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TRABAJOS ORIGINALES

New mammalian records in the Parque Nacional Cerros de Amotape, northwestern Peru

Nuevos registros de mamíferos en el Parque Nacional Cerros de Amotape, noroeste de Perú

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Abstract

The Pacific Tropical Rainforest and Equatorial Dry Forest are found only in southern Ecuador and northern Peru, and are among the most poorly known ecosystems of South America. Even though these forests are protected in Parque Nacional Cerros de Amotape (PNCA), they are threatened by fragmentation because of farming and agriculture. The aim of this study was to determine the medium and large mammalian species richness, using transect census, camera trapping, and specimen bone collection. Nine transects were established and 21 camera trap stations were placed along 16 km² in three localities of PNCA, from August 2012 to April 2013. Total sampling effort was 215 km of transects and 4077 camera-days. We documented 22 species; including 17 with camera trapping, 11 with transect census, and 10 with specimen collection. Camera traps were the most effective method, and four species (*Dasyprocta punctata*, *Cuniculus paca*, *Leopardus wiedii* and *Puma concolor*) were documented only with this method. This comprised the first Peruvian record for *Dasyprocta punctata*, and the first record for the western slope of the Peruvian Andes for *Cuniculus paca*. Also, both specimen collections and sightings confirm the presence of *Potos flavus*, first record in the western slope of the Peruvian Andes. *Panthera onca*, *Tremarctos ornatus* and *Saimiri sciureus* are considered locally extinct, while several species are in need of further research. We highlight the importance of the high diversity of this rainforests and encourage local authorities to give the area the highest priority in conservation.

Key words: Pacific Tropical Rainforest, Equatorial Dry Forest, mammals, camera trapping, transect census.

Resumen

El Bosque Tropical de Pacífico y el Bosque Seco Ecuatorial, solo se encuentran desde el Sur de Ecuador hasta el Norte de Perú y están dentro de los ecosistemas más pobremente estudiados de Sudamérica. A pesar que estos bosques se encuentran protegidos dentro del Parque Nacional Cerros de Amotape (PNCA), están amenazados por fragmentación de hábitat debido a la agricultura y la ganadería. El objetivo de esta investigación fue determinar la riqueza de mamíferos medianos y grandes utilizando censos por transecto, cámaras trampa y colecta de especímenes. Se establecieron nueve transectos y se colocaron 21 estaciones con cámaras trampa en tres localidades del PNCA (16 km²) de agosto del 2012 a abril del 2013. El esfuerzo de muestreo acumulado fue 215 km de censos por transecto y 4077 cámara-días. Registramos 22 especies de mamíferos, 17 registradas con cámaras trampa, 11 con censos por transecto y diez con colecta de especímenes. El uso de cámaras trampa fue el método más efectivo y cuatro especies (*Dasyprocta punctata*, *Cuniculus paca*, *Leopardus wiedii* y *Puma concolor*) fueron registradas únicamente con este método. El registro de *Dasyprocta punctata*, es el primero para Perú y *Cuniculus paca*, el primer registro para la vertiente occidental de los Andes peruanos. Además, con avistamientos y colecta de especímenes se confirmó la presencia de *Potos flavus* para el PNCA siendo también el primer registro para la vertiente occidental de los Andes peruanos. A *Panthera onca*, *Tremarctos ornatus* y *Saimiri sciureus* se les considera localmente extintos, mientras que varias especies más necesitan mayor investigación para confirmar su presencia. Se resalta la importancia y alta diversidad de estos bosques y se recomienda a las autoridades locales darle prioridad en conservación.

Palabras clave: Bosque Tropical del Pacífico, Bosque Seco Ecuatorial, mamíferos, cámaras trampa, censos por transecto.

Introduction

Peru holds at least 508 species of mammals in eleven ecoregions (Pacheco et al. 2009). Although several inventories documented the mammal fauna of some Peruvian regions (Pearson 1951, 1957, Emmons 1984, Emmons et al. 1994, Solari et al. 2001, Emmons et al. 2001, Aquino et al. 2001, Solari et al. 2006, Pacheco et al. 2007, Pacheco et al. 2008, Tobler et al. 2008, Jiménez et al. 2010) the medium and large mammals of the northwestern region are known only by a few reports (Grimwood 1969, Pulido & Yockteng 1983, Encarnación & Cook 1998, INRENA 2000, 2005, Cossíos 2005, Alzamora 2005, Williams 2008). This issue may be attributed to the elusive behavior and nocturnal activity patterns of most mammalian species, and the high cost of appropriate equipment and methods for monitoring medium and large mammals such as camera trapping or genetic sampling (Kelly et al. 2011, MacKay et al. 2008).

The Parque Nacional Cerros de Amotape (PNCA) is located in the Tumbes Province, northwestern Peru, and has two distinct ecoregions; the Pacific Tropical Rainforest (hereafter PTR) and de Equatorial Dry Forest (hereafter EDF) (Brack-Egg 1986). The PTR holds high tropical diversity, similar to Eastern Amazonia and Central America (Lamas 1976, Cabrera & Willink 1980, Brack-Egg 1986, Morrone 2006), whereas the EDF has high diversity and endemism from different taxonomic groups (Best & Kessler 1995, Linares-Palomino et al. 2010, 2011).

These forest types are extremely important and because of their restricted distribution, they exhibit high endemism (Sagastegui et al. 1999, Aguilar 1994) and poorly known species, and are recognized as world hotspots (Mittermeier et al. 2005, Olson & Dinerstein 2002). Furthermore, this area is losing connectivity from the Ecuadorian forest because of deforestation for farming and agriculture, causing numerous local extinctions (Dodson & Gentry 1991, Wunder 2001).

Most mammalian research at PNCA has been focused on bats (Pacheco et al. 2007) and primates with a few reports on medium- and large-sized mammals (Encarnación & Cook 1998). Grimwood (1969) collected mammalian information across Peru and registered 17 medium- and large-sized mammals for Tumbes. Pulido and Yockteng (1983) registered in PNCA 24 species but only 7 of them were recorded by direct observation and the other 17 through interviews. Encarnación and Cook (1998) registered 17 mammals by direct observations and 2 by indirect evidence. In 2000, PNCA managers compiled a list of 29 mammals for the area based on interviews (INRENA, 2000) and Pacheco et al. (2009) who compiled a list of all mammals found in Peru mentioned just 17 medium and large mammal species for the PTR.

The aim of this study was to determine the medium and large mammalian richness in the PNCA using a combination of traditional methods such as transect censuses, and specimen

bone collection with camera trapping. Also, we reviewed previous species lists to confirm, add and discuss the occurrence of mammals in the area. This survey was carried out for 8 months, covering part of the PTR and EDF and the dry and rainy seasons. Also, we provide recommendations to park managers in order to focus conservation efforts in certain areas and species of the national park.

Materials and methods

Study area

The PNCA is located in the northeastern region of Tumbes Province, Peru ($03^{\circ}50'S - 80^{\circ}16'W$). Three major forest types can be distinguished in the study area: Equatorial Dry Forest, Pacific Tropical Rainforest, and a transitional forest; one locality per forest type was selected. The temperature is above $24^{\circ}C$ throughout the year and the annual mean precipitation is about 610.9 mm (Cadenillas 2010).

La Angostura, 100 – 350 m ($03^{\circ}42'S - 80^{\circ}23'W$): Equatorial Dry Forest with a predominance of *Prosopis pallida*, *Acacia macracantha* on lower areas, and *Ceiba trichistandra*, *Cordia lutea* and *Loxopterygium huasango* on hillsides (Pacheco et al. 2007).

El Caucho, 350 – 600 m ($03^{\circ}50'S - 80^{\circ}16'W$): Transitional forest between the Equatorial Dry Forest of La Angostura and the Pacific Tropical Rainforest of Campo Verde. It is dominated by *Ceiba trichistandra*, *Cavanillesia platanifolia*, *Ficus jacobii*, *Triplaris cumingiana*, *Bougainvillea peruviana*, *Tessaria integrifolia*, *Inga feuillei*, and *Cecropia peltata* (Ponte 1998, Pacheco et al. 2007).

Campo Verde, 600 – 850 m ($03^{\circ}50'S - 80^{\circ}10'W$): Pacific Tropical Rainforest, dense with rough topography and high humidity. Dominated by *Centrolobium ochroxylum*, *Cordia eriostigma*, *Tabebuia chrysantha*, *Triplaris cumingiana*, *Gallea integrifolia*, *Ficus jacobii*, and *Cedrela fissilis* (Ponte 1998, Pacheco et al. 2007).

Sampling techniques

Camera trapping: a set of 21 unbaited camera trap stations were placed from September to December of 2012 (dry season) and from January to April 2013 (rainy season), with seven camera stations per type of forest that run continuously during the entire survey period. Each station had one camera trap (Bushnell trophy cam-standard edition) set along animal trails, into the woods or near a stream or water source. Also each camera trap was separated by at least 1 km, the minimum home range of the studied species (Fig. 1). Cameras were placed at an average height of 30 cm above ground (Kelly 2008) and set to take three photos at one-second intervals after each detection. Hence an area of 16 km² was covered with the three localities with 21 camera traps.

Transects censuses: three transects of 3 – 4 km were marked and set at each locality (nine transects in total). The transects were walked by one researcher and one local guide at approximately 1 to 1.5 km/hour, in the morning from 6:00 to 12:00 and at night from 18:00 to 22:00 (Peres & Cunha 2011). After each sighting the species name, time, number of individuals and GPS location were recorded. A total of 35 km were placed along the three localities. The dry season was surveyed from August to December 2012 while the rainy season from January to April of 2013.

Specimen collection: After each survey of either transect census or camera trapping the surroundings were searched for evidence of mammalian species. Skulls and other bones on the ground were collected in plastic bags and labeled with the date, time, GPS location and type of specimen. Later, the samples were washed and air-dry for proper identification at the Museo de Historia Natural of Universidad Nacional Mayor de San Marcos (Lima City, Peru).

Data analyses

Each survey sample (transects and camera traps) was standardized by sampling completeness using the coverage-based rarefaction method proposed by Chao and Jost (2012), confidence intervals were obtained with 100 bootstraps. Accumulation curves were obtained from iNEXT (R package) (Chao & Jost 2012, Hsieh et al. 2013). The sampling unit for the transect census was the transect (76 in total) while for cameras was one night per camera (4077 in total), no extrapolation was needed. We compared our data with previous surveys at the study site (Pulido and Yockteng 1983, Encarnación and Cook 1998, and Pacheco and Cadenillas unpublished data) to complete and update the species list (Table 1).

We follow the nomenclature of Wilson and Reeder (2005), Pacheco et al. (2009) and recent changes found in de Vivo and Carmignotto (2015) and Patton and Emmons (2015).

Results

We registered 22 medium- and large-sized mammals in the three types of forest: 17 species in the Pacific Tropical Rainforest, 20 in the transitional forest, and 13 species in the Dry Forest (Table 1, Appendix). The coverage-based accumulation curve shows that camera trapping performed better than transect census obtaining 99.9% of sample completeness and almost 50% more species richness (Fig. 2). Transect censuses had a sample completeness of 91.2% registering only 11 species (Fig. 3).

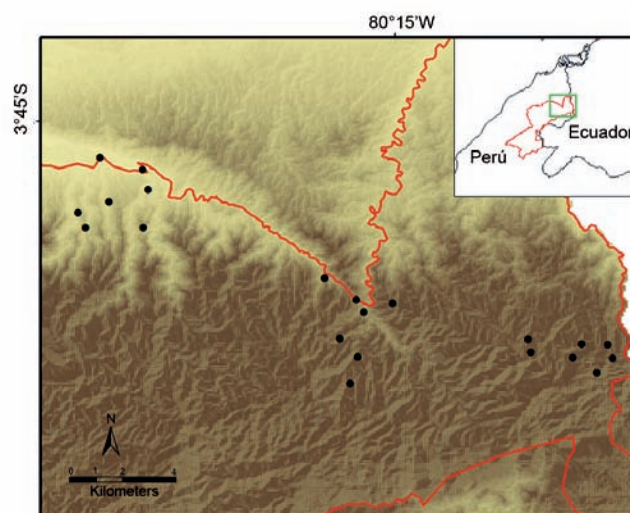


Figure 1. Study Area, circles represent camera trapping stations. Equatorial Dry Forest in beige, while Pacific Tropical Rainforest is represented in brown, Transitional forest is the limit between the two. Red border represents the PNCA limits.

Table 1. List of species registered for the PNCA and Conservation status according to IUCN (2008). V: voucher specimen () number of collected specimens. P: photographs from camera trapping survey, S: Sightings, I: Interviews. LC: Least Concern, DD: Data deficient, NT: Near threatened, VU: Vulnerable, CR: Critically endangered.

Order	Species	Pulido & Yockteng (1983)	Encarnación & Cook (1998)	Pacheco & Cadenillas (2005, unpublished data)	This research	Conservation Status
Didelphimorphia	<i>Didelphis marsupialis</i>	I	-	V	P, S, V (5)	LC
Cingulata	<i>Dasyurus novemcinctus</i>	I	S	I	P,S	LC
Pilosa	<i>Bradypus variegatus</i>	I	-	-	-	LC
	<i>Choloepus hoffmanni</i>	I	-	-	V(1)	LC
	<i>Cyclopes didactylus</i>	I	-	-	-	LC
	<i>Tamandua tetradactyla</i>	I	S	-	-	LC
	<i>Tamandua mexicana</i>	-	S	I	P, S	LC
Primates	<i>Cebus albifrons aequatorialis</i>	S	S	V, I	P, S,V(1)	CR
	<i>Saimiri sciureus</i>	-	S	-	-	LC
	<i>Alouatta palliata aequatorialis</i>	S	S	V	P, S,V (1)	VU
Rodentia	<i>Simosciurus neboxii</i>	S	S	-	P, S	LC
	<i>Coendou bicolor</i>	I	-	-	-	LC
	<i>Dasyprocta punctata</i>	-	-	-	P	LC
	<i>Cuniculus paca</i>	-	-	-	P	LC
Lagomorpha	<i>Sylvilagus brasiliensis</i>	S	-	I	-	LC
Carnivora	<i>Leopardus colocolo</i>	I	-	-	-	NT
	<i>Leopardus pardalis</i>	I	S	P	P,S,V(1)	LC
	<i>Leopardus wiedii</i>	-	S	-	P	NT
	<i>Puma concolor</i>	I	T	I	P	LC
	<i>Puma yagouarundi</i>	-	-	S	-	LC
	<i>Panthera onca</i>	I	-	I	-	NT
	<i>Lycalopex sechurae</i>	I	-	-	P, S	NT
	<i>Tremarctos ornatus</i>	-	T	-	-	VU
	<i>Lontra longicaudis</i>	S	-	-	P, S	DD
	<i>Eira barbara</i>	S	S	-	P, S	LC
	<i>Conepatus semistriatus</i>	I	-	S, I	I	LC
	<i>Nasua nasua</i>	I	S	S, I	P, S,V(5)	LC
	<i>Potos flavus</i>	-	-	S	V(1)	LC
	<i>Procyon cancrivorus</i>	I	S	T	P, S,V(1)	LC
Cetartiodactyla	<i>Pecari tajacu</i>	S	S	V	P, S,V(3)	LC
	<i>Mazama americana</i>	T	S	S,V	P, S,V(9)	DD
	<i>Odocoileus virginianus</i>	T	S	-	P, S	LC
Species Total		24	17	16	22	

Camera trapping

We obtained 1061 records of 17 medium- and large-sized mammals in 4077 camera days (Table 1). *Simosciurus neboxii* (I. Geoffro St.-Hilaire, 1855) and *Cebus albifrons* (Humboldt, 1812) were the only two arboreal species registered and these were excluded from analysis because of difference in capture probabilities. Latency to initial detection (number of days needed for the first mammal detection) was seven camera-days for the dry season and 21 camera-days for the rainy season. The 15 species were registered during the first 53 days or 984 camera-days (Fig. 3).

Transect census

After 215 km of diurnal and nocturnal census transects, 45 independent records of 11 medium and large mammals were obtained (Table 1). The most registered species with this method was *Mazama americana* (Erxleben, 1777) with 15 sightings, followed by the primates *Alouatta palliata* (Gray, 1849) with 11 sightings, and *Cebus albifrons* with six. *Pecari tajacu* (Linnaeus, 1758) had only five sightings while *Tamandua mexicana* (Saussure, 1860) and *Dasyurus novemcinctus* Linnaeus, 1758 only

two. The other seven species were represented only by a single sighting during the whole study period (Table 1).

Specimen collection

In total, 29 specimens of 10 medium-sized mammals were collected and deposited at the Museo de Historia Natural of Universidad Nacional Mayor de San Marcos, MUSM (Table 1). The identification of these specimens was confirmed with museum vouchers. The species recorded were *Potos flavus* (Schreber, 1774) which was previously sighted in 2005 (V. Pacheco pers. obs.); *Choloepus hoffmanni* Peters, 1858 and *Didelphis marsupialis* Linnaeus, 1758 reported previously by interviews from Pulido and Yockteng (1983); and, *Leopardus pardalis*, *Alouatta palliata*, *Cebus albifrons*, *Nasua nasua*, *Procyon cancrivorus*, *Mazama americana* and *Pecari tajacu* previously registered by direct observation in 1994 (Encarnación & Cook 1998).

New records

In this study we report the presence of three new species for the area and the western slope of the Peruvian Andes. *Cuniculus paca* was only registered by camera trapping in the

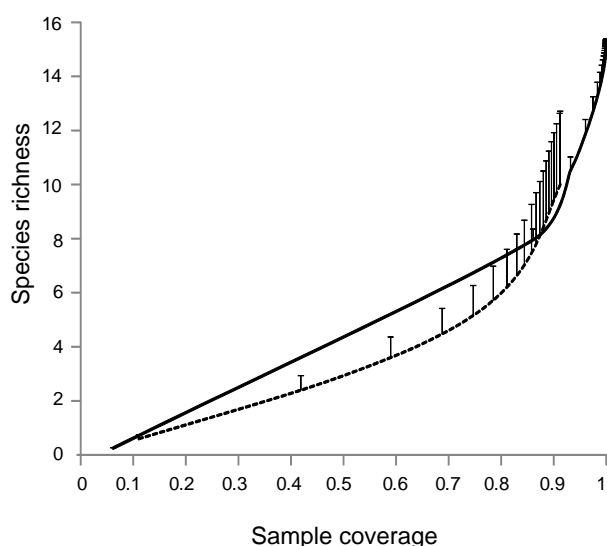


Figure 2. Comparison of species richness by transect censuses (dotted line) and camera trapping (straight line) with 95% confidence intervals.

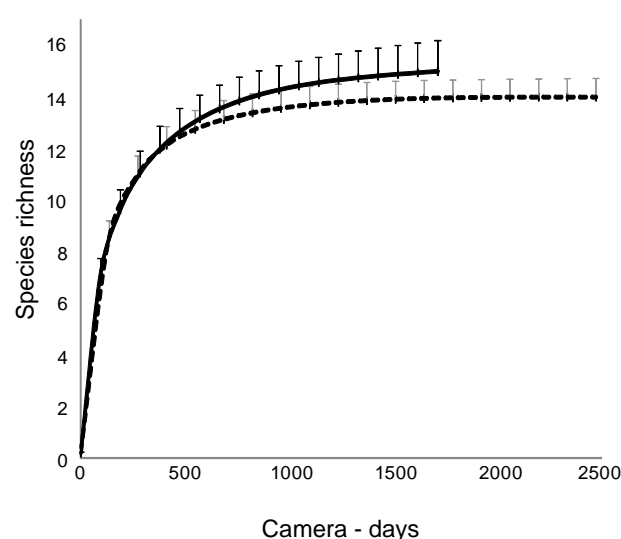


Figure 3. Comparison of camera trapping richness between dry (straight line) and rainy season (dotted line) with 95% confidence intervals.

transitional forest and Pacific Tropical Rainforest (3°51'13"S, 80°16'3.20"W). Also, camera traps registered *Dasyprocta punctata*, first record for Peru, found in the Pacific Tropical Rainforest (3°51'13"S, 80°16'3.20"W) and identified by its coloration patterns and distribution range (Patton & Emmons 2015). *Potos flavus* was confirmed in the area by a complete skeleton found in the transitional forest (3°49'44"S, 80°15'34.85"W) (Table 1).

Discussion

Species richness

We report 22 species of medium- and large-sized mammals in PNCA using three sampling methods, confirming that multiple non-invasive methodologies are required to register the complete mammalian fauna (Gompper et al. 2006). Camera trapping was more effective at registering several medium and large cryptic carnivores (Fig. 2), confirming reports of previous surveys (Silveira et al. 2003, Tobler et al. 2008, Jiménez et al. 2010). On the other hand, transect censuses were better at registering arboreal species such as *A. palliatta*, *C. albifrons*, and *S. neboxii* (Table 1). Also, specimen collection was extremely helpful in registering arboreal and nocturnal species as *P. flavus*, as well as silent species as *C. hoffmanni*.

From previous inventories, Pulido and Yockteng (1983) registered 24 species for the PNCA based mainly on interviews (Table 1). Compared to them we found no evidence of seven species: *Bradypus variegatus* Schinz 1825, *Cyclopes didactylus* (Linnaeus 1758), *Tamandua tetradactyla* (Linnaeus 1758), *Coendou bicolor* (Tschudi 1844), *Sylvilagus brasiliensis* (Linnaeus 1758), *Leopardus colocolo* (Molina 1782), and *Panthera onca* (Linnaeus 1758). Encarnación & Cook (1998) registered 17 species by sightings and tracks. From their list we did not find any evidence of *T. tetradactyla* which was registered by observation; *Saimiri sciureus* (Linnaeus 1758) that was registered by observation nor *Tremarctos ornatus* (F. G. Cuvier 1825) registered by track (Table 1).

Tamandua tetradactyla, registered by interviews (Pulido & Yockteng 1983) and sightings (Encarnación & Cook 1998), was probably mistaken with *Tamandua mexicana* (Saussure

1860). The fur color pattern of *T. tetradactyla* may vary along its distribution, at times not showing the black vest found in *T. mexicana* (Wetzel 1975, Eisenberg & Redford 1989). At present, *T. tetradactyla* is only found in the eastern slope of the Andes (Eisenberg & Redford 1989, Gardner 2007, Hayssen 2011). According to Gardner (2007), the subspecies found in Tumbes is *T. m. punensis* J. A. Allen, 1916.

In need of research

The arboreal *Bradypus variegatus*, *Cyclopes didactylus* and *Coendou bicolor* previously registered by Pulido and Yockteng (1983) are cryptic arboreal species. In consequence, to confirm its presence a species-specific research needs to be developed.

Sylvilagus brasiliensis, also registered by Pulido and Yockteng (1983), could have been mistaken with *Dasyprocta punctata* because some local people in Ecuador (Tirira 2007), and people from Tumbes as well, call it "conejo" (rabbit in Spanish), which also is the common name for *S. brasiliensis*. Nonetheless, further research needs to be carried out in order to confirm the species in the area.

The pampas cat (*Leopardus colocolo*) likely is present in the area, as it was reported in Tumbes by Grimwood (1969), and has a wide distribution range from sea level (García-Olaechea et al. 2013) to 4982 m in the Andes (Cossíos et al. 2007). In the Lambayeque Equatorial Dry Forest, south of our study site, this species relative abundance is about 22.1 (number of photographs/1000 camera-days), while *Leopardus pardalis* (Linnaeus 1758), is considered rare with much lower relative abundance 0.7 (number of photographs/1000 camera-days) (A. García-Olaechea pers. com.). This pattern in the adjacent forest suggests that there may be some competition between these two small cats. In our study area we registered the small cats, *L. pardalis* and *L. wiedii* (Schinz 1821) which may limit the abundance of *L. colocolo*. Still, more survey effort needs to be obtained to confirm its presence.

One individual of *Puma yagouaroundi* (É. Geoffroy Saint-Hilaire 1803) was seen by one researcher in an expedition in

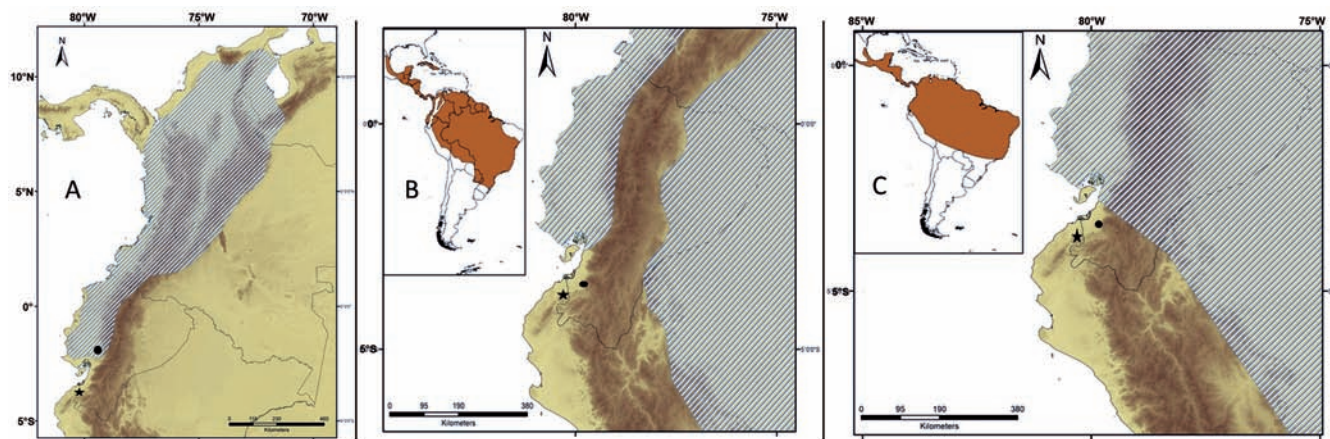


Figure 4. Distribution range according to the IUCN (shaded/yellow area) and new mammal records for the PNCA (star). Closest known distribution record (circle). A. *Dasyprocta punctata*. B. *Cuniculus paca* and C. *Potos flavus*.

2004 (V. Pacheco pers. obs.). Nonetheless, we could not get any photograph of this species with camera trapping what suggests that this might be a rare species in the area.

Local extinctions

The jaguar (*Panthera onca*) has been registered in Tumbes by several authors (Grimwood 1969, Pulido & Yockteng 1983, INRENA 2000), was often sighted in the PNCA, and reports of cattle killing were made by local peasants (Rodríguez 1998, INRENA 2000). However, at present there is no confirmed evidence of its presence. Local farmers are familiar with these animals but believe that they are no longer present. We agree with this statement due to the fact that jaguars when present are usually registered in camera photos, even with low capture frequency (Wallace et al. 2003, Maffei et al. 2004, Tobler et al. 2013), because they usually use trails (Maffei et al. 2004, Harmen et al. 2010), where some cameras were located. Moreover, world jaguar distribution surveys from 1999 (Sanderson et al. 2002, Zeller 2007, Zeller et al. 2011) showed that the Tumbes population was left isolated from the remaining populations with the closest being found in Peru and Ecuador east of the Andes. In this scenario the possibility of a remaining population of jaguars in the area is scarce.

Another species that might have suffered the same fate is the Andean bear (*Tremarctos ornatus*). This species was found in previous reports for the Parque Nacional Cerros de Amotape (Encarnación & Cook 1998, Maravi et al. 2003) contrary to some authors that considered Tumbes as its historic distribution (Peyton 1999, García-Rangel 2012, Wallace et al. 2014). Unfortunately, new records are lacking even though local people remember its presence; the last record we could obtain by interviews was around 1994 from a footprint near the Ecuadorian border, sighted by one of our local guides.

The squirrel monkey (*Saimiri sciureus*) is known to be distributed in Ecuador, Peru, Colombia, Venezuela, Brazil and Guyanas, always in the east side of the Andes (Cabrera 1957, Hershkovitz 1977, Boinski & Cropp 1999), except the single record from Tumbes on the western slope of the Andes, based on a sighting of Encarnación and Cook (1998) of a mixed troop with *Cebus albifrons* (Encarnación & Cook 1998). Until 2011 there had been at least two undergraduate theses (Alzamora 2005, M. Sánchez pers. com.) involving long-term census of

Alouatta palliata, as well as field expeditions in 2004-2005 (V. Pacheco pers. com), with no more evidence of *S. sciureus*. Although we had several encounters with *C. albifrons* and *A. palliata* from September 2011 through May 2013 we found no further evidence of its presence.

Based on the above evidence, we suggest that these three species; *Panthera onca*, *Tremarctos ornatus* and *Saimiri sciureus* should be considered locally extinct.

New Records

In this study we verified the presence of four species of mammals previously reported by indirect evidence; *Didelphis marsupialis*, *Choloepus hoffmanni*, *Lycalopex sechurae* (Pulido & Yockteng 1983) and *Puma concolor* (Pulido & Yockteng 1983, Encarnación & Cook 1998, Table 1). Also reported are *Dasyprocta punctata*, the first record for Peruvian fauna, and both *Cuniculus paca* and *Potos flavus* as first recordings for the western slope of the Peruvian Andes.

Dasyprocta punctata is distributed from northern Colombia to northwestern Venezuela, along the western coast of Colombian and Ecuadorian Pacific coast (Patton & Emmons 2015) with its southern limit range in San Jose, Ecuador (Patton & Emmons 2015). Based on our photographic records, the known distribution of this species is extended by 205 km South to Las Pavas locality (3°51'13"S, 80°16'3.20"W), northeastern Peru (Fig. 4A). The subspecies found in the study area would correspond to *Dasyprocta punctata chocoensis* (Cabrera 1957), but direct examination of vouchers is required to confirm determination.

Cuniculus paca is found from lowland rainforests from Mexico, along Central America through Paraguay (Perez 1992, Patton & Emmons 2015). Its western distribution was known to occur to southern Ecuador (Patton & Emmons 2015). Currently, the species is known in Peru only in the eastern side of the Andes (Pacheco et al. 2009). Based on photographs, we present the first record for the western side of the Peruvian Andes, 70 km west of the closest locality known, Portovelo, Ecuador (AMNH 46547) (Figure 4B).

Potos flavus is distributed from Mexico, through Central America and south to Bolivia and Brazil (Ford & Hoffmann 1988, Emmons & Feer 1997, Kays et al. 2008); on the western Andes it is known to occur until Zaruma, southern Ecuador

(AMNH 46513). Based on one full skeleton, collected specimen and previous sightings, we extend its distribution range to La Unión locality (3°49'44"S, 80°15'34.85"W) northern Peru by 72 km, which constitutes the first record in the western slope of the Peruvian Andes (Figure 4C).

Because these three species (*Dasyprocta punctata*, *Cuniculus paca* and *Potos flavus*) were found only in the transitional forest and Pacific Tropical Rainforest we believe that PNCA likely is the southern limit of their distribution; further south the area becomes dryer and more open and less suitable for these species.

Conservation

PNCA is an area of unique diversity but also of great concern because several species are listed as threatened or endangered. The primates found in the area are at risk of extinction, especially *C. albifrons aequatorialis* J. A. Allen, 1914 which is considered Critically Endangered by the IUCN (2008). Also, *A. palliatta aequatorialis* Festa, 1903 is listed as Vulnerable. Furthermore PNCA holds two species in Data Deficient category; *Lontra longicaudis* (Olfers, 1818) and *Mazama americana* (Table 1). Even though *Nasua nasua* is listed as low concern, in Tumbes we believe it should be categorized as Data Deficient or Vulnerable because local people hunt males for their bacula which is erroneously thought to increase sexual properties in men. Cook and Encarnación (1994) informed that this practice was common not only with *Nasua nasua* but with *Eira barbara* for the same purposes. Additionally, some people not familiar with the species also hunt *Procyon cancrivorus*. The baculum is sold in the markets for about \$300 (A. García pers. com).

Furthermore, the fact that at least three species are now considered locally extinct may indicate that the area of PNCA is insufficient to hold large carnivores. Nonetheless, in other protected areas in the USA, extinction rate is highly correlated with the density of human population in the surrounding areas (Parks & Harcourt 2002). The effect that roads and anthropogenic disturbances cause in wildlife extinction may be greater than the size of the natural protected area (Parks & Harcourt 2002). This statement is relevant to the PNCA, since we found that the buffer area, comprised of dry forest and transitional forest, was greatly impacted by anthropogenic activities such as farming and agriculture (we documented high capture rate of cattle in camera trapping).

We also registered a full skeleton of *Leopardus pardalis* poisoned by farmers because it preyed on their poultry; this confirms human-carnivore conflicts, also expressed in interviews. This small cat feeds on chicken and eggs causing monetary losses for farmers who end up killing them. Furthermore, illegal boulder extraction is being carried out within the limits of the national park; altering the course of streams or disperses them among multiple channels, making them almost nonexistent. Several photographs of dogs and hunters were obtained which suggests that hunting for bush meat (*Mazama americana* and *Pecari tajacu*) is fairly common. The presence of people resulted in the theft of three camera traps, later replaced to continue the study. Also, illegal logging is common and hard to control by park guards because of limited personnel. As result, this rainforest is losing its connectivity with the forest in Ecuador (see Hansen et al. 2013). The area of Campo Verde should be one of the better protected parts of the National Park; it holds great diversity

and is threatened by locals and foreigners. In summary, a lot of conservation work is needed in PNCA. An effective management plan should be developed by administrators of the park in association with the Academia and local people.

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Appendix 1. Medium and Large Mammals of The Parque Nacional Cerros de Amotape, Tumbes-Peru. Cindy Hurtado, Víctor Pacheco & Alan García Cruz. Photos: Cindy Hurtado, except for 12 (Arturo Noblecilla M.), 15 y 20b (Álvaro García-Olaechea). Common names (Spanish) were taken from La Angostura village in 2012.

