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Jaguar hunting in Amazonian extractive reserves: acceptance and prevalence

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Summary

Hunting is a major threat to the endangered jaguar in Brazil. Effective interventions for jaguar conservation demand a better understanding of the prevalence and motivations for hunting. In this study, I investigate the prevalence of jaguar hunting and the potential factors driving the acceptance of this behaviour among residents of two extractive reserves in the eastern Brazilian Amazonia. Between September and October 2013, I surveyed 134 households to assess people's acceptance of jaguar hunting and potential predictors of acceptance using multiple-item rating scales. To estimate the prevalence of jaguar hunting, I used direct questioning and the randomized response technique. Acceptance of jaguar hunting was neutral to slightly positive on average, being related negatively to educational level and to people's perceptions of risk of suffering sanctions for hunting a jaguar and related positively to perception of jaguars as a threat to humans. The prevalence rates of jaguar hunting among surveyed households were 9% and 23% according to direct questioning and the randomized response technique, respectively. The results suggest that investments in education and law enforcement may help decrease local support for jaguar hunting in the study area.

Introduction

Hunting is a major threat to large carnivores worldwide (Ripple et al. 2014). Because large carnivores usually have a disproportionate role in ecosystem balance, the negative impacts of carnivore hunting are likely to affect entire ecosystems. Thus, hunting of carnivores is of great concern (Ripple et al. 2014).

Carnivore hunting has frequently been associated with retaliation for livestock predation (Carvalho Jr et al. 2015, Jędrzejewski et al. 2017). Yet, its motivations are complex and not always directly related to this kind of human–wildlife conflict (see Madden 2004). Several social, psychological and contextual factors may interact to influence the acceptance, intentions and behaviour of individuals regarding carnivore hunting (Dickman 2010, Engel et al. 2017, Inskip et al. 2014, Marchini & Macdonald 2012). For example, Marchini and Macdonald (2012) applied the Theory of Planned Behaviour to investigate rancher's intentions to kill jaguars (*Panthera onca*) in Brazil, and they found that hunting depended on a complex interplay between psychological (internal) and social (external) influences. Similarly, Inskip et al. (2014) found that motivations for tiger (*Panthera tigris*) hunting in Bangladesh depend on a mix of social, psychological and contextual drivers. External factors such as fear of sanctions and social norms also have a role to play in deterring or stimulating illegal hunting of carnivores (St John et al. 2012, 2015). Since effective interventions aiming at behavioural change depend on knowledge of the underlying factors of behaviour (Klöckner 2013, Steg & Vlek 2009), a better understanding of the major drivers of jaguar hunting is needed in order to guide actions to mitigate this impact (Engel et al. 2017).

In Amazonian direct use reserves (hereafter, sustainable use reserves), hunting of carnivores is a pressing issue (Carvalho Jr & Pezzuti 2010, Ramalho 2012). Sustainable use reserves are designed to promote both sustainable livelihoods and management of natural resources (Fearnside 1989). As such, sustainable use reserves officially constitute a major conservation strategy, representing the largest share of formally protected areas in Brazilian Amazonia (Peres 2013). However, to effectively protect carnivores, sustainable use reserves must actively promote coexistence between humans and carnivores.

Hunting of carnivores is illegal in Brazil and investigations can be challenging, since people fear reprisals if they speak openly about it. However, because non-commercial hunting of non-threatened species for subsistence purposes is allowed in sustainable use reserves (Antunes et al. 2019), communities living inside these areas are usually more willing to share information on this topic. Nevertheless, underreporting may occur (Carvalho & Pezzuti 2010, Ramalho 2012). In recent years, a suite of specialized techniques for sensitive research, originally developed within the social sciences, have been adopted for studying non-compliance in natural resource

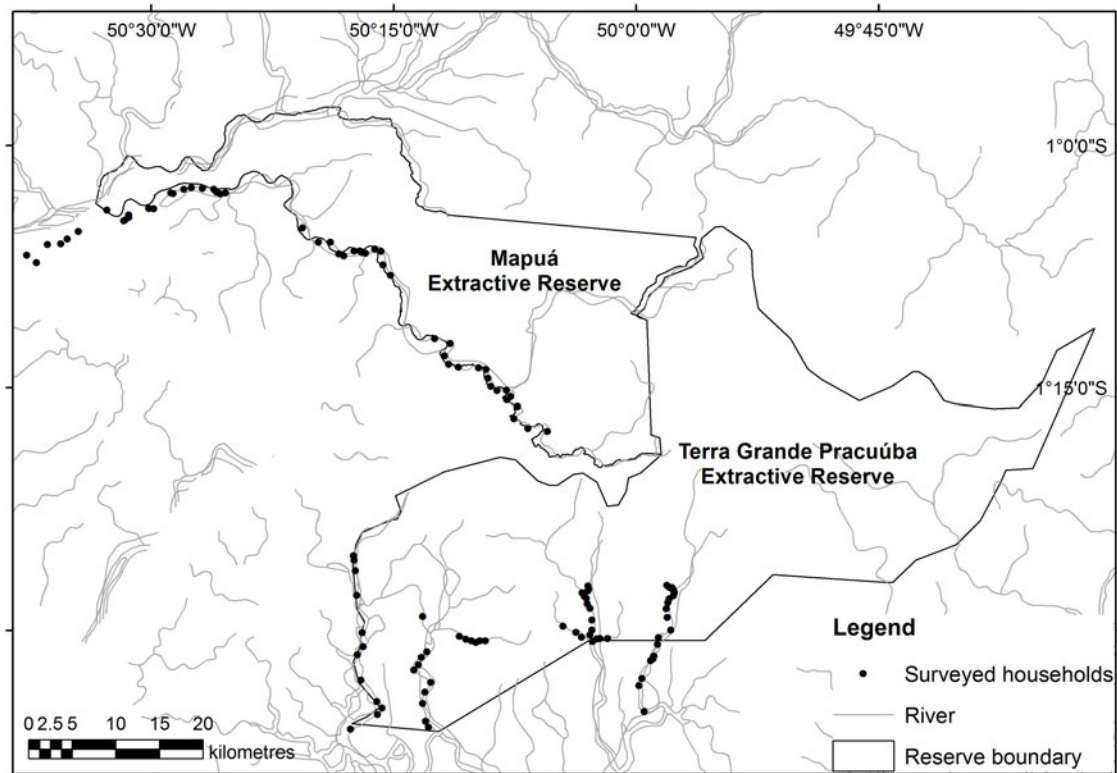


Fig. 1. Diagrammatic map of Mapuá and Terra Grande Pracuúba Extractive Reserves in Marajó Island, showing the distribution of surveyed households.

use and conservation (Gavin et al. 2010, Nuno & St John 2015, St John et al. 2016). These methods are designed to protect respondent privacy and usually provide more reliable results than conventional, direct questioning methods (Nuno & St John 2015, St John et al. 2016).

In this paper, I investigate how individual attributes, perceptions of risk and social norms affect jaguar hunting acceptance in two eastern Brazilian Amazonia sustainable use reserves. I also assess jaguar hunting prevalence in the area through direct questioning and the randomized response technique (RRT; a specialized method for sensitive research; Nuno & St John 2015). I also compare the performance of the two methods. Finally, I discuss the results in order to contextualize how the findings can contribute to the prospects of coexistence between people and jaguars in these areas.

Methods

Study area

The study was conducted in the Mapuá Extractive Reserve (MER; 94 000 ha) and the Terra Grande Pracuúba Extractive Reserve (TGPER; 195 000 ha), two contiguous sustainable use areas located on the western part of Marajó Island (Fig. 1), the main island at the mouth of the Amazon river (c. 50 000 km²) and one of the largest river islands in the world (Goulding et al. 2003). Together, the two reserves host c. 1400 households (Ferreira et al. 2017, NS Menezes, personal communication 2017). The households are distributed along the main rivers draining to the west of the island. The main activities in the reserves are subsistence agriculture, fishing, hunting, small-scale selective logging and extraction of non-timber forest products (Goulding et al. 2003, Smith 1999). Apart from poultry and dogs, livestock is rare in the reserves, in contrast to

the eastern half of the island, which is a major cattle area (Goulding et al. 2003). The study was partly motivated by a recent record of human–jaguar conflict in the study area, where dogs from 24 different households were reportedly killed by jaguars in MER between 2011 and 2012 (EAR Carvalho Jr, unpublished data 2012).

Data collection

Between September and October 2013, I surveyed 134 households along the rivers Mapuá, Cantagalo and Coqueiro at MER and along the rivers Guajará, Mutuacá and Piriá-Miri in TGPER, as well as households bordering both reserves (Fig. 1). I visited every fifth house along the surveyed rivers in an attempt to collect a systematic, unbiased sample, while covering the widest possible stretch of each river. At each household, I interviewed one adult individual (>18 years old). I applied a structured questionnaire including questions on: (1) household and respondent characteristics; (2) perceptions about jaguars as a threat to human safety; (3) acceptance of jaguar hunting; (4) neighbours' involvement in jaguar hunting (i.e., descriptive norms, or 'what most others do'; Cialdini et al. 1990); (5) perceptions of risk of suffering sanctions for hunting jaguars; and (6) involvement of household in jaguar hunts within the 5 years prior to the study (2008–2013). I conducted interviews in Portuguese under verbally informed consent from the participants. Acceptance and perceptions were recorded using four- to five-point multiple-item rating scales (Newing et al. 2011). The full questionnaire, including the items used for each construct and the scales used, is available in Supplementary Appendix S1 (available online).

The question about household involvement in jaguar hunting is potentially sensitive and may compromise the validity of the data

due to underreporting (Nuno & St John 2015). To circumvent this, I used the RRT as a complement to direct questioning. The RRT is a method designed for sensitive research, which has been successfully applied in previous studies on non-compliance in natural resource use (Razafimanahaka et al. 2012, Solomon et al. 2007, St John et al. 2012, 2015).

When using the RRT, a randomizing device is used to deliberately add noise with a known distribution to the response data. The noise protects respondents from self-incrimination, while the prevalence of the behaviour of interest may be calculated for the sample population by correcting for the noise (St John et al. 2012). I used the 'forced response' RRT design (St John et al. 2012) using a 12-sided die placed in an opaque plastic mug as a randomizing device. I presented the method to interviewees as a game with a set of rules (Razafimanahaka et al. 2012, Schill & Kline 1995). I instructed the respondents to answer truthfully, or to say 'yes' or 'no' regardless of the truth, depending on the outcome of the die roll. Outcomes 1–3 required a 'forced yes' answer, outcomes 4–10 required a truthful answer and outcomes 11–12 required a 'forced no'. Dice results were concealed from me, guaranteeing respondent privacy. I presented the RRT section of the questionnaire to all interviewees immediately after presenting the direct question about jaguar hunting.

Data analysis

I assessed the internal reliability of the scales using the Spearman–Brown coefficient, a reliability measure that ranges from 0 to 1 and is the best choice for two-item scales (Eisinga et al. 2013), which was the case for many variables in this study. The coefficient was calculated in the R package *multicon* (Sherman & Serfass 2015). To evaluate potential drivers of acceptance of jaguar hunting, I ran generalized linear models including education level, perception of jaguars as a threat to human safety, descriptive norms on jaguar hunting and perceptions of risk of suffering sanctions as predictors. I did not include household characteristics in the analysis because the response variable was a subjective, individual attribute not directly related to household sociodemography. I used a multi-model inference approach to select the best models among all possible candidate models using the selected predictor variables. I based the model selection on the Akaike information criterion corrected for small samples (AIC_c) and retained models with $\Delta AIC_c < 2$ in the subset of best models (Burnham & Anderson 2001). I assessed the relative importance of each variable by summing the Akaike weights of all models in which they appeared (Burnham & Anderson 2001). I ran the analysis in the R package *MuMIn* (Bartón 2013).

I estimated the RRT prevalence of jaguar hunting by the formula $\pi = (\lambda - \theta)/P_1$, where π is the estimated prevalence of hunting, λ is the proportion of 'yes' answers, θ is the probability of 'forced yes' answers and P_1 is the probability of having to say the truth (Lensvelt-Mulders et al. 2005, St John et al. 2012). I calculated confidence intervals by bootstrap resampling ($n = 1000$). I considered prevalence estimates derived from direct questioning and RRT to be significantly different if the bootstrapped 95% confidence interval (CI) of the mean difference did not include 0 (Razafimanahaka et al. 2012, St John et al. 2012). To evaluate whether RRT respondents and non-respondents differed in age, gender and education, I used χ^2 tests.

Table 1. Summary data on the characteristics of the surveyed respondents/households in Marajó Island, Brazilian Amazonia ($n = 134$).

Variable	Mean	Range
Respondent age (years)	41	18–83
Respondent education level (six-level rank)	3.6	0–5
People living in household	6	1–13
People <15 years of age living in household	2.6	1–10
Household income (four-level rank)	2.3	1–5
Number of cattle heads in household	0.03	0–1
Number of horse heads in household	0	0
Number of pigs in household	0.5	0–20
Number of poultry in household	6.3	0–30
Number of dogs in household	1.6	1–8

Results

All individuals who were approached ($n = 134$) agreed to participate in the survey. Respondent and household characteristics are summarized in Table 1 and scores for latent variables are summarized in Table 2. On average, scores for the acceptance of jaguar hunting were close to neutral (Table 2), suggesting that local people do not have strong opinions on this subject. Most interviewees do not see the jaguar as a threat to humans, nor do they perceive jaguar hunting as a prevalent behaviour among their neighbours, as evidenced by the negative scores for these variables (Table 2). On the other hand, people are highly afraid of sanctions, as indicated by the high scores recorded for the perceived risk of sanctions for hunting a jaguar (Table 2).

Most multiple-item scales had adequate reliability, except for perception of risk of suffering sanctions (Table 2). The two questions comprising this scale focused on different aspects of perception: one affective (dread of suffering sanctions) and the other cognitive (the rational perception of the likelihood of suffering a sanction). Since the two items were not correlated (Supplementary Appendix S1), I kept them as separate predictors in the global model for attitudes towards jaguar hunting.

Only three models were retained within the set of models that best explained the variation in the acceptance of jaguar hunting, $\Delta AIC_c < 2$ (Table 3). The two most important predictors were education level and perception of jaguars as a threat to humans, which were retained in all top-ranked models and had high relative importance (sum of Akaike weights > 0.9 ; Table 4). Perceptions of risk of sanctions for hunting jaguars (both the affective and the cognitive aspects) were also retained in the set of best models, but displayed lower relative levels of importance. Acceptance of hunting was negatively related to education level and both to the cognitive and affective aspects of the perception of the risk of sanctions for hunting jaguars; on the other hand, it was positively related to the perception of jaguars as a threat to humans (Table 4).

All respondents answered the direct question about jaguar hunting, but 35 did not answer the RRT question. Of these, 16 were unable to understand the game instructions, 15 were unable to recognize or see the die numbers and four simply refused to answer the question. RRT respondents and non-respondents had similar average ages ($\chi^2 = 38.50$, $p = 0.9$), but differed in gender ($\chi^2 = 6.57$, $p = 0.01$) and in educational level ($\chi^2 = 28.37$, $df = 4$, $p < 0.001$). Women and less educated individuals were less likely to answer the RRT question.

According to the RRT estimate, approximately a fifth of households were involved in jaguar hunting during the 5 years prior to

Table 2. Items used to measure latent variables (acceptance, perceptions and norms), means and standard deviations and Spearman–Brown coefficient. All scales range from –2 to 2, except perception of sanctions, which ranges from 1 to 4.

Variable/item	Mean	SD	Spearman–Brown coefficient
<i>Acceptance of jaguar hunting</i>	0.21	1.14	0.82
To hunt a jaguar in this reserve would be (very bad to very good)	0.48	1.31	
To hunt a jaguar in this reserve would be (very unhelpful to very helpful)	0.31	1.42	
To hunt a jaguar in this reserve would be (very wrong to very correct)	0.38	1.43	
To hunt a jaguar in this reserve would be (very unpleasant to very pleasant)	–0.26	1.54	
<i>Perception of jaguars as a threat to human safety</i>	–0.57	1.25	0.77
What are the chances of a jaguar attacking you in the next 12 months?	–0.69	1.37	
What are the chances of a jaguar attacking a local in the next 12 months?	–0.38	1.39	
<i>Descriptive norms on jaguar hunting</i>	–1.03	1.14	0.78
How many of your neighbours hunt jaguars?	–1.17	0.88	
How many people in the region hunt jaguars?	–0.87	0.81	
<i>Perceptions of the risk of sanctions</i>	3.02	0.92	0.35
How much fear do you have of being punished for hunting a jaguar?	2.63	1.19	
What are the chances of you being punished for hunting a jaguar?	3.37	1.2	

Table 3. Top-ranked models ($\Delta AIC_c < 2$) explaining variation in attitudes towards jaguar hunting in Marajó Island.

Model	AIC _c	ΔAIC_c	ω_i
edu + risk.human + sanction.a + sanction.c	376.8	0	0.221
edu + risk.human + sanction.a	376.9	0.07	0.213
edu + risk.human + sanction.c	377.6	0.72	0.154

Predictors: edu = education level (rank); risk.human = perception of jaguars as a threat to humans; sanction.a = affective aspect of the perception of the risk of sanctions (fear of sanction); sanction.c = cognitive aspect of the perception of the risk of sanctions (rational perception of the likelihood of suffering a sanction).
 AIC_c = Akaike information criterion adjusted for small sample bias; ΔAIC_c = difference between a given model and the best model; ω_i = Akaike weights.

Table 4. Model-averaged coefficients, standard errors and relative importance of potential predictors of attitudes towards jaguar hunting in Marajó Island.

Predictor	Coefficient	Adjusted SE	Importance
Edu	–0.43	0.14	0.97
risk.human	0.21	0.08	0.90
Norm	0.08	0.08	0.26
sanction.a	–0.16	0.09	0.66
sanction.c	–0.14	0.09	0.55

Predictors: edu = education level (rank); risk.human = perception of jaguars as a threat to humans; norm = descriptive norms (perception of neighbours' involvement in jaguar hunting); sanction.a = affective aspect of the perception of the risk of sanctions (fear of sanctions); sanction.c = cognitive aspect of the perception of sanctions (rational perception of the likelihood of suffering a sanction).

this study (proportion = 0.229, 95% CI: 0.06–0.40). In contrast, the outcomes of direct questioning indicated that a little less than 10% of households were involved in jaguar hunts (proportion = 0.09, 95% CI: 0.04–0.15). Though the difference was large, it was not statistically significant, since the CIs of the two estimates overlapped.

Discussion

The acceptance of jaguar hunting being negatively related to the level of education of interviewees corroborates previous studies on attitudes towards jaguars and carnivores in general (Porfirio et al. 2016, Røskaft et al. 2007). The effect of education was detected despite the fact that it was measured through a rank that targeted general, ‘non-environmental’ education. This suggests that prospects for coexistence between people and jaguars in the study area could be improved simply by increasing general access to

education, a measure that may also help in poverty alleviation (Pinho et al. 2014).

The second most important predictor variable in the study was the perception of jaguars as a threat to humans, which had a positive effect on the acceptance of jaguar hunting. At other Amazonian sites, the perceived impact of jaguars on human safety was also a predictor of people’s intention to kill jaguars (Marchini & Macdonald 2012). Moreover, in the Brazilian Atlantic Forest, fear was associated with negative attitudes towards jaguars and pumas (*Puma concolor*) (Engel et al. 2016). People who see wildlife as a threat tend to be more hostile to it (Dickman 2010, Inskip et al. 2014). Carnivores are usually associated with ‘dread risks’ that involve a perceived lack of control, dread and fatal consequences, which people naturally want to minimize (Slovic 1987). Furthermore, the perception of carnivores as a threat is usually stronger among vulnerable social groups, which are less resilient to impacts on their livelihoods (Dickman 2010, Inskip et al. 2013). In Guatemala (Soto-Shoender & Main 2013) and the Brazilian Pantanal (Porfirio et al. 2016), villagers are more prone to see jaguars as a threat than wealthier ranchers.

Perceptions of the risk of suffering sanctions (both the affective and the cognitive aspects) were negatively related to people’s acceptance of jaguar hunting. This probably occurs because fear of sanctions is a discouraging factor (St John et al. 2015, Steg & Vlek 2009). Law enforcement can reduce environmental non-compliance (Baruch-Mordo et al. 2011, Harrison et al. 2015, Jachmann 2008, St John et al. 2015). By increasing people’s fear of sanctions, law enforcement could help decrease local support for jaguar hunting in the study area. However, this may be undesirable in the context of sustainable use reserves, since such actions may undermine the trust between managers and local people, which is hard to attain yet essential for effective reserve management. Furthermore, local households would hardly be able to afford the harsh penalties for killing endangered wildlife.

To my knowledge, this was the first study to use the RRT to study illegal hunting in the Amazon. The experience demonstrated the feasibility of using the technique among rural illiterate people, although the fact that a high proportion (26%) of interviewees could not respond to the RRT question indicates that the implementation of the technique needs adjustments (Razafimanahaka et al. 2012, Solomon et al. 2007).

The prevalence of jaguar hunting as estimated by the RRT was more than double that derived from direct questioning.

Unexpectedly, the difference was not statistically significant. This may be an artefact of the sample size being insufficient, considering that the RRT produces inflated variances (Lensvelt-Mulders et al. 2005). Furthermore, the two methods may perform similarly in 'non-sensitive' areas (Razafimanahaka et al. 2012, Solomon et al. 2007), and, perhaps, Amazonian sustainable use reserves may be regarded as such for studies on hunting. Recent studies on jaguar hunting in sustainable use reserves obtained first-hand accounts of jaguar hunts because people spoke openly about it (Carvalho & Pezzuti 2010, Ramalho 2012). In such cases, direct questioning may be the best choice because it is much easier to implement.

The mean proportion of households involved in at least one jaguar hunt in the 5 years prior to the study was estimated at 0.09 for direct questioning and at 0.229 for RRT. Even the more conservative direct question estimate is relatively high, since it implies that roughly one out of every ten houses was involved in at least one jaguar hunt during this period. This was observed despite the low levels of conflict in the area. For example, the average score for the perception of the jaguar as a threat to humans was negative (Table 2), indicating that most people do not see the species as a threat. Furthermore, the mean scores for the acceptance of jaguar hunting were close to neutral (Table 2), suggesting that people in the area probably do not have attitudes or opinions formed about jaguar hunting. The role of other incentives for hunting, in addition to attitudes, deserves further investigation.

To improve livelihoods without compromising biodiversity conservation, sustainable use reserves must improve the prospects of long-term coexistence between people and jaguars. Thus, tolerance towards jaguars must increase and support towards hunting them must decrease. This study suggests that improving basic education and reducing the perception of jaguars as a threat to humans may have roles to play in fostering coexistence in the study area.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/S0376892919000274>.

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