PAMPAS CAT *LEOPARDUS COLOCOLO* IN THE ATACAMA DESERT: FIRST RECORDS FROM LLANOS DE CHALLE NATIONAL PARK, CHILE

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Short title: *Leopardus colocolo* in the Atacama Region, Chile

ABSTRACT

Pampas cat (*Leopardus colocolo*) is distributed from Ecuador, and possibly Colombia, to Argentina and Chile. Heavily hunted in the 1900s for its fur, the pampas cat is currently threatened by conflict retaliation for poultry predation, habitat transformation and feral dogs. This species was historically considered to occur in the Atacama desert of Chile, based on occasional unverified reports. Current range maps indicate its potential occurrence; however, no confirmed records exist. Here, we report the first confirmed records of the pampas cat at a low elevation site in the Atacama Desert within Llanos de Challe National Park from camera-trap surveys and direct sightings during 2012. The species has a low frequency of capture within azonal vegetation known as *aguadas*. Our records confirm the distribution of this species between 38 and 461 m asl for the southernmost portion of the Atacama Desert. This finding represents a significant contribution to the species' known distribution and elevation range, a significant addition to the fauna of the Atacama Region, and a challenge for its conservation within the protected area.

KEY WORDS: camera-trap, Colocolo cat, Felidae, South America.

RESUMEN

El Gato de los pajonales *Leopardus colocolo* en el desierto de Atacama: primer registro en el Parque Nacional Llanos de Challe, Chile. El gato de los pajonales o colocolo (*Leopardus colocolo*) se distribuye desde Ecuador, y posiblemente Colombia, hasta Argentina y Chile. Fue fuertemente cazado por su piel en los años 1900, actualmente el gato colocolo está amenazado por el conflicto generado por la depredación de aves de corral, la transformación del hábitat y los perros ferales. Esta especie se considera históricamente distribuida en el desierto de Atacama de Chile, basado en reportes ocasionales no verificados. Mapas actuales de distribución indican su presencia potencial, sin embargo, no existen registros confirmados. Reportamos nuevos registros confirmados del gato pajero en un sitio a baja elevación en el desierto de Atacama, dentro del Parque Nacional Llanos del Challe, a partir de muestreos con cámaras-trampa y una observación directa durante el 2012. La especie tuvo una baja frecuencia de captura en la vegetación azonal, conocida localmente como aguadas. Nuestros registros confirman la distribución de la especies entre 38 y 461 msnm para la región más sureña del Desierto de Atacama. Este hallazgo representa una contribución importante al rango de distribución y elevación conocido para la especie, una adición significativa a la fauna conocida de la región de Atacama y un reto para su conservación dentro del área protegida.

PALABRAS CLAVE: cámaras-trampa, Felidae, gato de los pajonales, Sudamérica.

INTRODUCTION

The pampas cat (*Leopardus colocolo* Molina, 1782) is a South American felid originally distributed from Ecuador, and potentially southwestern Colombia (Alberico *et al.* 2000), to Chile and Argentina; and inhabits diverse ecoregions, ranging from the Patagonia and Pampas in Argentina and Uruguay, to the Chaco in Bolivia, Argentina and Brazil (Pereira *et al.* 2008). This wild cat is currently included in CITES Appendix II (CITES 2013), considered Near Threatened globally by the IUCN Red List of Threatened Species (Pereira *et al.* 2008), and catalogued as Near Threatened in Chile (D.S. No. 42 Ministerio del Medio Ambiente 2011). Major historical threat over pampas cat is illegal hunting, with reported harvests from 1977 to 1979 with 78,239 skins traded in Argentina alone (Mares and Ojeda 1984). Currently, habitat loss and degradations are the main hazards to this wild cat (Pereira *et al.* 2008).

Although the pampas cat is considered common throughout most of its range, little is known about its ecology (Sunquist and Sunquist 2009), and the taxonomic of the species had been large discussed (García-Perea 1994; Johnson *et al.* 2006); however, populations in Chile are considered to be decreasing and threatened by hunting (mainly in retaliation for poultry predation), habitat degradation, and the effects of domestic dogs (CONAMA 2009). Even when evidence supports threats information for the species, its distribution range in Chile is still not well known. For the Northern part of the country, in the Atacama Desert, the pampas cat has only been confirmed in Arica and Parinacota Regions between 2,000 and 4,600 m asl, in Camarones river (19°01′S 69°52′W), Putre (18°12′S 69°35′W; García-Perea 1994), Salar de Surire Natural Monument (18°84′S 69°04′W) and Las Vicuñas National Reserve (18°56′S 69°19′W; Napolitano *et al.* 2009), in Antofagasta Region at 2,300 m asl in Salar de Atacama (23º21`S 68º09`W; Spotorno *et al.* 1998) and in Coquimbo Region at 337 m asl in Marquesa (29º58`S 71º00`W; Osgood 1943).

The reported elevational distribution of the species ranges from 0 to 4,000 m asl, for the West side on the Andes in central and north of Chile (García-Perea 1994), but the species has been confirmed mainly in the central regions (Osgood 1943; García-Perea 1994), however, for the northern part of the country the elevational and latitudinal range is poorly understood due to few confirmed records (Osgood 1943; García-Perea 1994; Napolitano *et al.* 2009; Spotorno *et al.* 1998), distribution maps had been developed primarily using potential habitat modeling, suggesting the pampas cat occurs in a continuous distribution from the high Andes to the mid and lower zones of central Chile, including the Atacama Region (Iriarte 2008, Pereira *et al.* 2008, CONAMA 2009, however, only three anecdotal records publish exist for the region, and with no museum records (Valladares 2012), and local people form the coastal zone had been reported it to the authors, so it was necessary to confirm these inferences for this region.

The present study confirms the presence of pampas cat in the lowlands of the Atacama Region within a state protected area. Direct confirmation was necessary to start deploying conservations actions for the species inside the National Park and surroundings, this research also contribute information about other mammal species sharing the habitat with the wild cat.

METHODS

Study area

The Atacama Desert is located within the Peruvian-Chilean Coastal Desert geomorphologic unit between latitudes 5º and 26º South and includes three main physiographic units: the Coastal range, the Intermediate depression, and the Andes. Located within this ecological region, the political Atacama Region is characterized by a system of transverse valleys connecting the Andes with the Costal range and the Altiplano systems in the middle and high Andes, reaching an elevation of 6,893 m asl (Ulloa and Ortíz de Zárate 1989). Vegetation of this region is dominated by Desert and Steppe communities (Gajardo 1983; 1994). The Llanos de Challe National Park (25º18`-29º43`S 68º19`-71º30`W) is a protected area comprising 457.08 km^2, located in the coastal portion of this region, and includes two main desert vegetation formations: the Flowering Desert of the Plains (*Desierto Florido de los Llanos*) and the Huasco Costal Desert (*Desierto Costero de Huasco*; Gajardo 1983; 1994). Within these two vegetation formations,

an azonal vegetation community, locally known as *aguadas* (water spring), is formed by groundwater springs from the Andes. Despite the low flow rates of these groundwater springs, together with the coastal low fog or mist (*Camanchaca*), they represent the most important sources of water for fauna in this arid zone (Lubert and Pliscoff 2006).

Sampling methods

During January 2012, in a comprehensive survey of Llanos de Challe National Park, we documented a total of 13 azonal vegetation sites (*aguadas*) which represented 0.0036% of the protected area surface. *Aguadas* typically have low plant species richness (typically 1–4 species) but high areal coverage (mean ± standard deviation = 60.8 ± 42.4 %), compared with 2–10 species and mean areal coverage of 10.2 ± 6.8 % in zonal vegetation areas. Variation in azonal flora coverage was due to four sites without vegetation.

All *aguadas* sites within Llanos de Challe National Park were sampled using remote cameras between May and August 2012. Each site was sampled by setting one camera (Reconyx HC500) as close as possible from the water spring, if it exists, with veal pate as attractor, for 8 to 18 days (mean 9.9 ± 2.4 days) for a total of 139 trap days. All sampling sites were located within the Huasco Costal Desert zonal vegetation (Figure 1) and the closest distance between stations was two km. The use of an attractor could bias the frequency of capture of foxes and mice, but increases the probability to capture wild cats; species that we believed has a lower abundance due to the scarce number of direct sightings reported by the local community.

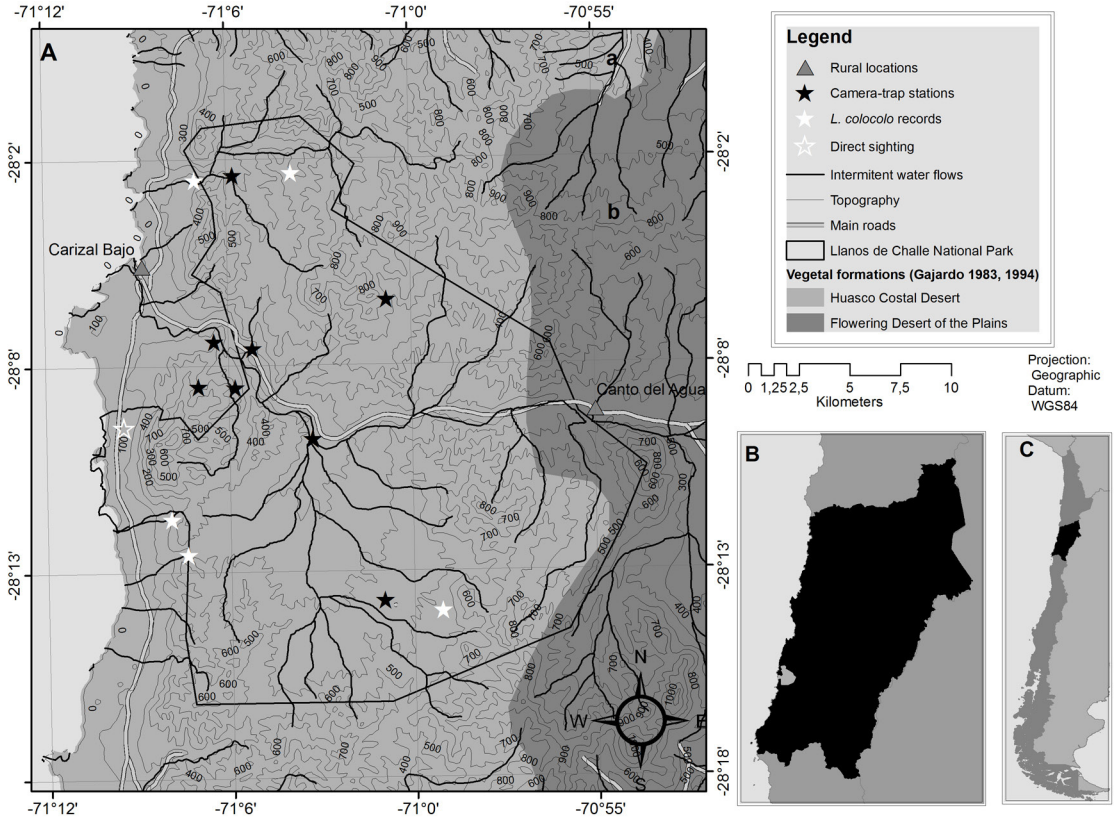

FIGURE 1. Remote camera stations and direct sight locations in Llanos de Challe National Park (A), with insets of the Atacama Region (B) and Chile (C).

Data analysis

Data was analysed to estimate capture frequencies for each mammal species detected by camera traps. Based on the effective sampling effort, estimated as trap-days (sum of the number of days for all cameras), we divided the number of independent photographs per species and estimated a detection rate per species. Independence of captures was considered in 30 minutes lapses, meaning that the same species detected in the same camera during 30-minutes lapses were considered as a single detection. Despite capture rates is not necessarily a direct measure of species abundance it is considered a good estimate of species frequency for comparison purposes, and has been proposed as a relative abundance index (González-Maya *et al.*2009). We did not perform any statistical analyses of the data and just directly compared these detection rates in order to provide an estimate of Pampas Cat frequency.

RESULTS

Of the 13 *aguadas* sampled, at least one pampas cat was detected at five different *aguadas* on six different occasions ranging in elevation from 38 to 461 m asl (mean = 228 ± 134 m asl; Figure 2A). Overall detection frequency for pampas cat was 0.004 ± 0.07 detections/trap day for all traps (Table 1) and 0.017 detections/trap day only considering the traps that captured the species. The species was detected during night and day, with four records between 2:00 and 4:00, two records between 9:00 and 11:00 and one record at 21:39. A pampas cat was also observed in Septe mber 2012 crossing a main road inside the protected area at 50 masl at 10:45 (Figures 1 and 2B).

In addition to pampas cat, seven other mammal species were detected: Andean or Culpeo fox *Pseudalopex culpaeus*, gray fox *P. griseus,* guanaco *Lama guanicoe*, Darwin's leaf-eared mouse *Phyllotis darwini*, olive grass mouse *Abrothrix olivaceus*, elegant fat-tailed mouse opossum *Thylamys elegans* and feral dogs. *P. griseus* was detected in all *aguadas*, followed by *L. guanicoe* and *P. darwini* (9 *aguadas* each). The most frequently detected species were *P. griseus* and *P. darwini* (2.10 ± 1.25 and 0.71 ± 1.93 detections/trap day, respectively). *P. griseus* was detected in all *aguadas* where pampas cat was detected, *L. guanaco* and *P. darwini* were each detected in 3 *aguadas* where pampas cats were detected, and the remaining four species were detected at 0–1 *aguadas* with pampas cats (Table 1).

FIGURE 2. *Leopardus colocolo* pictures in Llanos de Challe National Park, Atacama Desert, Chile. (A) camera trap detection (B) direct observation.

TABLE 1. Mammal species detection rates (number of detections/day) using remote cameras May–August 2012, Llanos de Challe National Park, Atacama Desert, Chile. *A: *Aguada*; Q: Creek: *Quebrada*; **ESN: Effective Sampling Nights.

Site name*	Elevation m asl	Longitude	Latitude	ESN**	*Abrothrix olivaceus*	*Lama guanicoe*	*Leopardus colocolo*	*Pseudalopex griseus*	*Pseudalopex culpaeus*	*Phyllotis darwini*	*Thylamys elegans*
A. Challe 4	325	-71°1'24.88"	28°13'45.15"	9	0	0.11	0	3.11	0	0.11	0
Q. Mina Oriente	226	-71°6'57.00"	28°8'4.09"	10	0	0	0	2.00	0	0.33	0
A. Puesto Uno	146	-71°5'43.70"	28°2'27.06"	9	0.22	0.11	0	1.89	0	1.00	0
A. Administración	130	-71°3'28.84"	28°9'29.69"	9	0.56	0.11	0	0.56	0.33	7.33	0.22
A. El Carrizo	93	-71°5'15.72"	28°7'4.35"	9	0.22	0	0	0.33	0	0.11	0
A. Las Cañas	124	-71°5'47.85"	28°8'3.04"	10	0	0	0	0.80	0	0	0
A. Fundición	461	-70°59'37.96"	28°14'9.97"	9	0	0	0.11	4.22	0	0	0
Q. La Higuera	38	-71°6'53.86"	28°2'35.20"	9	0	0	0.11	2.89	0	0	0
A. Hualtatas 2	209	-71°7'16.60"	28°12'32.19"	18	0	0.28	0.06	1.11	0	0.22	0
A. El Carrizo 1	135	-71°6'27.04"	28°6'54.81	9	0	0.22	0	3.33	0	0	0
Q. Algodones	519	-71°1'13.56"	28°5'49.78"	9	0	0.44	0	2.11	0	0.33	0
A. Los Pajaritos	330	-71°4'1.30"	28°2'28.61"	8	0	1.25	0.25	3.13	0	0.37	0
A. Rascamoños	186	-71°7'46.52"	28°11'36.78"	10	0	0.20	0.10	0.70	0	0.10	0
Total/Mean	139	0.07	0.34	0.04	2.10	0.02	0.71	0.02			
SD					0.16	0.58	0.07	1.25	0.09	1.93	0.06

DISCUSSION

The pampas cat is one of the least known cat species in the Americas (Nowell and Jackson 1996); thus, additional records through direct or remote observations represent important contributions to understanding species' distribution and habitat associations, considering that the occurrence of pampas cats in the Atacama Region is known only from unverified reports from the early 1900s (Valladares 2012). Although the species was previously related with desert ecosystems, we provide new data about the use of azonal vegetation with low surface coverage which we thought represent the most important source of resources, mainly water, in these arid environments, attracting most of the mammal species present in the deserts.

Our records increase the known elevational limits for the species for the North of the country, with only one record at 337 m asl, and the rest form 2,000 and above (García-Perea 1994), extending the elevational limit in lower coastal land from 38to 461 m asl. Also the latitudinal distribution of the specie is extend southward in the coastal zone from 29º58`S in Coquimbo Region (García-Perea 1994) to 28º1`S in the Atacama Region. In addition, we have confirmed the occurrence of pampas cat in a new vegetation association with low species diversity and extreme climatic conditions, expanding our understanding of the Pampas cat's potential ecological niche. Even when the species is considered common in most of its distribution range (Sunquist and Sunquist 2009), and this could explain the actual conservation status of the species; our reports give evidence of low relative abundance in extreme environments compare with other carnivores, and, at least, an occurrence relationship with a fragile and scarce wetland ecosystem, which all together show a potentially more delicate conservation status for the species in the Atacama Region of Chile.

Implications for conservation

The presence of the species in the *aguadas* highlights the importance of this wetland type in a desert ecoregion, where feeding and watering resources are scarce. The conservation of *aguadas* and the confirm presence of a new species in the mammal assemblage of the national park are relevant components to promote the conservation of the ecological interactions within this ecosystem. Also, these new records in low elevation coastal localities within the Atacama Desert represent a challenge for the protected area administration to better understand the ecology and habitat use of the pampas cat, to include it in the management zoning in order to take actions to reduce potential human-wild cats' conflicts and to improve conservations actions for the *aguadas*.

The local community surrounding the national park, represented by approximately 100 families, reported poultry predation attributed to foxes and feral dogs; however there is no evidence for these inferences, and wild cats can be contributing to this conflict and retaliations as it happens to foxes and dogs can be directed to pampas cats, so it is important to well inform the community, quantitatively measure conflict and improve practices within poultry production.

The potential of the species to be used as a conservation flagship for the national park and the region has to be assessed. We encourage conducting additional surveys for the pampas cat within the national park and adjacent areas to better estimate its distribution, habitat use, and threats, as well as the human perceptions of the species.

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