












A community-based survey of mammals in the Río Sapo basin, El Salvador

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ABSTRACT. Introduction: El Salvador is one of the most densely populated and most deforested countries of the American continent, where social insecurity make field research difficult. Here we present an experience in which rural and indigenous communities were part of a mammal survey. **Objectives:** To identify the mammals of Río Sapo basin, and establish the potential of local communities in scientific studies of mammals in El Salvador. **Methods:** We studied 17 sites in Joateca and Arambala, Río Sapo basin; 14 volunteers were organized, including local former hunters, forest owners, indigenous communities, and researchers. Fieldwork was done from August 2018 to December 2019. Mammals were identified during field visits and with camera traps. We also included the socio-cultural importance of wildlife within the Kakawira-Lenca indigenous worldview. **Results:** Twenty-two species were identified, including six that are threatened or endangered. We expanded the local range of *Tamandua mexicana* and *Pecari tajacu* for the department of Morazán, also, we added *Glaucomys volans* to the country's species list. We list traditional uses of mammals of the Kakawira-Lenca culture and report the indigenous names of 15 species. **Conclusion:** The participation of local communities is a valid option for field work in El Salvador, and probably in other areas where social insecurity makes field research dangerous.

Keywords: Community science, distribution, indigenous communities, Kakawira-Lenca, Morazán, wildlife.

RESUMEN. “Registro comunitario de mamíferos en la cuenca del Río Sapo, El Salvador”. **Introducción:** El Salvador es un país densamente poblado y deforestado, donde la inseguridad social dificulta la investigación de campo. Presentamos una experiencia en la cual las comunidades rurales e indígenas fueron parte de un registro de mamíferos. **Objetivos:** Identificar los mamíferos de la cuenca del Río Sapo y establecer el potencial de las comunidades locales en estudios científicos de mamíferos en El Salvador. **Métodos:** Estudiamos 17 sitios en Joateca y Arambala, Río Sapo, durante agosto del 2018 hasta diciembre del 2019; organizamos 14 voluntarios. Identificamos los mamíferos durante las visitas de campo y con cámaras trampa. También incluimos la importancia sociocultural de la vida silvestre dentro de la cosmovisión indígena Kakawira-Lenca. **Resultados:** Identificamos 22 especies, incluidas seis que están amenazadas o en peligro de extinción. Ampliamos el ámbito local de *Tamandua mexicana* y *Pecari tajacu* para el departamento de Morazán, además, agregamos a *Glaucomys volans* a la lista de especie del país. Enumeramos los usos tradicionales de los mamíferos de la cultura Kakawira-Lenca e informamos los nombres indígenas de 15 especies. **Conclusión:** La participación de las comunidades locales son una opción válida para el trabajo de campo en El Salvador, y probablemente en otras áreas donde la inseguridad social hace que la investigación de campo sea peligrosa.

Palabras clave: Ciencia comunitaria, distribución, comunidades indígenas, Kakawira-Lenca, Morazán, vida silvestre.



El Salvador is one of the most densely populated and most deforested countries of the American continent (Dull, 2008). Population growth and high demand for food have caused high deterioration of its territory, turning forests into agricultural and livestock areas, and this degradation has led to the extirpation of most large mammals in the country (Campbell & Torres-Alvarado, 2011; Campbell, 2015). Some authors suggest that a large part of Salvadoran ecosystems are vulnerable and present an endangered or threatened conservation status (Crespin & Simonetti, 2015, 2016). Although ~29% of the territory is considered forest (mainly secondary forests) (MARN, 2018), the protected areas (terrestrial) system covers only ~8% (UNEP-WCMC, 2019), which suggests that a large part of the forests and Salvadoran biodiversity is mainly in private areas exposed to human activity.

In the northeastern area of El Salvador, during the 1980s, many lands were abandoned due to the armed conflict, that lasted a little more than a decade, which allowed an increase in the forest cover in the following years (Hecht, Kandel, Gomes, Cuellar, & Rosa, 2006; Hecht & Saatchi, 2007; Clark, Aide, & Riner, 2012; Redo, Grau, Aide, & Clark, 2012). During the post-war period to date, agricultural and livestock activity has been diminished by the phenomenon of remittances (Hecht et al., 2006; Redo et al., 2012). However, deforestation by wood extraction, land-use change, poaching or illegal hunting, and uncontrolled tourism is evident in this part of the country. As a response to these problems, there are currently social organizations and local governments acting to protect its natural resources under the local environmental governance approach, including the contribution of Kakawira-Lenca indigenous communities. However, in El Salvador, these local actions tend to be underestimated or usually go unnoticed by decision-makers, though there are some documented cases in the country where local communities lead conservation efforts (e.g. Valencia, i Juncà, Linde, & Riera, 2011; Valencia, Riera, & Boada i Juncà, 2012). Therefore, it is important to know and divulge the link between biodiversity and local communities to develop better participatory biodiversity management and conservation strategies at a local and national level (Berkes, Colding, & Folke, 2000; Moller, Berkes, Lyver, & Kislalioglu, 2004; Berkes, 2007).

Currently, there are efforts to study the mammals in El Salvador, however, most information remains part of technical reports and very few get published in scientific journals (e.g. Morales Hernández, 2002; Girón, Owen, & Rodríguez, 2010; Campbell & Torres-Alvarado, 2011; Crespín, 2011; Owen & Girón, 2012; Crespin & García-Villalta, 2014; Campbell, 2015; Pineda Peraza, Segura Yanes, Medina Zeledón, Flores-Márquez, & López, 2017; Morales-Rivas et al., 2020), and many times, researchers ignore the role of local communities as crucial actors in the generation of data, despite when local actors can reduce research costs and increase the quality of information due to their knowledge of the territory, besides offering an exchange of knowledge between researchers and local communities (Conrad & Hilchey, 2011). Even this can favor the production of scientific material within hostile territories dominated by drug trafficking, gangs, or illicit associations in sites of biodiversity hot-spots, such as occurs in remote forests within the Central American region (Sesnie et al., 2017). In El Salvador, high rates of violence and social insecurity make field research work difficult, even the work of environmental defenders is a dangerous job in the country (Allison, 2017; Middeldorp & Le Billon, 2019). Therefore, this participatory mechanism between researchers and local communities provides opportunities to co-produce scientific efforts within the social context of El Salvador.

This work is the first community effort that has generated wildlife data on private properties in forested areas of the northeastern area of El Salvador. Also, this document collects information on the sociocultural link of wildlife to local communities. With this community science effort, we expect to contribute to the generation of knowledge and inputs for the management and protection of biodiversity in the territory. Therefore, this study's main goals were a) to establish the importance



of local communities in scientific studies in El Salvador; b) to rescue the sociocultural value of mammalian species within the indigenous and local communities in northeastern El Salvador.

MATERIALS AND METHODS

Study Area: The research was carried out in the municipalities of Joateca and Arambala, in the northeastern area of El Salvador in the department of Morazán (Fig. 1 in Digital Appendix). Between both municipalities, an approximate area of 190,3km² is covered. The elevation of the study area ranges from 450-950masl, the temperature and precipitation are typical of tropical regions, with a rainy season (May-October) and six months of the well-defined dry season (November-April). The predominant vegetation type is the pine-oak and subtropical dry forest association. There are very predominant rock formations in the landscape and its main sources of water are the Río Sapó, Río Guaco, and Río Talchiga, all belonging to the Río Torola basin. Within the department of Morazán, near the municipalities of Joateca and Arambala, there are indigenous communities (Kakawira-Lenca) in the municipalities of Guatajiagua, Sensembra, Chilanga, San Simón, Corinto, Lolotiquillo, Cacaopera, Yoloaiquín, and Delicias de Concepción, that impact the territory through participation in environmental actions.

Data collection: The participation of 14 volunteers was organized, including local people (former hunters), forest owners, indigenous communities, and researchers. The volunteers were trained through workshops about the use of camera traps, the use of GPS, images compilation, data processing in the computer, and species identification. Subsequently, camera traps and GPS were provided to the volunteer team. Seventeen sampling sites were selected within the Río Sapó basin, each site corresponding to properties of the project volunteers or private areas along the Río Sapó basin (Table 1 in Digital Appendix). The selected sites correspond to sites with less probability of theft of the camera traps, and they also represent sites with less delinquency or sites with less conflict between owners and volunteers team in this research.

Fieldwork began in the dry season of April 2018 with the organization of the voluntary work team and data were collected in the field from August 2018 to December 2019. Nine camera traps (Cabela's, Bushnell, and CamPark models) were used, changing sites approximately every 20-30 days to cover more area. The cameras were located at a minimum distance of 300m between them. The sites were selected according to traces or evidence of the activity of wild mammals in the area and experience of volunteers in the field. Sites with direct sunlight exposure and sites with high human activity were avoided. Memory cards were checked every 20-30 days to identify mammalian findings. The conservation status of registered species was verified according to international lists (IUCN, CITES) and national legislation.

At the end of the fieldwork, a workshop was held with land-owners, indigenous leaders, and researchers to identify documented species, identification of common names, traditional names of the Kakawira-Lenca culture, traditional uses of mammals, and identification of descriptive aspects of the habitat. Each animal was classified according to the predominant diet based on available literature. Additionally, sightings data were obtained that were registered within the forest by the team of researchers and volunteers. This was done to document the largest number of species that inhabit the area, only using records of high reliability.

Habitat descriptions: To describe important aspects of the habitat of the mammal species in the area, the type of forest cover was classified by the ecological categories that volunteers recognized and identified according to leaf type, dominant tree species, and leaf deciduousness. For this, participatory workshops were held where researchers and volunteers defined the forest cover type that predominates at each site where the camera traps were placed. Five categories were identified: Broadleaved forest (BLF; predominantly broad-leaved species always green), deciduous



forest (DF; Deciduous species in the dry season), Riparian forest (RF), Oak forest (OF), Pine-oak forest (POF) and Mixed forest (MF; deciduous species, broadleaf, fruit trees, and forest plantations).

RESULTS

We reported 22 species of mammals (Table 1) distributed in eight orders and 15 families in a sampling effort of approximately 8 160 camera hours (Fig. 2-4 in Digital Appendix). The most representative mammal order was Carnivora with 11 species. The most recorded species per sites were *Didelphis marsupialis* (10 sites), *Conepatus leuconotus* (eight sites), and *Odocoileus virginianus* (six sites), while the species *Desmodus rotundus*, *Sylvilagus floridanus*, *Canis latrans*, *Pecari tajacu*, and *Cuniculus paca* were registered only in one site (Table 1). The species recorded only through sightings by volunteers were *Lontra longicaudis*, *Nasua narica*, *Procyon lotor*, and *Glaucomys volans*. The trophic guilds of carnivores (eight species), herbivores (two species), omnivores (six species), insectivores (two species), frugivores (three species), hematophagous (one species) were identified (Table 1). In the case of endangered species for El Salvador, we recorded *Tamandua mexicana*, *Puma concolor*, *Leopardus wiedii*, *L. longicaudis*, *P. tajacu*, and *C. paca*. According to CITES status, the species *L. wiedii* and *L. longicaudis* are included in Appendix I, and *P. concolor*, *Puma yagouarundi*, and *P. tajacu* in Appendix II. In the case of IUCN status, only *L. wiedii* and *L. longicaudis* are found as Near Threatened (NT), and the rest of species are considered Least Concern (LC).

Regarding habitat types, Riverine Forest (RF) was the habitat with the highest species richness (13 species /four sites), followed by Deciduous Forest (10 species / five sites), Oak Forest (seven species / one site), Broad Leaved Forest (seven species/ three sites), and Mixed Forest (six species/ three sites), while in Pine-oak Forest only one species was recorded at one site (Table 1). In the Riverine Forest, we found three endangered species in El Salvador: *T. mexicana*, *L. wiedii*, *P. concolor*. The Broad Leaved Forest was the only habitat where we recorded *P. tajacu*, the Oak Forest the only habitat for *G. volans* and *C. paca*, and the Mixed Forest for *L. longicaudis*. We recorded, in almost all identified habitats, the presence of *O. virginianus* and *Dasyprocta punctata*, species which are known to be part of the diet of predators such as felines. The presence of cattle (*Bos taurus*) within forested areas was documented, as well as sightings of feral dogs (*Canis lupus familiaris*), domestic cats (*Felis catus*), and hunters on several occasions in locations with the occurrence of mammals such as *T. mexicana*, *P. yagouarundi*, *P. concolor*, and *O. virginianus*. During the study, we did not observe any threat to domestic animals or livestock by top predators, or any other conflict between wildlife and humans. However, through consults in communities near forests, we detected concern for the presence of *P. concolor*.



TABLE 1

List of mammalian species identified in 17 sites in the northern area of Morazán, in the period from August 2018-December 2019

Order	Family	Scientific name	Trophic guilds	Sites																
				BLF			RF				DF					MF			OF	POF
				A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Didelphimorphia	Didelphidae	<i>Didelphis marsupialis</i>	Omnivore	X	X		X		X		X	X	X		X	X				
		<i>Philander opossum</i>	Omnivore							X			X	X	X					
Cingulata	Dasypodidae	<i>Dasypus novemcinctus</i>	Insectivore	X		X	X													
Pilosa	Myrmecophagidae	<i>Tamandua mexicana</i>	Insectivore				X		X											
Chiroptera	Phyllostomidae	<i>Desmodus rotundus</i>	Hematophagous	X																
Lagomorpha	Leporidae	<i>Sylvilagus floridanus</i>	Herbivore						X											
Carnivora	Felidae	<i>Leopardus wiedii</i>	Carnivore						X		X						X	X		
		<i>Puma concolor</i>	Carnivore				X	X												
		<i>Puma yagouaroundi</i>	Carnivore				X		X				X							
	Canidae	<i>Canis latrans</i>	Carnivore										X							
		<i>Urocyon cinereoargenteus</i>	Omnivore						X									X		
	Mustelidae	<i>Lontra longicaudis</i> †	Carnivore										X							
	Mephitidae	<i>Conepatus leuconotus</i>	Carnivore		X				X	X	X	X	X	X	X	X	X	X	X	
		<i>Mephitis macroura</i>	Carnivore				X		X							X				
		<i>Spilogale angustifrons</i>	Carnivore				X		X	X	X	X								
		<i>Nasua narica</i> †	Omnivore								X							X		
		<i>Procyon lotor</i> †	Omnivore								X									
	Artiodactyla	Tayassuidae	<i>Pecari tajacu</i>	Frugivore			X													
		Cervidae	<i>Odocoileus virginianus</i>	Herbivore	X	X				X		X				X		X		
Rodentia	Dasyproctidae	<i>Dasyprocta punctata</i>	Frugivore			X	X	X	X											
	Cuniculidae	<i>Cuniculus paca</i>	Frugivore															X		
	Sciuridae	<i>Glaucomys volans</i> †	Omnivore															X		
Total species		22		4	3	3	8	2	6	5	4	3	4	2	4	3	2	4	7	1
Dogs (<i>Canis lupus familiaris</i>)								4	3				3							
Cats (<i>Felis catus</i>)						2														
Cattle (<i>Bos taurus</i>)						5				3		3								
Hunter						1	1		2											

Sighted reports (†). Broad Leaved Forest (BLF; 3 sites), Riverine Forest (RF; 4 sites), Mixed Forest (MF; 3 sites), Deciduous Forest (DF; 5 sites), Oak Forest (OF; 1 site), Pine-oak Forest (POF; 1 site). Dogs, cattle, and hunters were recorded; these values correspond to the number of times they were registered in the camera independently.



Regarding the socio-cultural value, we rescued 15 names of mammal's species in the Kakawira-Potón language of the Kakawira-Lenca culture (Table 2). We reported traditional uses of mammals that were classified into five categories: food, medicinal, worldview, artisanal (tools), and ornamental. The use of food (12 species) was the most predominant of all the mammals identified, followed by medicinal use (10), worldview (9), ornamental (four), and artisanal (two). Cougar (*P. concolor*) and Deer (*O. virginianus*) stand out as protective spirits and guardians of the forest within Kakawira-Lenca culture. These species are important within the worldview of the indigenous community, venerated by representing a significant link between the human being and mother earth. Although historically hunting was a source of food for these communities, this activity is not currently carried out and its main diet comes from agricultural production. Currently, the Kakawira-Lenca community makes conservation efforts in the territories autonomously and conservation efforts are made through environmental education, forest restoration, and organic agriculture, using the worldview of both cultures through the recognition of the value of species and their link with the forest.

TABLE 2

List of mammalian species identified in the northern area of Morazán, in the period from August 2018-December 2019

Scientific name	Common name (Salvadorean name)	Cultural use	Kakawira**, Potón* name
<i>Didelphis marsupialis</i>	Tacuazín negro	F, M	Tseve*
<i>Philander opossum</i>	Tacuazín cuatro ojos	F, M	Tseve*
<i>Dasybus novemcinctus</i>	Cuzuco, armadillo	F, M, A, O, W	Kí'sukisu/kisú**, Guat*
<i>Tamandua mexicana</i>	Oso hormiguero		
<i>Desmodus rotundus</i>	Murciélago vampíro	W	Mitzon*
<i>Sylvilagus floridanus</i>	Conejo silvestre	F, W	Kunikundi**, Mon*
<i>Leopardus wiedii</i>	Tigrillo	O, W	Lepa*†
<i>Puma concolor</i>	Puma	O, W	Lepa*†
<i>Puma yagouaroundi</i>	Gato zonto	F, W	Mitsikarran**, Kotan-mistu*
<i>Canis latrans</i>	Coyote	M, W	Wiru/wirru**, Shua*
<i>Urocyon cinereoargenteus</i>	Zorra gris	F	
<i>Lontra longicaudis</i>	Nutria		
<i>Conepatus leuconotus</i>	Zorrillo espalda blanca	M	
<i>Mephitis macroura</i>	Zorrillo listado	M	
<i>Spilogale angustifrons</i>	Zorrillo manchado	M	
<i>Nasua narica</i>	Pezote	F	Lanwalá**
<i>Procyon lotor</i>	Mapache	F, M, W	Wa'la/wala**, Guayan*
<i>Pecari tajacu</i>	Cuche de monte	F	
<i>Odocoileus virginianus</i>	Venado cola blanca	F, M, W, A, O	Yan**, Akuan*
<i>Dasyprocta punctata</i>	Cotuja	F	Su'susu/sususo**
<i>Cuniculus paca</i>	Tepezcluintle	F, M	Jalab**
<i>Glaucmys volans</i>	Ardilla planeadora		Tasta**, Shuli*

Names in Kakawira (**) and Potón (*), (†) Name refers to the Jaguar, in the absence of the Jaguar, it can also be referred to large cats; currently, the Jaguar (*Panthera onca*) is considered extinct in the country. Mammal use: Food (F), Medicinal (M), Worldview (W), Artisanal (A), and Ornamental (O).



DISCUSSION

In this study supported by indigenous and local communities, we have updated the knowledge of mammals in El Salvador, increasing the species richness from 76 to 79 in the northeast of the country and from 128 to 129 species of land mammals throughout the country (Owen & Girón, 2012). We recorded the ~17% of the mammalian species in El Salvador and ~60% of medium-sized mammals (Owen & Girón, 2012). The new species documented in the northeast of the country are *T. mexicana*, and *P. tajacu*. Also, *G. volans* is registered for the first time in El Salvador, although there is no specimen or photograph yet. This record was made through direct observation by a team of researchers and has been reported by volunteers on several occasions. Due to its unique and unmistakable characteristics (gliding capacity), different from any other animal in the sampled area, and the proximity of our study area with the known distribution area of the species (Diersing, 1980; Braun, 1988; Cassola, 2016; Kohler, Olson, Martin, & Anich, 2019), it was decided to incorporate as a valid record and recognize their presence in El Salvador.

One of the most relevant findings is the record of *P. concolor* in six different months during our study (April, July, August, September, October, and November 2019), becoming the study with the most evidence of this species in the country (see Morales-Rivas et al., 2020). This species was considered by some authors as extinct or unlikely to inhabit the country, mainly due to the demand for large forest areas (Campbell & Torres Alvarado, 2011; Crespin & García-Villalta, 2014; Campbell, 2015; Campbell, 2019). This result suggests conditions of good ecosystem health or at least favorable conditions for the presence of top predators (Miller et al., 2001; Ritchie, Elmhagen, Glen, Letnic, Ludwig, & McDonald, 2012; Barry et al., 2019), although the adaptation of large predators is also possible in disturbed ecosystems (Moss, Alldredge, Logan, & Pauli, 2016). Despite the traditional uses of mammals in the territory, currently, local communities and indigenous people promote the protection of wildlife. Considering the spiritual value of Cougars in the Kakawira-Lenca culture and its recent records, an important link between beliefs and conservation of the species can be generated. Cougars are considered guardian spirits of the forest, which can be a powerful tool to create a positive image that helps conserve the species and natural forest that remains in the northeast of the country.

Due to the small amount of protected area in El Salvador (less than 9% of the territory), it is likely not enough to protect much of the biodiversity of this country, especially big predators like a Cougar (Crespin & García-Villalta, 2014). Our findings occur outside protected areas, which supports the proposal to generate management tools through biological corridors for biodiversity conservation within a landscape intermixed between forests, agricultural-livestock areas, and rural areas (Crespin & García-Villalta, 2014). Within our study area, there are efforts to establish private protected areas through the organization of forest owners. This strategy would contribute greatly to the survival of species through the conservation and connectivity of forest cover for El Salvador. Future works should be aimed at structuring these proposals for this area of study. Our work contributes to these efforts of local environmental governance and the participation of local actors in this study generates legitimacy in the use of this information (Berkes, 2007; Conrad & Hilchey, 2011; Parsons, Goforth, Costello, & Kays, 2018; Mohedano Roldán, Duit, & Schultz, 2019).

Future efforts of wildlife conservation must consider communication strategies about the perception of wildlife in this area, given that consultation with local communities and some researchers, suggests there are fears or myths about some predators that can generate conflict (Campbell & Torres-Alvarado, 2011). Despite this, our study does not identify any conflict with wildlife, so the forest in the area can likely sustain abundant or necessary prey to support big predators. Our results show different trophic guilds, which may suggest a balance in the ecosystem (Terborgh & Estes, 2013), but this affirmation is open to discussion for future works. On the other



hand, there is evidence of hunters, cattle, cats, and feral dogs in these forests, which is a warning call for the authorities responsible for watching over wildlife, taking actions to control poaching, watching over the health of the ecosystem, and avoiding future conflicts with wildlife. The use of camera traps with local community volunteer support can generate important data, a fact that was confirmed by the study, but it is important to first solve the challenges of creating a team of volunteers with training, equipment acquisition (camera traps, computer, GPS), and financing. This participatory effort allowed us to identify species that are difficult to detect the previous experience of the volunteers was crucial in this study. Also, we managed to encourage community participation and generate capacities that will be very useful in the following steps of this participatory research, where new techniques for the documentation of other mammals such as bats and small rodents will be included.

Finally, our results suggest that the forests of the northeastern of El Salvador has a high mammal species richness and their conservation should be a priority for decision-makers. This is the first initiative that exists in El Salvador, and probably one of the few efforts in the Central American region (e.g. Arévalo, Méndez, Roberts, Alvarado, & Vargas, 2015; Monge-Nájera & Seas, 2018), where local communities and indigenous leaders participate in the production of scientific material. Also, we collected valuable cultural information and identified links between ancestral knowledge and local conservation efforts of Kakawira-Lenca culture. The Kakawira-Lenca culture corresponds to one of the most representative indigenous groups in the country. However, there is little information about their worldview, language, and writing, due to the drastic decrease in their inhabitants (Lemus, 2010; Pineda, 2016). This effort is probably likely to be one of the first or one of the few available scientific documents of both cultures regarding biodiversity. This effort of involving local communities was an opportunity to promote research and generate scientific knowledge under a community science approach. Unlike in other areas of the country where there is usually not a strong social organization and illicit associations predominate, the social organization established in this territory facilitated our study. Therefore, the involvement of local communities in this territory can be an example of successful participatory work between researchers and local actors in El Salvador. We hope this information can be used within local conservation strategies, and that it can promote the cultural link between the Kakawira-Lenca roots and the intrinsic value of biodiversity in order to generate wildlife conservation participative mechanisms.

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ETHICAL, CONFLICT OF INTEREST AND FINANCIAL STATEMENTS

The authors declare that they have fully complied with all pertinent ethical and legal requirements, both during the study and in the production of the manuscript; that there are no conflicts of interest of any kind; that all financial sources are fully and clearly stated in the acknowledgments section; and that they fully agree with the final edited version of the article. A signed document has been filed in the journal archives.



The declaration of the contribution of each author to the manuscript is as follows: J.G.A.R., E.A.A.R., J.P.A.R. and M.C.C.: Data collection and analysis. M.S.H., J.H.C. and V.P.M.: Data collection. X.P-O., L.G. and F.S.A.: Data collection, data analysis, writing and review of the manuscript.

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Digital Appendix

TABLE 1.

Description of 17 sampling sites in the northern area of Morazán, in the period from August 2018-December 2019.

Sites	Latitude	Longitude	Elevation (masl)	Forest cover	Urban	Natural grass	Livestock	Agriculture	Roads	Distance to the river (km)	Distance to the road (km)
A	13° 55.808'N	88° 6.200'O	675	■						0.01	0.88
B	13° 55.931'N	88° 6.205'O	727	■						0.03	1.12
C	13° 56.088'N	88° 6.134'O	725	■						0.05	0.95
D	13° 56.239'N	88° 6.005'O	684	■			■			0.01	1.5
E	13° 56.210'N	88° 5.860'O	691	■						0.02	1.45
F	13° 56.091'N	88° 5.963'O	685	■						0.01	1.4
G	13° 55.761'N	88° 6.102'O	664	■						0.03	0.79
H	13° 51.896'N	88° 5.702'O	470	■	■					0.20	3.4
I	13° 52.174'N	88° 5.502'O	429	■		■	■			0.06	3.15
J	13° 52.681'N	88° 5.698'O	573	■			■	■		0.45	3.33
K	13° 51.802'N	88° 4.990'O	455	■						0.07	2.13
L	13° 52.818'N	88° 5.455'O	448	■		■				0.09	3.48
M	13° 51.880'N	88° 5.558'O	397	■						0.03	3.13
N	13° 54.604'N	88° 4.373'O	712	■	■		■		■	2.00	0.15
O	13° 56.361'N	88° 5.789'O	700	■			■			0.27	1.99
P	13° 55.865'N	88° 4.977'O	950	■		■	■			1.85	1.19
Q	13° 56.807'N	88° 6.177'O	800	■						0.15	2.62

The land use comes of circular areas with a diameter of 250 m, taking as a central point the location of each camera traps. The proximity to water sources and roads, which was measured in meters and km in a straight line, respectively. This was done in a single measurement using Geographic Information System (GIS).



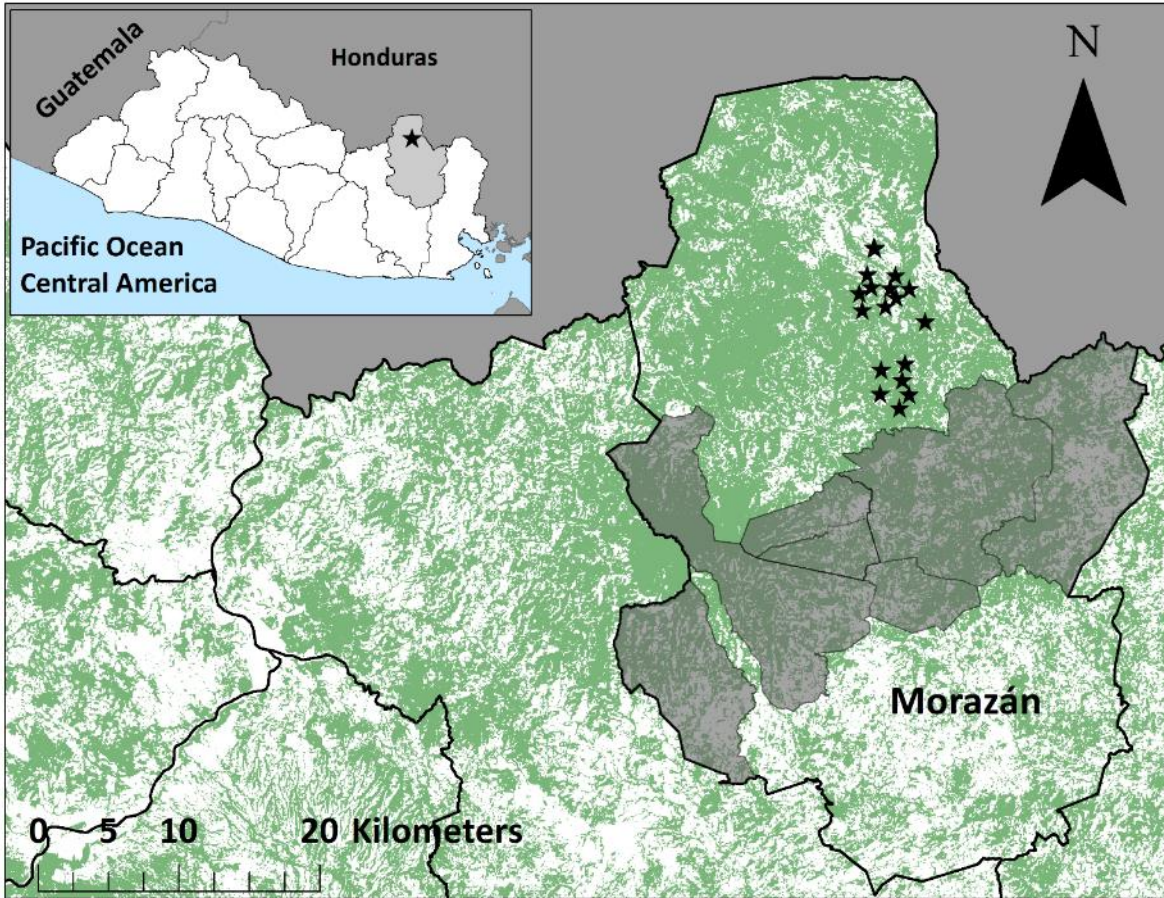


Fig. 1. Study area in the municipalities of Joateca and Arambala, Morazán department, El Salvador. Dark gray polygons represent municipalities with indigenous communities of the Department of Morazán, and green polygons represent forest cover.



Fig. 2. Species identified in camera traps: A) *Didelphis marsupialis*, B) *Philander opossum*, C) *Dasypus novemcinctus*, D) *Tamandua mexicana*, E) *Desmodus rotundus* flying over a cow inside the forest, and F) *Sylvilagus floridanus*.

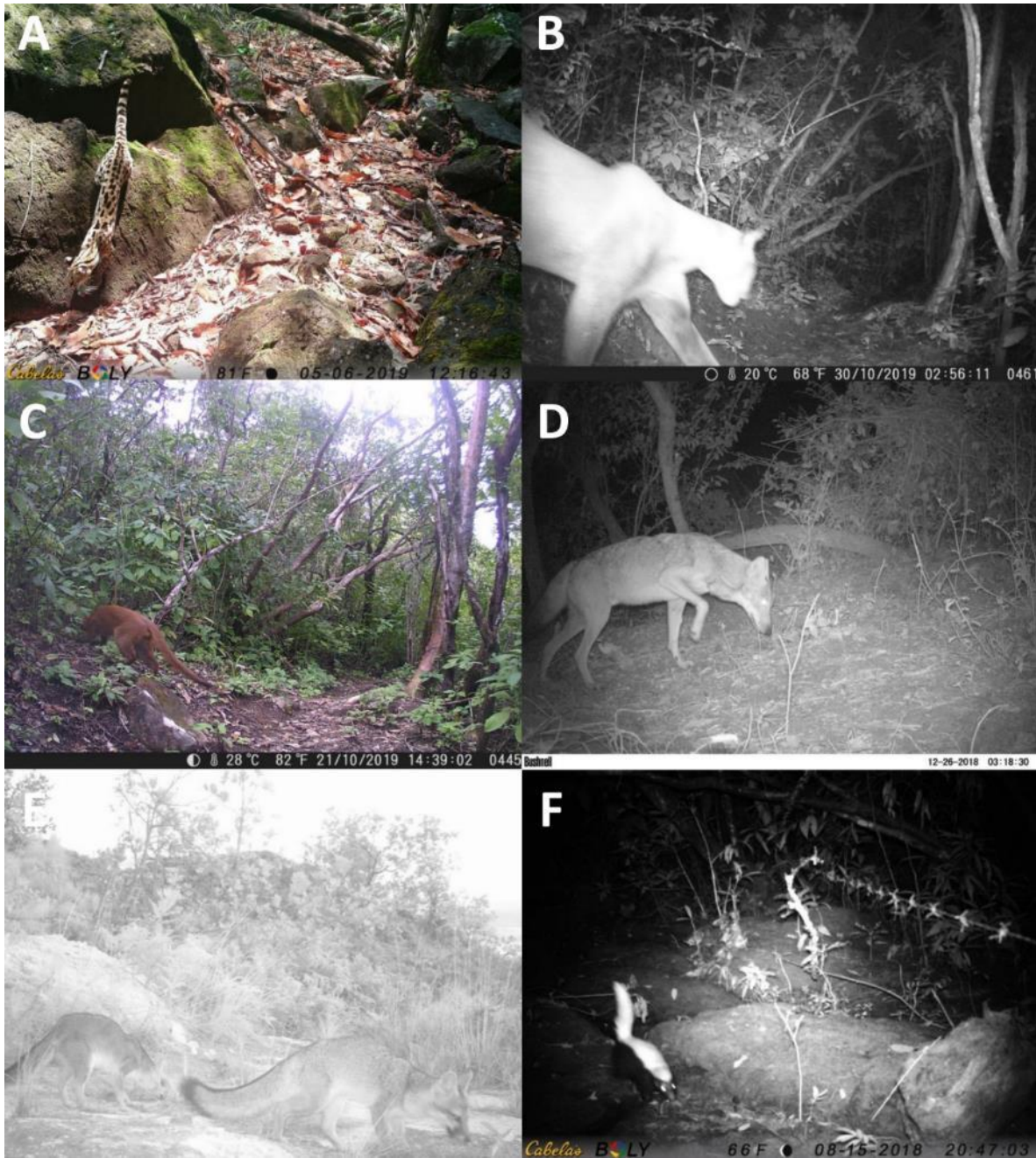


Fig. 3. Species identified in camera traps: A) *Leopardus wiedii*, B) *Puma concolor*, C) *Puma yagouaroundi*, D) *Canis latrans*, E) *Urocyon cinereoargenteus*, and F) *Conepatus leuconotus*.

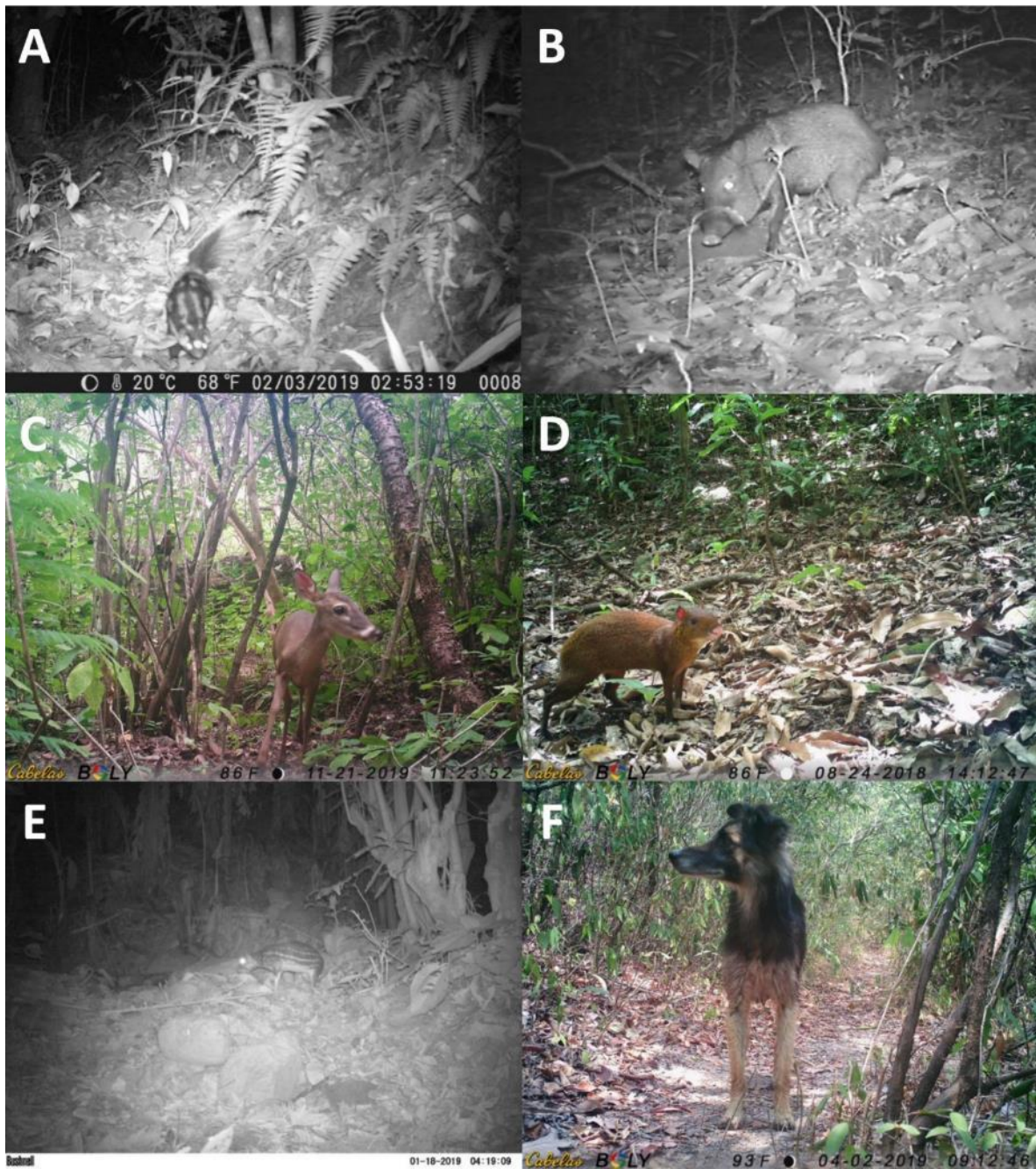


Fig. 4. Species identified in camera traps: A) *Spilogale angustifrons*, B) *Pecari tajacu*, C) *Odocoileus virginianus*, D) *Dasyprocta punctata*, E) *Cuniculus paca*, and F) *Canis lupus familiaris* (Domestic dog).