

Short Communication

Hunting of jaguars and pumas in the Tapajós–Arapuins Extractive Reserve, Brazilian Amazonia

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Abstract We surveyed the Tapajós–Arapuins Extractive Reserve in Brazilian Amazonia to investigate hunting of jaguars *Panthera onca* and pumas *Puma concolor*. We interviewed 115 people in 45 villages in 2007–2008, and recorded numbers of jaguars and pumas killed and the circumstances associated with each killing. At least 32 jaguars and 22 pumas were killed in the Reserve, most within the last 10 years. However, these are underestimates because people probably did not mention all kills during interviews. The first-order jackknife suggests that the actual mortality for the two species is almost double that reported. Using data from 2006–2007 as a reference we estimated a minimum mortality of 12 jaguars and seven pumas per year in the Reserve. Most animals were killed during chance encounters, a large number of these elicited by domestic dogs. Hunting motivated by livestock predation or perceived risks to human life were rare. Hunters kill large carnivores on sight and thus one alternative to reduce hunting is to take measures that will decrease encounter rates, such as forbidding hunting with dogs. Education and extension programmes are needed to ensure the long-term coexistence of humans and large carnivores in this Reserve.

Keywords Brazil, human–wildlife conflict, hunting, *Panthera onca*, *Puma concolor*, Tapajós–Arapuins Extractive Reserve

Jaguars *Panthera onca* and pumas *Puma concolor* are declining across most of their range, generally because of hunting and habitat loss (Currier, 1983; Sanderson et al., 2002; Zeller, 2007). The relative importance of these impacts varies from place to place. The impact of habitat loss is easier to evaluate than hunting because the latter occurs secretly, and it is thus difficult to obtain reliable estimates of hunting pressure (Smith, 1976; Chetkiewicz & Raygorodetsky, 1999). Because hunting may occur in the absence of habitat loss, and even inside protected areas

(Woodroffe & Ginsberg, 1998), estimates of hunting impact on these felids are needed. Here, we present an investigation of hunting of jaguars and pumas in the Tapajós–Arapuins Extractive Reserve in Brazilian Amazonia.

Tapajós–Arapuins is a 650,000 ha reserve located west of the Tapajós River in Central Amazonia (Fig. 1). The Reserve is inhabited by 15,000 people of mixed Indian and European descent, living in 70 villages and engaged in slash-and-burn agriculture, extraction activities, fishing, hunting and livestock rearing. Vegetation cover is mostly undisturbed rainforest but some areas have been deforested or logged. Mean annual temperature is 27°C and mean annual rainfall 1,950 mm.

From October 2007 to October 2008 we visited 45 villages and conducted 115 interviews. The villages cover the spectrum of social and environmental variation within the Reserve. In the interviews we asked people if they were aware of any big cat killed in the village. If the answer was affirmative we gathered as much additional information as possible, including site, date and circumstances of the kill, and species and sex of the animal killed. Whenever possible we checked data by speaking personally to the hunter or his family and we examined all available evidence of kills, such as body parts and photographs. We used data on number of kills to estimate the minimum number of large felids killed annually in the Reserve, and data on circumstances of hunts to evaluate mortality patterns and potential ways to reduce hunting. Contradictory information was discarded.

People reported the killing of at least 32 jaguars and 22 pumas, most within the last 10 years (Table 1). However, these are probably underestimates. People fear reprisals and earlier killings may not be recalled with the same facility. To evaluate error resulting from interviewees withholding information we estimated the number of cats killed since 1998, using the first-order jackknife (Manly, 1997). The input data for the analysis was a presence–absence matrix in which each interview was a sample (row) and each individual cat killed was a column. For the jaguar, the jackknife estimate is 54.6 animals killed, a number 95% higher than the 28 cases reported for the period. For pumas, the jackknife estimate is 37.7 animals killed, 88% more than the 20 cases reported.

Assuming that recent data are more reliable, and considering that 2008 was not completely sampled, we used only data for 2006–2007 to estimate minimum annual mortality. Surveyed villages represent 64% of all villages, so we corrected the estimate by multiplying by 1.56. Fifteen

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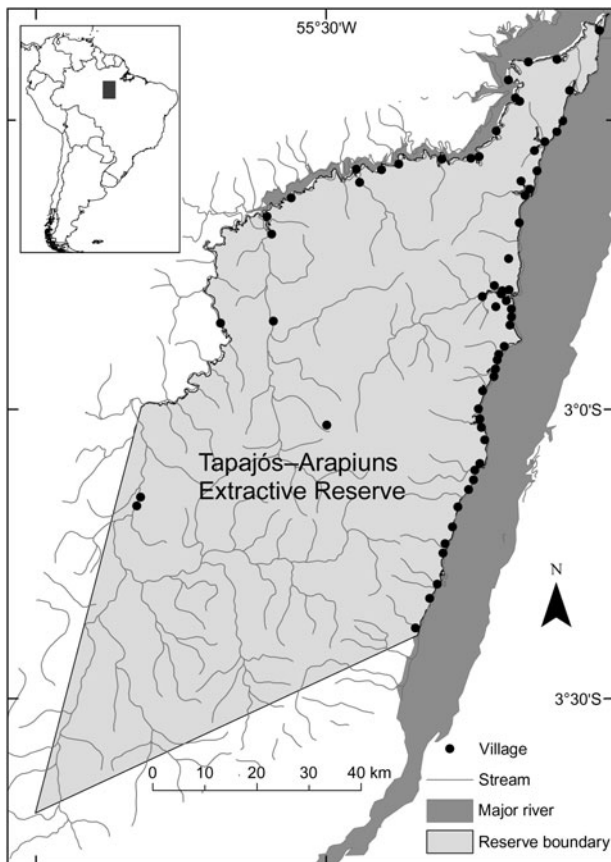


FIG. 1 Tapajós-Arapiuns Extractive Reserve, Central Amazonia, showing the distribution of villages and the main river drainages. The square in the inset indicates the location of the main figure in South America.

jaguars were killed in 2006–2007 or 7.5 jaguars per year, a number similar to the jackknife estimate of 5.46 animals per year. The corrected estimate for the entire Reserve is 11.7 jaguars killed annually. We obtained detailed data on the killing of 18 of the 32 jaguars, including circumstances,

TABLE 1 Number and sex of jaguar *Panthera onca* and puma *Puma concolor* killed annually in the Tapajós-Arapiuns Extractive Reserve according to reports from local people.

Year	Jaguar			Puma		
	Female	Male	Unknown	Female	Male	Unknown
<1998			4			2
1998		1				
1999						
2000						
2001		1	1			
2002		2				
2003		1	1			1
2004	1	1	1		2	1
2005	1		1	2	1	1
2006		1	6		1	2
2007		1	7	1		5
2008		1		2		1
Total	2	9	21	5	4	13

methods used to find the animals, and their sex. Most (67%, $n = 12$) were killed during chance encounters. In nine of these cases people were hunting for other species, in two the jaguar appeared near a village and was subsequently hunted, and in one the jaguar was swimming in a river and was clubbed to death by people on a boat. Few jaguars (33%, $n = 6$) were hunted as reprisal for killing livestock. People informed us of the methods used to find nine jaguars: four were found with dogs, two by ambushing near a jaguar kill, and three by chance. We obtained information on the sex of 11 jaguars: nine males and two females, a sex ratio of 4.5:1. We examined evidence of three kills (the canines, and photographs, of two jaguars and the skull of a third).

Nine pumas were killed in 2006–2007, or 4.5 pumas per year, a number similar to the jackknife estimate of 3.8 per year. The corrected estimate for the entire Reserve is seven pumas killed annually. We obtained detailed data on the killing of 13 of the 22 pumas. Most (77%, $n = 10$) were killed during chance encounters. In eight of these cases people were hunting in the forest and, in two, pumas appeared near a village and were subsequently hunted. Three pumas (23%) were hunted as reprisal for killing cattle. People informed us of the methods used to find eight pumas: six were found with dogs, one by ambushing near a puma kill, and one by chance. We obtained information on the sex of nine pumas: four males and five females, a sex ratio of 0.8:1. We examined evidence of five kills (a freshly killed puma, two skulls, a skin and a photograph).

Causes of mortality were similar for both species: they were killed during chance encounters or, in a few cases, the hunter was specifically searching for them. Few hunts were motivated by livestock predation or risk to human life. In most instances the felids were encountered with the intervention of dogs, the presence of which increases encounter rates as they are effective in detecting large felids (Khan, 2009). Thus, one way to reduce mortality of jaguars and pumas could be to forbid hunting with dogs. This recommendation is already included in the management plan for the Reserve but needs to be enforced.

Despite the similarities in mortality patterns between the two species, there were two differences. Firstly, jaguars were killed almost twice as often as pumas. It is unclear, however, whether jaguars are more vulnerable or are being hunted in proportion to their abundance. We do not have the data for these species in the Reserve to allow us to distinguish between these possibilities. However, previous studies have reported higher densities of jaguars than pumas in rainforests and wetter habitats (Silver et al., 2004; Kelly et al., 2008), suggesting that jaguars may be more abundant than pumas in this Reserve. Secondly, the sex ratio of jaguars was strongly male-biased but that of pumas was close to unity. Other studies have also detected male-biased sex ratios in jaguar populations (Silver et al., 2004; Soisalo & Cavalcanti, 2006) and this is expected: males are more vulnerable to hunting than females

because they move more and are bolder (Rabinowitz, 1986). The puma sex ratio is also similar to that of other populations (Currier, 1983; Scognamillo et al., 2003) but is unexpected: male pumas are also bolder than females and thus expected to be more vulnerable to hunting (Currier, 1983).

We do not have data for the populations of these species in the Reserve to determine whether hunting of them is sustainable. However, assuming there are 600,000 ha of remaining habitat in the Reserve and a density of three jaguars per 100 km² in Amazonian rainforest (Silver et al., 2004), then there would be c. 180 jaguars in the Reserve and the annual mortality of 11.7 animals would correspond to 6.5% of the population. Similarly, assuming a density of two pumas per 100 km² in rainforest (Kelly et al., 2008), there would be c. 120 pumas in the Reserve and the annual mortality of 7.0 pumas per year would correspond to 5.8 % of the population. These estimates are obviously conservative, considering that the actual hunting pressure for both species is almost certainly higher than our minimum estimates. Whether such a hunting pressure is sustainable will depend on jaguar and puma population sizes and on conditions outside the Reserve (i.e. on the source–sink dynamics).

The large size of the Reserve, good forest cover of the surrounding areas, and the riverine distribution of human settlements (Fig. 1; which means that large continuous tracts of undisturbed forest remain inside the Reserve), favour the conservation of these two large felids. However, this situation is likely to worsen as human population increases and the amount of available habitat and prey decreases. Reprisal hunts are likely to become more prevalent because cattle raising is spreading (there are currently c. 5,000 cattle inside the Reserve; E.A.R. Carvalho Jr, unpubl. data). In addition, most villagers have a negative attitude towards large felids. Extractive Reserves are designed to allow sustainable use of the forest but this negative perception means that long-term coexistence between humans and carnivores is problematic. To help achieve this coexistence we recommend enforcement of existing laws regarding wildlife use in the Reserve, the banning of hunting with dogs, education for a more tolerant attitude of the local people towards large wild carnivores (Conforti & Azevedo, 2003), and extension work that includes measures to decrease livestock depredation by large cats (Hoogesteijn, 2001; Azevedo & Murray, 2007).

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References

- AZEVEDO, F.C. & MURRAY, D.L. (2007) Evaluation of potential factors predisposing livestock to predation by jaguars. *Journal of Wildlife Management*, 71, 2379–2386.
- CHETKIEWICZ, C.B. & RAYGORODETSKY, G. (1999) *Jaguar Reconnaissance Survey in Mamirauá and Amanã Sustainable Development Reserves*. Unpublished Report. Wildlife Conservation Society, New York, USA.
- CONFORTI, V.A. & AZEVEDO, F.C.C. (2003) Local perceptions of jaguars (*Panthera onca*) and pumas (*Puma concolor*) in the Iguaçu National Park area, south Brazil. *Biological Conservation*, 111, 215–221.
- CURRIER, M.J.P. (1983) *Felis concolor*. *Mammalian Species*, 200, 1–7.
- HOOGESTEIJN, R. (2001) *Manual on the Problems of Depredation Caused by Jaguars and Pumas on Cattle Ranches*. Wildlife Conservation Society, Tikal, Guatemala.
- KELLY, M.J., NOSS, A.J., DI BITETTI, M.S., MAFFEI, L., ARISPE, R.L., PAVIOLO, A. et al. (2008) Estimating puma densities from camera trapping across three study sites: Bolivia, Argentina, and Belize. *Journal of Mammalogy*, 89, 408–418.
- KHAN, M.M.H. (2009) Can domestic dogs save humans from tigers *Panthera tigris*? *Oryx*, 43, 44–47.
- MANLY, B.F.J. (1997) *Randomization, Bootstrap and Monte Carlo Methods in Biology*. Chapman & Hall, London, UK.
- RABINOWITZ, A.R. (1986) Jaguar predation on domestic livestock in Belize. *Wildlife Society Bulletin*, 14, 170–174.
- SANDERSON, E.W., REDFORD, K.H., CHETKIEWICZ, C.B., MEDELLIN, R.A., RABINOWITZ, A.R., ROBINSON, J.G. & TABER, A.B. (2002) Planning to save a species: the jaguar as a model. *Conservation Biology*, 16, 58–72.
- SCOGNAMILLO, D., MAXIT, I.E., SUNQUIST, M. & POLISAR, J. (2003) Coexistence of jaguar (*Panthera onca*) and puma (*Puma concolor*) in a mosaic landscape in the Venezuelan llanos. *Journal of Zoology*, 259, 269–279.
- SILVER, S.C., OSTR, L.E.T., MARSH, L.K., MAFFEI, L., NOSS, A.J., KELLY, M.J. et al. (2004) The use of camera traps for estimating jaguar *Panthera onca* abundance and density using capture/recapture analysis. *Oryx*, 38, 1–7.
- SMITH, N.J.H. (1976) Spotted cats and the Amazon skin trade. *Oryx*, 13, 362–371.
- SOISALO, M.K. & CAVALCANTI, S.M.C. (2006) Estimating the density of a jaguar population in the Brazilian Pantanal using camera-traps and capture-recapture sampling in combination with GPS radio-telemetry. *Biological Conservation*, 129, 487–496.
- WOODROFFE, R. & GINSBERG, J.R. (1998) Edge effects and the extinction of populations inside protected areas. *Science*, 280, 2126–2128.
- ZELLER, K. (2007) *Jaguars in the New Millennium Data Set Update: The State of the Jaguar in 2006*. Unpublished Report. Wildlife Conservation Society, New York, USA.

Biographical sketches

ELILDO CARVALHO JR, is a herpetologist who has been involved in wildlife research and conservation in Amazonia since 2001. He currently works at Grande Sertão Veredas National Park in central Brazil where he is evaluating the conservation status of Cuvier's dwarf caiman and broad-snouted caiman. JUAREZ PEZZUTI's main interests are in applied ecology and the sustainable use of natural resources by traditional peoples.