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Large mammal richness in Llanganates National Park, Ecuador

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Abstract: Llanganates National Park (LNP) was created in the Andes of Ecuador with the goal of protecting the biodiverse biota of the Napo and Pastaza river watersheds. Data on richness and abundance of the mammal community in this park are scarce. From February to August 2016 we installed 58 camera-trap stations along an altitudinal gradient ranging from 2000 to 4000 m. With a sampling effort of 2320 trap-nights, we recorded 2034 pictures of 13 species of large native mammals, 10 of which are included in Ecuador's Red List of Endangered Mammal Species. Relative abundance ranged from 0.17 to 3.58 photos/100 trap-nights. Our results are similar to those of other protected areas in the Ecuadorian Andes. During field work, we found evidence of uncontrolled and threating activities for conservation. There is an urgent need to strengthen patrol and law enforcement in the park to reduce human impacts on wildlife and habitat.

Keywords: abundance; Andes; camera trap; Neotropic; wildlife inventory.

Introduction

In 1996, the Ecuadorian government created Llanganates National Park (LNP), in the Andes of Ecuador, with the goal of protecting important biotic and abiotic features in the upper watersheds of the Napo and Pastaza rivers (República de Ecuador 1996). This park is located in the Cauca and *páramo* biogeographic provinces (Morrone 2014), which encompass both subtropical and temperate zoogeographic regions of Ecuador (Albuja et al. 1980).

Subtropical and temperate regions in Ecuador harbor more than 1500 vertebrate species, including 200 species of mammals (Albuja et al. 2012). However, little is known about the mammalian community in LNP. There has been only one study, which reported 46 species, that is available in the pertinent literature (Castro and Román 2000). Despite being a protected area, LNP is under a growing pressure from anthropogenic activities and unsustainable use of the natural resources. Therefore, the design of conservation and management actions is critical for this area.

In addition, information on the presence and abundance of organisms is crucial for monitoring and understanding species vulnerability and to overcome the Wallacean shortfall. Nevertheless, scientific data on these aspects of the mammal community of LNP are still non-existent. To fill this gap, we report here the results of a camera trap assessment of large native mammals in LNP.

Materials and methods

Study site

LNP is located in the central Andes of Ecuador (–01°08′08″S –78°14′27″W, Figure 1). It covers an area of 2119 km^2 with an altitudinal range of 840–4638 m. Vegetation types in LNP corresponded to *páramo* grasslands and scrublands with Andean stem-rosettes (*frailejones*), subnival wet *páramo* grasslands and montane forests (Ministerio del Ambiente del Ecuador 2013).

This work was carried out with the research permit MAE-006-16 IC-FAU-DNB/MA, which was granted by the Ministry of Environment of Ecuador. We conducted fieldwork in western LNP (Figure 1) from February to August 2016. We randomly selected 58 sampling points, with an average separation distance of 2000 m between points (range = 100–4000 m), in an elevation gradient ranging from 2000 to 4000 m. At each point, we installed a camera trap station (CTS). These included one Reconyx C550 (RECONYX, Holmen, WI, USA) digital camera trap placed 50 cm above the ground and programmed to take five pictures per activation event with an inactivity period of 60 s between events. Each CTS was active 24 h/day for 40 days.

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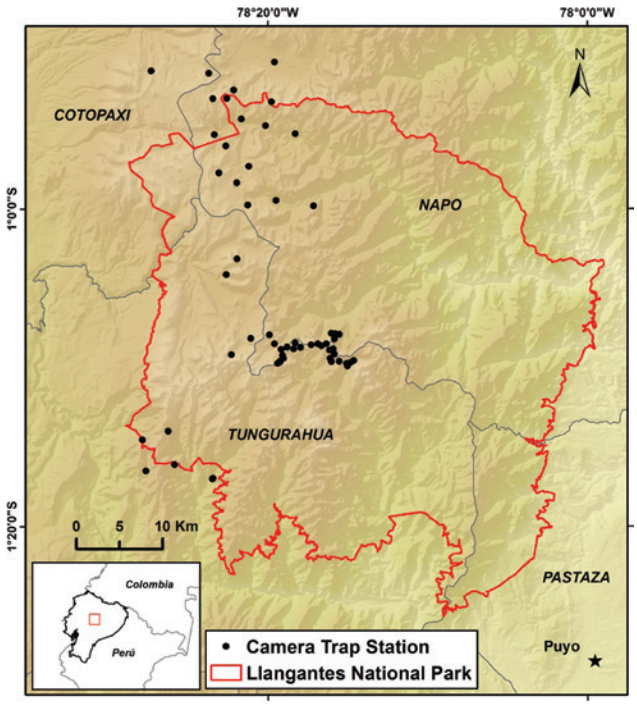

Figure 1: Study area and location of camera trap stations (CTS) in Llanganates National Park, Ecuadorian Andes.

Data analyses

We identified photographed species based on field guides of Neotropical mammals (Emmons and Feer 1997; Gardner 2007; Tirira 2007). Species list taxonomy follows Tirira (2015). We evaluated sampling effort with a species accumulation curve and estimated species richness in Estimates 8.2 (Colwell 2013) using the first order jackknife estimator, as this offers greater precision and reduces bias (Walther and Morand 1998; López-Gómez and Williams-Linera 2006; González et al. 2010). Relative abundance was estimated for each species and reported as the number of independent photographic events/100 trap-nights. We followed the definition of independent photographic events as laid out by Zapata-Ríos and Branch (2016). Conservation status was then determined using the categories for the mammal red list of Ecuador (Tirira 2011).

Results

With a sampling effort of 2320 trap-nights, we recorded 2034 pictures which corresponded to 344 independent photographic events of 13 species of medium to large-sized native mammals. The species were distributed within 10 different families and six orders (Table 1, Figures 2 and 3); one introduced species (Cattle [*Bos taurus*]) was detected and excluded from the analysis. Of the total number of species detected, 10 are considered endangered in Ecuador (Tirira 2011, Table 1). Species accumulation curves (Figure 4) of predicted and observed richness reached the asymptote at 19 and 34 sampling points (CTS), respectively. The richness as predicted by the first order jacknife estimator was 14 species. Our results are similar to those of other national parks of the Ecuadorian Andes (Figure 5).

Native species relative abundance ranged from 0.17 to 3.58 photos/100 trap-nights (Table 1), with the striped hog-nosed skunk (*Conepatus semistriatus*) and the forest rabbit (*Sylvilagus brasiliensis*) being the species with the lowest and highest abundances, respectively. Relative abundance of cattle was 2.27 (90% CI: 1.27–3.28) photos/100 trap-nights; the mountain paca (*Cuniculus taczanowskii*), Oncilla (*Leopardus tigrinus*), Western mountain coati (*Nasuella olivacea*), mountain tapir (*Tapirus pinchaque*), little red brocket (*Mazama rufina*) and the northern pudu (*Pudu mephistophiles*) were not detected where Cattle were present.

Discussion

The only documented wildlife survey in LNP recorded 46 mammalian species (Castro and Román 2000), of which 11 species corresponded to 10 different families of large mammals; nine of these species were restricted to the highlands of Llanganates. Our results added two families and four species to the large mammal community in the highlands of LNP: Andean white-eared opossum (*Didelphis pernigra*), oncilla, striped hog-nosed skunk and western mountain coati. The composition of the large mammal community in LNP is similar to those of other protected areas in the Ecuadorian Andes. A total of 13 and 11 species were recorded in the high Andes of Cayambe-Coca National Park (Zapata-Ríos and Branch 2016) and Sangay National Park (Brito and Ojala-Barbour 2016), respectively. The slight differences in species richness and composition are due to the sampling methods applied in each study; Zapata-Ríos and Branch (2016) used camera traps and line transects, whereas Brito and Ojala-Barbour (2016) only used line transects.

This study recorded 93% of the species richness predicted by the jackknife estimator; however, this estimation may be biased since most of the data used (75%)

Table 1: Medium and large mammals from western Llanganates National Park.

Taxa	Conservation status	Relative abundance (±90% confidence interval)	
		This study	Cayambe-Coca National Park
Didelphimorphia			
Didelphidae			
Didelphis pernigra (J. A. Allen, 1900)	Least concern	0.39 (0.35)	10.7 (0.9)
Rodentia			
Cuniculidae			
Cuniculus taczanowskii (Stolzmann, 1865)	Near threatened	0.34 (0.28)	1.75 (0.49)
Lagomorpha			
Leporidae			
Sylvilagus brasiliensis (Linnaeus, 1758)	Least concern	3.58 (2.03)	
Carnivora			
Felidae			
Leopardus tigrinus (Schreber, 1775)	Vulnerable	0.30 (0.26)	
Puma concolor (Linnaeus, 1771)	Vulnerable	0.65 (0.35)	
Canidae			
Lycalopex culpaeus (Molina, 1782)	Vulnerable	2.16 (1)	
Ursidae			
Tremarctos ornatus (F. G. Cuvier, 1825)	Endangered	0.86 (0.48)	6.64 (1.1)
Mephitidae			
Conepatus semistriatus (Boddaert, 1784)	Least concern	0.17 (0.14)	6.34 (0.65)
Procyonidae			
Nasuella olivacea (Gray, 1865)	Endangered	0.26 (0.22)	
Perissodactyla			
Tapiridae			
Tapirus pinchaque (Roulin, 1829)	Critically endangered	1.64 (1.22)	
Artiodactyla			
Cervidae			
Mazama rufina (Bourcier y Pucheran, 1852)	Vulnerable	0.82 (0.81)	
Odocoileus virginianus (Zimmermann, 1780)	Near threatened	2.97 (2.15)	13.8 (1.06)
Pudu mephistophiles (de Winton, 1896)	Vulnerable	0.69 (0.70)	

Taxonomy follows Tirira (2015), and conservation status Tirira (2011).
Relative abundance (photographic events/100 trap-nights) estimates from this study, and Cayambe-Coca National Park estimates from Zapata-Ríos (2014).

came from grasslands and scrublands, although there are species restricted to the forest interior. From all the large mammal species of the high Andes of Ecuador, the quichua porcupine (*Coendou quichua*) and the pampas cat (*Leopardus pajeros*) were not recorded in this study, but are likely to occur in the highlands of LNP (Tirira 2007; Delgado 2016; Lucherini et al. 2016).

Relative abundance in LNP was the lowest as compared with other localities in Ecuador. Zapata-Ríos (2014) estimated relative abundance of mammals in Cayambe-Coca National Park using two different survey methods, camera traps and track-and-sign surveys. Estimates in this area, using camera traps, when compared with our results were 27 times greater for the Andean white-eared opossum, five times greater for the mountain paca, seven times greater for the Andean bear (*Tremarctos ornatus*), 36 times greater for the striped hog-nosed skunk and four times greater for white-tailed deer (*Odocoileus virginianus*) (Table 1). We found these large differences to be related to survey design and habitat quality between study areas. Our survey effort was concentrated in grasslands and scrublands, and only 25% of the CTS were located inside Andean forest. Abundance of the mountain paca and Andean bear is expected to be higher in forested

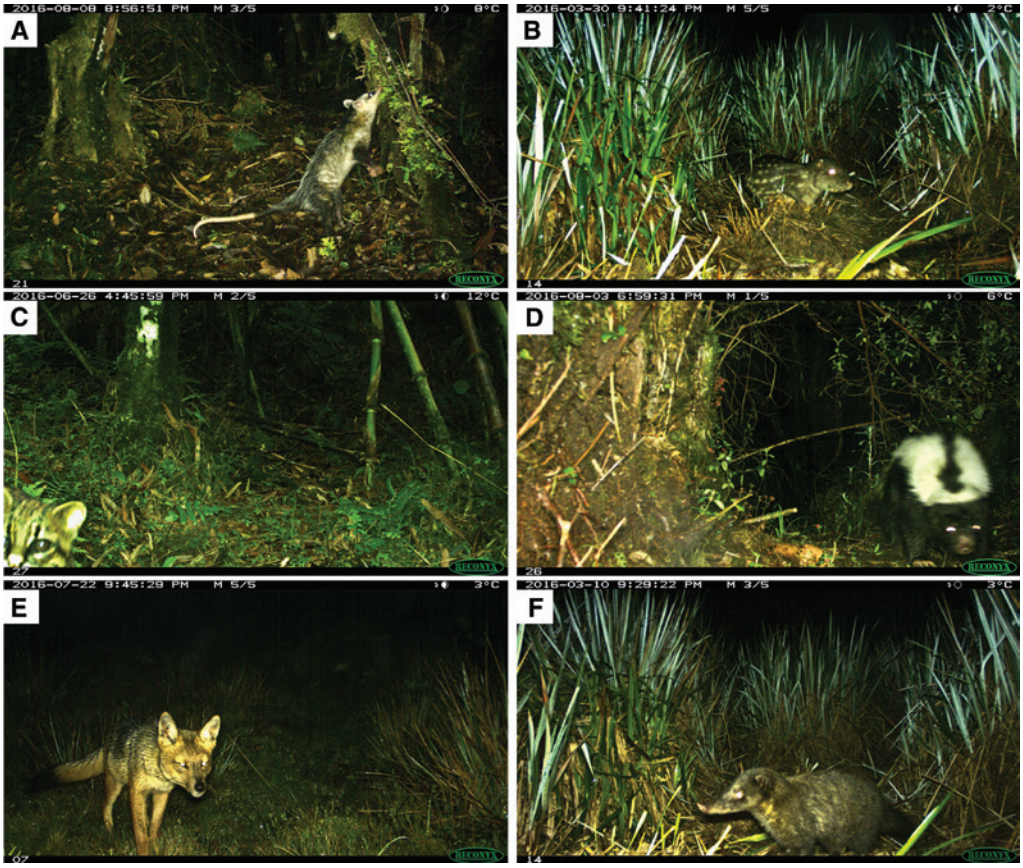

Figure 2: Photographs of six species of medium-sized mammals recorded in Llanganates National Park.
(A) *Didelphis pernigra*, (B) *Cuniculus taczanowskii*, (C) *Leopardus tigrinus*, (D) *Conepatus semistriatus*, (E) *Lycalopex culpaeus*, (F) *Nasuella olivacea*.

areas. Meanwhile, the abundance of the Andean white-eared opossum, striped hog-nosed skunk and white-tailed deer is likely to increase in disturbed habitats as present in Cayambe-Coca National Park.

We could not compare our results with those of Sangay National Park because Brito and Ojala-Barbour (2016) only provided a qualitative estimation.

Data on relative abundance of large Andean mammals in Ecuador is almost nonexistent, although understanding the factors regulating wildlife population abundance is key in ecology and conservation. For instance, Zapata-Ríos and Branch (2016) found that abundance of native mammals in the Andes of Ecuador was driven by the presence of feral dogs. In our study area, we did not detect feral dogs, but we speculate that the occurrence and abundance of the mountain paca, oncilla, western mountain coati, mountain tapir, little red brocket and northern pudu may be influenced by the presence of cattle as these were not detected where cattle were; nonetheless, specific research is needed to test this hypothesis. We encourage future wildlife inventories to estimate and report relative abundance of the native and alien species detected.

Sixty-one percent of the species recorded are classified as critically endangered, endangered or vulnerable, whereas 15% are near-threatened species. For all the species, the main threat is habitat loss and fragmentation (Tirira 2011). In addition, during fieldwork we found evidence of uncontrolled and threatening human activities in the survey areas. Although permanent human settlements and private lands do not exist in the surveyed areas, we observed extensive cattle ranching in the *páramo* grasslands. Ranching activities included unprescribed and uncontrolled burning twice a year, and opportunistic large mammal hunting during burning activities. Off-road racing is another activity occurring year round and promoting habitat loss and fragmentation in the highlands of this protected area. In LNP, montane forests and *páramo* grasslands loss are being lost at a rate of 0.1% per year (Paredes 2016). This situation might worsen if uncontrolled activities continue, and because of

Figure 3: Photographs of six species of large mammals recorded in Llanganates National Park.
(A) *Puma concolor*, (B) *Tremarctos ornatus*, (C) *Tapirus pinchaque*, (D) *Mazama rufina*, (E) *Odocoileus virginianus*, (F) *Pudu mephistophiles*.

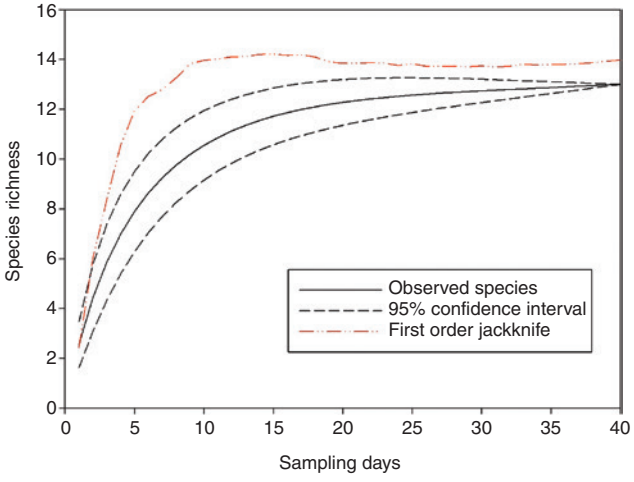

Figure 4: Species accumulation curve and first order jackknife estimator of species richness in Llangantes National Park.

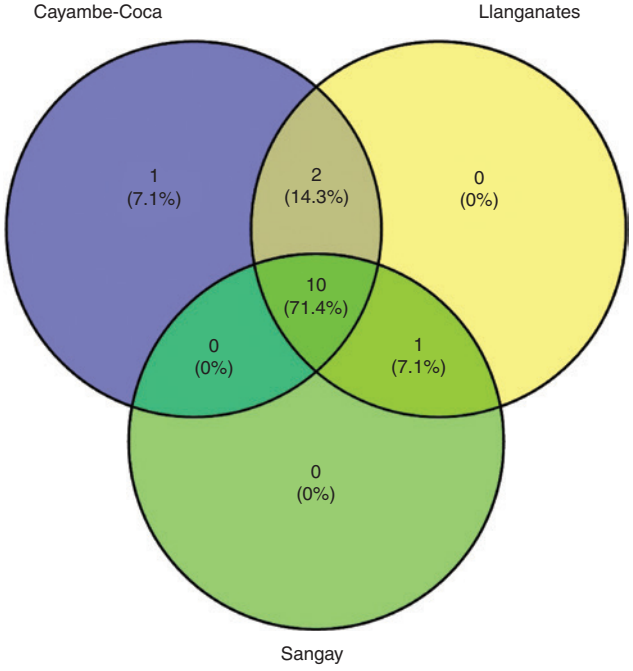

Figure 5: Venn diagram for species richness among three protected areas in Ecuadorian Andes.

the negative effects of climate change. There is an urgent need to improve patrol and law enforcement programs in the protected area to minimize impacts on wildlife and the habitat in LNP.

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