population, and manager awareness of the presence of jaguars and pumas in the reserve and hunting of these big cats during the previous two years. To verify the reliability of responses, the questionnaire was sent to managers of 297 federal protected areas of Brazil, including reserves located outside the area of potential distribution of jaguar and puma [7, Paula et al., unpubl.]. However, in the following analysis we focused only on those areas where the presence of at least one of these cats was confirmed by reserve managers.

In the statistical analysis, we used the record of at least one case of big cat hunting in the reserve within the last two years as the dependent (binary) variable. This variable is likely to be a function of two factors. The first is the actual number of cats killed. The more prevalent that hunting is in a given reserve, the greater the probability that at least a few cases will be reported to managers. This, in turn, can be affected by additional factors such as management practices (e.g., monitoring and enforcement), size of human population, relative abundances of felid populations, etc. The second main factor is the ability of managers to detect hunting. This will depend on such subjective aspects as a manager's relationship with local people, knowledge of potential informants, communication skills, etc.

With these considerations in mind, we selected a few candidate explanatory variables that could affect the probability of big cat hunting occurring  in protected areas. To evaluate the effect of reserve management on hunting, we classified reserves according to a four-level rank of restriction to human use (Table 1). Reserves were scored based on the following items: resident population, tourism, extractivism, farming, rearing of livestock and subsistence hunting. These items are incompatible with the nominal objectives of higher ranking reserves, but are all

allowed in the lowest ranking ones (though it should be noted that management objectives are rarely fully implemented, so our ranking may reflect nominal, but not necessarily actual, differences in management). To evaluate the effect of human population, we assigned reserves to a five-level rank of resident population size: 0, 0-100, 101-500, 501-1.000, >1.000 residents. We used a population rank instead of absolute population size or density because this kind of data is missing for many reserves. Since the impact of human population may be affected by the area under consideration, we also included reserve size (log-transformed) as a predictor variable. Finally, we used duration of the manager's residence in the reserve (in years) as a proxy for the degree of integration between the manager and local people. To reduce the effect of a few outliers, this variable was set to a maximum value of 10 years. We note that this last variable should be treated with caution, since many factors besides duration can affect a manager's relationship with people.

We used hierarchical partitioning (HP) to evaluate the effect of independent variables on the probability of occurrence of big cat hunting. HP compares the influence of independent variables over a hierarchy of all possible models, instead of selecting a single best model, and allows the simultaneous use of correlated variables [8]. The analysis was run using the hier.part package [9] in the statistical software R version 2.15.1 [10]. The significance of independent contributions to variance (I) for the independent variables was assessed using Z-scores from a comparison between observed Is and Is obtained after 100 permutations on randomized data. Only those reserves that reported the presence of jaguar and/or puma were included in this analysis (n=77).

## Results

Overall, 100 managers replied to the questionnaire, representing 48 strictly protected areas and 52 sustainable use areas (Table 1). This sample corresponds to one third of all federal protected areas of Brazil, and covers a wide range of geographic, social and environmental variation (Fig. 1).
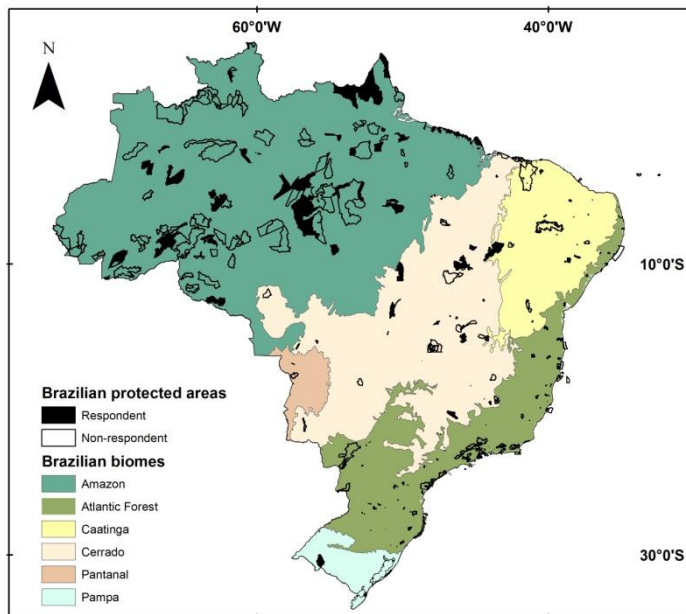


**Fig. 1 Map of Brazil, showing major biomes and federal protected areas. Reserves that responded to this survey are highlighted in black.**

The presence of jaguars was confirmed in 49 reserves. This information was based on tracks (n=31), sightings (n=30) and photographs (n=11), and agrees with the potential area of distribution of jaguar [7]. Hunting of jaguars within the last two years was reported in 42.8% (n=21) of the reserves where the species was confirmed. At least 38 jaguars were killed within this timeframe; the number of animals killed per reserve ranged from one to six (mean=1.8). The most frequently stated reasons for killing jaguars were: retaliation for depredation of livestock (n=10), perceived risk to human life (n=6), and sport hunting (n=3).

Table 1. Classification of federal protected areas in Brasil, sample size for each category and assignment to rank of restriction to human use.

| Category | Sub-Category | Sample size | Rank |
|---|---|---|---|
| Strictly protected | Biological Reserve | 12 | I |
| | Ecological Station | 12 | I |
| | National Park | 23 | II |
| | Wildlife Refuge | 1 | II |
| | Natural Monument | - | - |
| Sustainable use | Area of Relevant Ecological Interest | 2 | III |
| | National Forest | 25 | III |
| | Environmental Protection Area | 6 | III |
| | Extractive Reserve | 18 | IV |
| | Sustainable Development Reserve | 1 | IV |
| | Faunal Reserve | - | - |
| | Particular Reserve | - | - |

The presence of pumas was confirmed in 68 reserves, based on tracks (n=47), sightings (n=46) and photographs (n=20). This agrees with the potential area of distribution of the puma, which covers most of Brazil [Paula et al., unpubl.]. Hunting of pumas in the last two years was reported for 31% (n=21) of these. At least 22 individuals were killed; the number of animals killed per reserve ranged from one to two (mean = 1.25). As observed for the jaguar, the main reasons for killing pumas were livestock depredation (n=12), perceived risk to humans (n=4) and sport hunting (n=4).

Table 2 shows survey results subdivided by main Brazilian biomes. Jaguars were more common in reserves in Amazonia and in the Cerrado/Pantanal, while pumas seem to be better distributed in other biomes. There was considerable variation in the proportion of reserves reporting hunting of each species in each biome. However, besides the fact that (when present) jaguars seem to be more hunted than pumas, there are no clear patterns that could be attributed to differences between biomes.

According to hierarchical partitioning analysis, reserve management was the most important variable explaining variation in the reporting of big cat hunting by managers (60.3%, P < 0.05, Fig. 2 and 3). Reporting rates were inversely related to the level of restriction to human use, with a greater proportion of reserves in the less restrictive class reporting hunting (Fig. 3). The effect of the other variables was relatively smaller and non-significant (Fig. 2).

Table 2. Sample size for each biome (N), number of reserves in each biome reporting the presence of jaguars and pumas, and number of reserves reporting presence plus hunting of these species. Numbers in parenthesis are percentages; hunting percentages were taken from reserves reporting the presence of each species.

| Biome | N | Jaguars | | Pumas | |
|---|---|---|---|---|---|
| | | Present | Hunted | Present | Hunted |
| Amazon | 41 | 33 (80) | 16 (48.5) | 26 (63.4) | 6 (23) |
| Atlantic Forest | 36 | 5 (13.8) | 0 | 22 (61.1) | 8 (36.3) |
| Caatinga | 6 | 2 (33.3) | 0 | 6 (100) | 2 (33.3) |
| Cerrado and Pantanal | 15 | 9 (60) | 5 (55.5) | 13 (86.6) | 5 (38.5) |
| Pampa | 2 | 0 | 0 | 1 (50) | 0 |

## Discussion

Despite limitations with interview data, this study shows that hunting of big cats in Brazilian protected areas is a widespread problem. Nearly half of the reserves where the presence of one or more big cat species was confirmed reported the killing of at at least one individual within the last two years. This resulted in the deaths of a minimum total of 60 individuals of the two species. These are conservative estimates and actual killing rates are certainly higher. For example, the few studies of big cat mortality from hunting in Brazilian protected areas have reported high death rates, usually in the dozens per year [3-4, 11].

Brazil is a large country, and its protected areas system includes a wide range of social and environmental variation (Fig. 1). These variations are likely to be reflected in hunting. The protected areas in the Amazon, for example, are likely to be different from those in the Atlantic Forest or in the Cerrado, which have fewer protected areas and suffer greater anthropogenic impact. However, we did not find evident patterns in hunting variation among biomes. This may be due to the qualitative nature of our data; it is possible that hunting pressure varies quantitatively between the different biomes.

Reserve management, measured as a ranking of restriction to human use, was the most important factor affecting the probability of a manager reporting big cat hunting. Since it is reasonable to expect a correlation between reporting rates and actual hunting pressure, this result suggests that even nominal differences in reserve management can affect big cat mortality. This, in turn, points to less effective big cat conservation in less restrictive reserves. However, this must be considered with caution, since the absolute number of animals killed and cat population sizes have the most impact on the viability of populations [12]. Furthermore, there are alternative explanations for this result. It may be that the greater reporting rates for the less restrictive reserves are related to

their greater human population sizes, and not to differences in management. After all, residents from strictly protected areas are supposed to be relocated from reserves, while sustainable use areas are specifically designed for people - and more people means more hunting [13]. However, we did not detect any effect of population size on the probability of managers reporting hunting in their reserves. It is possible that we failed to detect this effect because population size affects not hunting as a binary response, but the absolute number of animals killed. This needs further investigation.
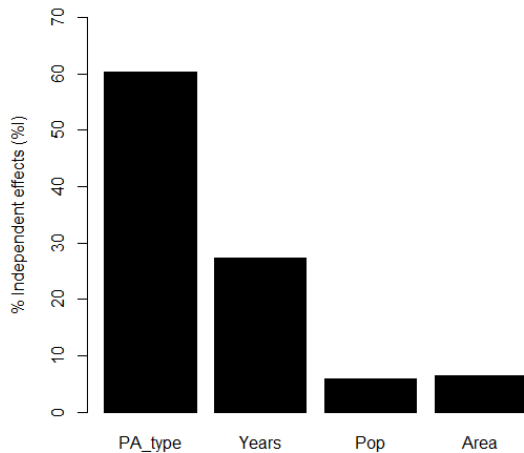


**Fig. 2 Percentage contribution of independent effects calculated from hierarchical partitioning for explanatory variables. PA_type = management class (ranking of restriction to human use); Years = duration of manager presence in the reserve; Pop = size of resident population in the reserve (rank-transformed); Area = size of the protected area (log-transformed).**
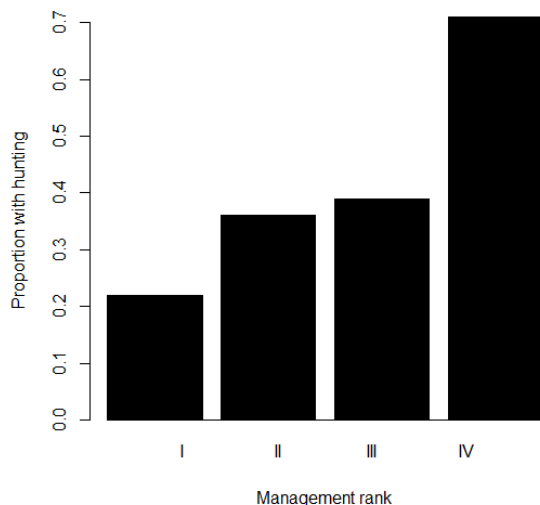


**Fig. 3 Proportion of protected areas with different levels of management class reporting hunting of big cats within the last two years. The four level rank indicates levels of restriction to human use.**

Another explanation for the higher reporting rates for less restrictive reserves may be that managers from these areas have a better relationship with residents, and thus have more access to information. Although we cannot discard this possibility, it is interesting to note that duration of a manager's presence in the reserve, a proxy indicator of manager integration with local people, did not significantly affected reporting rates. Furthermore, if true, this hypothesis would mean that residents of less restrictive reserves are less concerned with the risk of suffering legal sanctions for having hunted. This is likely to be correlated with actual hunting: when the probability of being punished is low, the psychological power of deterrence is weakened [14], which can influence people's intention to kill large cats [1].

## Implications for conservation

This study represents a first assessment of the scale of big cat hunting in Brazilian protected areas, presenting baseline information on the prevalence of hunting, as well as the relative importance of factors that may affect its occurrence. It confirms that hunting is widespread in protected areas and that legally protected status is no guarantee of actual protection for large felids. However, these results are preliminary. More studies are needed to evaluate death rates, factors associated with hunting, the effects of human population size and of specific management measures. Most important is the need to know how hunting affects population viability in these areas. Managers of protected areas should try to systematize the available information and investigate possible cases. Only by recognizing the problem will it be possible to take measures to solve it.

## Acknowledgements

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