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Non-volant mammals from the protected areas associated to hydroelectric projects on the eastern slope of the northern Cordillera Central, Colombia

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Abstract: The northern part of the Cordillera Central in Colombia has been recognized as a region of particular relevancy in vertebrates biodiversity. We provide a list of non-volant mammal species in Jaguas and San Carlos, two protected areas around hydroelectric projects on the eastern slope of the Cordillera Central in Antioquia. As part of an ongoing monitoring project, we obtained records from a standardized survey in 2011 and sporadic surveys in 2014–2015 (capture and non-invasive methods), and from the revision of voucher specimens. From 132 records we generated a list of 34 species, 22 species in Jaguas and 27 in San Carlos, belonging to 20 families and seven orders. We record the occurrence of four endemic and four threatened species, including the endemic and Endangered Tamarin, *Saguinus leucopus*, highlighting the importance of these protected areas for mammal conservation in this highly diverse region.

Key words: species inventory; mammals; northern Andes; Middle Magdalena valley

INTRODUCTION

Power generation in Colombia relies heavily on generation from hydroelectric dams. Currently, 24 active hydroelectric projects and at least five more in construction represent nearly 64% of the generated electricity in the country (Palacios 2013; UPME 2013). Over the last decade, continued biodiversity studies associated with hydroelectric power projects have indirectly become an important and alternative means for obtaining biodiversity data on flora and vertebrate fauna in some regions of the country (e.g., Cardona et al. 2010, 2011; Andrade et al. 2013; Cuartas-Calle & Marín 2014; Jiménez-Segura et al. 2014; Pareja-Carmona & Ospina-Pabón 2014; Peña & Quirama 2014). Often, hydroelectric projects are located in understudied areas with expansive natural habitat of high conservation value. Colombia is one of the countries in the Neotropical Region with the greatest number of environmental studies associated with the development of hydroelectric projects. However, about half of these studies remain available only as unpublished reports (Jiménez-Segura et al. 2014). Therefore, the access and use of biological information for management and conservation and by the academic community is limited.

The eastern flank of the northern Cordillera Central (between 06°11′ N and 06°27′ N) holds one of the main hydroelectric power complexes in the country with five operational hydroelectric plants (Palacios 2013). Altogether, this system maintains an important area in a highly fragmented landscape with over 8,000 ha of protected forest covering a wide elevational range (400–1,800 m) and several life zones (Cardona et al. 2011). The northern Cordillera Central is recognized as a region with high biogeographic value because of the confluence of biological elements from different areas (e.g., Chocó, Central America, and inter-Andean valleys), resulting in high levels of richness and endemism of plants and vertebrates (Kattan & Franco 2004; Kattan et al. 2004; Cuervo et al. 2008a, 2008b; Idárraga & Callejas 2011). Likewise, during the last decade the discovery of 10 new species, including birds, frogs, snakes and lizards, have come from this region (Cuervo et al. 2001; Passos et al. 2009; Bravo-Valencia & Rivera-Correa 2011; Velasco et al. 2010; Rivera-Correa & Gutierrez-Cárdenas 2012; Rivera-Correa & Faivovich 2013; Rivera-Prieto et al. 2014).

The northern part of the Cordillera Central has been the focus of mammalian studies since the early 1900s (Allen 1916; Patterson 1987; Sánchez-Giraldo & Díaz-Nieto 2015). Recent survey efforts have significantly improved the species lists for several sites, finding new populations of threatened and endemic species from Colombia, and complex taxonomic entities (e.g., Castaño & Corrales 2010; Díaz-N et al. 2011; Sánchez-Giraldo & Díaz-Nieto 2015). Nonetheless, large portions of the region

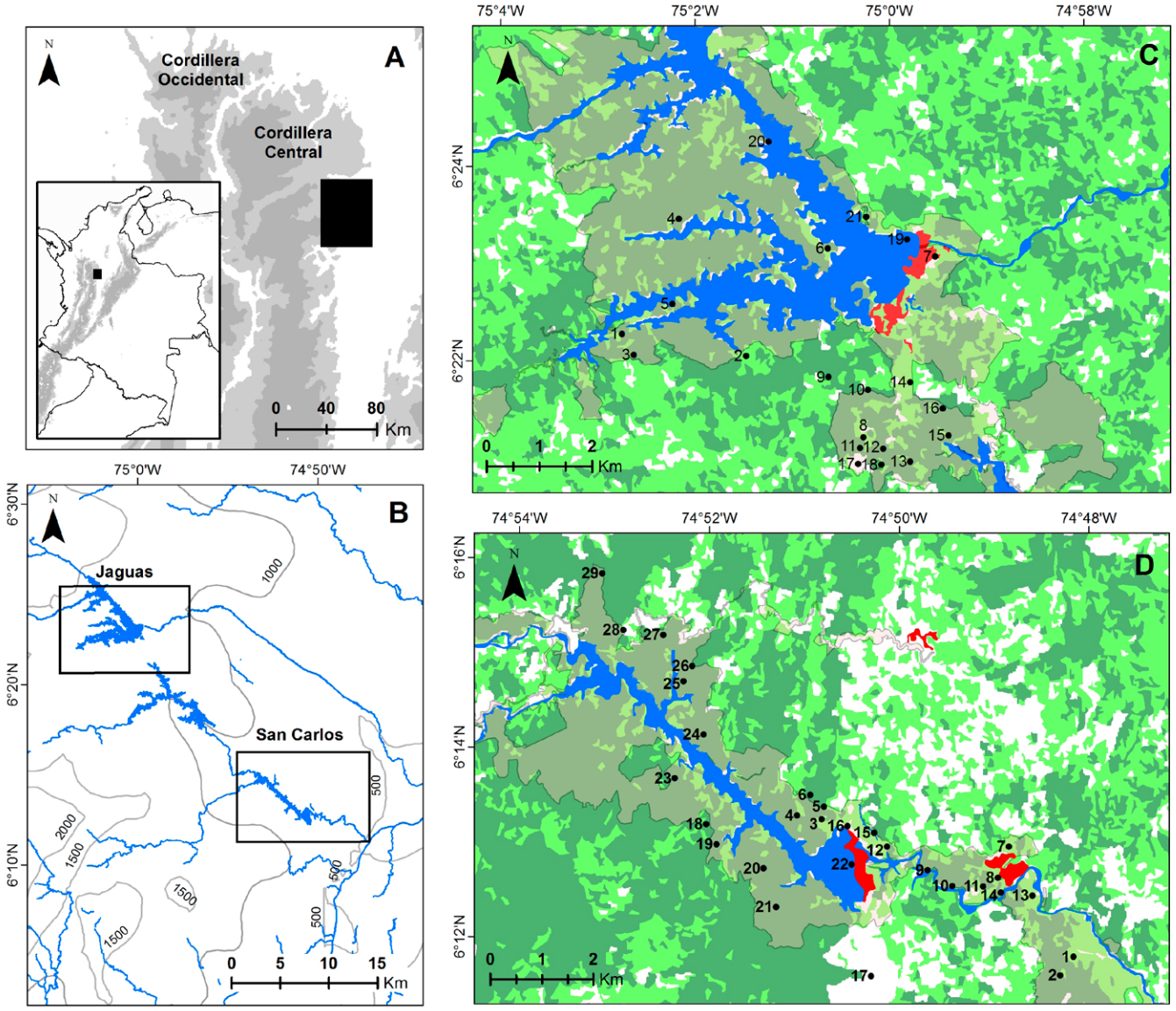

Figure 1. Study area location in Colombia (**A**) and detail within hydroelectric complex on the eastern slope of the Cordillera Central (**B**). Map showing in detail the localities (numbers; see Appendix 1) and covers (red: infrastructure and towns; blue: water bodies; dark green: fragmented forest; light green: shrubland) in Jaguas (**C**) and San Carlos (**D**) hydroelectric power plants. The transparent layer indicates the Protected Areas in Jaguas and San Carlos respectively.

have not yet surveyed, or surveys have been sporadic and scattered; information on mammal diversity is incomplete (Sánchez-Giraldo & Díaz-Nieto 2015). For the area on the eastern slope of the Cordillera Central holding hydroelectric power complex, check lists of mammal species are based mainly on literature reviews, sparse specimen collections, and focus mostly on bats (e.g., Cuartas-Calle & Muñoz-Arango 2003; Navarro et al. 2005).

Over the last decade, as part of a mammal monitoring program, intensive fieldwork has been conducted in the protected areas of two hydroelectric power plants in the northeastern Cordillera Central (ISAGEN S.A. 2007, 2008a, 2009). Even though these studies have produced important sources of information, and start to fill the knowledge gap of mammals in the region, they are unpublished. Here, we update the knowledge of the species richness and distribution of the mammal fauna on this region. We provide a taxonomic list for non-volant mammal species in the protected areas of Jaguas and San Carlos hydroelectric power plants. We compile data from previous studies supported by museum specimens and from our own recent surveys.

MATERIALS AND METHODS

Study sites

We conducted the study in the protected areas of the Jaguas and San Carlos hydroelectric power plants (ISAGEN S.A.) on the eastern slope of the northern Cordillera Central, Department of Antioquia, Colombia (Figure 1). Areas in both hydroelectric plants are privately protected areas since mid-1980s and recently they have been declared as Regional Forest Reserves (Cardona et al. 2011). The protected area at Jaguas hydroelectric plant (within 06°26′ N, 075°05′ W; 06°21′ N, 074°59′ W) covers ca. 50 km^2 and includes the San Lorenzo reservoir (10.2 km^2). The area is classified as Premontane Wet Forest (bmh-PM), with an elevation range between 1,100 of

1,300 m (above sea level), an annual average temperature between 18–24 °C, and annual rainfall from 2,000–4,000 mm (Holdridge 1964). San Carlos hydroelectric plant (06°16′ N, 074°55′ W; 06°12′ N, 074°49′ W) has a protected area of 30 km^2, with Punchiná reservoir covering ca. 3.3 km^2 (Figure 1). The San Carlos area has an elevational gradient from 400 to 1,100 m and is mostly Tropical West Forest (bh-T), with a zone of warm transition to Premontane Wet Forest (bmh-PM), characterized by annual rainfall of 2,000–4,000 mm and annual average temperature exceeding 24 °C (Holdridge 1964). Vegetation cover in the two protected areas includes different successional states of secondary forest, shrubs and bushes, and small areas used for agricultural and cattle activities (Cardona et al. 2011) (Figure 1).

Data collection

We obtained records of non-volant mammal species in both hydroelectric plants from fieldwork and the revision of voucher specimens. Fieldwork was conducted in two periods: (1) a standardized survey during 2011, and (2) several sporadic surveys between 2014 and 2015. The 2011 survey included the capture of small mammal species (marsupials and rodents) and the collection of data by non-invasive methods, including opportunistic observations and the search of footprints, feces and carcasses. Surveys in 2014 and 2015 only used non-invasive methods. The 2011 survey was conducted in four sampling periods: 1) 26 March–11 April, 2) 8–22 June, 3) 29 September–13 October, and 4) 17 November–1 December in Jaguas; and 1) 14–28 April, 2) 30 June–14 July, 3) 7–23 September, and 4) 6–20 December in San Carlos. The sampling included 12 localities in Jaguas and 16 in San Carlos (Figure 1). The 2014–2015 survey included three occasional sampling periods (May and October of 2014, and March 2015) only in San Carlos.

We used large Sherman (H.B. Sherman Traps, Tallahassee, USA) folding live traps (ca. 8 × 9 × 23 cm) to capture small species in different vegetation types. Traps were placed in single stations ca. 10 m apart from each another, following a transect arrangement (Pearson & Ruggiero 2003), and baited every morning during the sampling days with a mixture of peanut, rolled oats and vanilla essence. We sampled 47 nights in Jaguas and 52 in San Carlos, representing a total sampling effort of 940 and 1,040 trap-nights, respectively. We recorded standard measurements from each captured individual, and collected reference material preserved as fluid and dry specimens (following Hall 1962). All procedures were conducted under permit No. 112-0046 granted by the local environmental authority, Corporación Autónoma Regional CORNARE. The collected material is deposited in the Colección Teriológica Universidad de Antioquia (CTUA), Medellín, Colombia (Appendix 2).

Direct observations of individuals were obtained during opportunistic walks of transects following paths and dirt roads available within each study area. We searched for footprints, feces and carcasses along these transects and on sand banks and watercourses margins. For each record, we collected data of specific locality, geographic coordinates, and photographic material whenever possible. We used specialized field guides for identification of signs (Emmons & Feer 1999; Defler 2003; Aranda 2012).

In addition to field observations, we reviewed the voucher specimens deposited at the Colección Teriológica Universidad de Antioquia, Medellín, Colombia (CTUA). Most of the examined material was collected between 2006 and 2009 during surveys of terrestrial vertebrate fauna in the protected areas of Jaguas and San Carlos hydroelectric plants. We recovered the specific locality information, geographic coordinates and checked the taxonomic identification for all examined specimens. We followed the taxonomic nomenclature by Wilson & Reeder (2005) for those taxonomically stabile species. Additionally, for specific nomenclature, we followed Patton et al. (2015) for rodents, Voss & Jansa (2009) and Rossi et al. (2010) for some marsupials, and Ryland & Mittermeier (2009) and Rylands et al. (2013, 2016) for primates (Table 1; Table A1).

RESULTS

We obtained 132 records (52 in Jaguas and 80 in San Carlos) from 49 specific sites; of these, 20 were from newly collected specimens, 56 were direct observations, one was photo-trapped, one was a carcass, 19 were based on footprints, and 35 were museum specimens (Table 1; Appendices 1 and 2). The record from photo-trapping was provided by Faunativa S.A.S. as a result of an occasional survey with camera-traps carried out in Jaguas power plant in 2014. In total from both hydroelectric plants, we recorded the occurrence of 34 species of non-volant mammals belonging to seven orders and 20 families (Table 1; Figures 2, 3). One species, Black Rat [*Rattus rattus* (Linnaeus, 1758)] is exotic. The greatest number of species recorded belonged to the orders Rodentia and Carnivora, with 14 and eight species respectively. The orders Primates and Didelphimorphia had four species each, followed by Pilosa with two, and Cingulata and Artiodactyla with one species each (Table 1). We recorded most of the species from primary sources: 19 species from capture and museum vouchers, 13 from direct observations, one from photo-trapping [*Puma yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803)], and one exclusively from carcasses (*Dasypus novemcinctus* Linnaeus, 1758) (Table 1).

In Jaguas, we found records of 22 species from 20 localities covering an elevational range of 1,000 to 1,400 m, and in the case of San Carlos we recorded 27 species from 29 localities between 600 to 1,150 m (Table 1; Appendix 1). Rodentia and Carnivora had the highest richness at both study areas, with 11 and five species in Jaguas, and 11 and six species (respectively) in San Carlos. Didelphimorphia also reached a high representation with four species in Jaguas (Table 1; Figure 2). Species of Cingulata, Pilosa and Artiodactyla were not recorded in Jaguas. Fifteen spe-

Table 1. Non-volant mammal species recorded in Jaguas and San Carlos hydroelectric power plants, Department of Antioquia, Colombia. Numbers indicates the specific localities in each power plant (see Appendix 1). Type of record. C: Capture (2011 survey), V: voucher, Si: sightings, Ca: carcasses, phototrapping: Pt, and Ft: footprint. IUCN: global conservation status according to IUCN (2015). COL: Colombian conservation status according to MADS (2014)

Order/Family	Species	Jaguas	San Carlos	Record	COL	IUCN
Didelphimorphia						
Didelphidae	*Didelphis marsupialis* Linnaeus, 1758	13	20	C/V		LC
	Marmosa (Micoureus) demerarae O. Thomas, 1905 [a]	12, 14		V		LC
	Marmosa (Marmosa) isthmica Goldman, 1912 [b]	1, 17, 20	1, 4, 12, 25	C/V		
	Metachirus nudicaudatus (É. Geoffroy Saint-Hilaire, 1803)	6		V		LC
Cingulata						
Dasypodidae	*Dasypus novemcinctus* Linnaeus, 1758		1, 7, 23	Ca/Ft		LC
Pilosa						
Megalonychidae	*Choloepus hoffmanni* W. Peters, 1858		8	Si		LC
Myrmecophagidae	*Tamandua mexicana* (Saussure, 1860)		2, 23	Si		LC
Carnivora						
Felidae	*Puma concolor* (Linnaeus, 1771)		17	V		LC
	*Puma yagouaroundi (*É. Geoffroy Saint-Hilaire, 1803)	21		Pt		LC
Canidae	*Cerdocyon thous* (Linnaeus, 1766)	7	1	Si		LC
Mustelidae	*Eira barbara* (Linnaeus, 1758)	8	9, 11, 13, 28	Si/Ft		LC
	Lontra longicaudis (Olfers, 1818)	1, 2, 5, 7, 15	11, 15	Si/Ft	VU	DD
Procyonidae	*Nasua nasua* (Linnaeus, 1766)		24	Si		LC
	Potos flavus (Schreber, 1774)	4		Si		LC
	Procyon cancrivorus (G. Cuvier, 1798)		7, 13	Si/Ft		LC
Artiodactyla						
Tayassuidae	*Pecari tajacu* (Linnaeus, 1758)		18, 21, 29	V/Si/ Ft		LC
Primates						
Aotidae [c]	*Aotus griseimembra* Elliot, 1912	4, 10, 16, 18	1, 3	Si	VU	VU
Atelidae	*Alouatta seniculus* (Linnaeus, 1766)		1, 3, 10, 11, 26, 27	Si		LC
Callitrichidae [d]	*Saguinus leucopus* (Günther, 1877) *	2, 5, 10, 13	1, 3, 7, 9, 12-15, 22, 24, 25	Si	VU	EN
Cebidae	*Cebus versicolor* Pucheran, 1845 * [e]		21	Si		EN
Rodentia [f]						
Sciuridae	*Notosciurus granatensis* (Humboldt, 1811)	2	1, 3, 21, 23, 25	Si		LC
Heteromyidae	*Heteromys anomalus* (Thompson, 1815)	1, 2, 11, 20	25	C/V		LC
Muridae	*Rattus rattus* (Linnaeus, 1758)†	11		V		LC
Cricetidae	*Handleyomys alfaroi* (J.A. Allen, 1891) [g]	1		C/V		LC
	Melanomys caliginosus (Tomes, 1860)	1, 9	18	C/V		LC
	Neacomys tenuipes Thomas, 1900	3, 9	4, 6, 15	C/V		LC
	Nectomys grandis Thomas, 1897 *	15, 11	18	C/V		DD
	Rhipidomys latimanus (Tomes, 1860)	9, 10		C/V		LC
	Sigmodon hirsutus (Burmeister, 1854)		16	V		LC
	Tylomys mirae Thomas, 1899		18, 25	V		LC
	Zygodontomys brevicauda J.A. Allen & Chapman, 1893	19	16	V		LC
Cuniculidae	*Cuniculus paca (*Linnaeus, 1766)	1, 2, 4	5, 9, 12, 14, 25	V/Ft		LC
Dasyproctidae	*Dasyprocta punctata* Gray, 1842	12	1, 25	V/Ft		LC
Echimyidae	*Proechimys chrysaeolus* (Thomas, 1898)*		3, 4, 20, 23, 25	C/V		DD

* Endemic species. † Exotic species. [a] Following Voss & Jansa (2009). [b] Following Rossi et al. (2010). [c] Following Rylands et al. (2013). [d] Following Rylands et al. (2016). [e] Following Rylands et al. (2013). [f] Following Patton et al. (2015). [g] Following Weksler (2015).

cies—two didelphids, three carnivores, two primates and eight rodents—were common to both study areas; and seven and 12 species were recorded only in Jaguas and San Carlos, respectively (Table 1).

Among the 33 native species listed here, four species are endemic to Colombia: the primates *Saguinus leucopus* (Günther, 1877) and *Cebus versicolor* Pucheran, 1845, and the rodents *Nectomys grandis* Thomas, 1897 and *Proechimys chrysaeolus* (Thomas, 1898) (Figures 2, 3). *Saguinus leucopus* has the smallest distribution among all *Saguinus* species. Its distribution ranges from the confluence of the Magdalena and Cauca rivers in the north, southward on the Cordillera Central between the eastern bank of the lower Cauca River and the western bank of the middle Magdalena River, to elevation of 1,500 m (Defler 2010). *Cebus versicolor* populations inhabit the middle Magdalena valley from southern department of Magdalena to department of Tolima (Defler 2010; Rylands et al. 2013). *Nectomys grandis* is found in the north-central part of the country throughout the basins of the Magdalena and Cauca rivers, between 0 and 2,000 m (Patton et al. 2015). Lastly, the known localities for *P. chrysaeolus* are found from the Caribbean coast into the lower Cauca and Magdalena valleys, including the departments of Antioquia, Bolívar, Boy-

Figure 2. Records of individuals and footprints of some mammal species found in protected areas of Jaguas and San Carlos hydroelectric power plants. A) *Didelphis marsupialis*. B) *Marmosa* (*Micoureus*) *demerarae*. C) *Marmosa* (*Marmosa*) *isthmica*. D) *Metachirus nudicaudatus*. E) *Choloepus hoffmanni*. F) *Puma yagouaroundi* (camera-trap image). G) *Eira barbara*. H) *Potos flavus*. I) *Procyon cancrivorus*. J) *Aotus griseimembra*. K) *Alouatta seniculus*. L) *Saguinus leucopus*. Photos by ISAGEN S.A. and Juan D. Valencia (A-E, and G-J), Faunativa S.A.S. (F), and CSG (K and L).

acá, Córdoba, Santander and Sucre, at elevations between 100 and 500 m (Solari et al. 2013; Patton et al. 2015).

Regarding the conservation status of species recorded, four species are assessed by nationally or globally: the endemic primates *Saguinus leucopus* and *Cebus versicolor*, the primate *Aotus griseimembra*, and the otter *Lontra longicaudis* (Olfers, 1818) (MADS 2014; IUCN 2015) (Table 1). *Saguinus leucopus*, *A. griseimembra* and *L. longicaudis* are assessed as Vulnerable at the national level (MADS 2014). Globally, *A. griseimembra* is Vulnerable, while *S. leucopus* and *L. longicaudis* are assessed as Endangered and Deficient Data, respectively (IUCN 2015). *Cebus versicolor* has not been assessed nationally, but globally, it is Endangered (MADS 2014; de la Torre et al. 2008).

Species accounts

We list basic information for each recorded species and provide a brief diagnosis for those difficult-to-identify species.

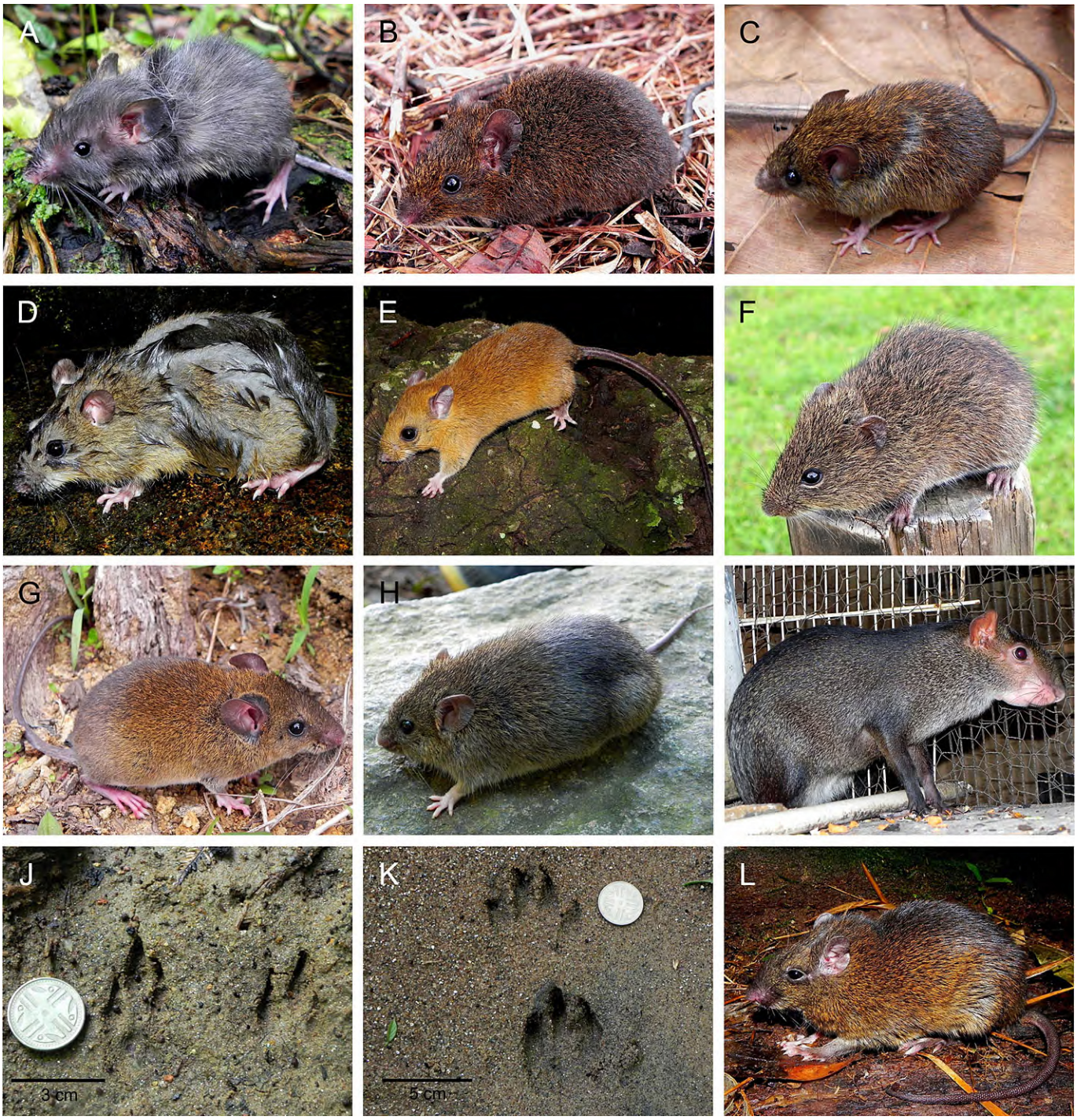

Figure 3. Records of individuals and footprints of some rodent species found in protected areas of Jaguas and San Carlos hydroelectric power plants. A) *Heteromys anomalus*. B) *Melanomys caliginosus*. C) *Neacomys tenuipes*. D) *Nectomys grandis*. E) *Rhipidomys latimanus*. F) *Sigmodon hirsutus*. G) *Handleyomys alfaroi*. H) *Zygodontomys brevicauda*. I and J) *Dasyprocta punctata* (I, individual kept as pet by local community). K) *Cuniculus paca*. L) *Proechimys chrysaeolus*. Photos by ISAGEN S.A. and Juan D. Valencia.

Didelphis marsupialis Linnaeus, 1758

Figure 2

Didelphis marsupialis Linnaeus (1758): 54. — Cerqueira & Tribe (2008): 22.

Material examined: Appendix 2.

Marmosa (Micoureus) demerarae O. Thomas, 1905

Figures 2, 4

Marmosa cinerea demerarae Thomas (1905): 313.

Micoureus demerarae — Gardner (1993): 20; Patton et al. (2000): 66; Gardner & Creighton (2008): 77.

Material examined: Appendix 2.

Adult specimens of *Marmosa* (*Micoureus*) spp. are distinguished externally from species of *Marmosa* (*Marmosa*) by exhibiting long, woolly, gray to grayish brown dorsal pelage, and tail usually with white tip and longer dense fur on the base (Patton et al. 2000; Gardner & Creighton 2008). *Marmosa* (*Micoureus*) *demerarae* is distinguished from *M.* (*Micoureus*) *regina*—with which can be found in sympatry in some inter-Andean valleys—by more extensively furred base of tail, with distinctive white tip or conspicuous mot-

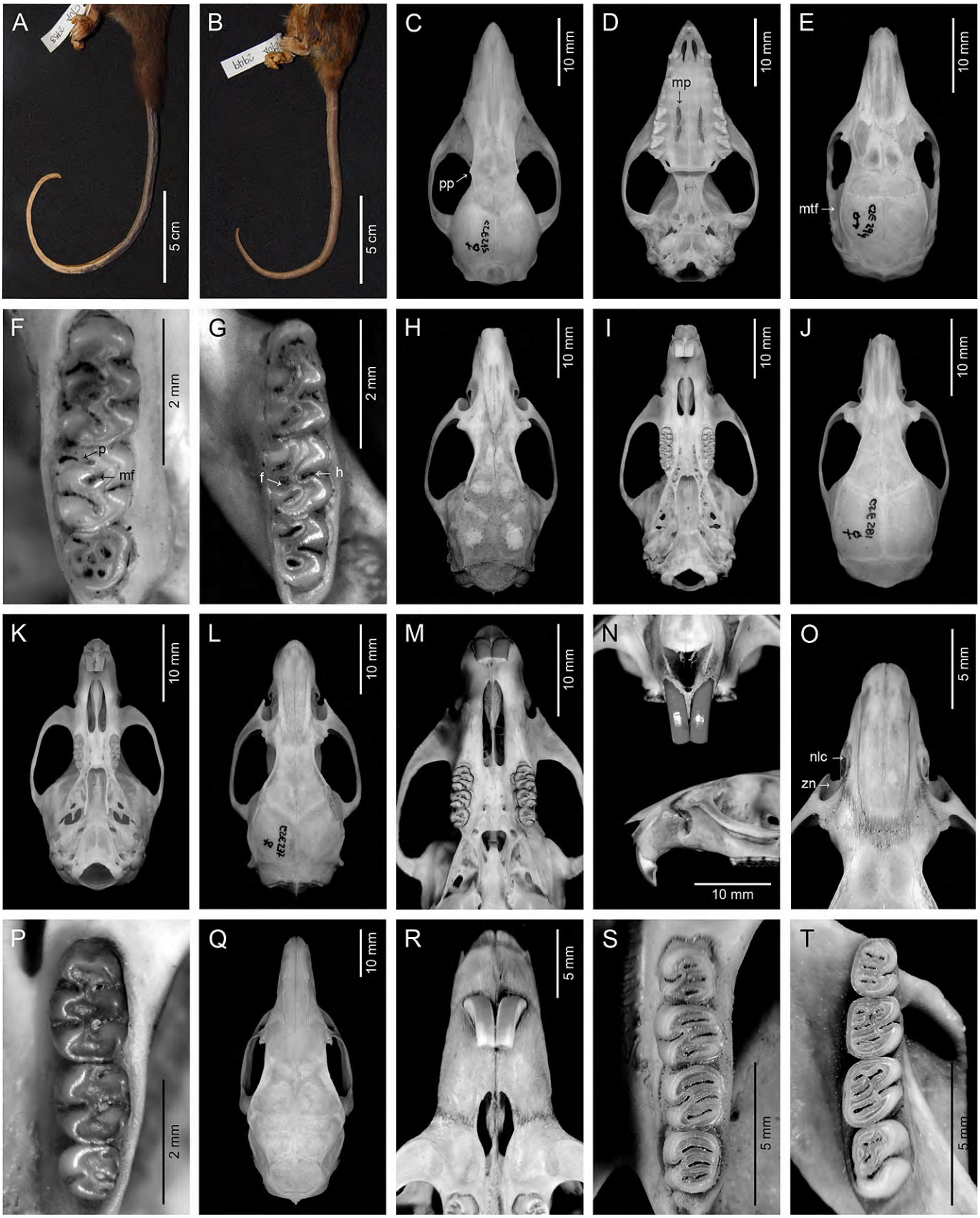

Figure 4. Morphological characteristics of the proximal end of the tail of A) *Marmosa* (*Micoureus*) *demerarae* and B) *Marmosa* (*Marmosa*) *isthmica*. C) Dorsal and D) ventral cranial views of *M.* (*M.*) *isthmica* (pp: postorbital process; mf: maxillopalatine fenestrae). E) Dorsal cranial view of *Heteromys anomalus* (mtf: masseter-temporal fossae). F) Occlusal views of right upper and G) right lower molar rows of *Handleyomys alfaroi* (p: paraflexus; mf: medial fossette; h: hypoflexid; f: fossettid). H) Dorsal and I) ventral cranial views of *Nectomys grandis*. J) Dorsal and K) ventral cranial views of *Rhipidomys latimanus*. L) Dorsal and M) ventral cranial view of *Sigmodon hirsutus* detailing palatal region. N) Front (above) and lateral (low) views of upper incisors of *S. hirsutus*. O) Dorsal view of the rostrum of *Zygodontomys brevicauda* (nlc: nasolacrimal capsule; zn: zygomatic notch). P) Occlusal view of left upper molar row of *Z. brevicauda*. Q) Dorsal cranial view of *Proechimys chrysaeolus*. R) Ventral cranial view of *P. chrysaeolus* detailing incisive foramina. S) Occlusal views of left upper and T) right lower molar rows of *P. chrysaeolus*. Photos by Camilo Sánchez-Giraldo.

tling of the distal portion, gray-based ventral pelage and longer ears (Gardner & Creighton 2008). However, both species show significant geographic variation in some of these characters, becoming extremely similar in some areas of sympatry (Patton et al. 2000).

According to Gardner & Creighton (2008), the most consistent external character useful to distinguished *M. demerarae* from *M. regina* is the extent of the long pelage on the base of the tail, which extends beyond 30 mm in *M. demerarae* and usually cover less than 25 mm in the latter. We assigned all specimens from study area to *M. demerarae* considering their characteristic morphological pattern of the tail, including a tip white and mottle distally, and long fur extending above 35 mm. Future studies delimiting the variation of *M. demerarae* in our study area and this region of the Cordillera Central are necessary.

Marmosa (Marmosa) isthmica Goldman, 1912
Figures 2, 4
Marmosa isthmica Goldman (1912): 1. — Rossi et al. (2010): 42.
Marmosa robinsoni isthmica — Creighton & Gardner (2008): 59.

Material examined: Appendix 2.

In contrast to species of *Marmosa* (*Micoureus*), adult members of *Marmosa* (*Marmosa*) have brown or reddish-brown dorsal pelage, tail often lacking of white tip, and longer dense fur on the base of tail extending only for 15 mm or less (Creighton & Gardner 2008). *Marmosa* (*Marmosa*) *isthmica* could be confused with *M.* (*Marmosa*) *robinsoni*, a species with similar body size and morphological aspect with which could overlap potentially its range in the inter-Andean valley of the Magdalena River. Specimens examined from the study area have consistently a well-developed and distinct postorbital process and absence of palatine fenestrae, which are diagnostic characters of *M. isthmica* (Rossi et al. 2010).

Metachirus nudicaudatus (É. Geoffroy St.-Hilaire, 1803)
Figure 2
Didelphis nudicaudatus Geoffroy St.-Hilaire (1803): 142.
Metachirus nudicaudatus colombianus — Gardner & Dagosto (2008): 35.

Material examined: Appendix 2.

Dasypus novemcinctus Linnaeus, 1758
Dasypus novemcinctus Linnaeus (1758): 15.
Dasypus novemcinctus fenestratus — Wetzel et al. (2008): 134.

Records: Appendix 3.

Choloepus hoffmanni W. Peters, 1858: Figure 2
Choloepus hoffmanni Peters (1858): 128.
Choloepus hoffmanni augustinus — Gardner & Naples (2008): 167.

Records: Appendix 3.

Tamandua mexicana (Saussure, 1860)
Myrmecophaga tamandua var. *mexicana* Saussure (1860): 9.
Tamandua mexicana instabilis — Gardner (2008): 173.

Records: Appendix 3.

Puma concolor (Linnaeus, 1771)
Felis concolor Linnaeus (1771): 522.
Puma concolor concolor — Wozencraft (2005): 545.

Material examined: Appendix 2.

Puma yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)
Figure 2
Felis yagouaroundi É. Geoffroy Saint-Hilaire (1803): 124.
Herpailurus yagouaroundi — Oliveira (1998): 1.

Records: Appendix 3.

Cerdocyon thous (Linnaeus, 1766)
Canis thous Linnaeus (1766): 60. — Berta (1982): 1; Wozencraft (2005): 578.

Records: Appendix 3.

Eira barbara (Linnaeus, 1758)
Figure 2
Mustela barbara Linnaeus (1758): 46. — Wozencraft (2005): 606.

Records: Appendix 3.

Lontra longicaudis (Olfers, 1818)
Lutra longicaudis Olfers (1818): 233. — Larivière (1999): 1.

Records: Appendix 3.

Nasua nasua (Linnaeus, 1766)
Viverra nasua Linnaeus (1766): 64. — Wozencraft (2005): 626.

Records: Appendix 3.

Potos flavus (Schreber, 1774)
Figure 2
Lemur flavus Schreber (1744): 188. — Ford & Hoffman (1988): 1; Wozencraft (2005): 626.

Records: Appendix 3.

Procyon cancrivorus (Cuvier, 1798)
Figure 2
Ursus cancrivorus Cuvier (1798): 113. — Wozencraft (2005): 627.

Records: Appendix: 3

Pecari tajacu (Linnaeus, 1758)
Sus tajacu Linnaeus (1758): 50. — Grubb (2005): 644.

Material examined and records: Appendixes 2 and 3.

Aotus griseimembra Elliot, 1912
Figure 2
Aotus griseimembra Elliot (1912): 33. — Rylands & Mittermeier (2009): 32; Defler (2003): 265.

Records: Appendix 3.

Alouatta seniculus (Linnaeus, 1766)
Figure 2
Simia belzebul Linnaeus (1766): 37. — Defler (2003): 340; Rylands & Mittermeier (2009): 32.

Records: Appendix 3.

Saguinus leucopus (Günther, 1877)
Figure 2
Hapale leucopus Günther (1876): 743. — Defler (2003): 340; Rylands et al. (2016): 1023.

Records: Appendix 3.

Cebus versicolor Pucheran, 1845
Cebus versicolor Pucheran (1845): 335 — Boubli et al. (2012); Rylands et al. (2013): 411.

Records: Appendix 3.

Notosciurus granatensis (Humboldt, 1811)
Sciurus granatensis Humboldt (1811): 8. — de Vivo & Carmignotto (2015): 34.

Records: Appendix 3.

Heteromys anomalus (Thompson, 1815)
Figures 3, 4
Mus anomalus Thompson (1815): 161. — Anderson (2000): 619; Anderson (2003): 25.

Material examined: Appendix 2.

Heteromys anomalus has a large, elongated and robust skull, with a narrow, flat and strongly ridged braincase, which contrasts with the shorter and relatively broader skull and the wide and inflated braincase of similar species *H. australis* (Anderson 1999, 2003). *Heteromys anomalus* can be distinguished from *H. australis* by more robust zygomatic arches, masseter-temporal fossae well excavated, and an interorbital region strongly constricted (Anderson 1999, 2003). Specimens from the study area conform to the diagnostic characters described above, and have the typical well excavated masseter-temporal fossae.

Rattus rattus (Linnaeus, 1758)
Mus rattus Linnaeus (1758): 61. — Musser & Carleton (2005): 1484.

Material examined: Appendix 2.

Handleyomys alfaroi (J.A. Allen, 1891)
Figures 3, 4
Hesperomys (*Oryzomys*) *alfaroi* Allen (1891): 214. — Musser et al. (1998): 167; Weksler (2015): 323.

Material examined: Appendix 2.

Weksler (2015) included provisionally *alfaroi* (member of "*alfaroi* group") as a member of *Handleyomys*. *Handleyomys alfaroi* is morphologically similar and become confused with oryzomyine species *Transandinomys talamancae*, with which overlap partially its distributional range (Musser et al. 1998). *Handleyomys alfaroi* differs from *T. talamancae* by having less body size, shorter length of molar row (range: 3.8–4.2 mm), and longer incisive foramina relative to length of skull (see Musser et al. 1998: 165, fig. 72). Cranially, both species differ consistently in the occlusal surface patterns of second upper and lower molars. Second upper molars of *H. alfaroi* exhibit a medial fossete and shorter paraflexus, and second lower molars have a shorter hypoflexid and conspicuous fossetid; in contrast, *T. talamancae* lacks of a medial fossete and fossetid, and exhibits larger paraflexus, and deep hypoflexid (Musser et al. 1998).

Material examined from the study area was previously assigned to *T. talamancae*; however, it exhibits the diagnostic features of *H. alfaroi*. It has characteristic occlusal pattern in second molars, and reaches length of molar row below 4.2 mm (3.8–4.0 mm).

Melanomys caliginosus (Tomes, 1860)
Figure 3
Hesperomys caliginosus Tomes (1860): 263.
Melanomys caliginosus — Weksler & Lóss (2015): 350.

Material examined: Appendix 2.

Neacomys tenuipes Thomas, 1900
Figure 3
Neacomys spinosus tenuipes Thomas (1900): 153. — Weksler & Bonvicino (2015): 368.

Material examined: Appendix 2.

Nectomys grandis Thomas, 1897
Figures 3, 4
Nectomys grandis Thomas (1897): 498. — Hershkovitz (1944): 62–64; Bonvicino & Weksler (2015): 372.

Material examined: Appendix 2.

Specimens of this species normally lack a dark mid-dorsal stripe on the dorsal pelage, and cranially are recognized mainly by exhibiting a skull uniformly convex, markedly different from other congeneric species that have frontally flattened skulls (Bonvicino & Weksler 2015). The skull is heavy with upper profile evenly convex throughout, and frontal and parietal regions swollen (Bonvicino & Weksler 2015). Additionally, it has incisive foramina widely opened, with parallel sides, and rounded at both ends; posterior palate with large and deep lateral pits; and palatal margin of the mesopterygoid fossa squared. Specimens examined by us exhibited consistently a skull uniformly convex.

Rhipidomys latimanus (Tomes, 1860)
Figures 3, 4
Hesperomys latimanus Tomes (1860): 213. — Tribe (2015): 599.

Material examined: Appendix 2.

Rhipidomys latimanus overlaps partially its range with *R. caucensis* (Tribe 2015), with which it can become confused. Specimens of *R. latimanus* are differentiated from *R. caucensis* mainly by its larger body size (head–body length: 120–140 mm in *R. latimanus*, and about 100 mm in *R. caucensis*), larger upper molar (maxillary toothrow length: 4.7–5.3 mm and 3.8–4.3 mm), and hind feet with narrow metatarsal dark path (poorly defined dorsal dark patch in *R. caucensis*) (Tribe 2015). *Rhipidomys latimanus* has a skull with supraorbital ledges or ridges pronounced, straight, and converging strongly to front of interorbital region; compared with hourglass-shaped interorbital, and very slight supraorbital ridge in *R. caucensis* (Tribe 2015). Adult

specimens examined from study area conform to diagnostic characters, and reach body sizes (140–146 mm) and molar lengths (4.7–4.9 mm) within the variation of the species.

Sigmodon hirsutus (Burmeister, 1854)
Figures 3, 4
Lasiomys hirsutus Burmeister (1854):16. — Voss (1992): 26; Voss (2015b): 566.

Material examined: Appendix 2.

Sigmodon hirsutus is recognizable from other congeneric species in Colombia by its long nasal bones (which conceal the upper incisors from dorsal view) and narrow, ungrooved and strongly opisthodont upper incisors (Voss 1992, 2015b). Likewise, *S. hirsutus* has a broad interorbital region, long incisive foramina, posterior palatal foramina usually enclosed by the palatine bones, and broad and long palatal bridge without conspicuous longitudinal grooves (Voss 1992, 2015b). Specimens examined from study area conform to above diagnostic characters.

Tylomys mirae Thomas, 1899
Tylomys mirae Thomas (1899): 278. — Álvarez-Castañeda (2015): 687.

Material examined: Appendix 2.

Zygodontomys brevicauda (J.A. Allen & Chapman, 1893)
Figures 3, 4
Oryzomys brevicauda Allen & Chapman (1893): 215. — Voss (1991): 47; Voss (2015a): 460.

Material examined: Appendix 2.

Zygodontmys brevicauda is distinguished from *Z. brunneus*, with which occurs sympatrically in some regions of Magdalena Valley, by differences in molar and cranial characters. Molars of *Z. brevicauda* are less hypsodont, and upper molars have a simpler occlusal architecture with principal cusps symmetrically disposed in opposite labial-lingual pairs, and less oblique mures and murids (overall aspect of orthogonality); upper incisors are more opisthodont (Voss 1991). *Zygodontmys brevicauda* exhibits also deeper zygomatic notches, and more inflated nasolacrimal capsules (Voss 1991). Additionally, populations of *Z. brevicauda* in the upper Magdalena Valley have lower measures of length of hind foot (< 28 mm) and length upper molars (< 4.5 mm) (Voss 2015a). Specimens from the study area conform to the occlusal architecture of upper molars and cranial characters, and to the measurements (length of hind foot: 23.3 and 24.3 mm; length upper molars: 3.96-4.13 mm) of *Z. brevicauda*.

Cuniculus paca (Linnaeus, 1766)
Figure 3
Mus paca Linnaeus (1766): 81. — Patton (2015): 729.

Material examined and records: Appendixes 2 and 3.

Dasyprocta punctata Gray, 1842: Figure 3
Dasyprocta punctata Gray (1842): 264. — Patton & Emmons (2015): 753.

Material examined and records: Appendixes 2 and 3.

Proechimys chrysaeolus (Thomas, 1898): Figures 3, 4
Echimys chrysaeolus Thomas (1898): 244. — Patton (1987): 320–339; Patton & Leite (2015): 983.

Material examined: Appendix 2.

According to Patton (1987), *P. chrysaeolus* is the most distinctive species within *trinitatis* group, exhibiting consistency in morphological characters associated to incisive foramina and counterfold pattern of the cheek teeth. Specimens of *P. chrysaeolus* possess an oval to teardrop-shape incisive foramine with weakly posterolateral flanges, which extend onto the anterior palate; counterfold pattern of the all maxillary cheek teeth have consistently three folds (3-3-3-3), and mandibular check teeth varying slightly: mp4 usually with three folds, m1 always with three folds, and m2 and m3 with two or three folds (Patton & Leite 2015). Specimens from the study area exhibit the folds distribution, occlusal architecture of upper and lower toothrows (see Patton 1987: fig. 30), and incisive foramine morphology characteristic of the species.

DISCUSSION

Mammal diversity studies with broad multi-taxa efforts are few in the northern Cordillera Central (e.g., Castaño & Corrales 2010; Escobar-Lasso et al. 2013; Cuartas-Calle & Marín 2014). Available mammal checklists for the region where our study area is located include 36 to 39 non-volant mammal species of eight orders (Cuartas-Calle & Muñoz-Arango 2003; Navarro et al. 2005). Jaguas and San Carlos reach richness values similar to that of the region, with 33 native species and seven orders, even though we did not record 13 species. No species recorded in Jaguas and San Carlos belong to the genera *Caluromys*, *Philander*, *Chironectes*, *Cyclopes*, *Cabassous*, *Bradypus*, *Ateles*, *Mustela*, *Galictis*, *Leopardus*, *Microsciurus*, *Coendou*, and *Sylvilagus*. In comparison to specific localities on the eastern slope with similar elevational ranges (400–1,200 m) and life zones (bh-T, bp-PM, bh-PM), Jaguas (22 species and five orders) and San Carlos (27 species and seven orders) reached a comparable composition of taxonomic orders and similar or lower values of species richness. Localities in the Río La Miel basin recorded between 21 and 26 species and six and seven orders (ISAGEN S.A. 2008b; Castaño & Corrales 2010), and in the Río Porce basin were recorded 47 species and eight orders (Cuartas-Calle & Marín 2014). Except for the order Lagomorpha, the mammal communities in Jaguas and San Carlos included all orders found in the La Miel and Porce river basins.

Species composition was also similar between localities, 17 species recorded in Jaguas and 22 in San Carlos were found in at least one of the localities in the La Miel and Porce rivers, with six species common to all localities: *Didelphis marsupialis* Linnaeus, 1758, *Cerdocyon thous* (Linnaeus, 1766), *Saguinus leucopus*, *Notosciurus granatensis* (Humboldt, 1811), *Cuniculus paca* (Linnaeus, 1766) and

Dasyprocta punctata Gray, 1842 (ISAGEN S.A. 2008b; Castaño & Corrales 2010; Cuartas-Calle & Marín 2014). We found no records in Jaguas and San Carlos for 18 species recorded in the La Miel or Porce river basins, including five marsupials (species of *Caluromys*, *Marmosops*, *Monodelphis, Chironectes* and *Philander*), two sloths (*Bradypus* and *Cyclopes*), one armadillo [*Cabassous centralis* (Miller, 1899)], five carnivores (species of *Leopardus*, *Mustela* and *Panthera*), and five rodents (species of *Microsciurus*, *Oligoryzomys*, *Oecomys*, *Dinomys* and *Coendou*) (ISAGEN S.A. 2008b; Castaño & Corrales 2010; Cuartas-Calle & Marín 2014). The absence of records of such species in both hydroelectric plants is partially consequence of the differences in the surveyed area size and the methods used. Surveys in the Porce and La Miel river basins included a larger area and more sampled localities, and records from secondary information (i.e., interviews) (Castaño & Corrales 2010; Cuartas-Calle & Marín 2014). However, some of these species are probably part of the non-volant mammal communities in Jaguas and San Carlos, given that there is prior information from local residents and field surveys (2006 to 2009) of their occurrence (ISAGEN S.A. 2007, 2008a, 2009) (Table A1).

Records from 2006–2009 surveys of the terrestrial fauna of Jaguas and San Carlos have been previously published on the digital platform SIB (Sistema de información en Biodiversidad) Colombia (ISAGEN S.A. 2007, 2008a, 2009). According to these data, in Jaguas and San Carlos were recorded 36 and 38 species of non-volant mammals distributed in seven orders (Table A1). We found museum vouchers for 19 species (11 species in Jaguas and 13 in San Carlos) collected during 2006–2009 surveys, which included 13 rodents, four marsupials, and large mammals such as *Pecari tajacu* (Linnaeus, 1758) and *Puma concolor* (Linnaeus, 1771) (Table 1; Table A1). However, for 13 of the species in the SIB platform, and not recorded in our surveys between 2011 and 2015, no reference material was found (Table A1). We did not include these records due to the unavailability of reference material and the inability to confirm their identifications. Some of these records were incompletely identified or are small rodents and didelphids, whose taxonomic assignment could be doubtful.

Non-volant mammal communities of Jaguas and San Carlos had similar species composition, with 15 species common to both (Table 1). Eight of them are considered common and widespread species (i.e., *Didelphis marsupialis*, *Cerdocyon thous*, *Notosciurus granatensis, Cuniculus paca* and *Dasyprocta punctata*), while the remaining correspond to exclusively species distributed either along the Cauca and Magdalena inter-Andean valleys and the Caribbean region (i.e., *Aotus griseimembra* Elliot, 1912 and *Zygodontomys brevicauda* J.A. Allen & Chapman, 1893), or are endemic to Colombia (i.e., *Saguinus leucopus* and *Nectomys grandis*) (Solari et al. 2013) (Table 1). Among the 19 species recorded in only one of the hydroelectric plants (seven in Jaguas and 12 species in San Carlos), 13 also have wide distributional ranges and occur between lowlands and areas above 1,500 (Solari et al. 2013), so they could be present in both study areas. *Proechimys chrysaeolus*, *Tylomys mirae* Thomas, 1899, and *Sigmodon hirsutus* (Burmeister, 1854) found in San Carlos are associated with typical lowlands assemblages (Solari et al. 2013; Sánchez-Giraldo & Díaz-Nieto 2015; Patton et al. 2015).

In addition to be a representative community of non-volant mammal on the eastern slope of the northern Cordillera Central, with threatened and endemic species, the protected areas in Jaguas and San Carlos hydroelectric power plants become important areas for biodiversity conservation at the regional scale. In the current scenario, in which such areas are located within a highly fragmented landscape, they play an important role as refuges for the mammalian fauna and other vertebrate groups. These are also the most relevant protected areas including low and mid elevation habitats in this part of the Central Andes of Colombia (Vásquez & Serrano 2009). Maintaining these protected areas, as well as those associated to other hydroelectric projects in the region, and improving the connectivity between them will allow the establishment of a network of reserves that would contain large forest extensions in an otherwise highly human-modified ecosystem.

As suggested by this and other studies, the development and maintenance of hydroelectric infrastructure may become an important source of biodiversity data for the region. We strongly advocate for the publication of these results of environmental and monitoring studies associated with hydroelectric projects. In the next few decades the Colombian government expects to increase hydropower development as part of its energy–mining infrastructure program (UPME 2013). This is an important opportunity for biodiversity research that aims to evaluate the responses of the biota to large infrastructure projects, and to design strategies to minimize the associated impacts (Jiménez-Segura et al. 2014).

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APPENDICES

Table A1. Non-volant mammal species recorded in Jaguas and San Carlos hydroelectric power plants during the 2006-2009 surveys of terrestrial fauna (ISAGEN S.A. 2007, 2008a, 2009). V: Species with reference material in CTUA. X: Species without reference material. The list includes the taxonomic identification from the SIB database. Changes in the scientific names according to revision of vouchers and recent nomenclatural arrangements are detailed in the footnote.

Order	Family	Species	Jaguas	San Carlos
Didelphimorphia	Didelphidae	*Caluromys lanatus**	X	X
		*Chironectes minimus**		X
		Didelphis marsupialis	X	V
		Marmosa murina [*b]	V	V
		Marmosa robinsoni [a, b]	X	V
		*Marmosa sp.** [b]	X	V
		*Marmosops sp.**	X	
		Metachirus nudicaudatus	V	X
		Micoureus demerarae [c]	V	X
		*Philander opossum**	X	
Cingulata	Dasypodidae	*Cabassous centralis**	X	X
		Dasypus novemcinctus	X	X
Pilosa	Megalonychidae	*Choloepus hoffmanni*		X
	Myrmecophagidae	*Tamandua mexicana*	X	X
Carnivora	Felidae	*Leopardus sp.**	X	
		*Leopardus wiedii**	X	
		*Panthera onca**		X
		Puma concolor		V
	Canidae	*Cerdocyon thous*	X	X
	Mustelidae	*Eira barbara*	X	X
		Lontra longicaudis	X	X
	Procyonidae	*Nasua nasua*	X	
		Potos flavus	X	X
		Procyon cancrivorus		X
Artiodactyla	Tayassuidae	*Pecari tajacu* [d]		V
Primates	Aotidae	*Aotus griseimembra*	X	X
	Atelidae	*Alouatta seniculus*		X
	Callitrichidae	*Saguinus leucopus*	X	X
	Cebidae	*Cebus albifrons versicolor* [e]		X
Rodentia	Sciuridae	*Sciurus granatensis* [f]	X	X
		*Microsciurus pucheranii** [g]	X	X
		*Microsciurus sp.**	X	
	Heteromyidae	*Heteromys anomalus*	V	V
	Muridae	*Rattus rattus*	V	
	Cricetidae	*Melanomys caliginosus*	V	V
		Neacomys tenuipes	V	V
		Nectomys cf. magdalenae [h]	X	V
		Rhipidomys latimanus	V	
		Oryzomys gr. capito [i]	V	X
		Sigmodon hispidus [j]	X	V

Continued

Table A1. *Continued.*

Order	Family	Species	Jaguas	San Carlos
		Tylomys mirae		V
		Zigodontomys brevicauda	V	V
	Cuniculidae	*Cuniculus paca*	X	V
	Dasyproctidae	*Dasyprocta punctata*	V	X
	Echimyidae	*Hoplomys gymnurus**	X	X
		Proechimys gr. trinitatus [k]		V

* Species not recorded in 2011–2015 surveys. [a] *Marmosa* (*Marmosa*) *isthmica* following Rossi et al. (2010) and Voss & Jansa (2009). [b] All revised specimens in CTUA of genus *Marmosa* (*Marmosa*) corresponded to *Marmosa* (*Marmosa*) *isthmica*. [c] All revised specimens in CTUA of genus *Marmosa* (*Micoureus*) corresponded to *demerarae* species (following Voss & Jansa 2009). [d] Records of the species were not included in SIB database, but reference specimens collected during 2006–2009 surveys are deposited in CTUA. [e] *Cebus versicolor* following Rylands et al. (2013). [f] *Notosciurus granatensis* following de Vivo & Carmignotti (2015). [g] *Notosciurus pucheranii* following de Vivo & Carmignotti (2015). [h] *Nectomys grandis* following Bonvicino & Weksler (2015). [i] All revised specimens in CTUA correspond to *Handleyomys alfaroi* (following Weksler 2015). [j] *Sigmodon hirsutus* following Voss (2015). [k] All revised specimens in CTUA correspond to *Proechimys chrysaeolus* (following Patton & Leite 2015).

APPENDIX 1

Localities surveyed in Jaguas and San Carlos hydroelectric power plants, Department of Antioquia, Colombia. Each specific locality is identified by a consecutive number and followed by the geographic coordinates and elevation (in meters above sea level) presented in square brackets. Consecutive numbers for each power plant are listed in the Figure 1 and the Appendices 2 and 3. Localities 1, 2, 4, 5, 7, 8, 10, 13, 15, 16, 18 in Jaguas, and 1, 3, 6-9, 12-15, 19, 21-25 in San Carlos were included during 2011-2015 surveys.

Jaguas Hydroelectric Power Plant

Colombia, Department of Antioquia, Municipio Alejandría, vereda El Cerro, (1) bosque Santa Ana [06.3714° N, 075.0457° W; 1,294 m]; (2) El Edén [06.3676° N, 075.0244° W; 1,273 m]; (3) quebrada Santa Ana [06.3678° N, 075.0437° W; 1,269 m]; (4) La Arenosa [06.3911° N, 075.0360° W; 1,295-1,315 m]; (5) sector San Lorenzo [06.3765° N, 075.0371° W; 1,270 m]; (7) zona vertedero [06.3847° N, 074.9920° W; 1,263 m]. **Vereda El Respaldo**, (6) embalse San Lorenzo [06.3861° N, 075.0105° W; ca. 1,280 m]. **Municipio San Rafael, vereda El Jague,** (8) puente cable [06.3537° N, 075.0043° W; 1,099 m]; (9) bosque almenara [06.3640° N, 075.0102° W; 1,390 m]; (10) almenara [06.3619° N, 075.0035° W; 1,385 m]; (11) antiguo vivero Cornare [06.3519° N, 075.0049° W; ca. 1,075 m]; (12) helipuerto [06.3518° N, 075.0009° W; ca. 1,060 m]; (13) helipuerto [06.3496° N, 074.9962° W; 1,087 m]; (14) lindero ISAGEN fuga-almenara [06.3632° N, 074.9963° W; ca. 1,145 m]; (15) sector fuga, zona baja [06.3540° N, 074.9897° W; 1,008-1,221 m]; (16) sector fuga-almenara [06.3587° N, 074.9907° W; 1,133 m]; (17) sector puente cable [06.3492° N, 075.0052° W; 1,099 m]; (18) vivero [06.3490° N, 075.0012° W; 1,036 m]. **Municipio San Roque,** (19) embalse San Lorenzo, muro de presa [06.3877° N, 074.9968° W; ca. 1,245 m]. **Vereda Playa Rica,** (20) sector Papayos [06.4044° N, 075.0206° W; ca. 1,250 m]; (21) [06.3915° N, 075.0039° W; ca. 1,280 m].

San Carlos Hydroelectric Power Plant

Colombia, Department of Antioquia, Municipio San Carlos, corregimiento El Jordán, vereda El Cinco, (1) almenara [06.1966° N, 074.8025° W; 792-866 m]; (2) almenara [06.1934° N, 074.8048° W; 839 m]. **Vereda Juanes,** (3) filo Las Torres [06.2207° N, 074.8468° W; 917 m]; (4) filo Las Torres (vertedero) [06.2214° N, 074.8512° W; 880 m]; (5) quebrada El Macho [06.2230° N, 074.8464° W; 850 m]; (6) quebrada El Macho [06.2250° N, 074.8488° W; 842 m]; (7) sector casino viejo [06.2160° N, 074.8139° W; 708-718 m]; (8) sector unidad canina [06.2105° N, 074.8159° W; ca. 645 m]; (9) El Piñuelo [06.2118° N, 074.8282° W; 715-773 m]; (10) El Piñuelo [06.2095° N, 074.8239° W; 741 m]; (11) poblado ISAGEN [06.2090° N, 074.8184° W; 699 m]; (12) puente roto [06.2160° N, 074.8353° W; 732 m]; (13) sombrero fino [06.2074° N, 074.8098° W; 609-643 m]; (14) unidad canina [06.2079° N, 074.8153° W; 655 m]; (15) sector zona baja [06.2184° N, 074.8376° W; 724-747 m]; (16) terraplén embalse Punchiná, pastizal vertedero [06.2196° N, 074.8422° W; ca. 775 m]. **Vereda Peñol Grande,** (17) finca Peñas Grandes [06.1932° N, 074.8381° W; 933 m]; (18) quebrada La Negra [06.2199° N, 074.8671° W; ca. 955 m]; (19) quebrada La Negra [06.2163° N, 074.8653° W; 846 m]; (20) quebrada La Villa [06.2121° N, 074.8570° W; ca. 930 m]; (21) quebrada La Villa [06.2053° N, 074.8548° W; 798-884 m]; (22) sector vertedero [06.2128° N, 074.8415° W; 797 m]. **Vereda Tinajas,** (23) caño Borbollones [06.2279° N, 074.8726° W; 831 m]; (24) caño Tinajas [06.2356° N, 074.8676° W; 813 m]; (25) bosque quebrada La Lloré [06.2449° N, 074.8711° W; 745-892 m]; (26) sector La Lloré [06.2476° N, 074.8696° W; 889 m]; (27) sector La Lloré [06.2531° N, 074.8746° W; 913 m]. **Vereda La Holanda,** (28) sector El Alto [06.2539° N, 074.8817° W; 973 m]; (29) sector El Alto [06.2639° N, 074.8854° W; 1,115 m].

APPENDIX 2

List all the specimens included in this study and their corresponding collecting localities represented with number between parentheses. Specific locality, geographic coordinates, and elevation are presented in Appendix 1. Each specimen is identified by museum number (CTUA).

Jaguas Hydroelectric Power Plant

Colombia, Department of Antioquia, Municipio Alejandría. *Marmosa* (*Marmosa*) *isthmica*: CTUA 2943 (1). *Metachirus nudicaudatus*: CTUA 2954 (6). *Heteromys anomalus*: CTUA 2987 (1), CTUA 2988 (2). *Handleyomys alfaroi*: CTUA 2971-2973 (1). *Melanomys caliginosus*: CTUA 2955 (1). *Neacomys tenuipes*: CTUA 2958 (3). Municipio San Rafael. *Didelphis marsupialis*: CTUA 2941-2942 (13). *Marmosa* (*Marmosa*) *isthmica*: CTUA 2949-2950 (17). *Marmosa* (*Micoureus*) *demerarae*: CTUA 2952 (12), CTUA 2953 (14). *Heteromys anomalus*: CTUA 2990 (11). *Rattus rattus*: CTUA 2992 (11). *Melanomys caliginosus*: CTUA 2957 (9). *Neacomys tenuipes*: CTUA 2962 (9). *Nectomys grandis*: CTUA 2964 (11), CTUA 2965 (15). *Rhipidomys latimanus*: CTUA 2966-2968 (9), CTUA 2969 (10). *Dasyprocta punctata*: CTUA 2979 (12). **Municipio San Roque.** *Marmosa* (*Marmosa*) *isthmica*: CTUA 2951 (20). *Heteromys anomalus*: CTUA 2991 (20). *Zygodontomys brevicauda:* CTUA 2977 (19).

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Colombia, Department of Antioquia, Municipio San Carlos. *Didelphis marsupialis*: CTUA 2940 (20). *Marmosa* (*Marmosa*) *isthmica*: CTUA 2944-2945 (25), CTUA 2946 (4), CTUA 2947 (1), CTUA 2948 (12). *Puma concolor*: CTUA 2939 (17). *Pecari tajacu*: CTUA 2938 (18). *Heteromys anomalus*: CTUA 2989 (25). *Melanomys caliginosus*: CTUA 2956 (18). *Neacomys tenuipes*: CTUA 2959 (4), CTUA 2960 (6), CTUA 2961 (15). *Nectomys grandis*: CTUA 2963 (18). *Sigmodon hirsutus*: CTUA 2970 (16). *Tylomys mirae*: CTUA 2974 (25), CTUA 2975 (18).

Zygodontomys brevicauda: CTUA 2976 (16). *Cuniculus paca*: CTUA 2978 (5). *Proechimys chrysaeolus*: CTUA 2980 (4), CTUA 2981 (20), CTUA 2982 (23), CTUA 2983-2984 (3), CTUA 2985-2986 (25).

APPENDIX 3

List all visual records, images from camera-traps, footprints and carcasses included in this study and their corresponding locality information represented with number between parentheses. Specific locality, geographic coordinates, and elevation are presented in Appendix 1.

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Colombia, Department of Antioquia, Municipio Alejandría. *Cerdocyon thous:* visual record (7). *Lontra longicaudis*: visual record (1, 2, 5) and footprints (7). *Potos flavus:* visual record (4). *Aotus griseimembra*: visual record (4). *Saguinus leucopus:* visual record (2, 5). *Notosciurus granatensis:* visual records (2). *Cuniculus paca*: footprints (1, 2, 4). **Municipio San Rafael.** *Lontra longicaudis*: visual record (15). *Eira barbara*: visual record (8). *Aotus griseimembra*: visual record (10, 16, 28). *Saguinus leucopus:* visual record (10, 13). **Municipio San Roque.** *Puma yagoauroundi*: image from camera-trap (21).

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Colombia, Department of Antioquia, Municipio San Carlos. *Dasypus novemcinctus*: carcasses (7) and footprints (1, 23). *Tamandua mexicana*: visual record (2, 23). *Choloepus hoffmanii*: visual record (8). *Cerdocyon thous*: visual record (1). *Eira barbara*: visual record (11, 13, 28) and footprints (9). *Lontra longicaudis*: visual record (15, 19). *Nasua nasua:* visual record (24). *Procyon cancrivorus*: visual record (13) and footprints (7). *Pecari tajacu*: visual record (29) and footprints (21). *Aotus griseimembra*: visual records (1, 3). *Alouatta seniculus*: visual record (1, 3, 10, 11, 23, 27). *Saguinus leucopus*: visual record (1, 3, 7, 9, 12-15, 22, 24, 25). *Cebus versicolor*: visual record (21). *Notosciurus granatensis:* visual records (1, 3, 21, 2, 25). *Cuniculus paca*: footprints (9, 12, 14, 25). *Dasyprocta punctata:* footprints (1, 25).