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Andean bears below the Andes

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Abstract: We lack many quantitative data on the current distributions of several bear species, and hypotheses about the mechanisms underlying those distributions. We raise this point by discussing visual detections of Andean bears (*Tremarctos ornatus*) in sampling from 14 September 2016 to 24 August 2017 in the Haramba Queros Wachiperi Ecological Reserve Conservation Concession in southeastern Peru, at 811–920 m above sea level, lower in elevation than >90% of known locations for this species on the eastern slope of the Peruvian Andes.

Resumo: No tenemos muchos datos cuantitativos sobre las distribuciones actuales de varias especies de osos, ni hipótesis sobre los mecanismos detrás de esas distribuciones. Ilustramos esto discutiendo unos registros visuales del oso andino (*Tremarctos ornatus*) durante foto trampeo del 14 septiembre 2016 al 24 agosto 2017 dentro de la Concesión para la Conservación Reserva Ecológica Haramba Queros Wachiperi, de elevaciones de 820–920 msnm, más bajos que 90% de los lugares conocidos para la especie en las laderas orientales de los Andes peruanos.

Key words: Amazon, Andean bear, camera traps, distribution, elevational gradient, *Tremarctos ornatus*, Tropical Andes, visual detection

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The Tropical Andes of southeastern Peru are a biodiversity hotspot and a conservation priority (Myers et al. 2000). Conservation efforts there began with the creation of Manu National Park across an elevational gradient of vegetation communities from alpine grasslands >4,000 meters above sea level (masl) descending through cloud forest to tropical rainforests (Palma et al. 2003, SERNANP 2014). Species inventories there and elsewhere are important for comparisons between sites and for updating species' distribution maps (e.g., Tobler et al. 2008), and to generate and test mechanistic hypotheses for those distributions (e.g., Rehm and Feeley 2015, Rojas-VeraPinto et al. 2022). Those distributions and hypotheses are crucial to understand species' ecology and support conservation (Kearney 2006, Anderson et al. 2016, Sargent et al. 2022). However, although some mammal inventories have been completed at lower elevation not far from Manu National Park (e.g., Tobler et al. 2018), information on medium- and large-sized mammals is still lacking from higher elevations; where sampling has occurred on the eastern slope of the Andes, it has produced new knowledge about species' distributions (e.g., Pillco Huarcaya et al. 2019).

We used camera traps to assess the presence of the Andean bear (*Tremarctos ornatus*), and other medium- and large-sized mammals and birds, in an intact forest between 2 major protected areas in southeastern Peru, to contribute to effective conservation planning and to lay a foundation for future research. For comparison with our data, we use data from relevant open-access databases to evaluate the relative frequency of low-elevation detections of Andean bears, then use them as catalysts to think about the limits to this species' distribution.

Study area

The Haramba Queros Wachiperi Ecological Reserve Conservation Concession (−13°5′60″N, −71°20′60″W) in southeastern Peru (Paucartambo Province, Cusco) covers 69.76 km^2 from 740 to 2,320 masl, between 2 large, protected areas, close to the town of Pilcopata (population ~4,400; P. Luna, Amazon Conservation and Conservación Amazónica, personal communication, 2024; Fig. 1). The concession was created in 2008 to replace logging with more sustainable activities related to conservation and tourism and it is managed by the native Haramba Queros Wachiperi community. The terrain is mountainous, with ridges and valleys across 3 vegetation communities: premontane rain forest, lower montane moist forest, and cloud forest (Fig. 1; ACCA and Comunidad Nativa de Queros 2008). The concession contains a mineral lick (collpa, 744 masl), which provides minerals to a range of animals (Bravo et al. 2008). Average annual rainfall in the concession is approximately 3,103 mm with an annual relative humidity of 87%; November–March are the rainiest months.

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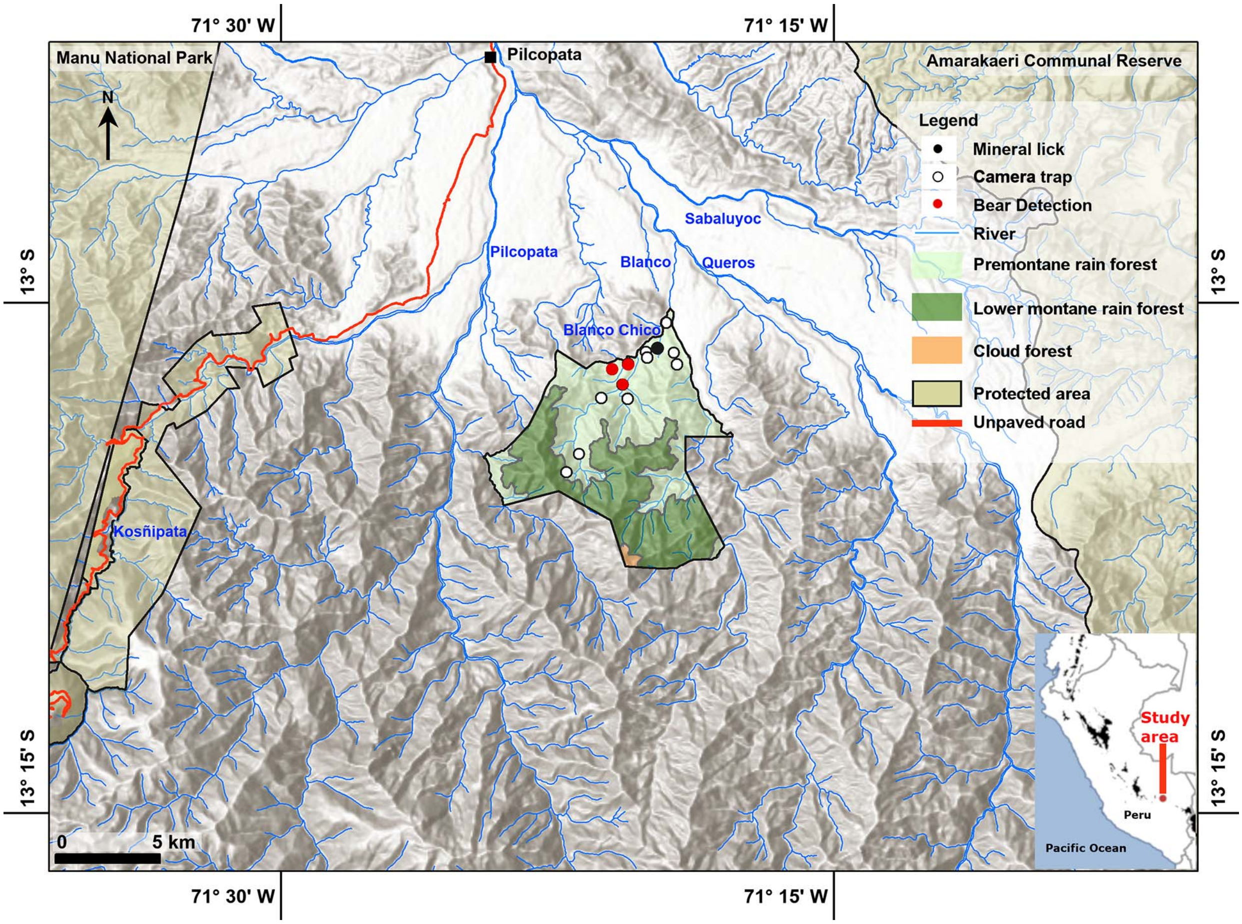

Fig. 1. Study area where we conducted camera-trap detections of Andean bear (*Tremarctos ornatus*) from 14 September 2016 to 24 August 2017 within the Haramba Queros Wachiperi Ecological Reserve Conservation Concession (69.76 km^2) in southeastern Peru, relative to legally protected areas (e.g., Manu National Park and Amarakaeri Communal Reserve), the town of Pilcopata (population ~4,400), and the known distribution of the Andean bear (shown in black in the inset; Vélez-Liendo and García-Rangel 2017).

Mean annual temperatures range from about 18°C to 29°C, with temperatures sometimes reaching between 6°C and 9°C in the coldest season, May–August.

Methods

From September to November 2016 we explored as much of the study area as possible, given the topography and dense forest conditions. With no preset spatial pattern, we installed unbaited single camera traps (Bushnell 14MP Trophy Cam HD Aggressor Low-glow, Bushnell Corporation, Overland Park, Kansas, USA; and Reconyx Hyperfire HC550, Reconyx, Inc., Holmen, Wisconsin, USA) at the mineral lick and at 13 other locations along wildlife trails or at signs of medium- and large-sized mammals, across 10.3 km^2 (14.8% of the concession; Fig. 1). We placed most cameras in primary premontane rain forest near the Chico Blanco River and its tributaries; one was placed in lower montane moist forest. We treated each camera as an independent sampling location. We determined precise positioning of cameras by the presence of trees suitable for support. We cut vegetation in each camera's field of view to reduce false triggers. We set cameras between 0.2 and 0.5 m from the ground with a horizontal field-of-view in a north–south orientation to avoid the confounding effects of sunlight. We programmed cameras to operate continuously, with high sensor sensitivity, taking 3 photographs, 1 second apart, per trigger. We also programmed cameras to take photographs at 0000 hours and 1200 hours, to help estimate the timing of any camera failures. Cameras operated for variable time periods from 14 September 2016 to 24 August 2017, at elevations from 744 to 1,293 masl.

We managed photographs and associated metadata with CameraBase 1.7 (Tobler 2015). We defined independent records as those that were recorded >60 minutes after the previous image of the same species. We attempted to identify all terrestrial mammals, and birds of the Families Columbidae, Cracidae, Odontophoridae, and Tinamidae. After observing records of ≥1 Andean bear at a low elevation (<1,000 masl), we sought reference data on the elevation of the Andean bear's distribution because elevation has often been found to be correlated with the occurrence of Andean bears (Peyton 1999, Vélez-Liendo et al. 2013, Wallace et al. 2014, Morrell et al. 2021, Rojas-VeraPinto et al. 2022), but not always (e.g., Aurich-Rodríguez et al. 2022). To obtain reference data for the elevations of Andean bears detected on the eastern slopes of the Andes in Peru and Bolivia, we extracted data from 2 open access databases (Falconi et al. 2020a, b; Antunes et al. 2022a, b). Elevation changes rapidly across short distances in the Andes, so we included data from the Global Biodiversity Information Facility database (GBIF; https://www.gbif.org) that had a spatial uncertainty of <5 km, in Peruvian political provinces lying at least partly on the eastern slope of the Andes (Amazonas, Cajamarca, Cusco, Huanuco, Junin, Loreto, Madre de Dios, Pasco, Puno, San Martin, and Ucuyali). We then estimated location elevations using a digital elevation model of 24 m in ArcGIS Pro (ESRI Inc., Redlands, California, USA).

Results

In 2,330 camera-days, we recorded 2,434 independent records of wildlife: 28 species or morphotypes of mammals (16 Families, 8 Orders) and 13 species or morphotypes of birds (4 Families, 3 Orders). We were unable to identify to species some small mammals and birds. We detected large, presumably adult, Andean bears on 3 occasions, at 3 different sampling locations (Fig. 2): 1240 hours on 27 March 2017 at 811 masl, 0623 hours on 3 June 2017 at 920 masl, and 0756 hours on 11 July 2017 at 830 masl. The lowest of these 3 records (811 masl) is lower than 90.6% (770 of 850) of the published records for which we can extract elevation data (Falconi et al. 2020a, Antunes et al. 2022a). We cannot determine how many bears were detected because the three records did not show the face, which can be used to identify individual bears (Roth 1964, Van Horn et al. 2014, Reyes et al. 2017).

Discussion

We detected most of the medium- and large-sized terrestrial mammals expected in the primary subtropical rainforest of this region (Solari et al. 2006, Tobler et al. 2018). The confirmed presence of large species that require large intact habitat patches (e.g., jaguar [*Panthera onca*]), as well as rarer species, (e.g., giant anteater [*Myrmecophaga tridactyla*]) demonstrates the potential value of this area as a stepping stone between the nearby larger protected areas (Fig. 1). Conservation of tropical forests outside of strictly protected areas requires the engagement of local people in developing approaches with long-term benefits for people and wildlife (e.g., Berkes 2007, Kirkby et al. 2011). The presence of charismatic megafauna may benefit the Queros by attracting further research and ecotourism (Preston and Fuggle 1987, Higginbottom et al. 2003, Krüger 2005), countering the attraction for community members to seek economic opportunities elsewhere.

The locations at which we detected bears are outside the current International Union for Conservation of Nature map for the Andean bear (Fig. 1; Vélez-Liendo and García-Rangel 2017). These locations, like those in other recent reports (e.g., Falconi et al. 2020a, b; Antunes et al. 2022a, b), contribute to the knowledge of where these bears occur. However, the scarcity of bears in our data set, among more numerous detections of other species, suggest that there is not a resident population of bears within our study area; this is in agreement with Figueroa (2012), who worked nearby. Instead, we may have detected one or more dispersers, perhaps descending from higher elevation or moving between larger protected areas. The dispersal abilities of Andean bears are unknown because the dispersal distance of only one Andean bear has ever been tracked (15 km), opportunistically (Rechberger et al. 2001). Alternatively, we could have detected ≥1 Andean bears whose home ranges lay mostly at higher elevations. The longest daily movement of an Andean bear noted to date was >6 km, crossing 2,000 m in elevation (Paisley 2001), and home-range estimates have been published for only 10 adults (6M:4F) and 1 subadult male, spanning 10° latitude, and varying from 7.25 to 189 km^2 (Paisley 2001, Castellanos 2011, Vela-Vargas et al. 2021).

Fig. 2. Sample photos from 3 detections of ≥1 Andean bear (*Tremarctos ornatus*) during 2017 in the Haramba Queros Wachiperi Ecological Reserve Conservation Concession (Cusco, Peru). Each row includes 2 images from the same detection. From top to bottom, detections were located at 811 m above sea level (masl), 920 masl, and 830 masl.

Elevation has often been identified as an important predictor of where Andean bears will be detected (Peyton 1999, Vélez-Liendo et al. 2013, Wallace et al. 2014, Morrell et al. 2021, Rojas-VeraPinto et al. 2022), with most records from >1,000 masl (García-Rangel 2012, Cáceres-Martínez et al. 2020). Although Andean bears are sometimes detected at lower elevations elsewhere in their range (e.g., Vargas and Azurduy 2006, Cáceres-Martínez et al. 2020), including at lower elevations at some locations in the northern edge of their distribution, there apparently are not populations of Andean bears at low elevations on the eastern or northern edge of their range, such as in Panama (Goldstein et al. 2008). Thus, elevation is a generally useful but imperfect proxy for the abiotic or biotic factors underlying the common association of the Andean bear with higher elevations. The current spatial and seasonal occurrence of Andean bears has been modelled with some abiotic and anthropogenic factors (Vélez-Liendo et al. 2013, 2014; Morrell et al. 2021; Aurich-Rodríguez et al. 2022; Rojas-VeraPinto et al. 2022), but only at a smaller scale, not widespread enough to determine why there are not Andean bears living permanently in the Amazon.

It seems worthwhile, then, to consider what higher elevations convey to an Andean bear. Morrell et al. (2021) suggested that elevation in their relatively low study area (140–2,600 masl) in northwestern Peru might reflect a positive association with precipitation and with food resources. Pillco Huarcaya et al. (2019) worked in a cooler and wetter area on the eastern slope, with presumably more food resources for Andean bears, yet did not detect bears as low as in Morrell et al. (2021) or as in our data. These studies are consistent with the pattern noted by García-Rangel (2012): Andean bears are detected lower on the west side of the Andes than on the east side of the Andes. Thus, if elevation serves as a proxy for habitat suitability for Andean bears, temperature or precipitation alone must not be the determining factors (Figueroa 2012), and the factor(s) for which elevation is a proxy must work differently on each side of the Andes. Elevation may serve as a proxy for food availability; however, our knowledge of Andean bear foraging ecology is primarily based on indirect evidence and uncorrected tallies of fecal contents (e.g., Figueroa 2013, Gonzales et al. 2016), usually without concurrent data on food availability, so we know neither how nor why the foraging ecology of Andean bears changes with elevation at a large scale.

Elevation might serve as a proxy for the distribution of the jaguar. Peyton (1999) suggested that jaguars may prey on bears, noting that the two species overlap only slightly in Bolivia and Peru. We detected both species at one location (839 masl), as did Pillco Huarcaya et al. (2019; 1,418 masl). Figueroa (2012) detected indirect evidence of both species at low elevations in southeastern Peru (370–635 masl), but we disagree with her that inconsistent co-occurrence of the two species means that jaguar presence does not affect bear presence; it seems biologically unlikely that there would be a total lack of range overlap between bears and jaguars. Figueroa (2012) interpreted Peyton's (1999) suggestion to mean that bears and jaguars might be competitors. Regardless of whether jaguars might compete with bears, or kill all female and subadult Andean bears, dispersing bears would sometimes venture into otherwise suitable habitat. The larger scale work of Rojas-VeraPinto et al. (2022) found that almost all bear occurrences were at higher elevations (>1,500 masl), above typical jaguar range; similarly, bears were found at only 0.8% of sampling locations (15/1,908) across the Amazon, while jaguars were found at 54.8% of sampling locations (1,046/1,908; Antunes et al. 2022a). Large cats can be effective predators on bears; female Asiatic black bears (*Ursus thibetanus*) and cubs are common prey items for tigers (*Panthera tigris*) in some populations and bear remains are commonly found in tiger feces (Tkachenko 2012, Seryodkin et al. 2018). If jaguar presence precludes permanent Andean bear presence, and jaguars respond to climate change by following their prey upslope, how much less available Andean bear habitat will there be than would be predicted based on the habitat distribution for Andean bears?

Climate change is a current threat to the Andean bear (Vélez-Liendo and García-Rangel 2017). However, although the potential future distributions of Andean biomes have been modelled (e.g., Tovar et al. 2013), the underlying mechanisms are not well-defined. This is so on the eastern slope of the Andes, where climate change is changing the distribution of tree species in southeastern Peru in complex ways (Feeley et al. 2011, Lutz et al. 2013, Rehm and Feeley 2015, Fadrique et al. 2018). Analyses of bear presence and absence, and abiotic and biotic factors, at a broader spatial scale and with explicitly mechanistic thinking, are needed to extrapolate the future distribution of this bear (e.g., Kearney 2006, Sargent et al. 2022).

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