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Predicting ranchers' intention to kill jaguars: Case studies in Amazonia and Pantanal

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ABSTRACT

The killing of jaguars by ranchers in Amazonia and the Pantanal is a major threat to the species. We used the Theory of Planned Behavior to examine the role of ranchers' perceptions, norms, attitudes and intentions concerning jaguar killing, in determining their jaguar-killing behavior. We also investigated the influence of: (1) descriptive norm and social identity on ranchers' intention to kill jaguars on their properties; and (2) the effect of perceptions of jaguar impact on human livelihoods (livestock and human safety), and of property size, on the variables that influence intention to kill. Results based on interviews with 268 cattle ranchers indicated that the impact of jaguars on livestock is not the only predictor of a rancher's intention to kill jaguars. Fear, personal and social motivations, and internal and external barriers (e.g. lack of skills and force of law, respectively) to killing jaguars can also influence jaguar killing. The relative importance of these factors in determining intention to kill varies with region and affluence. We recommend ways of deterring jaguar killing behavior through communication interventions. In addition to the economic and legal incentives that have already been considered by conservationists, effective strategies to protect jaguars on privately owned land will need to address the social and psychological factors that determine the killing of jaguars by ranchers. Conservationists need to find and support ways to make jaguar killing not only unprofitable and illegal, but also socially and personally unacceptable.

1. Introduction

The most urgent issue in jaguar (*Panthera onca*) conservation is the killing of jaguars by humans (Zeller, 2007). Because jaguars are renowned for preying on livestock (Hoogesteijn, 2000), one might assume that people kill jaguars in an effort to reduce economic losses associated with livestock predation. Conservationists have approached jaguar killing within the framework of human–wildlife conflicts (Rabinowitz, 2005) and to date research and conservation efforts have focused on the ecological (Azevedo and Murray, 2007; Cavalcanti, 2008; Michalski et al., 2006) and economic (Silveira et al., 2006) dimensions of the conflict. Little has been done to understand the link between jaguars killing livestock and people killing jaguars. The killing of jaguars may not be strictly retaliatory and might have motivations besides the economic. If we are to curb the killing of jaguars, first we have to understand the underlying causes of this behavior. We used an approach that went beyond the usual human–wildlife conflict framework to examine the reasons – both related and not related to conflict – for ranchers killing jaguars in Amazonia and Pantanal.

The few studies that have attempted to address human–jaguar conflict from the human side have assessed attitudes towards jaguars among people that were directly involved in conflict with jaguars over livestock (Conforti and Azevedo, 2003; Palmeira and Barrella, 2007; Santos et al., 2008; Zimmermann et al., 2005). Unfortunately, the relationship between attitudes and behaviors may not always be strong or direct. Moreover, by limiting the study of attitudes to the context of human–wildlife conflict, factors involved in the decision to kill a certain species, but not directly related to the impact of that species on human livelihood, may be overlooked. Theoretical frameworks have been developed by social scientists to predict human behavior from attitudes (Ajzen, 1985; Fazio, 1986), and these could provide a useful structure for studying the killing of jaguars. Key aspects of such an approach are the proper measurement of attitudes and inclusion of additional explanatory variables. In this study, we develop a framework based on the Theory of Planned Behavior (TPB) (Ajzen, 1985) to explore the relationships between landowners' perceptions of jaguar impact on human livelihood and their own jaguar killing behavior on the Amazon deforestation frontier and in northern Pantanal. We incorporate factors not related directly to the impact of jaguars on human livelihood, such as social motives for killing jaguars and perceived barriers to doing so.

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1.1. Theoretical framework

The TPB proposes that human behaviors are governed not only by personal attitudes, but also by social pressures and perceived control over one's own behavior. According to the TPB, the most proximal determinant of a person's behavior is their intention to engage in that behavior (Fig. 1). In turn, behavioral intentions are influenced by three main factors: attitudes towards the behavior, subjective norms and perceived behavioral control (PBC). Attitude scores reflect an individual's overall positive or negative evaluation of performing the behavior. Subjective norms represent an individual's perception of whether people important to them would approve of them performing the behavior. Perceived behavioral control reflects the extent to which an individual perceives the behavior to be under their volitional control. Thus, according to TPB, people who have positive attitudes towards killing jaguars, think that there is normative support for killing jaguars, and perceive that they can easily kill jaguars (or pay someone else to do it for them), should have strong intentions to kill jaguars. In addition, to the extent that PBC is a proxy for the actual control (accurately accounts for both the internal factors [e.g. knowledge, skills, courage] and external factors [e.g. legal barriers, money, equipment, help from others]) needed to perform the behavior, it may also have a direct impact on behavior.

While the great majority of attitudinal studies conducted in wildlife or conservation research have assessed attitudes about the species in question (Bruskotter et al., 2007; Kaczensky et al., 2004; Lindsey et al., 2005), the TPB recognizes that attitudes will not predict behavior unless they are measured with corresponding levels of specificity: attitudes about objects (such as jaguars) will not necessarily predict behaviors (such as killing jaguars). In order for attitudes to predict behavior, the attitude and behavior must correspond on four levels of specificity: action, target, context and time. In this study, we could have had four different attitude objects: (1) killing (action), (2) killing a jaguar (action and target), (3) killing a jaguar on own property (action, target and context), and (4) killing a jaguar on own property in the near future, or the next jaguar that appears (action, target, context and time). Questions about attitude objects 1 and 2 should predict general intentions to kill jaguars in the future or indices of killing jaguars in the past, but would be poor predictors of the behavior described in attitude objects 3 and 4. Questions about attitude objects 3 and 4 are specific and would be expected to predict the behaviors described in the statements (Manfredo, 2008). We therefore assessed attitudes (and other TPB variables) related to the specific rancher's behavior of "killing (action) the next (time) jaguar (target) that appears on his property (context)".

A multitude of variables can be related to or influence attitude, subjective norm and PBC: age, gender, education, socioeconomic status, personality, emotions, general attitudes, religion, knowledge, past experience and so forth (Fig. 1). The TPB recognizes the potential significance of such background factors. Although reviews and meta-analyses have demonstrated broad support for the basic TPB (e.g., Ajzen and Cote, 2008; Armitage and Conner, 2001), it is acknowledged that for some behaviors and contexts, the inclusion of other variables may increase the predictive utility of the model. Descriptive norms and social identity are examples of such variables. Descriptive norms reflect an individual's perception of whether other people perform the behavior in question (Cialdini et al., 1990). Descriptive norms describe what is typical or normal, and motivate action by indicating what is likely to be effective, adaptive and appropriate action (White et al., 2009). For instance, a rancher who believes that all his neighbors kill jaguars will feel motivated to do the same. Social identity is that component of an individual's concept of himself that is derived from his knowledge of group membership, and the value and emotion attached to that membership (Tajfel, 1981). According to the social identity theory, people define and evaluate themselves in terms of distinct social categories [e.g. rancher, *pantaneiro* (i.e. native to the Pantanal)]. By allocating himself a particular social identity an individual is encouraged to accentuate both the similarities between himself and other group members, and the differences between himself and people outside the group (Fielding et al., 2009). A social identity approach assumes that if a certain behavior, for example killing a jaguar, is centrally linked to a social identity, then that behavior will be influenced by the norms of that social group rather than by the expectations and desires of generalized others.

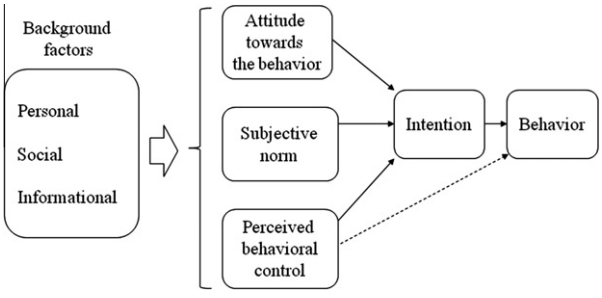

Fig. 1. Diagrammatical representation of the Theory of Planned Behavior.

1.2. Hypotheses

Perceptions of conflict with jaguars (more specifically, perception of jaguar impact on livestock and on human safety) were expected to affect intention: people who perceive that their livestock, or safety, is threatened by jaguars are more likely to intend to kill jaguars (Hypothesis 1). However, we hypothesized that the killing of jaguars by ranchers is not strictly retaliatory, and that by taking into account factors that are not related directly to livestock depredation, or threat to human safety (i.e. subjective norm and PBC), the TPB would offer a more predictive model of intention to kill jaguars (Hypothesis 2).

During the preliminary stages of this study we gathered anecdotal evidence of a social dimension to jaguar killing, especially in the Pantanal surveyed site. Evidence included photographs of hunted jaguars and jaguar paw trophies displayed prominently in ranchers' living rooms, boastful stories told by ranchers about their bravery in hunting jaguars, and repeated mention that killing jaguars is something that everybody does, or have done for generations, as an important element of the local tradition. Therefore, including descriptive norm and group identity in the model was expected to increase significantly the predictive utility of the TPB model (Hypothesis 3): ranchers who believe that other ranchers kill jaguars and identify themselves with those ranchers will have stronger intentions to kill jaguars themselves.

Attitude towards a particular behavior is measured using experiential items (i.e. how it feels to perform the behavior e.g. unpleasant–pleasant) and instrumental items (i.e. whether the behavior achieves something e.g. detrimental–beneficial and worthless–useful) (Ajzen and Fishbein, 1980). Retaliatory killing of jaguars is instrumental in nature: it is expected to bring the benefit of decreased livestock loss or increased human safety. Therefore, we predicted that attitudes towards killing jaguars would be affected by perceptions of jaguar impact on livestock and on human safety. Indeed, in the TPB, background factors are assumed to influence intentions and behavior indirectly by affecting attitude, norms and PBC: we predicted therefore that perceptions of conflict with jaguars would influence jaguar persecution indirectly by affecting attitude towards the killing of jaguars (Hypothesis 4).

Commercial, sport, and recreational hunting are prohibited in Brazil. Nonetheless, in remote areas of rural Amazonia and

Pantanal people do not expect to be penalized for breaking the law. Expectation of law enforcement and perceived risk associated with breaking the law are probably lower among large, affluent, and consequently, more influential ranchers. Furthermore, jaguars are more likely to be present on larger properties and their landowners more likely to have the resources for killing jaguars. In summary, the larger the property the more volitional control its owner should have over killing jaguars. Therefore, we hypothesized that perceived behavioral control increases with property size (Hypothesis 5).

While hosting relatively large populations of both cattle and jaguars (Cavalcanti et al., 2010), the two study areas differ distinctly in some socioeconomic aspects. The Amazon frontier was colonized recently by people from different parts of Brazil, including areas where jaguars had long been extirpated. Small family-owned farms coexist with large commercial cattle ranches on the Amazon frontier. In contrast, Northern Pantanal is home to a few traditional families that own large ranches and have been raising cattle in the region for generations. In communities where residents come from different parts of a country, for example, in frontier areas, there may be no consensus on what are acceptable or unacceptable behaviors towards wildlife. In other words, descriptive norms are unclear. Even if there is some agreement, many people may not care about the opinions of others, and so the subjective norm and group identity are less likely to influence behavior. In contrast, where traditional communities are intact and there is collective thinking and articulation about what constitutes acceptable practice, subjective norms and group identity may be sufficiently powerful to maintain practices that are illegal but socially encouraged. Therefore, we hypothesized that the relative importance of the social determinants of jaguar killing and perceived control over this behavior would differ between the Amazon deforestation frontier and northern Pantanal (Hypothesis 6).

2. Materials and methods

2.1. Study areas and participants

The Amazonia survey was carried out in the district of Alta Floresta, in the north of the State of Mato Grosso. Alta Floresta was founded in 1976 and colonized by migrant farmers from other parts of Brazil. Alta Floresta has approximately 49 000 urban inhabitants, and overall the district rears over 748 000 head of cattle (Brazilian Institute of Geography and Statistics, 2007). Cattle depredation by jaguars is regarded as a severe problem in Alta Floresta (Michalski et al., 2006), and persecution and habitat loss are major threats to jaguars there (Michalski and Peres, 2005). The Pantanal study was conducted in the districts of Cáceres and Poconé, also in the State of Mato Grosso. Cáceres and Poconé have approximately 84 000 and 31 000 inhabitants respectively, and cattle ranching is their main economic activity (Brazilian Institute of Geography and Statistics, 2007). As with the Amazon frontier, northern Pantanal rears large cattle herds (around 832 000 and 347 000 head in Cáceres and Poconé, respectively) (Brazilian Institute of Geography and Statistics, 2007) and livestock depredation by jaguars is a major complaint among ranchers (Marchini, 2003; Zimmermann et al., 2005).

The sample unit was the property, with either owner – but preferably the husband – from each surveyed (in a few large ranches, the ranch manager was interviewed when neither of the owners was available). We used a combination of sample selection techniques to maximize randomness and representativeness. Google Earth imagery (Google Inc., 2009) was used to map all roads within the study areas (available road maps do not include minor roads). Then we used a systematic sampling strategy, selecting every other property along randomly chosen roads. In Amazonia, ranches were easily accessible by land and all interviews were carried out on site. In the Pantanal some properties near the *Transpantaneira* highway could be visited but many others were inaccessible overland and so some ranchers, randomly selected from a list of members provided by the association of rural workers of Cáceres and Poconé, were interviewed in their second residences in town.

2.2. Procedures and measures

Interviews were conducted between March and October 2007 in Amazonia and between February and May 2008 in the Pantanal. The killing of jaguars is illegal and can be a sensitive issue for some ranchers. Therefore, some measures were taken to avoid response and interviewer biases. All interviews were conducted by SM, who is Brazilian and acquainted with the local culture and parlance in both study areas. SM was always accompanied by a male local field assistant during the interviews. SM was as objective and neutral in appearance and behavior as possible.

We conducted a pilot study using qualitative, semi-structured interviews (Oppenheim, 1998) with 130 people (90 rural and urban residents in Amazonia, and 10 ranchers and 30 urban residents in the Pantanal). By listening to people talk freely, we were able to identify salient beliefs, perceptions, and peculiarities of the local parlance, which were then used in the design of the questionnaire, and in adjusting our language to the target groups. During the piloting process, open-ended questions were replaced incrementally by clear, quantitative questions that would produce data suitable for statistical analysis. We used Cronbach's alpha to improve the internal coherence of the scales by discarding items to maximize the alpha value (Vaske, 2008).

We anticipated that some ranchers would feel inclined to omit their negative perceptions, attitudes, intentions and behaviors towards jaguars. Given that people attempt to provide answers consistent with the ones they have already given in the survey (Sudman et al., 1996; Tanur, 1992), questions were asked in the order in which we expected the likelihood of a deceiving answer to increase: questions of perceptions and attitudes first, then intention and, finally, behavior. All TPB components were measured according to the recommendations of Ajzen and Fishbein (1980) and Ajzen (1985). Where a TPB component was assessed using multiple questions, we created average scales to summarize that component. The variables used in the analyses and the items used to construct the variable scales are shown in Table 1. The variables are described in more detail below.

Perceptions of jaguar impact on livestock and on human safety were recorded on a 6-point scale coded 0–5 (no impact to high impact) according to the size of the impact. Respondents' attitudes towards killing jaguars were assessed by asking them to indicate their attitude towards killing the next jaguar that appeared on their properties, using five-point evaluative semantic differential scales. The attitude to jaguar killing scale ranged from −2 (most unfavorable) to 2 (most favorable). Subjective norms, descriptive norms, group identification, perceived behavioral control and intention to kill were recorded on a 5-point scale ranging from 1 (minimum) to 5 (maximum). We explained clearly to the respondents that by killing jaguars we meant using any of the methods and approaches used to kill jaguars in Amazonia and Pantanal (e.g. finding and pursuing a jaguar using dogs, creating a baiting station at which to shoot a jaguar, poisoning, and acting either alone or with others including hired professional hunters).

Three approaches were used to assess jaguar-killing behavior: (i) respondents were asked if they had ever killed a jaguar and, if so, when they had last done this; (ii) respondents were asked to say which of their neighbors had killed jaguars within the previous 5 years; and (iii) in Amazonia, two independent local

Table 1
Items used to measure each variable, Cronbach's coefficient alpha (α), and comparison of variables between the Amazon and Pantanal surveyed sites in the State of Mato Grosso, Brazil; means, standard deviations (SDs) and GLM results.

Variable/item	α	Amazonia		Pantanal		*F*	SE	*p*
		Mean	SD	Mean	SD			
Property size[a]		298.8	1581.1	5524.0	5342.4	209.30	368.63	<0.001
Perceived impact on livestock[b] Damage associated with depredation ever caused to you Damage associated with depredation ever caused to your neighbors Risk of any damage associated with depredation to you in the next 12 months Risk of any damage associated with depredation to your neighbors in the next 12 months	0.80	0.63	0.65	1.89	0.72	127.79	0.43	<0.001
Perceived impact on human safety[b] Number of people ever hurt by a jaguar in the neighborhood Number of family members ever hurt by a jaguar Risk of you being hurt by a jaguar in the next 12 months Risk of a family member being hurt by a jaguar in the next 12 month	0.76	2.95	0.59	2.57	0.89	13.54	0.42	<0.001
Attitude to jaguar killing[c] Killing the next jaguar the appears in your property would be: Bad – good Useless – useful Exciting –boring Beneficial – harmful Unenjoyable – enjoyable	0.90	0.25	0.91	0.42	1.24	1.10	0.16	0.296
Subjective norm[d] How many of the people important to you would disapprove of you killing jaguars? Most people important to me think that killing jaguars is admirable Among your neighbors, how much agreement would there be that it is a good thing to kill jaguars? In your family, how much agreement would there be that it is a good thing to kill jaguars?	0.85	1.85	0.71	2.70	0.91	50.30	0.12	<0.001
Perceived behavioral control[d] Whether I kill the next jaguar that appears on my property is up to me For me, to kill the next jaguar that appears on my property would be: The number of factors outside my control which could prevent me from killing the next jaguar that appears on my property are:	0.88	2.26	1.13	4.09	0.73	116.22	0.17	<0.001
Descriptive norm[d] How many of your neighbors do you think kill jaguars? Think of the landowners in (location) – what percentage of them do you think kill jaguars?	0.90	2.17	0.78	3.98	0.67	223.57	0.12	<0.001
Group identity[d] How much do you identify with the landowners in (location)? How much do you feel strong ties with the other landowners in (location)? In general, how well do you feel you fit into the group of landowners in (location)?	0.76	1.88	0.96	3.50	0.95	130.93	0.15	<0.001
Intention[d] I intend to kill the next jaguar that appears on my property If a jaguar appears on my property, I will try to kill it	0.92	2.40	1.13	3.47	1.25	33.92	0.18	<0.001

[a] Size in ha.
[b] Scale ranging from 0 to 5.
[c] Scale ranging from −2 to +2.
[d] Scale ranging from 1 to 5.

informants – a professional hunter and a veterinarian – indicated ranchers who were supposed to have killed jaguars in the previous 5 years. One year after the main survey we conducted a follow-up survey in Amazonia; we: (1) revisited a randomly-selected sub-sample of 40 respondents to ask them whether they had killed any jaguar since our last visit; and (2) asked the informants whether any of the study participants were supposed to have killed jaguars during the year since the survey. We used three different approaches (self-reporting, neighbor reporting and informant reporting) to guard against the likelihood that some respondents would fail to report their own killing behavior and, to a lesser degree, that of their neighbors.

2.3. Data analysis

All analyses were conducted in SPSS, version 14 (2005). For each study area separately we used χ^2 tests to test for a relationship between recent jaguar killing and intention to kill jaguars in the future (intention was recoded as a binary variable for this analysis, using 0 for no intention to kill jaguars and 1 for any level of intention). This provided a way of validating the measurement of intention. Pearson correlation coefficients were used to examine correlations between predictor variables. The internal consistency of scales was examined using Cronbach's alpha reliability coefficients (Vaske, 2008). Two sets of GLMs were performed to develop a predictive model of jaguar persecution for each study area. The first GLM analysis examined the prediction of intention to kill jaguars. Instead of an automated stepwise procedure, we carried out a structured comparison of specific models defined *a priori* based on different explanations of jaguar persecution. Because the models included multiple predictors that were somewhat correlated, we used sequential sum of squares (type I) models so that each effect in an individual model adjusted only for preceding effects in the model. The following models were assessed: (Model 1) perceptions of jaguar impact on livestock and on human safety; (Model 2) TPB variables; (Model 3) significant predictors of the TPB plus descriptive norm and group identity; and (Model 4) significant predictors of the extended TPB plus perceptions of jaguar impact on livestock and on human safety. We compared Models 1 and 2 to test the hypothesis that the TBP offers a more predictive model for jaguar persecution than the usual approach that assumes strictly retaliatory killing. By comparing Models 2 and 3 we examined whether adding descriptive norm and group identity to the TPB resulted in an increase in the predictive utility of the model. Finally, by contrasting Models 3 and 4 we assessed the contribution of the perceptions of conflict to the extended TPB. The second GLM analysis examined the effect of certain background factors ((i) perceived impact of jaguars on livestock, (ii) perceived impact of jaguars on human safety and (iii) property size) on those variables from the extended TPB that significantly affected intention to kill jaguars in the first GLM analysis.

3. Results

3.1. Characteristics of sample

On average, respondents in the Pantanal ($n = 48$) were older (mean = 54.8 years, SD = 11.8, range = 27–77) than those in Amazonia ($n = 220$, mean 42.4 years, SD = 13.1, range = 17–82). In the Pantanal, all respondents were male, whereas 26.7% of Amazonian respondents were female. This sample properly reflects relevant characteristics of the study populations: young landowners are more common in the small family-owned farms of the Amazon agricultural frontier and women are rare in the large, remote ranches of the Pantanal, and less likely to take part in the decision making process regarding jaguar management in the property. Table 1 presents additional information about the variables used in the analyses and comparisons between Amazonia and Pantanal.

3.2. Predicting intention to kill jaguars in the Amazon deforestation frontier

Both perceived impact of jaguars on livestock and on human safety were significant predictors of behavioral intention (Model 1) (Table 2). In support for Hypothesis 1, landowners who perceived a greater impact of jaguars on their livestock or their safety were more likely to intend to kill jaguars. However, in support for Hypothesis 2, the TPB model (Model 2) explained over twice as much of the variation in intention ($R^2 = 0.22$ compared with 0.10), even though subjective norm did not emerge as a significant predictor in the analysis. Landowners with more positive attitudes towards killing jaguars and a greater sense of control were more likely to intend to kill jaguars on their properties. In support of Hypothesis 3, the addition of descriptive norm (Model 3) accounted for a further 4.5% of the variation in intention to kill jaguars, over and above that explained by attitude, subjective norm and PBC. Respondents who perceived that other landowners killed jaguars had stronger intentions to kill jaguars.

Neither perceived impact on livestock nor perceived impact on human safety had a significant impact on intention to kill jaguars in the extended TPB model (Model 4), and inclusion of these variables accounted for only 1% of the variation in intention. Nonetheless, both perceived impact on livestock and on human safety had a significant effect on attitude ($\beta = 0.101$ and 0.126, respectively, both with $p < 0.001$), and therefore an indirect effect on intention to kill jaguars. These two findings provide support for Hypothesis 4: the perceived impact of jaguars on livestock and on human safety determine intentions indirectly by affecting attitude towards the killing of jaguars.

Property size was a significant predictor of perceived behavioral control ($\beta = 0.001$, $p = 0.015$). In support of Hypothesis 5, ranchers who owned large properties had a stronger sense of control over killing jaguars on their land. The main barriers to killing jaguars pointed out by the small landowners who perceived that killing jaguars was not under their volitional control were: fear of jaguars (43%); lack of skills (31%); lack of equipment (15%); and illegality (10%).

The above findings are summarized in Fig. 2. Landowners within the Amazon deforestation frontier were more likely to intend to kill the next jaguar that appeared on their property if they: (1) had more positive attitudes towards killing jaguars; (2) had a greater

Table 2
Results of GLM predicting intention to kill jaguars in the Amazon surveyed site in the State of Mato Grosso, Brazil.

Model	Predictor included	R^2	*B*	SE	*p*
1	Perceived impact on livestock	0.105	0.083	0.027	0.002
	Perceived impact on safety		0.110	0.031	<0.001
2	Attitude	0.222	0.510	0.076	<0.001
	Subjective norm		0.016	0.096	0.865
	Perceived behavioral control		0.178	0.061	0.004
3	Attitude	0.267	0.458	0.075	<0.001
	Perceived behavioral control		0.139	0.062	0.027
	Descriptive norm		0.322	0.088	<0.001
	Group identity		0.008	0.075	0.911
4	Attitude	0.278	0.458	0.084	<0.001
	Perceived behavioral control		0.139	0.060	0.027
	Descriptive norm		0.322	0.088	<0.001
	Perceived impact on livestock		0.033	0.026	0.207
	Perceived impact on human safety		0.039	0.030	0.198

sense of control over their jaguar-killing behavior; and (3) perceived that other landowners killed jaguars. Landowners with stronger perceptions of jaguar impact on livestock, or on human safety, had more positive attitudes towards killing jaguars. Larger landowners had a greater sense of control over their own jaguar-killing behavior.

3.3. Predicting intention to kill jaguars in the Pantanal site

Perceived impact of jaguars on livestock was a significant predictor of intention to kill jaguars (Model 1) (Table 3). Perceived jaguar impact on human safety had no significant impact on intention. In partial support for Hypothesis 1, landowners who perceived a greater impact of jaguars on livestock had stronger intentions to kill jaguars. The TPB (Model 2) offered a more predictive model, in support of Hypothesis 2. Even without a significant effect of perceived behavioral control, the TPB accounted for 55% of the variation in intention to kill jaguars. Ranchers with more positive attitudes towards killing jaguars and a greater perception of others' approval of jaguar-killing behavior had a stronger intention to kill the next jaguar that appeared on their properties. Descriptive norm and group identity (Model 3) emerged as significant predictors of intention, in support for Hypothesis 3. Ranchers who perceived that other ranchers killed jaguars and identified themselves with the other ranchers were more likely to engage in jaguar killing. Descriptive norm and group identity accounted for an additional 17% of the variation (over and above attitude and subjective norm), providing support for the inclusion of these variables in the model (Model 3). Including perceived impact on livestock and perceived impact on human safety in the extended TPB model (Model 4) did not improve the model significantly further (accounting for just 0.8% more of the variation in intention), and their effect on intention was not statistically significant. However, perceived impact of jaguars on livestock did have a significant effect on both attitude ($\beta = 0.172$, $p = 0.005$) and subjective norms ($\beta = 0.129$, $p = 0.006$), and therefore an indirect effect on intention to kill jaguars. Perceived impact of jaguars on livestock seems indirectly to determine intention by affecting attitude (and subjective norms), which supports Hypothesis 4.

Fig. 3 summarizes the above findings. Intention to kill jaguars in the Pantanal was greater among ranchers who: (1) had more positive attitudes towards killing jaguars; (2) believed there was normative support for performing such behavior; (3) perceived that other ranchers killed jaguars; and (4) identified themselves with the other ranchers. Ranchers who had a stronger perception of the impact of jaguars on livestock also had more positive attitudes towards killing jaguars and a stronger sense of social pressure to kill them.

Table 3
Results of GLM predicting intention to kill jaguars in the Pantanal surveyed site in the State of Mato Grosso, Brazil.

Model	Predictor included	R^2	*B*	SE	*p*
1	Perceived impact on livestock	0.200	0.193	0.061	0.003
	Perceived impact on safety		0.063	0.047	0.187
2	Attitude	0.552	0.323	0.115	0.007
	Subjective norm		0.734	0.152	0.000
	Perceived behavioral control		0.98	0.181	0.593
3	Attitude	0.722	0.345	0.089	<0.001
	Subjective norm		0.341	0.147	0.025
	Descriptive norm		0.550	0.162	0.001
	Group identity		0.431	0.132	0.002
4	Attitude	0.730	0.328	0.096	0.002
	Subjective norm		0.309	0.153	0.002
	Descriptive norm		0.530	0.165	0.003
	Group identity		0.448	0.134	0.002
	Perceived impact on livestock		0.039	0.042	0.359
	Perceived impact on safety		-0.014	0.031	0.645

The contrast between Figs. 2 and 3 supports Hypothesis 6: the relative importance of the social determinants of jaguar killing and perceived control over this behavior differs between the Amazon deforestation frontier and northern Pantanal.

3.4. Relationship between intention and behavior

The proportion of respondents intending to kill the next jaguar that appeared on their property was greater in the Pantanal (46%) than Amazonia (15%). No jaguar kills were observed or reported during the 12 months following the survey. However, by cross-referencing information provided by landowners and by independent informants, we identified 11 landowners in the Amazonia sample who had killed at least one jaguar on their property in the previous 5 years (six of these landowners had not reported these kills). This information was used to examine the relationship between landowners' declared intention to kill jaguars and their past jaguar-killing behavior. Most (82%) of the landowners that were confirmed to have killed jaguars in the previous 5 years said that they intended to kill the next jaguar that appeared on their property, whereas most (89%) of those that had not killed jaguars recently did not intend to do so in future ($\chi^2 = 40.5$, df: 1, $p < 0.001$). This relationship between measured behavioral intention and actual past behavior suggests that intention to kill jaguars may be a valid proxy for future killing behavior in Amazonia.

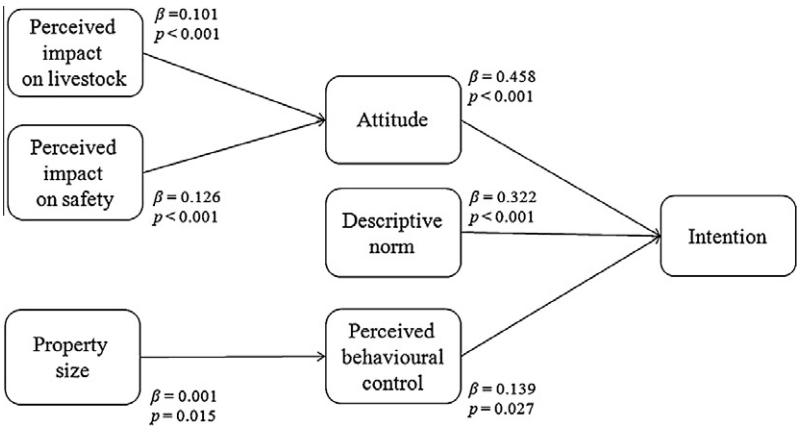

Fig. 2. Final model showing intention to kill jaguars in the Amazonia deforestation frontier, State of Mato Grosso, Brazil.

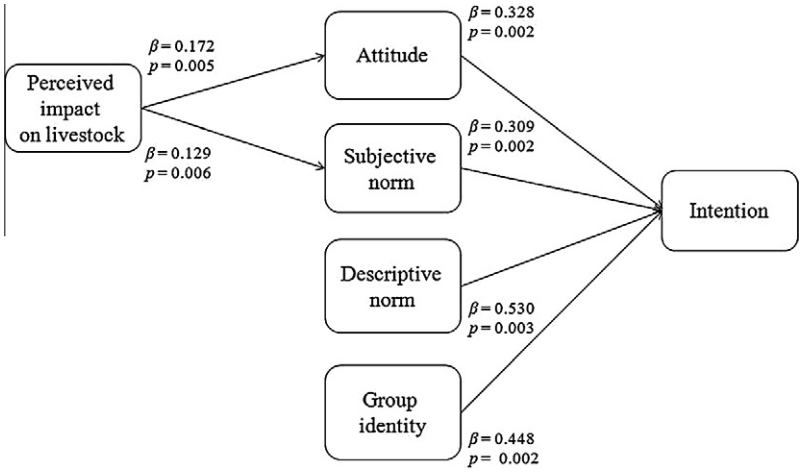

Fig. 3. Final model showing intention to kill jaguars in the Pantanal surveyed site, State of Mato Grosso, Brasil.

All seven ranchers in the Pantanal that reported killing at least one jaguar on their property in the previous 5 years said that they intended to kill the next jaguar that presented a similar opportunity. In contrast most (64%) of those that had not killed jaguars did not intend to do so in future (χ^2 = 8.9, df: 1, p = 0.003).

4. Discussion and conclusions

This study shows that the impact of jaguars on livestock is not the only predictor of a cattle rancher's intention to kill jaguars. Intention to kill jaguars is also determined by fear, personal and social motivations, and internal and external barriers to killing jaguars. The relative importance of these factors in determining intention varies with region and affluence. Conservation measures that aim to decrease jaguar persecution by ranchers will be more effective if these factors are taken into account.

Fear is an important factor in determining Amazonian landowners' intentions to kill jaguars. Fear affects intention through two distinct and opposing mechanisms. On one hand, fear of jaguar impact on human safety can increase the likelihood of a positive attitude towards killing jaguars, while, on the other, fear arising from landowners' own inability to kill jaguars (poor perceived behavioral control) may act as an internal barrier that limits their intention to engage in jaguar killing. A fear of jaguars is indeed common among the Amazonian frontiersmen (Cavalcanti et al., 2010), who are largely immigrants with little experience of jaguars and the forest, but fear of jaguars was also reported by some ranchers in the Pantanal. Jaguars are potentially dangerous to people, and a phobic response to the species might be instinctive. However, fear of jaguars varies with knowledge. The better informed people are about jaguars, the less they fear them (Cavalcanti et al., 2010.). After all, the strong fear of jaguars among Amazonian ranchers is not grounded in fact. Attacks on people by jaguars are extremely rare and have occurred almost invariably either when hunted jaguars are cornered or injured, or when jaguars are defending cubs or carcasses. The only documented, unprovoked, fatal attack by a jaguar on a human in Brazil occurred on 24 June 2008, when a young fisherman was believed to have been killed by a jaguar while sleeping in his tent on a bank of the Paraguay River in the district of Cáceres, northern Pantanal. This unique incident may have occurred as a result of jaguars becoming habituated to people around baits used to attract them to be photographed by tourists.

Attitude towards killing jaguars predicts landowners' intention to kill them in both Amazonia and the Pantanal. This attitude is shaped by both instrumental and experiential expectations. For example, landowners may favor killing jaguars because they consider such behavior beneficial and useful, as well as exciting and enjoyable. The thrill of the hunt may be an important additional motivation for retaliatory killing and may in some situations be the only reason for killing jaguars. Ranch hands that do not own livestock are known to kill jaguars on other people's ranches in the Pantanal, where absent owners have specifically banned the practice by (Cavalcanti, 2008). This provides further evidence that jaguar killing may be explained by personal motivations unrelated to the impact of jaguars on human livelihoods.

Social motivations are important determinants of the intention to kill jaguars in both Amazonia and the Pantanal. In the Pantanal, some ranchers justified their perception of the social approval of jaguar killing on the grounds of tradition. Ranchers and cowboys in the region often refer, with apparent pride, to the '*Pantaneiro* culture' and the conviction that jaguar hunting has been passed from generation to generation as an element of that culture. The subjective norm among Pantanal landowners is affected by their perception of jaguar impact on livestock; ranchers who perceive a strong impact of jaguars on livestock also perceive a strong peer pressure to kill jaguars. The economic and cultural centrality of cattle ranching in the region doubtless accounts for this correlation. It is widely perceived that jaguar killing is common in both Amazonia and the Pantanal, and the perception that neighbors often kill jaguars encourages landowners to intend to do the same. Despite it being an illegal practice, jaguar killing is not something people strive to keep secret. On the contrary, some perpetrators talk openly with other ranchers, about killing jaguars. Stories of jaguar hunting spread quickly among the community, are told repeatedly, and are often remembered vividly as a consequence. The ease with which stories of jaguar hunting are brought to mind among landowners could account for the strong descriptive norm concerning jaguar killing (Tversky and Kahneman, 1974). A vicious circle may exist in which hunts are readily remembered and repeated, often reaching other landowners, and creating the perception that jaguar killing is common and acceptable, which in turn causes more jaguars to be killed. Finally, social identity (group identity) also influences jaguar killing in the Pantanal. In our Amazon sample, many small landowners were settlers belonging to small, organized communities. Although group identity was greater among smaller settlers than among large landowners in the region, jaguar killing was not perceived to be an in-group behavior, and so group identity did not affect their intention to kill jaguars in Amazonia. In contrast, ranchers in the Pantanal have a strong group identity and perceive that jaguar killing is part of *Pantaneiro* culture. If perceived association of jaguar killing with in-group members is coupled with a perceived

association of jaguar conservation with out-group members, conservation efforts considered to emanate from outside the group may be poorly accepted and conflicts between ranchers and jaguars may be replaced by conflict, about jaguars, between ranchers and conservationists. The role of conflicts between human groups in resolving human–jaguar conflicts (Herda-Rapp and Goedeke, 2005) deserves further investigation.

Current behavior could not be measured. Consequently, the utility of the model to predict future behavior could not be verified. Jaguar killing is a particularly difficult behavior to measure for two reasons: (i) it is illegal and therefore some respondents might fail to report it; and (ii) it depends upon a contextual factor that is highly variable in time and space: an encounter with a jaguar. While most behaviors that have been addressed in TPB studies can be observed on a daily basis (e.g. exercising, recycling) or every month at most (e.g. reducing energy use) (Armitage and Conner, 2001), killing jaguars is something a rancher typically does when the opportunity arises, i.e. when a jaguar appears, e.g. a few times in 1 year and then not for several more years. Robust validation of the intention–behavior relationship would require the measurement of behavior either over several years for individual ranchers, or over larger areas encompassing a larger number of ranches than surveyed in this study. However this study provides some evidence that our measurement of intention to kill jaguars was valid: (i) observed relationships between intention and its predictors were consistent with expectations based on theory (Vaske, 2008); and (ii) there was a significant relationship between intention to kill jaguars and recent past killing behavior.

4.1. Further implications for conservation

Our model is not only useful to the extent that it can predict jaguar killing. It can also be used to assess the relative importance of the different factors that motivate or deter such behavior. Efforts to increase people's tolerance of jaguars and discourage jaguar killing have focused largely on economic incentives (e.g., monetary compensation for livestock loss; Silveira et al., 2006) and legal prohibitions and sanctions (e.g. establishment of protected areas). The role and importance of social and psychological factors have been far less considered. This study proposes a broader approach for understanding and preventing the killing of jaguars, an approach that goes beyond the usual framework of human–jaguar conflicts, and considers all the motivations and barriers – social and psychological as well as legal and economic – concerning jaguar killing.

Human behavior is partly determined by external, contextual factors (Clayton and Myers, 2009). The measures mentioned above aim to prevent jaguar killing behavior by changing the economic and legal contexts. Our findings, however, highlight the importance of social context. Social norms and social identity also affect jaguar killing and should be taken into account by conservationists. A number of techniques can be used to change social context. For instance, a persuasive communication campaign using models (i.e. conspicuous and respected group members or community institutions) might help to create or redefine a social norm by explaining that the community condemns rather than accepts the killing of jaguars.

Human behavior is also determined by internal, psychological factors (Clayton and Myers, 2009). This study revealed the importance of perceptions, knowledge, skills, attitudes and emotions such as fear and excitement in inciting the killing of jaguars. Education and information-intensive campaigns might be used to influence these factors in order to deter jaguar killing. The role of information in changing behavior is complex. While researchers agree that information alone will not necessarily motivate someone to adopt a new behavior (e.g. to tolerate jaguars) (Stern, 2000), it is equally clear that a lack of information can be a barrier to changing behavior (Schultz, 2002). Information interventions addressing livestock predation by jaguars might help ranchers correctly to identify a depredation event, implement preventive measures, and adjust exaggerated perceptions of jaguar impact on livestock and human safety to reality.

The behavioral approach explored in this study is relevant to the mitigation of the conflicts between people and other wildlife species, especially when the conflict involves deep rooted prejudices and feelings towards the species, which is often the case in the conflicts with large carnivores (Dickman et al., in press). As humans are the constant in the highly variable realm of human–wildlife conflict, and the course and resolution of conflict is determined by the thoughts and actions of the people involved, understanding the human behavior is the most crucial pre-requisite for developing effective mitigation (Manfredo and Dayer, 2004).

4.2. Conclusion

In neither Amazonia nor Pantanal would it be possible to construct an effective jaguar protection strategy based on a single field of influence. Jaguar killing results from the interplay between external incentives and internal influences, and effective strategies to prevent jaguar killing should therefore be based on the social and psychological aspects of human–jaguar relationships as well as on legal and economic considerations. We need to find and support ways to make jaguar killing not only unprofitable and illegal, but also socially and personally unacceptable.

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