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Cover: A female Javan Leopard *Panthera pardus melas* in rehabilitation phase at Cikananga Wildlife Center. © Yayasan Cikananga Konservasi Terpadu.



New queen? Evidence of a long-living Jaguar *Panthera onca* (Mammalia: Carnivora: Felidae) in Tikal National Park, Guatemala

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Abstract: Despite the abundant literature on the Jaguar *Panthera onca*, several aspects of its natural history and ecology such as longevity and residency of wild individuals are still little studied and poorly known. We conducted a camera trapping study in Tikal National Park, Guatemala, during the dry season and early rainy season from April to July 2018. We compared our results with results of previous studies and thereby came across a presumably female adult individual that was recorded in 2009 and again during our survey. We therefore assume that this virtual female is a potential long-term resident Jaguar in this core zone of the Selva Maya, one of the largest and well-conserved forests in the Neotropics and a priority area for the conservation of this species. We recommend implementing systematic and long-termed studies in Guatemala as a tool for the evaluation and management of the species, and to monitor the effectiveness of protected and priority areas in order to ensure the conservation of the Jaguar.

Keywords: Longevity, Maya Biosphere Reserve, protected areas management, residency, Selva Maya, wildlife management.

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INTRODUCTION

The majestic Selva Maya is the largest tropical forest remnant in Central America and is shared between joint areas in northern Guatemala, southern Mexico, and north-western Belize (Hansen et al. 2013). Selva Maya includes different types of area management and administration in each country. In Guatemala and Mexico, a great section includes multiple-use areas that are used by local communities to implement sustainable forestry (Radachowsky et al. 2012). Another section is restricted to protected areas purely for conservation (Radachowsky et al. 2012), such as national parks and protected biotopos as core zones within the Guatemalan side, national parks and biosphere reserves within Mexico, and wildlife sanctuaries within Belize. Maya Biosphere Reserve in Guatemala is a priority area for the conservation of the viable Selva Maya population of the threatened Jaguar *Panthera onca* and for habitat connectivity for wildlife between these countries (Sanderson et al. 2002).

Selva Maya is considered a Type I Jaguar Conservation Unit by the Wildlife Conservation Society, which indicates that it is of critical importance to Jaguar conservation (Marieb 2006). It is fundamental to implement long-term monitoring programs for Jaguar populations in such priority areas throughout their distribution, since this species has been categorized as “Near Threatened” on the IUCN Red List (Quigley et al. 2017). From the 34 recognized subpopulations of the Jaguar, only the Amazon Forest subpopulation is considered as “Least Concern”, while the remaining are considered Endangered or Critically Endangered (de la Torre et al. 2017). Because of this, long-term studies are necessary to detect and respond to changes in Jaguar populations to monitor the effectiveness of protected and priority areas for its conservation, and develop strategies under alternative scenarios for their conservation, enhancing management efforts. They are also important to mitigate threats such as human-Jaguar interactions and to assess and update population status of the Jaguar in currently recognized subpopulations (Clutton-Brock et al. 2010; de la Torre et al. 2017; Harmsen et al. 2017).

Monitoring protocols have been applied for several sites for studying Jaguar populations (Silver 2004; Ceballos et al. 2011; Harmsen et al. 2017). However, most surveys are short-termed (Foster & Harmsen 2012), and long-termed studies quite scarce (Gutiérrez-González et al. 2015; Harmsen et al. 2017). Long-term monitoring studies help to ensure the effectiveness of protected areas and allows conservationists to assess

the viability for Jaguar populations through life-history parameters such as survival and mortality of individuals, longevity, sex ratio, home ranges, and residency (McCain & Childs 2008; Watkins et al. 2014; Gutiérrez-González et al. 2015; Zanin et al. 2015; de la Torre et al. 2017; Olson et al. 2019a,b).

Furthermore, in wide-ranging, low-density, and long-lived species like the Jaguar, high variations in population density and abundance estimates are expected in repeated surveys over several years (Harmsen et al. 2017). This is because transient individuals are likely to be detected less often than resident individuals in single survey sites, as they may range foremost outside respective survey sites or may avoid trails used by resident individuals (Harmsen et al. 2017).

In Maya Biosphere Reserve, no continuous long-term monitoring studies targeting the Jaguar have been carried out within specific management areas, but sporadic and short-term studies implemented independently by different administrators and actors in the reserve (Kawanishi 1995; Moreira et al. 2008, 2009, 2010; García-Anleu et al. 2015; González-Castillo et al. 2018; García et al. 2019). In addition, most of these studies’ results remain unpublished or grey literature. Because Maya Biosphere Reserve is an important international conservation area for the Jaguar, we report evidence of a long-living Jaguar individual in Tikal National Park, based on independent surveys. This communication represents an input for the management and assessment of the reserve and help to better understand the ecology of long-living Jaguars within the management type of areas where occur.

STUDY AREA

Maya Biosphere Reserve, in northern Guatemala, represents the largest continuous forest patch and protected area complex in Central America, stretching over more than 2,110km² in area (Radachowsky et al. 2012). Its administrative division comprises the buffer zone, the multiple use zone, and many core zones such as national parks and protected biotopos (CONAP 2015). Tikal National Park comprises 575.83km² and is one of the first core zones declared even before the declaration of the Maya Biosphere Reserve by the Guatemalan government in 1990 (CONAP 2015). Tikal National Park borders the Buffer Zone to the south, El Zotz Protected Biotopo to the west, Yaxhá National Park to the east and the Multiple Use Zone in the north (Figure 1). According to Guatemalan legislation, category 1 protected areas

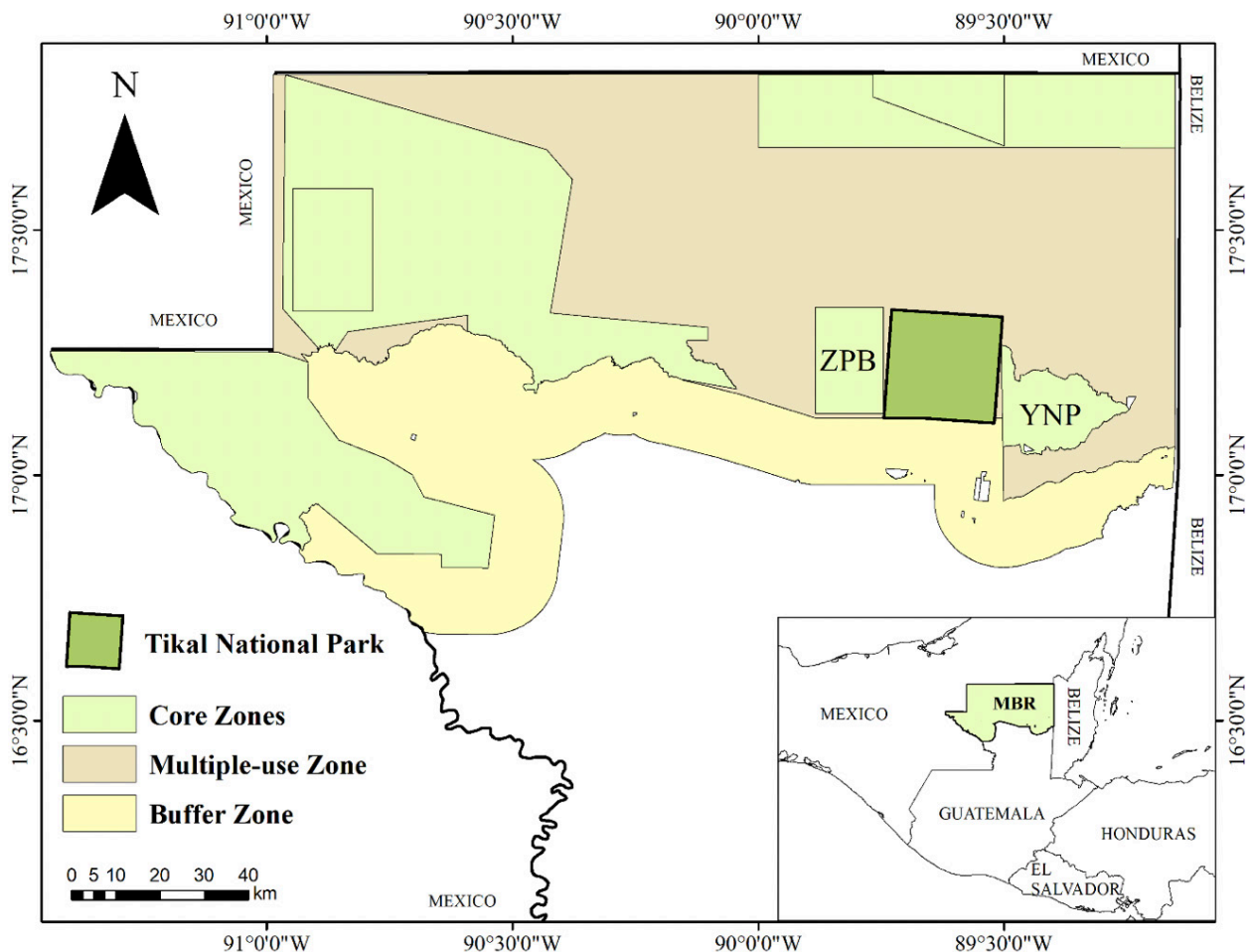


Figure 1. Location of Tikal National Park and management area types within Maya Biosphere Reserve in Guatemala, Central America. ZPB: El Zotz Protected Biotopo; YNP: Yaxhá National Park.

such as core zones are intended exclusively for scientific research and for low-impact tourism, and most resulting in areas with minimal human impact (CONAP 2015).

However, because of the international fame of Tikal National Park as an iconic archaeological site and as a cultural World Heritage Monument with a high incidence of tourism activities (Cleere 1995), important ecological changes have been detected as low detectability of highly mobile species such as Baird's Tapir *Tapirella bairdii*, White-lipped Peccary *Tayassu pecari*, Collared Peccary *Pecari tajacu* and Jaguar (García et al. 2019; McNab et al. 2019).

Tikal National Park and Maya Biosphere Reserve comprise low-land at elevations of 307–630 m with karstic and permeable soils, whereas the lower areas of the forest have the highest percentage of clayey soil and less permeability. These conditions favour the formation of water ponds that store rainwater during rainy season and become main bodies of water during dry season,

playing an ecological importance for interaction of individual Jaguars (García et al. 2018; Gaitán et al. 2021).

The climate is tropical with temperatures ranging from 20°C to 30°C with an annual average of 25°C and an annual precipitation of 1,160 to 1,700 mm with seasonal variations (CECON 1996). During rainy seasons in winter from June to December, the water bodies and the lower parts are flooded due to a monthly precipitation of 150mm. During the dry season from February to May, the area receives little to no rain, especially during the climatic event “El Niño”, and the water resource is limited for wildlife, as well as for administrators and visitors to the area.

MATERIAL AND METHODS

During the dry season and early rainy season from April to July 2018, the Centro de Estudios Conservacionistas

of the University of San Carlos of Guatemala (CECON/USAC) research team and the Biology Unit of Tikal National Park implemented a targeted sampling study for Baird's Tapir in different core zones of Maya Biosphere Reserve following the Guatemala Baird's Tapir Conservation Program of the CECON and Fundación Defensores de la Naturaleza (CECON & Defensores de la Naturaleza 2016). We installed sampling stations using Bushnell Trophycam 8M camera traps providing a photo resolution of 8 Megapixels, which were set to taking three photos per capture event with a 15 second interval between photographs (García et al. 2019). One sampling station consisted of one single camera trap per 9km² large cell, deployed at approximately 40cm above ground and affixed to trees (García et al. 2019).

We compared rosette patterns of recorded Jaguar individuals with photographs of individuals from previous studies in Tikal National Park and other areas within Maya Biosphere Reserve (Table 1; Karanth & Nichols 1998; Wallace et al. 2003; Silver et al. 2004; Moreira et al. 2008, 2009, 2010; Ruano et al. 2010; García-Anleu et al. 2015).

RESULTS

Our survey lasted from 4 April to 26 July 2018 with a total survey effort of 540 camera trap days in six locations. We obtained 10 photographs of right flanks of two Jaguar individuals entering a pond from one single camera trap station (16.7%) placed near one of the few river flows in Tikal National Park (Figure 2 and Image 1).

DISCUSSION

One of the two Jaguar individuals photographed during our survey was previously recorded during a 2-week survey from September and October 2009 by Ruano et al. (2010) as a sub-adult individual around 1–2 years old (Image 1). We therefore consider this individual as a potential long-term resident Jaguar in Tikal National Park since it would be 10–11 years old in 2018 and we called it “Unen B’alam”. Rosette patterns on the right upper and lower flanks can be confirmed to belong to the same individual by comparing the most conspicuous horizontal small linear rosette surrounded by four major rosettes in a cross-like arrangement (Image 1). The sampling station in which Unen B’alam was recorded in 2018 is located 11.25km from the sampling station in which it was first recorded in 2009 (Ruano et al. 2010; Figure 2, Image 1).

This photographic record of the long-lived Jaguar Unen B’alam represents the longest-lived Jaguar record in the wild to date within Maya Biosphere Reserve and Guatemala. Jaguars are considered to be sub-adult at the minimum age of 15 months to two years (Seymour 1989; Sunquist & Sunquist 2002; Nowak 2005). We estimate that Unen B’alam was in this age group of 1–2 years old when first recorded, so in 2018, it was at least 10–11 years old.

García-Anleu et al. (2015) recorded an adult female named “Rosario, the Queen of Tikal” in Tikal National Park that was recorded again five years later from its first record. Olson et al. (2019a) collated records of long-lived wild Jaguars and reported 15 individuals that lived for more than 11 years. Due to interaction of Jaguars among conspecifics occurring only during reproductive and cub

Table 1. Details of individual Jaguars recorded during camera trapping surveys in Tikal National Park and other areas within Maya Biosphere Reserve, Guatemala. NP: National Park; LC: Logging concession; F: Female, M: Male, U: Unknown sex, * Unen B’alam.

Area surveyed	Sampling stations	Survey effort (camera trap days)	Individuals recorded				Reference
			Total	F	M	U	
Tikal NP	18	574	1			1	Kawanishi (1995)
Tikal NP	19	510	7	1	3	3	García et al. (2006)
Tikal NP	25	384	7	1	5	1*	Ruano et al. (2010); García-Anleu et al. (2015)
Tikal NP	9	630	1		1		García et al. (2019)
Tikal NP	6	540	2			1, 1*	This study
Carmelita LC	20	900	10	3	7		Moreira et al. (2008)
Laguna del Tigre NP	24	1,127	9	4	5		Moreira et al. (2009)
Melchor de Mencos LC	23	1,035	9	4	4	1	Moreira et al. (2010)

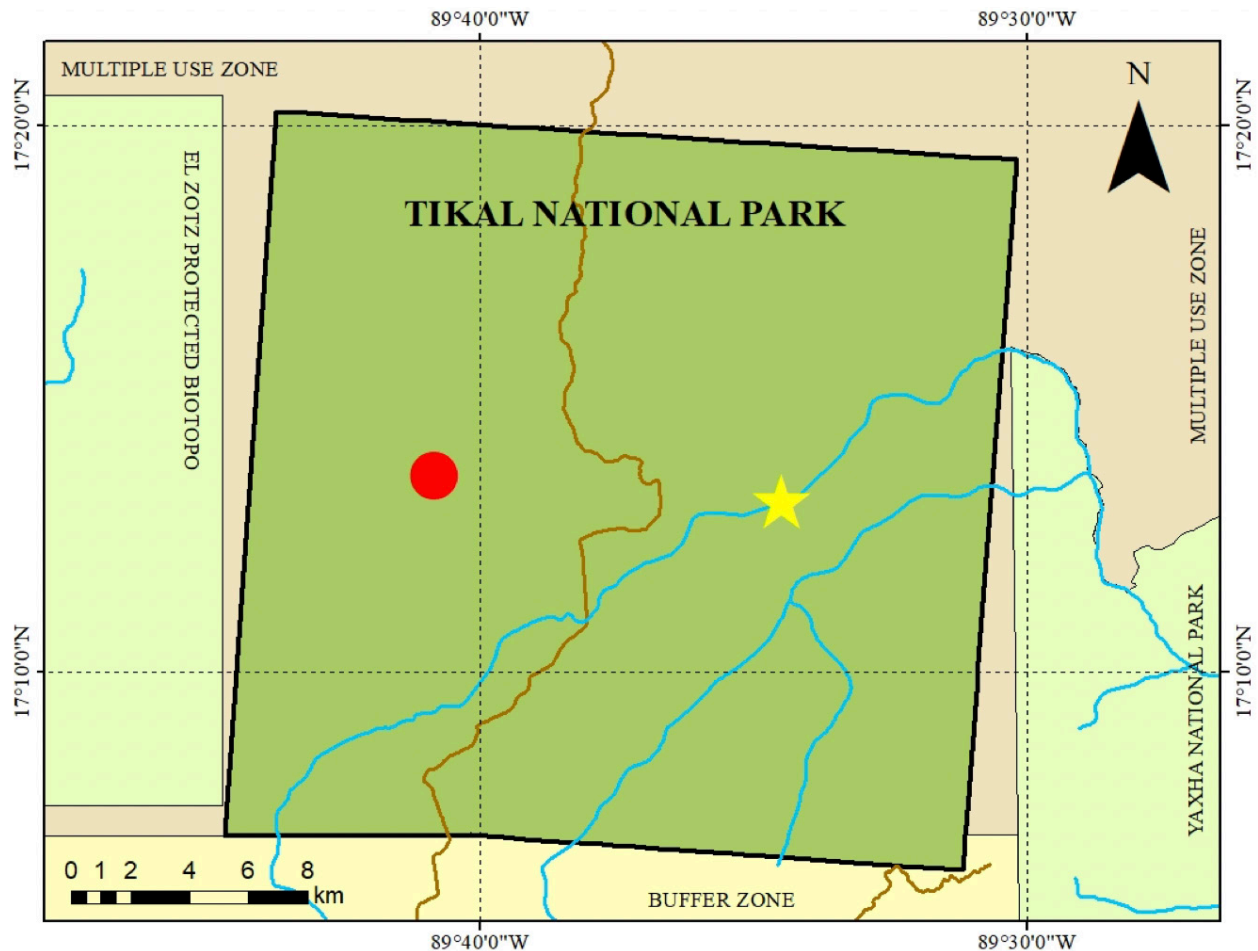


Figure 2. Camera trap locations of records of long-living Jaguar Unen B'alam in Tikal National Park, Maya Biosphere Reserve, Guatemala. Red circle corresponds to the camera station installed in 2009 by WCS Guatemala (Ruano et al. 2010). Yellow star corresponds to the camera station installed by CECON/USAC in 2018. Distance between both camera trap sampling stations: 11.25 km. Brown line: road; blue line: rivers.

raising periods (Jorge-Neto et al. 2018), we suggest that both individuals recorded in Tikal National Park in 2018 are either a reproductive couple or a mother female with a cub. As our photographs indicate that Unen B'alam is accompanied (followed) by a supposedly male Jaguar, it is presumably a mature female, and due to its behaviour was similar to Rosario's reported by García-Anleu et al. (Rosario being followed by an adult male; 2015).

In view of other records of long-lived wild Jaguars, the estimated life span for this species is of 11.3 ± 1.0 years for females, with the oldest known female reaching 13 years (Olson et al. 2019a). Unen B'alam would represent a relatively old female Jaguar and represents a record between the longest-lived wild Jaguars throughout all the species range (Olson et al. 2019a; b). When compared this record with similar-aged and older long-lived wild Jaguars reported in the literature for Argentina, Belize, Brazil, Costa Rica, United States and Venezuela (Scognamiglio et al. 2003; McCain

& Childs 2008; Rabinowitz 2014; Harmsen et al. 2017; Glennie et al. 2019; Olson et al. 2019a,b), Unen B'alam's age would suit to this kind of analysis.

Long-term studies on Jaguars have demonstrated that populations consist of resident and transient Jaguar individuals in Belize within the Selva Maya (Harmsen et al. 2017). This could be the case too for the Jaguar population of Tikal National Park, since Rosario, the Queen of Tikal (García-Anleu et al. 2015) and Unen B'alam are the only two individuals (11.8 % of at least 17 individuals recorded; Table 1) that have been spotted as potential residents in the medium and in the long-term within Maya Biosphere Reserve in Guatemala. In addition, since resident Jaguars must be recorded for at least three consecutive years in a row (Harmsen et al. 2017), we are highlighting Unen B'alam as potential resident by lacking complementary data. None of the other individuals recorded in 1994, 2005, 2009 and 2018 in Tikal National Park have been recorded repeatedly

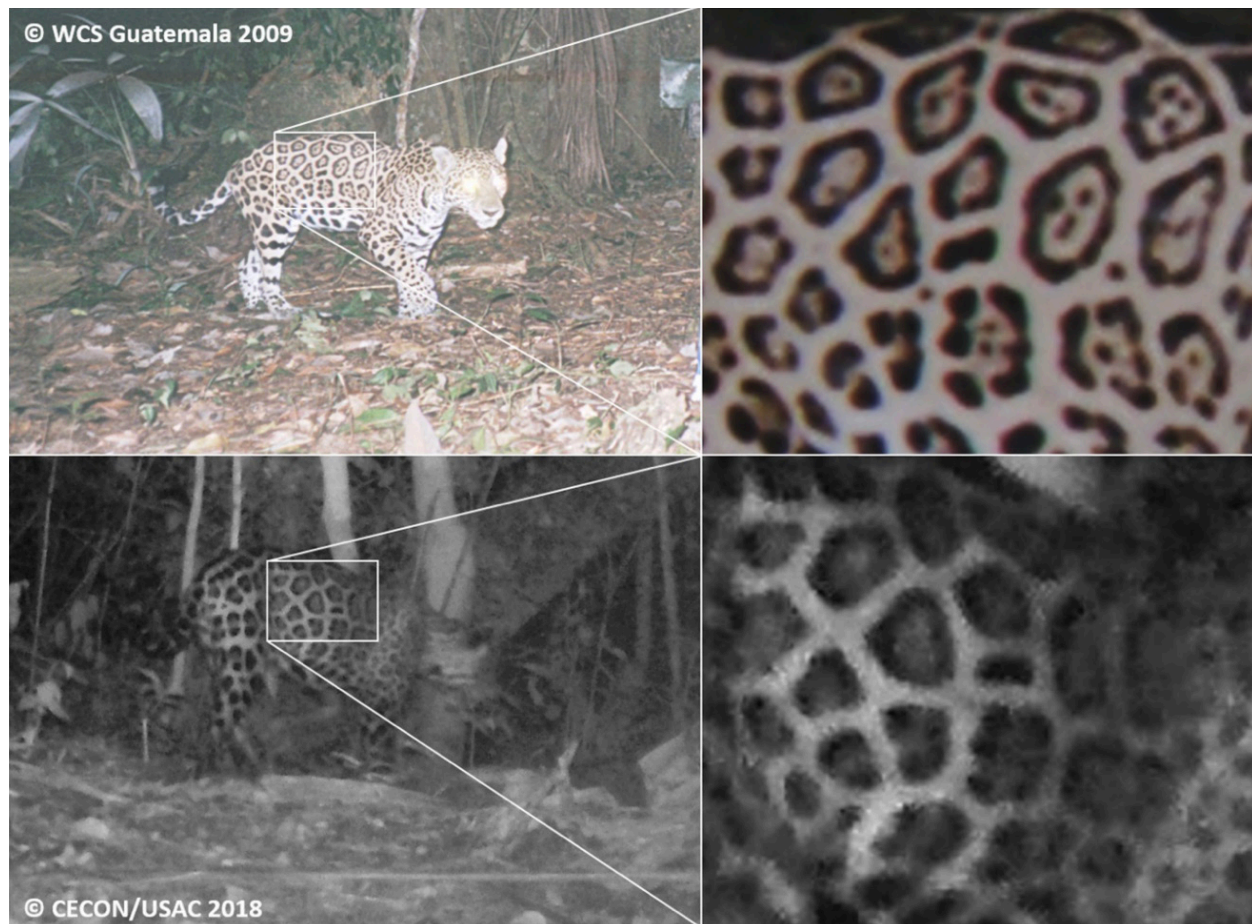


Image 1. Rosettes pattern on long-living Jaguar Unen B'alam photographed in 2009 (upper left; Ruano et al. 2010) and in 2018 (lower left; this study) in Tikal National Park, Maya Biosphere Reserve, Guatemala.

(Table 1; Kawanishi 1995; García et al. 2006; Moreira et al. 2008, 2009, 2010; Ruano et al. 2010; García-Anleu et al. 2015; García et al. 2019).

Female Jaguars tend to exhibit higher fidelity to their home range than males (Rabinowitz & Nottingham 1986; Cavalcanti 2008). In Tikal National Park, long-term survey efforts are required to detect and identify resident Jaguars. The failure to detect resident male Jaguars during such surveys may indicate a high mobility or in the worst scenario high mortality of male Jaguars in Tikal National Park and in Maya Biosphere Reserve (Harmsen et al. 2017).

This record of a long-living adult Jaguar may indicate that both the habitat quality and prey availability for the Jaguar population in Tikal National Park has remained stable according to García-Anleu et al. (2015). However, this national park of Maya Biosphere Reserve is prone to anthropogenic disturbances due to its location near the Buffer Zone (García et al. 2020; Figure 1). We therefore agree with previous authors that the conservation

status of the habitat needs to be evaluated (Morato et al. 2016; González-Gallina et al. 2017; García et al. 2019) as despite Tikal National Park remains with high forest cover but with possible low ecological integrity (García et al. 2019; 2020).

Due to the apparent increase in the number of male individuals over surveys (Table 1), it would be suggested that Tikal National Park is an area with a high male Jaguar home range overlap degree as García-Anleu et al. (2015) have suggested. We strongly recommend implementing a long-term survey in Tikal National Park targeting both Jaguar and prey populations. This information will provide the baseline data required for estimating and monitoring population changes in the different types of area management of Maya Biosphere Reserve such as core zones.

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