



Diversity of mammals and birds recorded with camera-traps in the Paraguayan Humid Chaco

Diversidad de mamíferos y aves registrados con cámaras trampa en el Chaco Húmedo Paraguayo

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Abstract.- Despite its vast extension and the rich fauna that it hosts, the Paraguayan Humid Chaco is one of the least studied ecoregions in the country. In this study, we provide a list of birds and medium-sized and large mammals recorded with camera traps in Estancia Playada, a private property located south of Occidental region in the Humid Chaco ecoregion of Paraguay. The survey was carried out from November 2016 to April 2017 with a total effort of 485 camera-days. We recorded 15 mammal and 20 bird species, among them the bare-faced curassow (*Crax fasciolata*), the giant anteater (*Myrmecophaga tridactyla*), and the neotropical otter (*Lontra longicaudis*); species that are globally threatened in different degrees. Our results suggest that Estancia Playada is a site with the potential for the conservation of birds and mammals in the Humid Chaco of Paraguay.

Keywords: *Species inventory, Mammals, Birds, Cerrito, Presidente Hayes.*

Resumen.- A pesar de su vasta extensión y la rica fauna que alberga, el Chaco Húmedo es una de las ecorregiones menos estudiadas en el país. En este estudio proporcionamos una lista de aves y mamíferos registrados con cámaras trampa en la Estancia Playada, una propiedad privada ubicada al sur de la región Occidental en la ecorregión del Chaco Húmedo de Paraguay. Los muestreos se llevaron a cabo entre noviembre de 2016 y abril de 2017 con un esfuerzo total de 485 días-cámara. Registramos 15 especies de mamíferos y 20 de aves, entre ellas el maitú (*Crax fasciolata*), el oso hormiguero gigante (*Myrmecophaga tridactyla*) y la nutria neotropical (*Lontra longicaudis*) que están globalmente amenazadas a diferentes grados. Nuestros resultados sugieren que la Estancia Playada es un sitio con potencial para la conservación de aves y mamíferos en el Chaco Húmedo de Paraguay.

Palabras clave: *Inventario de especies, Cerrito, Presidente Hayes.*

The Humid Chaco extends in Argentina, Bolivia, Brazil, and Paraguay (Olson *et al.*, 2001). In Paraguay, this ecoregion covers almost 13% of the territory, following the course of the Paraguay River and extending towards the South-West (Mereles *et al.*, 2013). The vegetation is composed of a mosaic of sub-humid forests, palm groves, savannas and aquatic vegetation (Mereles *et al.*, 2013), which creates many different natural communities and houses great biodiversity (Ginzburg & Adámoli, 2006). This region is considered a large producer of cattle, which drives the conversion of native grasslands (frequently flooded savannas) and

forests to exotic pastures for cattle ranching expansion (Baumann *et al.*, 2017). The region comprises rich biodiversity, including at least 60 amphibian species, 104 of reptiles, 392 of birds and 129 mammals (Brusquetti & Lavilla, 2006; Cacciali *et al.*, 2016; Guyra Paraguay, 2004; Rumbo, 2010).

Given this high diversity, this ecoregion should be considered a priority area for conservation. However, the number of protected areas covers only ~ 5% of its surface (Mereles *et al.*, 2013; Cacciali *et al.*, 2015). In Paraguay, Key Biodiversity Areas (KBAs) are identified under the criteria for Important Bird Areas (IBAs),



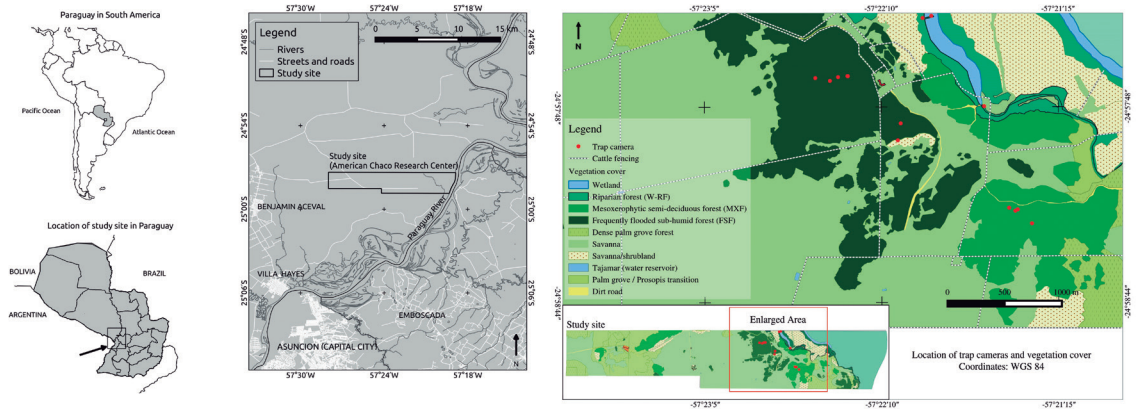


Figure 1. Location of Estancia Playada. Maps of South America and Paraguay highlighting the study site. The enlarged area is showing the position of the camera traps and vegetal formations at Estancia Playada.

but these are poorly represented in the Humid Chaco and do not imply legal protection (Guyra Paraguay, 2008; Eken *et al.*, 2004).

Although the mammal and bird composition of the Humid Chaco is well known, few studies exclusively focus on this region and most of them constitute new records for single species. To contribute to the knowledge and documentation of birds and mammals of the Humid Chaco in Paraguay, we present the results of six-month monitoring using camera traps in Cerrito (Presidente Hayes).

Materials and methods

Study area. We carried out fieldwork at Estancia Playada (24°57'59.88"S 57°21'56.12"W) in Cerrito, Municipality of Benjamín Aceval, Presidente Hayes Department (Fig. 1). This 4,000-ha private property is located in the floodplain of the Paraguay River and its main activity is extensive free-range cattle ranching in low density (one animal unit every 2 hectares) (Merenciano-González *et al.* 2018). Here, no evidence of clearings was found in the last 100 years (Laino *et al.* 2017), maintaining its original vegetation cover, except for selective extraction of wood used for cattle ranching infrastructure (cabin construction, fencing, and bridges).

Predominant ecosystems here are wet-

lands and vegetation formations are conditioned by topography and frequent flooding (Ginzburg & Adámoli, 2006) creating a mosaic of forests, subtropical forests, grasslands and marshes (Mereles *et al.*, 2013). Rainfall averages 1200 mm per year, and the average temperature ranges between 24-25° C (Mereles *et al.*, 2013).

Data collection. We used 5 Bushnell Trophy Cam HD Essential camera traps for mammal and bird detection from November 2016 to April 2017. Camera traps were installed 45 cm above the ground in trails used by cattle and were programmed to operate 24 hs per day. In order to obtain more information on the different assemblies in the study area we rotated camera traps in three different vegetation covers (Fig. 1): i) Wetlands and associated riparian forests (W-RF), 186 camera-days, ii) Mesoxerophytic semi-deciduous forests (MXF), 120 camera-days, and iii) Floodable sub-humid forest islets (FSF), 176 camera days.

Wetlands are floodable low areas that vary with the rainy season; the vegetation presents emergents of *Typha*, *Cyperus* and *Thalia*; in open waters, floating species of *Pistia*, *Eichornia*, *Victoria* among others appear (Peña-Chocarro *et al.* 2006). Wetlands presents a ~50-100 m riparian forest fringe

Table 1 (start). Species of mammals and birds recorded at Estancia Playada (Cerrito, Paraguay) and the number of records per habitat. (**W-RF:** Wetlands and associated riparian forests, **MXF:** Mesoxerophytic semi-deciduous forests, **FSF:** Floodable sub-humid forest islets). Conservation Status follows IUCN criteria. **EN:** Endangered; **LC:** Least Concern; **VU:** Vulnerable.

Class	Family	Scientific name	Common name	IUCN	Habitat			Number of records
					MXF	W-RF	FSF	
Mammalia	Didelphidae	<i>Didelphis albiventris</i> Lund, 1840	White-eared Opossum	LC	•			2
	Myrmecophagidae	<i>Myrmecophaga tridactyla</i> Linnaeus, 1758	Giant Anteater	VU		•	•	5
		<i>Tamandua tetradactyla</i> (Linnaeus, 1758)	Southern Tamandua	LC	•		•	3
		<i>Dasypus novemcinctus</i> Linnaeus, 1758	Nine-banded Armadillo	LC	•		•	39
	Canidae	<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating Fox	LC	•	•	•	70
	Procyonidae	<i>Nasua nasua</i> (Linnaeus, 1766)	South American Coati	LC	•	•	•	28
	Mustelidae	<i>Procyon cancrivorus</i> (Cuvier, 1798)	Crab-eating Raccoon	LC	•	•	•	22
		<i>Lontra longicaudis</i> (Olfers, 1818)	Neotropical Otter	NT		•		1
		<i>Eira barbara</i> (Linnaeus, 1758)	Tayra	LC			•	3
		<i>Leopardus geoffroyi</i> (d'Orbigny & Gervais, 1844)	Geoffroy's Cat	LC		•		1
Tayassuidae	<i>Pecari tajacu</i> (Linnaeus, 1758)	Collared Peccary	LC	•		•	11	
Cervidae	<i>Mazama gouazoubira</i> (Fischer, 1814)	Gray Brocket	LC	•		•	10	
Caviidae	<i>Hydrochoerus hydrochaeris</i> (Linnaeus, 1766)	Capybara	LC		•		3	
Aves	Dasyproctidae	<i>Dasyprocta azarae</i> Lichtenstein, 1823	Azara's Agouti	DD				15
	Leporidae	<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	Tapeti	LC	•		•	15
	Tinamidae	<i>Crypturellus tataupa</i> (Temminck, 1815)	Tataupa tinamou	LC	•		•	3
Columbidae	Craciidae	<i>Ortalis canicollis</i> (Wagler, 1830)	Chaco chachalaca	LC	•	•	•	8
		<i>Crax fasciolata</i> Spix, 1825	Bare-faced curassow	VU		•	•	18
		<i>Leptotila verreauxi</i> Bonaparte, 1855	White-tipped dove	LC	•	•	•	20

Table 1 (end). Species of mammals and birds recorded at Estancia Playada (Cerrito, Paraguay) and the number of records per habitat. (**W-RF**: Wetlands and associated riparian forests, **MXF**: Mesoxerophytic semi-deciduous forests, **FSF**: Floodable sub-humid forest islets). Conservation Status follows IUCN criteria. **EN**: Endangered; **LC**: Least Concern; **VU**: Vulnerable.

Class	Family	Scientific name	Common name	IUCN	Habitat			Number of records
					MXF	W-RF	FSF	
	Cuculidae	<i>Crotophaga major</i> Gmelin, 1788	Greater ani	LC		•		5
	Aramidae	<i>Aramus guarana</i> (Linnaeus, 1766)	Limpkin	LC		•	•	5
	Rallidae	<i>Aramides ypecaha</i> Vieillot, 1819	Giant wood-rail	LC		•		29
		<i>Aramides cajaneus</i> (Müller, 1776)	Grey-necked wood-rail	LC		•	•	9
	Ardeidae	<i>Tigrisoma lineatum</i> (Boddaert, 1783)	Rufescent tiger-heron	LC		•		8
		<i>Ardea cocoi</i> Linnaeus, 1766	Cocoi heron	LC		•		2
	Cathartidae	<i>Coragyps atratus</i> (Bechstein, 1783)	American black vulture	LC	•			1
	Accipitridae	<i>Rupornis magnirostris</i> (Gmelin, 1788)	Roadside hawk	LC			•	1
	Strigidae	<i>Pulsatrix perspicillata</i> (Latham, 1790)	Spectacled owl	LC			•	1
	Ramphastidae	<i>Ramphastos toco</i> Müller, 1776	Toco toucan	LC		•		1
	Cariamidae	<i>Cariama cristata</i> (Linnaeus, 1766)	Red-legged seriema	LC	•			3
	Furnariidae	<i>Furnarius rufus</i> (Gmelin, 1788)	Rufous hornero	LC		•		1
	Corvidae	<i>Cyanocorax chrysops</i> (Vieillot, 1818)	Plush-crested Jay	LC			•	6
		<i>Cyanocorax cyanomelas</i> (Vieillot, 1818)	Purplish Jay	LC		•	•	2
	Turdidae	<i>Turdus rufiventris</i> Vieillot, 1818	Rufous-bellied thrush	LC		•		1
		<i>Turdus amaurochalinus</i> Cabanis, 1850	Creamy-bellied Thrush	LC	•		•	9
	Icteridae	<i>Cacicus haemorrhous</i> (Linnaeus, 1766)	Red-rumped cacique	LC			•	1
		<i>Cacicus chrysopterus</i> (Vigors, 1825)	Golden-winged cacique	LC			•	3

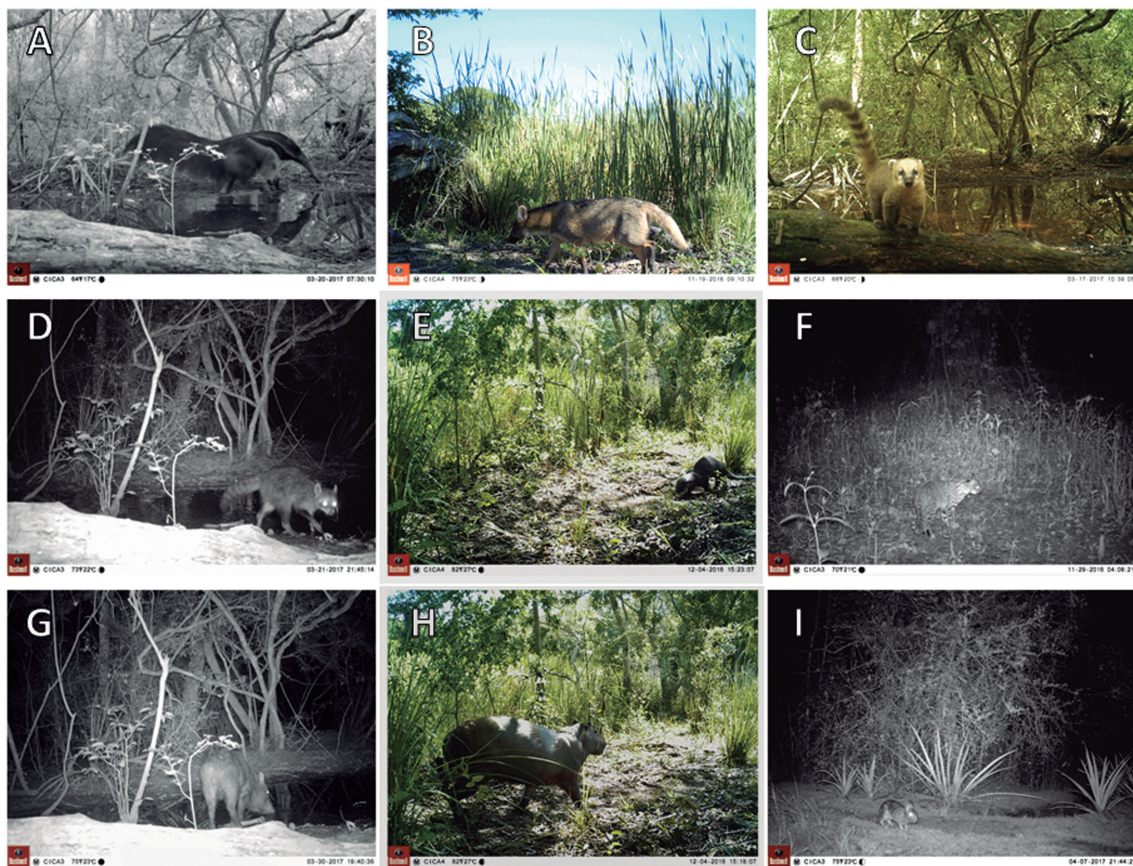


Figure 2. Some of the mammal species found in the camera trap sampling at Estancia Playada. **a)** *Myrmecophaga tridactyla*, **b)** *Cerdocoyon thous*, **c)** *Nasua nasua*, **d)** *Procyon cancrivorus*, **e)** *Lontra longicaudis*, **f)** *Leopardus geoffroyi*, **g)** *Pecari tajacu*, **h)** *Hydrochoerus hydrochaeris*, **i)** *Sylvilagus brasiliensis*.

linked to periods of flooding (Peña-Chocarro *et al.* 2006, Maturo *et al.* 2005).

Mesoxerophytic semi-deciduous forests or *quebrachales* are dominated by *Schinopsis balansae*, *Cesalpinea paraguayensis*, and occasionally *Aspidosperma quebracho-blanco* (Mereles *et al.* 2005, Peña-Chocarro *et al.* 2006).

Flooded sub-humid forests (FSF) are present in the Paraguay River floodplain and are associated with palm groves of *Copernicia alba* (Perez de Molas 2016). Some tree species of the sub-humid forest are shared with the riparian forest; however, these occur in islets, surrounded by savannas rather than following the course of streams or wetlands.

We identified the photographed species of mammals using Eisenberg and Redford (1992),

De Angelo *et al.* (2015) and birds following Mata *et al.* (2006), Narosky and Yzurieta (2006), Erize *et al.* (2006), and Ridgely & Tudor (2009). We tagged the photographs using DigiKam (www.digikam.org) and extracted the metadata with R package camtrapR (Niedballa *et al.* 2016). We considered as independent each record of each species separated by 24 hours (Torres-Porras *et al.* 2017). The study focuses on birds and medium and large-sized mammals; thus, we did not include domestic animals and humans in our counts. We performed the species rarefaction curves with R package iNEXT (Hsieh *et al.* 2016).

Results

With a sampling effort of 485 camera-days, we

obtained 391 records of 15 species of native mammals and 20 birds (Table 1, Figs 2 and 3). We failed in identifying to species level a bat and a passerine bird. This latter was using an abandoned furnariid's nest of thorns located 20 meters away from the camera trap.

Among mammals, the order Carnivora was the richest with six species, followed by Pilosa, Artiodactyla and Rodentia, with two species each. The species with the highest number of records were *Cerdocyon thous* (n=70), *Dasypus novemcinctus* (n=39) and *Nasua nasua* (n=28). On the other hand, *Leopardus geoffroyi*, *Lontra longicaudis* and *Didelphis albiventris* were only recorded once.

Passerines birds were the best-represented order with seven species, followed by Gru-

iformes with three, and Galliformes and Pelecaniformes with two species each. The highest numbers of records were for *Aramides ypecaha* (n=29), *Leptotila verreauxi* (n=20) and *Crax fasciolata* (n=18). *Coragyps atratus*, *Rupornis magnirostris*, *Pulsatrix perspicillata*, *Ramphastos toco*, *Furnarius rufus* and *Turdus rufiventris* were only recorded once during the study. The record of the spectacle owl (*Pulsatrix perspicillata*) is the first confirmation for the species in Presidente Hayes Department in the Low Chaco (Hayes, 1995; Guyra Paraguay, 2004).

According to the rarefaction graph, none of the curves reached its asymptote; this is more noticeable in the case of birds and particularly in the wetland area (Fig. 4).

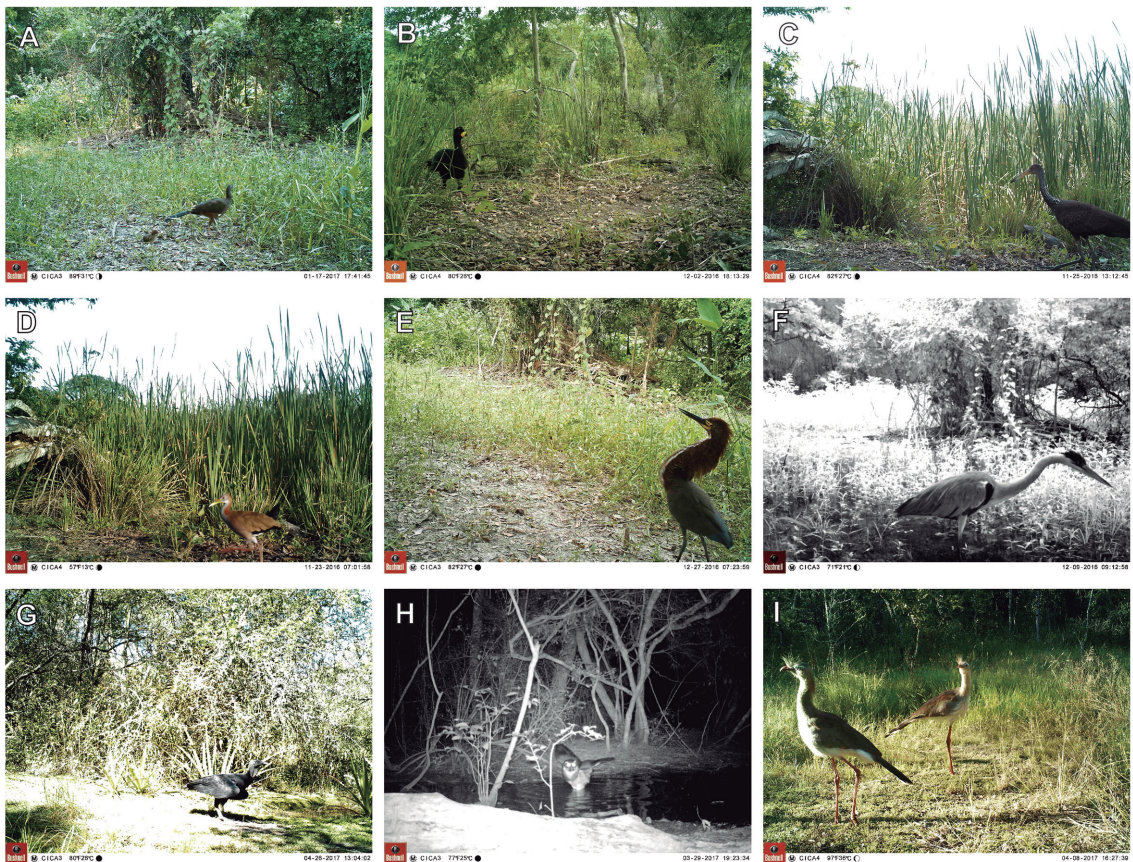


Figure 3. Some of the bird species found in the camera trap sampling at Estancia Playada, **a)** *Ortalis canicollis*, **b)** *Crax fasciolata*, **c)** *Aramus guarauna*, **d)** *Aramides ypecaha*, **e)** *Tigrisoma lineatum*, **f)** *Ardea cocoi*, **g)** *Coragyps atratus*, **h)** *Pulsatrix perspicillata*, **i)** *Cariama cristata*.

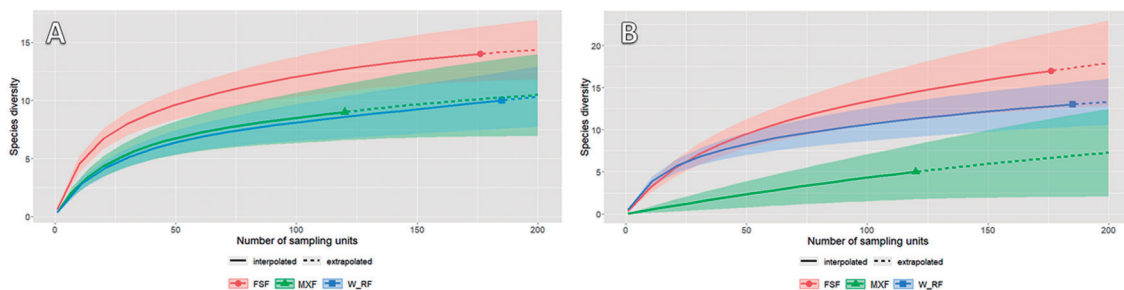


Figure 4. Species rarefaction curves for: **a)** mammals and **b)** bird species for each site (**W-RF:** Wetlands and associated riparian forests, **MXF:** Mesoxerophytic semi-deciduous forests, **FSF:** Floodable sub-humid forest islets).

Discussion

Diversity of medium and large-sized mammals found in this study represents 19% of the total recorded in the Humid Chaco ecoregion (Rumbo, 2010). Carnivora had the highest richness among the mammals recorded, being *Cerdocyon thous* the most frequently recorded species and, found in all habitats studied; this species is commonly associated to areas with combination of forest patches, savannas and grasslands (Maffei *et al.*, 2007) and show a cathemeral activity according to Huck *et al.* (2017). *Nasua nasua* and *Procyon cancrivorus* were also recorded frequently and in all types of vegetation, the latter associated with puddles and other water bodies (Redford & Eisenberg, 1992). Another species with numerous records was *Dasyurus novemcinctus*, which was associated with humid forest habitats, as mentioned by Neris *et al.* (2002) and was observed mainly during the night. Records of felids were low, and the only species was *Leopardus geoffroyi*, this may be due to the short period and size of our sampling, and to the fact that probably felids are in low density in the area because of the presence of cattle and humans. Additionally, traces of *Puma concolor* were recently found in a pasture area in the study site by locals, and its presence was later confirmed by camera trap data obtained later than those analyzed in this study. Species associated with wetlands and other water bodies such as *Lontra longicaudis* and *Hydrochoerus hydrochaeris* were recorded

in low numbers probably due to the low sampling effort dedicated to these habitats.

In regard of the conservation status, almost all the species recorded are listed as Least Concern according to the IUCN, except for *Myrmecophaga tridactyla* which is categorized as Vulnerable, *Lontra longicaudis* as Near Threatened and *Dasyprocta azarae* as Data Deficient. The first two species are considered threatened despite having wide ranges of distribution, because of local extinctions mainly due to the degradation of their habitats and the pressure by hunting (Miranda *et al.*, 2014; Rheingantz & Trinca, 2015). Recently, the conservation status of mammals was evaluated at the national level and *Myrmecophaga tridactyla* was also categorized as Vulnerable. Other modifications are that *Lontra longicaudis* is listed as LC, as well as *Dasyprocta azarae*, and the species *Sylvilagus brasiliensis* was not evaluated (Asociación Paraguaya de Mastozoología & Secretaría del Ambiente, 2017).

A record that is worth mentioning, although it was not obtained with the camera traps, is that of the maned wolf *Crhysocyon brachyurus*, which was observed at night in an internal vehicular path. We consider that this species was not recorded with the camera traps because it is usually associated with grasslands (Dietz, 1985) and this type of habitat was not analyzed in this study.

Birds recorded with camera traps in our study site represent only 5% of all species cited for the Humid Chaco in Paraguay (Guyra

Paraguay, 2004). Bird size and distance to the camera affect the triggering; also, temperature and flock size have an impact with larger flocks being captured more often (Randler & Kalb, 2018). This study provides the first record of *Pulsatrix perspicillata* for the Presidente Hayes Department, which was considered as hypothetical for the Humid (Low) Chaco region by Hayes (1995). Another remarkable result of our study was the detection in high numbers of the species *Crax fasciolata* which is categorized as Vulnerable due to loss of forest cover mainly in the Amazon region and to other factors such as hunting and edge effect (Birdlife International 2016). Solitary individuals and groups of up to 5 were detected in the subtropical forest and riparian forest (Laino *et al.* 2018), as suggested by Fernández-Duque *et al.* (2013) this species was registered more frequently during daylight and near water bodies.

Most species in the present study have geographic ranges that include the Humid Chaco ecoregion, but this study confirms its presence, and given that wildlife inventories for this region are still scarce, our work provides essential information for the area. The diversity found at Estancia Playada suggests that it may play a key role in the preservation of wildlife in addition to be an area of connectivity to the IBA Estancia Rafaela (IBA code PY022). Therefore, we consider imperative to carry out conservation efforts promoting the establishment of protected areas, since these represent slightly modified natural environments, and are very threatened by the lack of a land-use planning policy.

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