

First assessment of the conservation status of the jaguar *Panthera onca* in the Sierra Madre de Chiapas, Mexico

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Abstract Although the Near Threatened jaguar *Panthera onca* ranges from the south-west USA to central Argentina, populations outside Amazonia are generally small and isolated. One such area, the Sierra Madre de Chiapas in the state of Chiapas, Mexico, is potentially an important area for jaguar conservation but information on the species in this region is limited and its conservation status is unknown. In this study we documented the occurrence and abundance of jaguars in the Sierra Madre de Chiapas complex. We compiled all available records of the species within the region and conducted a camera-trap survey during August 2015–December 2016. Interviews were conducted to determine the perception of the jaguar by cattle owners and to obtain information on any livestock predation. We found that jaguars still occur throughout the Sierra Madre de Chiapas landscape, including the plains on the Pacific Coast of Chiapas, but its abundance in the region is low. On the basis of our findings we have incorporated the Sierra Madre de Chiapas in Mexico's National Jaguar Conservation Strategy, and recommend that international organizations include this area in their priorities for jaguar conservation. To improve coexistence between jaguars and the communities of the Sierra Madre de Chiapas, strategies need to be developed, in collaboration with the local communities, to improve livestock practices for reduction of predation by jaguars, to strengthen government conservation policies and to implement educational and communication programmes about the importance of this species in the region.

Keywords Camera trap, conservation, Mexico, occurrence, *Panthera onca*, Sierra Madre de Chiapas

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Although the jaguar *Panthera onca*, categorized as Near Threatened on the IUCN Red List (Quigley et al., 2017), ranges from the south-west USA to central Argentina, populations outside Amazonia are generally small and isolated (de la Torre et al., 2018). One such area, the Sierra Madre de Chiapas in the state of Chiapas, Mexico, is potentially an important area for jaguar conservation but information on the species in this region is limited. To provide information for Mexico's National Jaguar Conservation Strategy, we document here the occurrence and abundance of the species in this region.

The Sierra Madre de Chiapas (Fig. 1) is one of the most biodiverse regions in Mexico, with tropical rainforest, montane cloud forest, pine–oak forest, and tropical deciduous forest (Pérez-Farrera et al., 2006). The complex of the Sierra Madre de Chiapas comprises the Natural Resources Protection Area La Fraileskana (1,775 km²) and two Biosphere Reserves, El Triunfo (1,191 km²) and La Sepultura (1,673 km²). The terrain is rugged and steep, with altitudes of 280–2,600 m. Climate is tropical to subtropical, with a rainy season in May–October. Mean annual temperatures are 22–26°C, and mean annual rainfall is 1,200–2,000 mm at mid–low altitudes and 4,000 mm at the highest altitudes.

We compiled all available historical records for the species in the region from the National System of Information on Biodiversity. Additionally, we include confirmed records of individuals that were poached and confirmed records of jaguar signs. To document the jaguar's current presence in the region we deployed 55 camera-trap stations during August 2015–December 2016 in c. 420 km² of the Natural Resources Protection Area La Fraileskana. Camera traps were installed at a height of 40 cm from the ground and distances between camera-trap stations were 385–3,373 m (mean distance 1,073 ± SD 753 m). Total sampling effort was 9,274 trap-days. Individual jaguars detected were identified in the images and videos by the pattern of their pelage (Silver et al., 2004).

To make a rapid assessment of the perception of the jaguar by the local communities and to obtain information on any jaguar predation on domestic animals, we interviewed 102 cattle owners in the Natural Resources Protection Area La Fraileskana. We used a semi-structured questionnaire with three sections: knowledge about jaguars, cattle loss and perceptions (Table 1).

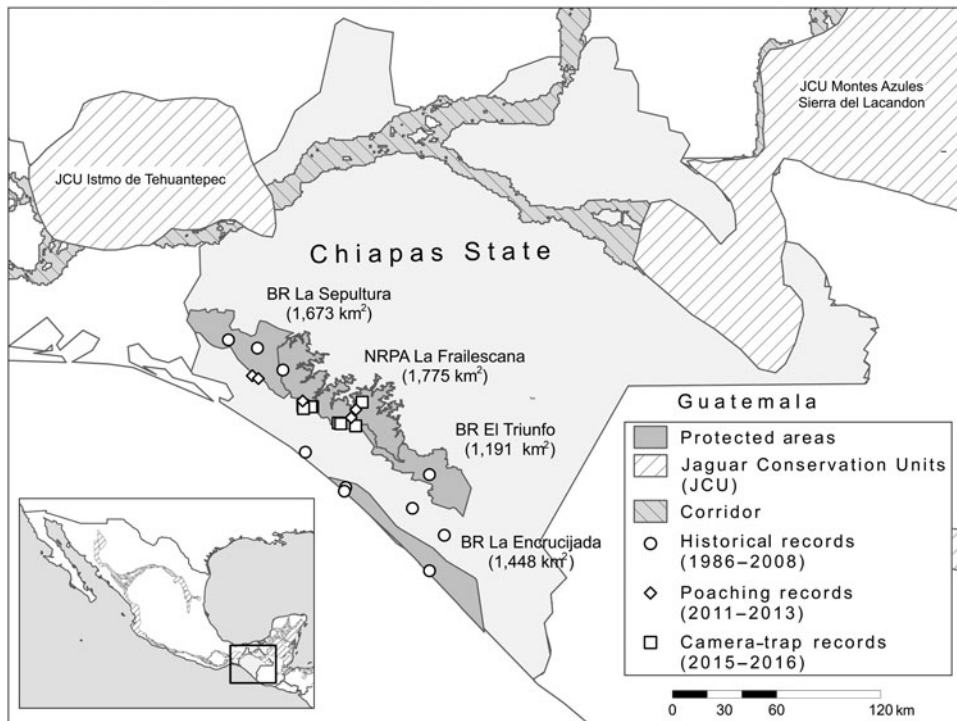


FIG. 1 Protected areas of the Sierra Madre de Chiapas landscape (Biosphere Reserves (BR) La Sepultura, El Triunfo and La Encrucijada, and Natural Resources Protection Area (NRPA) La Frailesca), jaguar *Panthera onca* records in this region, and Jaguar Conservation Units and the network of jaguar corridors modelled for the region (Rabinowitz & Zeller, 2010).

We obtained 11 records of jaguars for 1986–2008 (Muñoz & March, 2003; Lorenzo Monterrubio et al., 2005; Morales Pérez, 2005; Fig. 1), at altitudes of 0–1,632 m in the Sierra Madre de Chiapas region and the neighbouring coast of Chiapas (Fig. 1), which was originally tropical rainforest and mangroves but is now mostly deforested (Aranda, 1996). We obtained four confirmed records of jaguars killed, three in retaliation for predation of domestic animals in 2012–2013 and one poached in 2011. Jaguar capture rate across all camera stations was 0.97 per 1,000 trap-days. We identified three male and two female jaguars, and we recaptured three of these individuals. These records were over 1,120–1,758 m, from montane cloud forests and oak forests.

The interviews indicated that the jaguar is well known. More than half of the interviewees had either seen dead jaguars or observed them in the wild, and most of the interviewees had lost some cattle. However, only 10% of these losses were attributed to predation by large felids; 77% were a result of illness or accidents. Jaguars were the main species identified as the predator of cattle (29%) but other wildlife also caused significant loss (40%; Table 1). Although the interviewees considered the jaguar's presence beneficial for ecosystem functioning, many people felt that jaguars were the predator mostly responsible for their loss of cattle (Table 1).

A landscape strategy for jaguar conservation in the Sierra Madre de Chiapas would need to include areas with suitable jaguar habitat, such as the coast of Chiapas, which includes the Encrucijada Biosphere Reserve and adjacent areas of primary forest (Aranda, 1996). Considering the large spatial

requirements of jaguars (de la Torre et al., 2017) it is likely that individuals are moving between the Sierra Madre de Chiapas and adjacent areas (Fig. 1). This complex, together with the Encrucijada Biosphere Reserve and adjacent areas, encompasses c. 5,500 km² of primary forest, sufficient to maintain a population of jaguars (Rodríguez-Soto et al., 2011). However, the limited number of historical records that we located indicates that the jaguar population in this region is sparse, and our camera-trap survey indicates that abundance in the region is low compared to other areas in Central America (Silver et al., 2004; de la Torre & Medellín, 2011; Chávez et al., 2016).

International jaguar conservation strategies have not previously included the Sierra Madre de Chiapas (Fig. 1), and the region was excluded from the Jaguar Conservation Units and corridors that were defined to establish continental priorities to conserve the species (Sanderson et al., 2002; Rabinowitz & Zeller, 2010). Our results indicate that the species is still present in the region, and we have therefore included the Sierra Madre de Chiapas in Mexico's National Jaguar Conservation Strategy (CONANP, 2009; Zarza et al., 2013; Ceballos et al., 2016), and we recommend that international organizations include this area in their priorities for jaguar conservation.

We found that local perceptions of the jaguar included fear and respect, and jaguars were considered harmful and dangerous, but most interviewees believed that the jaguar should be preserved. Although most cattle owners noted that jaguar conservation in the region is not their responsibility, some showed an interest in implementing actions to

TABLE 1 Percentage of responses (of 102 cattle owners interviewed) to questions regarding knowledge about jaguars, the main causes of livestock loss, and perceptions about jaguars in the Natural Resources Protection Area La Fraileskana (Fig. 1).

Question	Answer	%	Complementary question	Answer	%
Knowledge about jaguars					
Can you recognize the jaguar through cards?	Yes	83			
	No	17			
Have you seen a jaguar either dead or alive?	Yes	51	How long ago did you see a jaguar?	< 1 year	8
				1–10 years	63
				> 10 years	29
	No	49			
Have you killed or heard that someone else has killed a jaguar?	Yes	30	How many jaguars have you killed or heard to have been killed?	1 jaguar	60
				2 jaguars	11
				3 jaguars	14
				4 jaguars	14
	No	70			
Livestock loss					
Have you ever had loss of livestock?	Yes	66	Which were the main causes of loss of livestock?	Illness	42
				Accident	34
				Predation by large carnivores	10
				Parturition	8
				Drought	3
				Theft	2
				Misplacement	1
	No	34			
Have you ever suffered cattle loss from wildlife?	1 species	30	What kind of wildlife attacked your cattle?	Jaguars	29
	> 1 species	60		Vampire bats	20
				Venomous snakes	20
				Puma	17
				Coyote	7
				Other	6
			How did you identify the animal that attacked your cattle?	Footprints	60
				Marks left by the predator on the dead cattle	20
				Dung or signs of burial	13
				Sighting	7
	No	8			
Perceptions					
What does the word jaguar mean to you?	Fear	60			
	Respect	16			
	Admiration	12			
	Danger	6			
	Risk of extinction	3			
	Harmless	3			
Do you think the presence of the jaguar in the region is beneficial for you?	Yes	60			
	No	40			

minimize jaguar predation of cattle. Rearing of livestock is one of the main economic activities in the areas adjacent to jaguar habitat in the region, and retaliatory killing of jaguars in response to attacks on cattle (Treves & Bruskotter, 2014) could be one of the main reasons for the low abundance of jaguars in this region. To improve co-existence between jaguars and the communities of the Sierra Madre de Chiapas, strategies need to be developed, in collaboration with the local communities, to improve livestock practices for reduction of predation by jaguars (Azuara et al., 2010), to strengthen government conservation

policies, and to implement educational and communication programmes about the importance of this species in the region.

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Conflicts of interest None.

Ethical standards All interviews abided by the ethical standards of the Social Research Association.

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