

Management of Domestic Livestock Predation by Jaguars in Brazil

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Like other large predators, jaguars can prey on domestic livestock and are often killed in retaliation to this. The management of this conflict is not an easy task, as appropriate management measures depend on local landscape characteristics, herd husbandry practices, and the scale of the problem, as well as social situation and culture. In Brazil, the conflict between jaguars and ranchers has a considerable impact on jaguar populations. A lack of governmental help does not alleviate the problem. Here, the applicability of techniques used worldwide to manage the conflict between large predators and humans to examine management options for the jaguar-rancher conflict across the country's different biomes is evaluated. Major conflict zones in Brazil are mapped. Property zoning is recommended for the Amazon and smaller properties in the Pantanal. For the Caatinga, Atlantic Forest and partially the Cerrado, smaller scale approaches like guard animals or electric fences are applicable. Major conflict zones are located in the northwest of Brazil. Apart from the technical challenge, there is a political issue that must be tackled, namely, ascertaining who is responsible for developing and executing control measures for predator-human conflict in the country.

The exponential increase in human populations, combined with the world's demand for food, is creating ever-growing habitat conversion and fragmentation (Timan *et al.* 2001). Human population growth and expansion and the resulting habitat loss tend to increase the conflicts between people and wild animals, as the latter are forced to live closer to humans and their domestic livestock. Large carnivores, such as the jaguar, which require extensive areas and a stable natural prey base to live, are pushed into situations where they compete with humans for food and space. As a result, killing predators in reaction to or to prevent domestic livestock predation can have a considerable impact on carnivore populations. The jaguar is no exception to this trend: Though widely distributed, habitat conversion poses a major threat to the species (IUCN/SSC Cat Specialist Group, 1996). Known to prey on domestic livestock throughout its range (e.g. Rabinowitz 1986; Palmeira *et al.* 2008), hunting of jaguars in retaliation can seriously threaten local populations (IUCN/SSC Cat Specialist Group 1996; Fig. 1).

Although the above described predator-human conflict is increasing worldwide (see Treves & Karanth 2003), we still lack adequate solutions and management actions, the applicability of which is highly dependable on local factors. Actions can either prevent or increase tolerance for livestock predation and vary according to landscape characteristics, herd husbandry

practices, and the scale of the problem (Conover 2002). Moreover, geographic accessibility to conflict sites, combined with operational costs, can determine the viability of any proposed method. Thus, the identification and implementation of proper management practices demands good knowledge of the conflict site and its specific ecological, social and cultural characteristics.

With this in mind, we have selected from the literature the most common solutions used around the globe to mitigate conflict between large carnivores and humans and have assessed their applicability and potential efficiency, based on our own experiences, in the management of jaguar-rancher conflict across the different Brazilian biomes. To obtain a comprehensive picture of the problem in Brazil, we analyzed and mapped the potential jaguar-rancher conflict zones in the country.

Material and Methods

Identification and management of jaguar-rancher conflict

Management alternatives for predator and depredation control tested to date vary widely and can be very species-specific. Therefore, the first step in determining the most appropriate method to be used is to identify the predator responsible for the depredation. In the case of the jaguar, signs at a kill site could be confused with those left by a puma (*Puma concolor*) or by a large domestic dog. Thus, first, we compiled from our own experiences and the sci-

entific literature the characteristics and evidence typically found at a jaguar kill site. We then assessed management measures for the predator-human conflict used worldwide from the literature. Each of the measures was evaluated in terms of the operational, financial, political and socio-economic aspects and then overall rated as "recommended" or not. For this exercise, we took into account the conflict scenario expected for each Brazilian biome, given average property size, vegetation cover, predominant landscape features and local culture regarding the jaguar.

Jaguar-rancher conflict control measures can be classified according to three different approaches and scales, and we characterized each of the evaluated measures according to scale they address:

Problem animal - This approach concentrates on the individualization of the problem. Although any jaguar co-existing with cattle may eventually and occasionally prey on cattle, some individuals show a tendency to prey more consistently, inflicting greater financial losses to the ranchers. Generally, they are young animals in search of a territory, females with cubs, or old or injured individuals that have become unable to hunt wild prey (Rabinowitz 1986; Pitman *et al.* 2002). Management efforts should thus be specifically directed towards the problem animal rather than towards the entire carnivore population, which can coexist peacefully with domestic cattle.

Domestic herd - This approach adopts a “passive” point of view, focusing on herd management within the area of conflict. It is the traditional approach used by humans since ancient times (Linnell *et al.* 1996), utilizing, for example, night enclosures for livestock. The identification of the conflict at the herd level may also reveal problems associated with inadequate husbandry practices, avoiding the need to invest in alternative actions against depredating carnivores. For example, the absence of basic care (e.g. vaccination programs) makes domestic animals more vulnerable to predation (Pitman *et al.* 2002).

Landscape - This approach occurs at the environment level. The amount of wildlife damage depends in part on the landscape and land-use patterns in the broad area encompassed by the conflict site (Conover, 2001). The habitat and its degradation by human activities should also be considered; for example, the natural vegetation around and within pastures. Due to the cover they provide, areas close to forests and springs are more likely to be visited by predators (Pitman *et al.* 2002). Michalski *et al.* (2006), working in the Alta Floresta region (Northern Brazil), concluded that landscape variables such as distance to the nearest riparian corridor, proportion of forest area around farm headquarters, and the interaction between the distance to the corridor and the distance to the town are important predictors of the occurrence of predation events.

Distribution of potential jaguar conflict

In order to estimate and map the major expected jaguar conflict zones in Brazil, we overlaid the current jaguar distribution (see Tôrres *et al.*, this volume) with cattle abundance (heads of cattle per municipality) in the country (IBGE 2005). The zones were outlined as blocks of continuous jaguar presence and high cattle density, where conflicts are most likely to be present across the landscape.



Fig. 1. Jaguar cubs killed in the Pantanal by ranchers in retaliation to cattle predation (anonymous).

Results

Characterizations of a jaguar kill

Jaguars prey on a wide variety of wild animals, and may take domestic livestock as well, including pigs, horses and especially cattle. However, it is important to consider that they can also act as scavengers, feeding occasionally on carcasses (JCF, unpubl. data). Determining which type of predator is responsible for a kill can be difficult, although size can be an indicator. Prey smaller than 250 kg can be taken by any of the sympatric predators (e.g., jaguars, pumas, domes-

tic dogs), while kills greater than 250 kg can be definitively attributed to jaguars, since above this biomass the jaguar is virtually the only predator capable of preying on such large animals.

Kill – When analyzing a jaguar kill, some details should be taken into account: a) jaguars generally leave teeth marks in heavy dense bones such as the femur, the cranial base region or in the upper/lower part of the neck, causing fractures and ruptures of the vertebrae; b) many large prey are killed by jaguars breaking the neck and it is

Table 1. Methods used worldwide to control and/or prevent livestock predation by carnivores, characterization as to what scale of the conflict they address, and an assessment of their applicability for controlling/preventing jaguar livestock predation in the different Brazilian biomes. Methods considered as “Recommended” were marked with an “X” and those recommended depending on the property characteristics were marked with a “P” (partially).

Method	Scale	Atlantic				
		Amazon	Forest	Caatinga	Cerrado	Pantanal
Killing of problem animal	Problem animal	X			P	X
Guard animals	Herd	X	X	X		
Visual barrier	Problem animal	X		X		
Electric fence	Herd	X	X	X		
Protection collar	Herd					
Financial compensation	Problem animal / herd	X	X	X	X	X
Visual/audial stressors	Herd					
Propane explosives	Herd					
Herd management	Herd	P	X	X	P	P
Electronic guard	Herd					
Removal of problem animal	Problem animal	X	X	X		
Non-lethal shots	Problem animal					
Zoning of property	Landscape	X	X	X	X	X

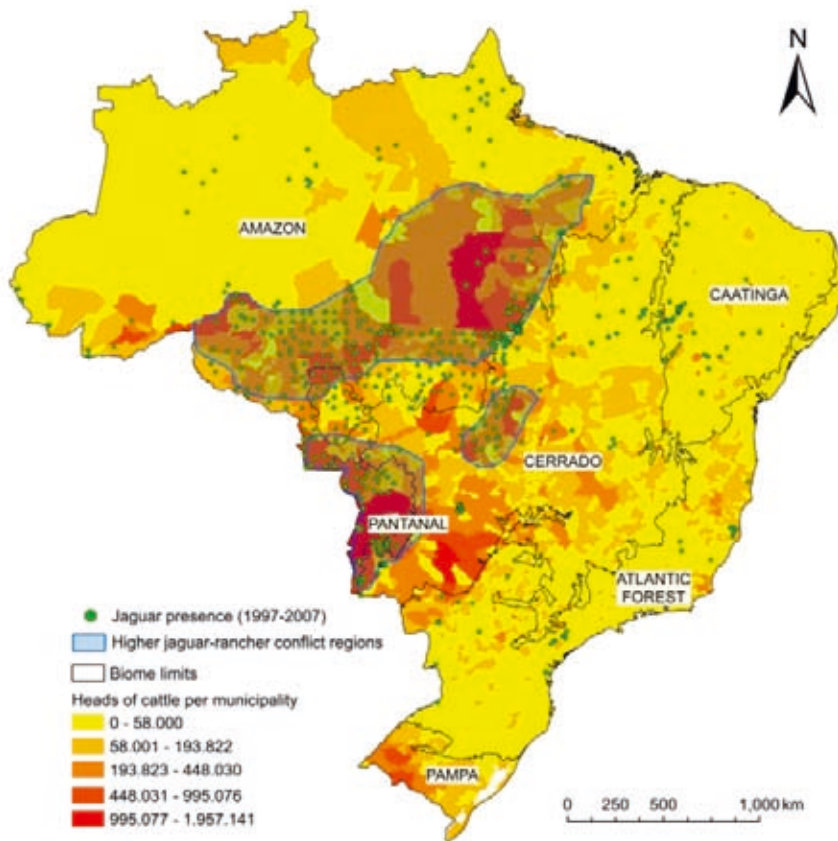


Fig. 2. Expected jaguar-rancher conflict zones in Brazil determined by current jaguar distribution overlapped with cattle abundance per municipality.

common to see the head of the animal turned backwards; c) unlike pumas, it is uncommon for jaguars to bite the throat to kill the prey by suffocation; d) in general, jaguars start to eat at the foreside of the prey and later the ribs and medial portion of the carcass; their preferred parts are the throat, the lower part of the neck, the hump and the chest, leaving the forelimbs untouched; small animals, such as calves, are generally entirely consumed; e) generally, jaguars do not cover the carcass with leaves and dirt as does the puma, but instead can drag it for distances as far as 1.5 km and hide it in vegetative cover (Pitman *et al.* 2002).

Kill site - When looking at a fresh kill scene it is important to check for fresh tracks. Compared to pumas and dogs, jaguar tracks are more rounded, their width is greater than their length and the toes are more rounded (for details see Miller and Jug 2001).

It is important to combine both evidence (the kill) and scenario (the environment) and analyze if there is enough

evidence to determine the predator. For instance, any of the sympatric predators can visit and eat parts of an existing kill and therefore confound the evidences. Only a careful analysis of all factors can yield an accurate identification of the predator.

Conflict control measures

We compiled 13 methods used to prevent, mitigate and/or eliminate large carnivore conflict (Table 1, for a description of the methods see Appendix I; a list of references used for this compilation can be obtained from the lead author upon request). Of those, 5 address conflict at the level of the problem animal, 8 address herd management, and 1 acts at a landscape scale. One method is applied at more than one level: financial compensation for livestock losses to predation can be seen as a kind of insurance, working at the herd level, while this measure can also be used to create tolerance for a problem animal where removal or elimination is not recommended. Among the five biomes,

the Amazon was eligible for 8 of the management measures, followed by the Caatinga (7), Atlantic Forest (6), Cerrado, and Pantanal (4, both). Land use patterns may vary significantly within a biome. Therefore, when analyzing the applicability of the methods, we attributed the term “partially” to those methods that we considered could only be implemented in restricted situations or regions of the biome.

Distribution of potential jaguar conflict
Combining herd size for each of the 2,193 municipalities in Brazil with current jaguar distribution (Tôrres *et al.* this volume), we identified three expected conflict zones in the country, all located in the northwestern portion of the country (Fig. 2).

Discussion

Amazon Rainforest

In the Amazon Rainforest, jaguar-livestock conflict is concentrated in the region known as the arc of deforestation (Fig. 2). This region is characterized by properties where a considerable portion of the natural forest has been converted into non-native pastures, leading to a convergence of jaguar habitat and cattle ranching. For this biome, we suggest the use of property zoning, that is, establishing delimited zones for cattle graze, safeguard and drinking points away from bush areas, reducing the chances of encounters with jaguars. Financial compensation for livestock losses caused by jaguars may also be considered; however, as this measure is not readily applicable at a large scale, mainly due to financial restrictions, it should be an alternative only for key areas where the loss of a single jaguar has considerable impact on its local population. The killing of a problem jaguar is only recommended when all other methods have failed, and only after a careful and thorough analysis of the situation.

Atlantic Forest

The agricultural structure of this biome is characterized by properties whose land ownership and/or occupation are long established, going back to colonial times. Cattle predation by jaguars is restricted to areas that still retain remnants of original forest: these are the southeast

portion of the Coastal Atlantic Forest in the São Paulo and Paraná States and the portion of the Mesophile Atlantic Forest in the São Paulo, Mato Grosso and Paraná States. For this biome, the introduction of guard animals may be tested to prevent jaguar attacks, as this method has been shown to work well with pumas (Rogério Cunha, personal communication). Electric fences are also recommended for small properties with intensive livestock management. Financial compensation for livestock losses is recommended at a local scale, accompanied by social-educational programs on how to prevent conflicts. Considering that properties in this biome are usually small, zoning is recommended as a viable alternative. The removal or translocation of a problem jaguar should be considered only in the most extreme cases, as jaguars are particularly threatened in this biome.

Caatinga

In comparison to the other Brazilian biomes, the Caatinga is the most adverse region for cattle ranching. Properties sizes are, on average, smaller and would favor localized management methods. Its harsh climatic conditions and dense semi-arid vegetation hinder extensive cattle enterprises. However, ranchers in this region usually raise cattle on a subsistence scale and are too poor to invest additional money in jaguar avoidance methods. Poverty among the Caatinga ranchers is already responsible for poor husbandry practices of their small herds of dairy cattle and goats. Although small properties and small herd size allow for the use of more localized management options, most of them would be too expensive for the rancher to implement without an outside sponsor. We recommend electric fences and visual barriers as potential methods to be tested, because they can be effectively applied to small to medium scale properties. Considering the critical status of the Caatinga jaguar (Sollmann *et al.*, this volume), we do not recommend killing of problem animals as a management alternative.

Cerrado

In the Cerrado, conflict is mainly concentrated in an area near the Amazon border. Herd management and property



Fig. 3. Jaguar cubs feeding on a bull killed by their mother on a Pantanal ranch (Photo by Jaguar Conservation Fund/Instituto Onça-Pintada).

zoning are recommended for smaller properties (up to 200 hectares). In this case, we consider that methods such as guard animals, electronic guards (automatic devices that emit a series of audio/visual stressors) and electric fences should be tested. A compensation program might be considered in joint collaboration between governmental and non-governmental organizations. However, this alternative should be prioritized around key jaguar populations. For example, in Emas National Park, State of Goiás, where no more than 30 jaguars are thought to live, we should not risk to lose a single individual due to jaguar-rancher conflict. Methods such as visual/auditive stressors or propane explosions should be tested in a long-term experiment in order to verify responses from problem-jaguars.

Pantanal

The Pantanal constitutes the third major jaguar-rancher conflict zone in Brazil. The biome is a seasonal flood plain with vast areas of natural pastures that offer good conditions for grazing. About 95% of the Pantanal is privately owned, of which some 80% is used for extensive cattle ranching. To increase cattle density on their lands, ranchers have been converting natural grasslands into exotic pastures since the early seventies. This long rancher presence has enabled jaguars to live close to cattle and incorporate them in their diet since the early stages of their lives (Fig. 3). Ranches

in the Pantanal are usually large, where some may reach several hundred thousand hectares. We therefore consider herd management an alternative only for properties up to 1.000 hectares. As the Pantanal is very heterogeneous in terms of vegetation cover and habitat distribution, property zoning may not be applicable to all regions. Financial compensation programs should be applied in key areas. The killing of problem jaguars should be considered only where high abundance of the cat is proven. Sport hunting as a management tool could be tested in this biome. However, the killing of problem animals is recommended only in extreme cases and should never be considered as the first option.

The jaguar-rancher conflict dilemma in Brazil: who is responsible for what?

Usually governmental institutions around the world base their actions regarding predator-human conflict on three distinct strategies that can be summarized as: 1) eliminating the predator (Treves & Naughton-Treves 1999, Treves & Karanth 2003); 2) regulated harvest (Harbo & Dean 1983, Okarna 1993, Landa *et al.* 1999, Angst 2001, Treves & Karanth 2003), and 3) preservation, through full legal protection (Karanth *et al.* 1999, Rangarajan 2001), sometimes along with compensation programs (Montag 2003, Naughton-Treves *et al.* 2003, Treves & Karanth 2003). However, when searching for

Brazil's official experience and statistics (state and federal) on managing the jaguar-rancher conflict there is virtually nothing available in the scientific literature or governmental database.

In Brazil, hunting has been regulated since 1967, when the first Fauna Law was created (Law 5197-67-03/01/1967). In this law, the Brazilian State declares itself as proprietary of all the wildlife species, forbidding hunting in all circumstances, except for scientific purposes. A later complement of this law (Law 9605-1998) states that the "destruction" of wild animals is permitted when considered as "pests" to agriculture and public health. On the other hand, permits to eliminate such pests can only be given by a not specified "competent authority."

The Brazilian Constitution of 1988 says that the State and the people should preserve and defend the environment, but that the State should be responsible for preserving and restoring essential ecological processes, thus providing ecological management of species (Art. 225). The Federal Government is responsible for the establishment of general directions (Art. 24) and states and municipalities have powers to legislate over specific issues, including hunting, fishing, and nature conservation (Art. 23 & 24). Later, the Law for *Environmental Crimes* (Law 9605-1998) complemented the one from 1967, extending to prison the punishment to those that hunt endangered species such as the jaguar. Therefore, based on the current Brazilian legislation, the aspect of management of a predator such as the jaguar still relies, in practice, on the goodwill of the government to implement the law for pest control and determine who has the responsibility to execute it.

The existing techniques to eliminate, reduce or compensate losses from jaguars still seem unsustainable in a large country with such heterogeneous landscapes as Brazil, where land use and management practices vary among the five distinct biomes. There is no formal and official authorization or government statistics of predator management in the country. It still stands as if this problem did not exist nor needed any special attention. Therefore, jaguar management in Brazil seems to be more of a political than a technical challenge.

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Supporting Online Material SOM

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Appendix I: Description of conflict control measures