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Rediscovery of jaguar in an Atlantic Rainforest area, southeast of Bahia State, Brazil

For more than 20 years, there was no real evidence of jaguar *Panthera onca* occurrence in Atlantic Forest areas in the south region of Bahia state, Brazil. The species was rediscovered during a fauna monitoring study carried out at Reserva Particular do Patrimônio Natural RPPN Estação Veracel, which is a huge remnant of native vegetation surrounded by *Eucalyptus* spp. plantations, croplands and rural settlements. There were three jaguar records, all of them obtained on trails located inside the private conservation unit. The species was first recorded in May 2017, through a sequence of photos captured by a camera trap and subsequently by a footprint. Six months later, new images of the jaguar were taken by the Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros CENAP team in a research designed to monitor the jaguar.

The jaguar is the largest cat in the Americas (Macdonald et al. 2010) and a top predator. In the Neotropical region it is one of the most known cat species and compared to other mammals its historical and current distribution is relatively well mapped (Sanderson et al. 2002, Zeller 2007, de la Torre et al. 2017). Nevertheless, for some localities its presence is uncertain. Originally, its geographic distribution area extended from the north of Argentina to regions of North America (Sanderson et al. 2002, Zeller 2007). Nowadays, the species can be found in 18 countries, is vanishing from some countries such as El Salvador and Uruguay, and is almost extinct in others, as in the United States (de la Torre et al. 2017). Its actual distribution comprises around 45% of its historical extension (de la Torre et al. 2017), half of that within Brazilian territory (Zeller 2007).

According to the Brazilian list of endangered species, the jaguar is considered vulnerable to extinction mainly due to changes in the environment, as habitat loss, degradation and fragmentation (Morato et al. 2013). The species can be found in all biomes with exception of the Pampa and its occurrence is related to a myriad of specific factors, such as prey availability, presence of water courses and amount of well-preserved native vegetation (Eisenberg & Redford 1999, Sunquist & Sunquist 2002, Arroyo-Arce et al. 2014). In Brazil, its largest populations are located in the Pantanal and Amazonian regions (Silveira & Crawshaw 2008, Cavalcanti et al. 2012, Oliveira et al. 2012, Morato et al. 2013).

In the last 15 years it is believed that the jaguar populations in the Brazilian Atlantic rainforest have been reduced by at least 80% (Morato et al. 2013) driven by intense fragmentation and habitat loss. Moreover, in this biome, the species is threatened by the

decrease of key prey availability and hunting pressure (Beisiegel et al. 2012). Although it is known that 24% of the Atlantic rainforest remnants have sufficient area to support the species, records of jaguar populations are found in only 7% of them (Jorge et al. 2013). It is believed that the jaguar is divided into only eight subpopulations along the Atlantic rainforest, each one containing less than 50 adult individuals. At a biome scale, this scenario leads to an even more critically conservation status of the jaguar (Beisiegel et al. 2012).

The Atlantic Forest is known as one of the most threatened hotspots in the world (Myers et al. 2000, Mittermeier et al. 2004). Historically, the biome stretched along the Brazilian coast, from north to south, extending inland up to Argentina and Paraguay, covering an area of 1,315,460 km² (IBGE 2008). Deforestation represents the main threat to this biome, which is currently reduced to approximately 15% of its original size (SOSMA & INPE 2014). In Bahia state, there are few remnants of the Atlantic Forest and most of them are located in the southern region restricted to the coastal strip. Besides, there is a seasonal forest formation in the central area of the state, on the plateau of Chapada Diamantina (Blinder 2005).

The species was recorded in three occasions during fauna monitoring at RPPN Estação Veracel (16°23′ S / 39°10′ E) property of Veracel Celulose S.A. The RPPN Estação Veracel has a total area of 60.69 km² and is located in the municipalities of Porto Seguro and Santa Cruz Cabrália, in Bahia state. The area is part of the Central Corridor of the Atlantic Forest and is composed predominantly by two vegetation types, Matas de Tabuleiro with gallery forests along the watercourses and Muçunungas (RPPN Estação Veracel 2007), with an altitude that varies from 10 to 80 m, and is immersed in a landscape of *Eucalyptus* spp. plantation, native vegetation, croplands and rural settlements. Besides being the largest private reserve in the Brazilian Northeast region and the second in the Atlantic Forest biome, RPPN Estação Veracel is also considered a Key Biodiversity Area (Paese et al. 2010). It represents one of the most important forest remnants of the southeast of Bahia state and the Central Atlantic Forest Corridor (RPPN Estação Veracel 2016). Nearby RPPN Estação Veracel is the Pau Brasil National Park, a federal conservation unit with an area of 190.27 km². Despite the proximity, these areas are not contiguous and there are two highways between them, one federal (BR-367) and one state (BA-001).

The fauna monitoring started in 2015 and it is done every two years. Each year comprises two field surveys with a six months interval between them. Eight camera traps, digital model (Bushnell Trophy Cam), were used, all of them programmed to run continuously for a period of approximately 40 days per survey, resulting in a total camera trapping effort of 16,512 camera*hours in 2015 and 16,128 camera*hours in 2017. To choose the sampling sites, the total area was divided into 1 km quadrants, which were later randomly ranked by the random ordering function of the Microsoft Excel 2010 programme. The first ranked quadrants were then selected. The camera traps were allocated within the selected quadrant area according to the environment characteristics found at each location.

In the third survey, on May 2017, three photos of an adult jaguar individual (Fig. 1A) were obtained. The record was made by a camera trap installed on a tree on a pre-existing narrow trail that is maintained and used by the Equilíbrio Florestal team for surveillance activities. Moreover, during one transect a jaguar footprint was encountered. After both records, the CENAP team mobilised itself to get more information about the species and reiterate its presence in the region. For this, 52 camera traps were installed in the areas, 21 at RPPN Estação Veracel (total camera trapping effort of 75,600 camera*hours) and 31 at Pau Brasil National Park (111,600 camera*hours), which remained active for approximately 150 days from October 2017 to February 2018. Two cameras installed sequentially on a road inside the forest remnant in RPPN Estação Veracel recorded the species (Fig. 1B–C). During the fauna monitoring we also documented other mammalian species, most of them are potential prey species of the jaguar (Garla et al. 2001, Cullen et al. 2013), such as collared peccary *Pecari tajacu*, coati *Nasua nasua*, paca *Cuniculus paca*, agouti *Dasyprocta leporina* and armadillo *Dasypus* sp. Jaguars have already been recorded on established pathways within a forest habitat in Atlantic Forest areas (Srbek-Araujo & Chiarello 2017) and can be assigned to habitat dependence; for example, as a consequence of different behavioural patterns of the species in each habitat type (Srbek-Araujo & Chiarello 2013).

The jaguar had already been reported in National Parks of Pau Brasil and Monte Pascoal, both located in southeast of Bahia state (Medellin et al. 2001, Beisiegel et al. 2012), with a population estimated at 1–5 mature individuals (Beisiegel et al. 2012). However, these are historical records. For over 20 years there has been no reliable record of jaguar presence in this region (Leite et al. 2001).

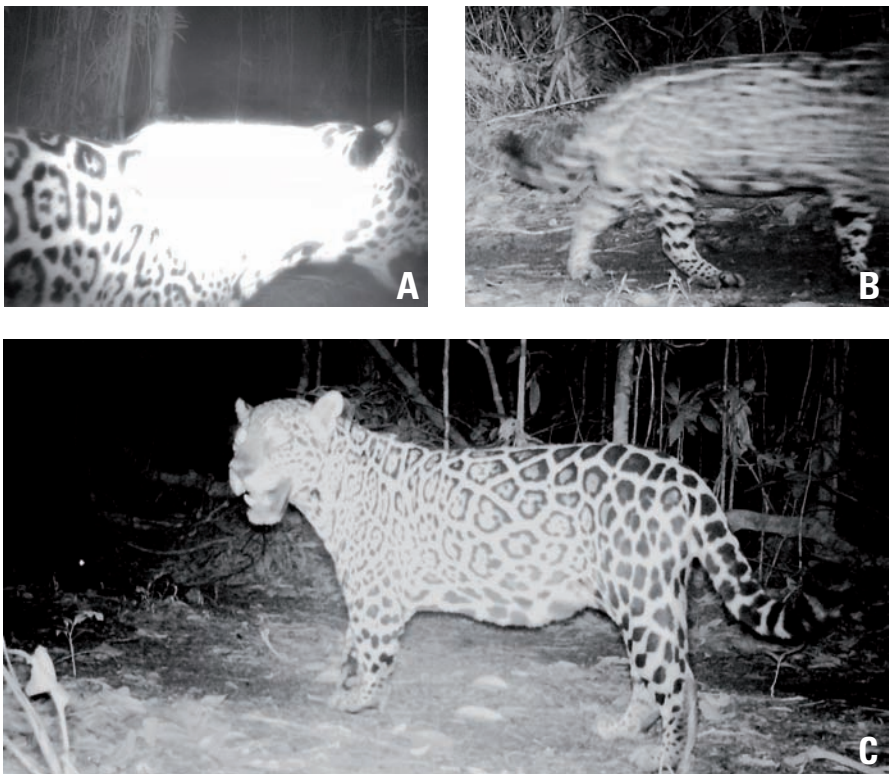

Fig. 1. Photographic records of jaguar obtained in May 2017 (A) and November 2017 (B–C) by cameras trap installed in RPPN Estação Veracel, Porto Seguro/Santa Cruz Cabrália, BA.

Thus, Rabinowitz & Zeller (2010) using information on jaguar's occurrence in the Americas did not consider south of Bahia as a locality with jaguar populations, and therefore did not identify a need to connect it to other subpopulations (Fig. 2). However, in a recent study, its possible occurrence in the region was reported, which was considered as a medium suitability habitat for the species in the future (Paviolo et al. 2016).

According to Beisiegel et al. (2012), the area of occupancy of the jaguar in the Atlantic Forest is approximately 30,300 km^2, summing up all areas of all Conservation Units with recent or inferred data of species occurrence. However, this available area may be higher if we take some private areas with recent jaguar records into account (Lima et al. 2013, Casanova & Bernardo 2017, this study). Yet, most of the Atlantic Forest areas considered suitable for jaguars (27.44%) encompassed the closed to open broadleaved evergreen (>15%) or semi-deciduous forests (55.26%), while non-adequate areas encompassed mainly mosaic of croplands (50–70%) and vegetation (20–50%; Ferraz et al. 2012). This species distribution model did not indicate any Atlantic Forest remnant in Bahia state as a potential area for jaguar occurrence probably due to the use of only the most recent and confirmed records of the species (5 years prior to the study date). In a recent study, Paviolo et al. (2016) increased the area of jaguar occupancy to 35,441 km^2, but in the southeast region of Bahia State was not assigned any areas with high potential for the species occurrence. In the Atlantic Forest, land cover (42%) is the major contributor variable for the jaguar distribution model (Ferraz et al. al. 2012), with its presence highly associated to the closed and open grasslands or woody vegetation regularly flooded (Ferraz et al. al. 2012). Yet, wetland areas and riparian vegetation are important core areas and dispersal corridors for jaguars (Cullen 2005).

The rediscovery of jaguar in the southeast of Bahia highlights the contribution of protected private areas to biodiversity conservation in one of the most endangered rainforests worldwide. Moreover, like another recent record in the biome (Casanova & Bernardo 2017, Brocardo 2018), it reveals a lack of knowledge about the species presence outside of Conservation Units, especially in private areas. This fact underscores the urgency of studies in these areas, in order to understand how the species is using the habitat, the impact of different disturbances (e.g. loss and fragmentation of habitat) on the species presence and movement and how it has been facing these issues. Jaguar is a top predator in the environment and also an umbrella species for the conservation of other key species and the management of natural habitats. However, fewer than 250 mature individuals are estimated to survive in the entire biome (Galetti et al. 2013, Paviolo et al. 2016). So, if none of the effective actions proposed by research teams and government agencies is conducted urgently, it is estimated that in the near future the Atlantic Forest will be the first global hotspot to lose its top predator (Paviolo et al. 2016). Besides, the records also show that RPPN Estação Veracel still has environmental attributes to harbour the largest cat in the Americas.

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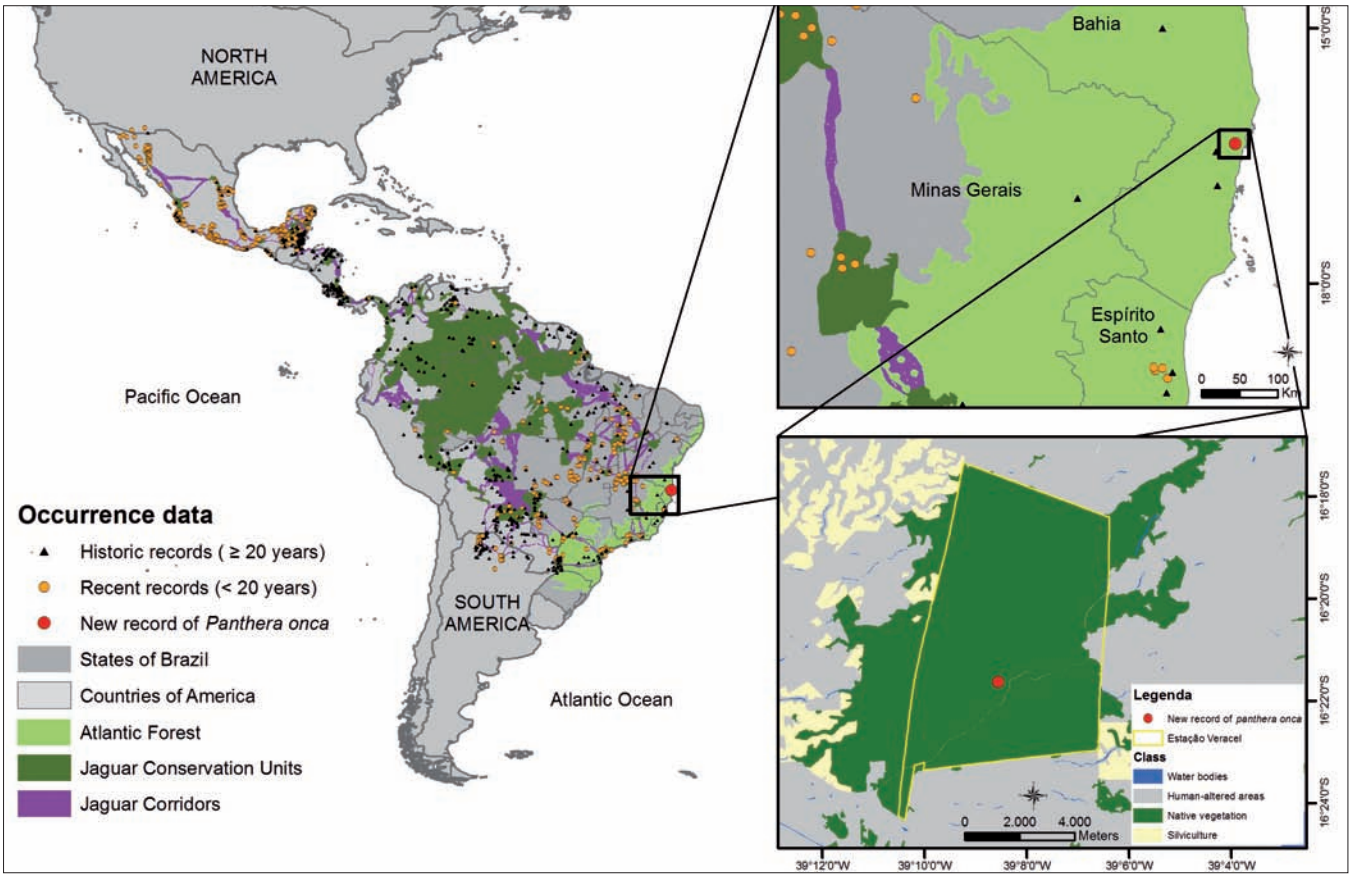

Fig. 2. Map with jaguar occurrence, indicating priority areas for connectivity between the subpopulations of the species (purple; Fig. reproduction authorised by Panthera, unpub. data).

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