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ECOLOGY AND BEHAVIOR

Unraveling the ecological interactions: Exploring prey selection and human-wildlife conflicts in the diet of pumas (*Puma concolor*) in the highlands of the Tarapacá Region, Chile

Desentrañando interacciones ecológicas: Explorando la selección de presas y los conflictos entre humanos y vida silvestre en la dieta de los pumas (*Puma concolor*) en el altiplano de la Región de Tarapacá, Chile

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ABSTRACT

The puma (*Puma concolor*) is a top predator, known for its adaptability and opportunistic behavior. This study examines its diet in the highlands of the Tarapacá Region (Chile) based on fecal samples collected during two field campaigns conducted in July 2012 and January 2013 (a total of 60 days), aiming to determine the presence of domestic livestock in its diet and assess its preference compared to wildlife. A total of fifteen food items were identified, with the alpaca (*Vicugna pacos*) as the primary prey, representing 47 % of the relative biomass. In second place, lamb (*Ovis orientalis*) contributed 16 % of the total consumed biomass. Applying the Ivlev preference index, the results indicate a stronger selection for wildlife over domestic livestock. Although the puma's diet is diverse, as documented in North America and southern Chile, the highland puma of Tarapacá exhibits a specialization in artiodactyls.

Keywords: alpaca (*Vicugna pacos*), ecology, relative biomass, predation.

RESUMEN

El puma (*Puma concolor*) es un depredador tope, reconocido por su adaptabilidad y comportamiento oportunista. Este estudio analiza su dieta en el altiplano de la Región de Tarapacá (Chile) a partir de muestras fecales recolectadas en dos campañas de terreno realizadas en julio de 2012 y enero de 2013

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(60 días en total), con el objetivo de determinar la presencia de ganado doméstico en su alimentación y evaluar su preferencia frente a la fauna silvestre. Se identificaron quince ítems alimenticios, donde la alpaca (*Vicugna pacos*) fue la presa principal, representando el 47 % de la biomasa relativa. En segundo lugar, el cordero (*Ovis orientalis*) aportó 16 % de la biomasa total consumida. Al aplicar el índice de preferencia de Ivlev, los resultados indican una mayor selección por la fauna silvestre sobre el ganado doméstico. Aunque su dieta es variada, como se ha documentado en Norteamérica y el sur de Chile, el puma altiplánico de Tarapacá demuestra una especialización en artiodáctilos.

Palabras clave: alpaca (*Vicugna pacos*), ecología, oferta de presas, biomasa relativa

INTRODUCTION

Top predators play a fundamental role in maintaining healthy ecosystems by having the ability to modify the population number, behavior, and structure of prey communities (Bergstrom 2017). *Puma concolor* (Linnaeus, 1771) is considered an adaptable and opportunistic top predator (Logan and Sweanor 2024). For North America, artiodactyls usually make up more than 50 % of their diet (Guerisoli *et al.* 2021). In South America, it has been described that the importance in the diet of the artiodactyl puma is less, as the consumption of smaller prey increases (Pacheco *et al.* 2004, Fernández and Baldi 2014, Guerisoli *et al.* 2021).

It is indicated that in the extreme north of Chile (Arica and Parinacota region) the main food item corresponds to artiodactyls (Jury 2016). In the central mountain range, it is described that the diet is based almost exclusively on lagomorphs (Osorio *et al.* 2020). Rau and Jiménez (2002) reported that most of the puma's diet corresponds to the European hare (*Lepus europaeus* Pallas, 1778), followed by pudú (*Pudu puda* Molina, 1782), rodents, and birds in the rainforests of southern Chile. In contrast, in the southernmost part of the country, it has been described that artiodactyls account for 47% of the total biomass consumed by the puma (Fernández and Baldi 2014).

The highlands of the Tarapacá region present a significant variety of wildlife and there is an important presence of livestock maintained by Aymara communities, this being one of their main economic activities in the area (Oliveira and Pereira 2014, INE 2022). Livestock loss is the greatest source of conflict between humans and wild carnivores, and in some cases has caused loss of their historic range and local carnivore extinctions (Palmeira *et al.* 2015). Although it is true that the indigenous communities of the highlands have lived with the puma for centuries, the protection that this predator currently has accentuated the conflict, since they believe that these measures have caused an increase in the puma population (Oliveira and Pereira 2014).

Alternatively, the progressive abandonment due to emigration from the highlands to the cities may have led to a greater perception of the conflict, due to the fact that control over the herds has been gradually lost and most of the causes of death are attributed to the puma (De Lucca 2010).

In the high Andean ecosystems of the Tarapacá region, the puma encounters a diversity of prey, including both wildlife and domestic livestock. The coexistence of this predator with local communities has generated increasing conflict, as livestock farming remains one of the primary economic activities in the area. However, previous studies have suggested that large felines may exhibit preferences for certain types of prey depending on their availability and accessibility. In this context, it is crucial to determine the extent to which pumas select domestic livestock over wildlife.

The objective of this study is to analyze the diet of the puma in the highlands of the Tarapacá region through the examination of feces collected throughout the year 2012, aiming to identify the presence of domestic livestock as a food item. Additionally, the study evaluates whether the puma demonstrates a preference for domestic livestock compared to the available wildlife.

MATERIALS AND METHODS

The study area was located in the highlands of the extreme north of Chile, in the Tarapacá region. Specifically, from north to south it includes an axis that goes from the Parasijo wetland (19°3'0,65 South, 68°53'20 West) to the Michincha salt flat (20°59'31 South, 68°33'10 West), over 3500 m to the border with Bolivia, which represents 12 997 km^2.

According to Köeppen (Faúndez 2015) the study area develops two types of climates:

a) Marginal high-altitude desert: Between 3500 and 4000 m, with average annual temperatures that fluctuate between 0° and 10° C.

b) High-altitude steppe: Between 4000 and 5000 meters above sea level, with average annual temperatures that fluctuate between -5° and 5° C.

Rainfall oscillates between 250 and 300 mm per year, concentrating in the months of December to March and gradually decreasing towards the south, which is reflected in a longitudinal impoverishment of floristic richness (Henríquez 2013, Castro and Verdugo 2014, Faúndez 2015, Bonacic *et al.* 2015, Chavez *et al.* 2023).

The vegetation is present in azonal patterns associated with water resources. Shrubs and herbs predominate, normally not exceeding one meter in height. Among the characteristic plant species, the shrub known as tola (*Baccharis tola* Phil.) and paja brava (*Festuca orthophylla* Pilg.) stand out. In areas where water runoff is constant, there are rushes and grasses, highlighting pako (*Oxychloe andina* Phil.), junco (*Scirpus atacamensis* (Phil.) Buchenau), paco hembra (*Distichia muscoides* Nees & Meyen), puccinella (*Puccinellia frigida* (Phil.) Parodi), arenaria (*Arenaria rivularis* Phil.), and pasto salado (*Distichlis humilis* (Phil.) Hicken) (Faúndez 2015, Biganzoli *et al.* 2022). The *bofedales* correspond to high-altitude wetlands, typically found in arid and cold environments, with a permanent water supply. These can be divided according to rainfall abundance: the Bolivian and Peruvian Altiplano correspond to the humid puna, while the Chilean and Argentine Altiplano correspond to the dry puna (Castro and Verdugo 2014, Izquierdo *et al.* 2018). Consequently, the dry matter productivity in wetlands varies geographically. Thus, for Chile (Arica and Parinacota Region), it has been calculated at 1860 kg/ha, and for Peru (Puno Department) at 2040 kg/ha (Izquierdo *et al.* 2018, Turin 2019).

Regarding fauna, there is a significant variety of wild species, with important areas of concentration being the Isluga Volcano National Park and the Salar de Huasco National Park (Núñez *et al.* 1988). Among the most representative species are suri (*Pterocnemia pennata* d'Orbigny, 1834), puna tinamou (*Tinamotis pentlandii* Vigors, 1837), Chilean flamingo (*Phoenicopterus chilensis* Molina, 1782), vicuña (*Vicugna vicugna* Linnaeus, 1758), culpeo fox (*Lycalopex culpaeus* Molina, 1782), puna chingue (*Conepatus rex* Thomas, 1898), Andean cat (*Leopardus jacobita* Cornalia, 1865) and puma (*Puma concolor*) (Núñez *et al.* 1988, Bonacic *et al.* 2015). For the altiplanic communes of the Tarapacá region, livestock was made up of llamas (*Lama glama* Linnaeus, 1758), alpacas (*Vicugna pacos* Linnaeus, 1758), lambs (Ovis orientalis Gmelin, 1774) and donkeys (*Equus asinus* Heuglin & Fitzinger, 1866) (INE 2022).

During field campaigns conducted in July 2012 and January 2013 (a total of 60 days), puma feces were collected and identified using published reference guides, considering their size, morphology, and location (Fig. 1). The samples were georeferenced and stored in paper bags for subsequent laboratory analysis (Chame 2003, Márquez and Goldstein 2014, Alibhai *et al.* 2017, Osorio *et al.* 2020).

Based on the literature, a list of potential prey present in the area was made, which was used as a reference for the future comparison of hair, feathers, and bone remains (Table 1).

Once in the laboratory, the samples were heated to 70°C using an industrial gas oven for three hours, ensuring proper drying. Subsequently, they were submerged in soapy water for at least 24 hours to loosen organic residues. After this period, the samples were thoroughly washed using fine mesh strainers appropriate for laboratory analysis, ensuring the removal of remaining debris. Finally, they were subjected again to 70°C in the industrial gas oven for two to three hours to complete the dehydration process (Osorio *et al.* 2020). For the microscopic description of the hair, photographs of the medulla-bark pattern and the scale pattern imprinted on a layer of enamel were taken using a Samsung ES10 digital camera (Chehébar and Martín 1989). The dental pieces were identified based on published keys (Reise 1973, Fernandez *et al.* 2011, Elbroch and Wittmer 2013, Duclos *et al.* 2024). Samples in which species identification was not possible were discarded from the analysis (Osorio *et al.* 2020).

The results are presented as:

Percent Occurrence (PO): Number of times a specific item (prey) was identified as a percentage of all items found. Indicator of the relative frequency with which each item is consumed (Castillo *et al.* 2020).

Relative biomass (BR): This variable indicates in a correct manner the percentage of the carnivore diet that a particular prey represents as a percentage of the total biomass consumed.

The Ackerman equation corrects the frequency of occurrence by a "Y" factor for the case of prey with an average body weight greater than one kilogram. This variable indicates in a correct way the percentage of the carnivore diet that a particular prey represents as a percentage of the total biomass consumed. The consumed biomass whose average weight is greater than one kilogram is calculated using the following formula:

$$BMi = FOi * (1.98 + 0.35Xi)$$

Where: BMi is the contribution of item *i* to the consumed biomass, *FOi* is the frequency of occurrence of item *i* and Xi is the average weight in kg of an individual of item *i*.

Food items weighing less than one kilogram are calculated with the following formula:

$$BMi = FOi * X i$$

Where: BMi is the contribution of item *i* to the consumed biomass, FOi is the frequency of occurrence of item *i* and *Xi* is the average weight in kg of an individual of item *i*.

The relative biomass of each item is calculated using the following formula:

Figure 1. Puma feces on the vegetation (*Baccharis tola* Phil.), in the areas bordering the Arabilla lagoon, Isluga Volcano National Park.

Table 1. List of potential prey species for the puma in the study area (Núñez *et al.* 1988, Bonacic *et al.* 2015).

Class	Order	Species
Mammalia	Carnivora	*Leopardus colocolo* (Molina, 1782)
		Leopardus jacobita (Cornalia, 1865)
		Lycalopex culpaeus (Molina, 1782)
		Galictis cuja (Molina, 1782)
		Conepatus rex (Thomas, 1898)
	Artiodactyla	*Lama glama* (Linnaeus, 1758)
		Vicugna vicugna (Linnaeus, 1758)
		Vicugna pacos (Linnaeus, 1758)
		Ovis orientalis (Gmelin, 1774)
		Equus asinus (Heuglin & Fitzinger, 1866)
	Cingulata	*Chaetophractus nationi* (Thomas, 1894)
	Rodentia	*Lagidium viscacia* (Molina, 1782)
	Lagomorpha	*Abrocoma cinerea* (Thomas, 1919)
Aves	Struthioniformes	*Eligmodontia puerulus* (Philippi, 1896)
	Phoenicopteriformes	*Auliscomys sublimis* (Thomas, 1902)
	Anseriformes	*Phyllotis darwini* (Waterhouse, 1837)
	Tinamiformes	*Phyllotis xanthopygus* (Waterhouse, 1837)

$$BR_i = \frac{BM_i}{\sum_1^i \quad BM_i}$$

Finally, the results obtained in diet were compared with results from transects carried out in the same study area (Leichtle 2013) in order to compare use (consumption) vs availability, using the Ivlev preference index (Muñoz and Simonetti 2013, Kalb *et al.* 2018, Geisa *et al.* 2018).

$$Ei = [r(i) - p(i)] / [r(i) + p(i)]$$

Where: $r_{(i)}$: Quantity (proportion) of records in each type of environment and $p_{(i)}$: Proportion of camera traps in each type of environment. Positive values indicate selection in favor of the item while negative values show rejection, considering -0.3 to 0.3 as indifference (Muñoz and Simonetti, 2013).

RESULTS

34 feces attributable to pumas were collected, none of which were fresh. Once in the laboratory, nine of these were discarded as they did not meet identification criteria. Of the remaining 25, coming from six different locations (Table 2), it was possible to identify fifteen different food items, which were analyzed using the Ackerman equation (Table 3).

In terms of relative biomass, the main food item corresponds to the artiodactyl order, representing 76 % of it, highlighting the presence of *V. pacos* with 47 % of the total relative biomass, while *O. orientalis* is in second place with 16 %. The second order of importance as a food item is made up of rodents, with a total relative biomass of 15.7 %, being the vizcacha (*Lagidium viscacia* Molina, 1782), with 13 % of total relative biomass, corresponding to the most important rodent in the cougar diet. When categorizing the biomass consumed according to weight into "large" (greater than 50 kg), "medium" (49 to 5 kg) and "small" (less than 5 kg), 76 % is made up of animals in the large category, not finding any food item in the "medium" category.

When categorizing the biomass consumed into "domestic" (domestic livestock) and "wild" (wild fauna), 71 % corresponded to domestic livestock.

Table 2. Species identified in feces collected in the study area.

Sample	Comunne	Locality	MSNM	UTM		Identified species
A-01	Colchane	Ancollo	4035	513387	7871867	*Vicugna pacos*
A-02	Colchane	Aravilla	4115	516582	7875942	*Lagidium viscacia*
A-03	Colchane	Ancollo	4085	513157	7872661	*Vicugna pacos*
A-04	Colchane	Ancollo	4056	513490	7872811	*Vicugna pacos*
A-06	Colchane	Ancollo	4034	513991	7871613	*Vicugna pacos*
A-07	Colchane	Angostura	4080	518062	7875360	*Vicugna pacos*
A-08	Colchane	Angostura	4080	518062	7875360	*Abrocoma cinerea, Phyllotis sp*
A-09	Colchane	Angostura	4080	518062	7875360	*Abrocoma cinerea, Phyllotis sp, Eligmondontia puerulus*
A-10	Colchane	Angostura	4080	518062	7875360	Pelecaniforme*
A-11	Colchane	Angostura	4080	518062	7875360	*Vicugna pacos*
A-12	Colchane	Angostura	4091	518052	7875379	Tinamiforme, Pelecaliforme*
A-13	Colchane	Angostura	4091	518052	7875379	*Phyllotis sp.*
A-14	Colchane	Angostura	4091	518052	7875379	*Lagidium viscacia*, Anseriforme*
A-15	Colchane	Ancollo	4100	513392	7871863	*Liolaemus sp*
A-16	Colchane	Ancollo	4100	513392	7871863	*Ovis orientalis, Lagidium viscacia*
A-17	Colchane	Aravilla	4105	518062	7875360	*roedor sp*
B-01	Pica	Sillajuay	4715	534719	7811400	*Thylamys pallidior, Akodon sp.*
B-02	Pica	Sillajuay	4703	534725	7811494	*Ovis orientalis, Lagidium viscacia*
B-03	Pica	Sillajuay	4715	534719	7811400	*Lagidium viscacia*
B-04	Pica	Cancosa	3929	541760	7803556	*Ovis orientalis*
B-05	Pica	Sillajuay	4703	534725	7877494	*Vicugna pacos, Galictis cuja*
N-01	Colchane	Ancollo	4026	514170	7871480	*Vicugna vicugna*
N-03	Colchane	Cariquima	3747	537116	7851424	*Eligmondontia puerulus*
N-04	Colchane	Ancollo	4023	514143	7871478	*Lama glama*
N-06	Colchane	Ancollo	4070	514060	7871514	*Vicugna pacos*

Table 3. Calculation of relative biomass of prey consumed by puma in the highlands of the Tarapacá region.

Food item	n° of stools	PO	Correction factor	BR
Bird*				
Pelecaniforme	2	4 %	0,55	14,0 %
Tinamiforme	1	2 %	0,7	0,9 %
Anseriforme	1	2 %	2.06	2,7 %
Mammal				
Artiodactyl				
Vicugna pacos	8	17 %	4,43	47,0 %
Vicugna vicugna	1	2 %	3,73	4,9 %
Lama glama	1	2 %	6,53	8,6 %
Ovis orientalis	3	6 %	4,08	16,0 %
Carnivora				
Galictia cuja	1	2 %	2,06	2,7 %
Marsupial				
Thylamys pallidior	1	2 %	0,02	0,0 %
Rodent				
Lagidium viscacia	5	10 %	2,03	13,0 %
Abrocoma cinerea	2	4 %	0,24	0,6 %
Eligmodontia puerulus	2	4 %	0,02	0,1 %
Auliscomys sublimis	1	2 %	0,03	0,1 %
Galenomys garleppi	1	2 %	0,05	0,1 %
Phyllotis darwini	1	2 %	0,05	0,1 %
Phyllotis xanthopygus	1	2 %	0,05	0,1 %
Phyllotis sp.	4	8 %	0,05	0,20 %
Unidentified	9	19 %	0,04	0,4 %
Reptiles				
Lialoemus sp.	1	2 %		0,0 %

*In the case of birds, it was only possible to identify species up to the order category.

Using the Ivlev preference index, the results of dietary preference obtained in depositions were compared with the availability of prey observed through transects as kg of biomass (Leichtle 2013). The results indicate a preference for the vizcacha (1.0), followed by vicuña (0.64), birds (0.61), alpaca (0.53) and lamb (0.48), while showing rejection for the llama (- 0.80) (Table 4).

Table 4. Ivlev preference index for puma diet in the highlands of the Tarapacá region.

	% Biomass diet	Frequency (pi)	pi²	% Availability	Ivlev preference index
Bird	5,1 %	0,05	0,0025	1,2	0,61
Vicugna pacos	47,0 %	0,47	0,2209	14,3	0,53
Vicugna vicugna	4,9 %	0,049	0,002401	1,1	0,64
Lama glama	8,60 %	0,086	0,007396	77,0	-0,80
Ovis orientalis	16 %	0,16	0,0256	5,6	0,48
Longidium viscacia	13 %	0,13	0,0169	0,0	1,0
Others	5,40 %	0,05	0,0025	0,8	0,74

DISCUSSION

The most consumed prey items by pumas do not necessarily correspond to the most abundant ones, reaffirming their selective behavior and suggesting consumption decisions based on factors such as prey size, accessibility, and vulnerability (Kalb *et al.* 2018). The analysis of 25 fecal samples identified a trophic niche composed of fifteen food items, a higher number than previously reported for central and southern Chile (Elbroch and Wittmer 2013, Osorio *et al.* 2020). This may be attributed to the faunal richness of the Tarapacá highlands and the diverse availability of both wild and domestic prey.

Within the rodent group, a notable difference was observed between *L. viscacia*, which accounted for 13 % of the relative biomass, and other rodent species, whose individual contributions did not exceed 1 %. This pattern is comparable to that documented by Rau and Jiménez (2002) for southern Chile, where *Myocastor coypus* (Molina, 1782) showed a significantly greater contribution to the puma's diet compared to cricetid species. Such a difference can be explained by the selection of larger prey, as rodents like the vizcacha and other caviomorphs exceed 2–3 kg, whereas cricetids rarely surpass 100 g (Pessino *et al.* 2001).

In this context, the absence of *Chinchilla chinchilla* (Lichtenstein, 1829) in the results is consistent with expectations. Although it was historically distributed in northern Chile, there are currently no reliable records of its presence in the highlands of the Tarapacá Region. Therefore, its absence in this study aligns with its extremely restricted distribution and critically endangered conservation status (Valladares *et al.* 2018).

Regarding artiodactyls, pumas show a clear preference for large-sized prey. *V. pacos* accounted for 47 % of the relative biomass consumed, followed by *O.orientalis* with 16 %. Despite *L. glama* being the most abundant in terms of availability (77 %), the Ivlev preference index indicates a marked avoidance (-0.80). This finding is especially noteworthy when compared to the study by Villalobos Aguirre (2008) in the Parinacota Province, where pumas showed a strong preference for *V. vicugna* over domestic species. In the present study, the proportion of vicuñas consumed was low (4.9 % of the relative biomass), which may be explained by their low local abundance in Tarapacá, as 95 % of the national population is located in the Arica and Parinacota Region (Arzamendia and Vilá 2015).

It is also worth noting that, although both vicuñas and llamas were detected, no guanacos (*Lama guanicoe* Müller, 1776) were recorded—another wild camelid that might be expected in high Andean ecosystems. This absence could be due to their low local density, a more southern distribution, or a preference for lower altitudes, where climatic conditions and vegetation availability are more favorable. This altitudinal difference limits the possibility of comparison with this species, despite its ecological and conservation relevance.

This pattern suggests that, although pumas do consume domestic livestock, this does not necessarily indicate active preference, but rather an opportunistic response to available resources. The gradual abandonment of traditional herding by Aymara communities has resulted in unsupervised livestock, making them more susceptible to predation. Additionally, the loss of anti-predatory behaviors in domestic llamas and alpacas, due to domestication, could explain the multiple-animal attacks documented in other studies (Miller and Schmitz 2019).

Finally, it is acknowledged that the sample size (n = 25) limits the generalization of the results and reduces the capacity to detect rare prey items. Despite the field effort invested, factors such as low puma density, extreme climatic conditions, and natural decomposition of feces complicated their detection. Therefore, it is recommended that future studies increase sampling effort both spatially and temporally and incorporate complementary methods such as camera traps, genetic analysis of feces, or stable isotope studies.

CONCLUSIONS

The trophic analysis of pumas in the highlands of the Tarapacá Region confirms their tendency to specialize in large-bodied prey, particularly artiodactyls, consistent with patterns observed in other parts of Chile and the Americas. Despite the presence of a wide variety of potential prey, including both wild and domestic species, pumas exhibited selective feeding behavior rather than opportunistic consumption based solely on availability.

Although domestic livestock was present in the diet, this appears to be a consequence of its abundance and vulnerability rather than a true dietary preference. Factors such as the abandonment of traditional herding practices and the reduced anti-predatory behavior of domestic species likely facilitate these predation events.

These findings underscore the importance of considering ecological, behavioral, and socio-cultural contexts when evaluating human-wildlife conflicts. They also highlight the need to strengthen coexistence strategies and promote responsible livestock management in areas where large carnivores persist.

AUTHOR CONTRIBUTIONS

JL conceived and designed the study, conducted fieldwork, performed data analysis, and wrote the first draft of the manuscript. CB contributed to the study design, provided guidance during data analysis, and critically revised the manuscript.

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LITERATURE CITED

Alibhai S, Jewell Z, Evans J. 2017. The challenge of monitoring elusive large carnivores: An accurate and cost-effective tool to identify and sex pumas (*Puma concolor*) from footprints. *PLoS ONE*. 12(3): e0172065. https://doi.org/10.1371/journal.pone.0172065

Arzamendia Y, Vilá B. 2015. Vicugna habitat use and interactions with domestic ungulates in Jujuy, Northwest Argentina. *Mammalia*. 79(3):267–278. https://doi.org/10.1515/mammalia-2013-0173

Bergstrom B. 2017. Carnivore conservation: Shifting the paradigm from control to coexistence. *Journal of Mammalogy*. 98(1):1–6. https://doi.org/10.1093/jmammal/gyw185

Biganzoli F, Oyarzabal M, Teillier S, Zuloaga F. 2022. Fitogeografía de la provincia Altoandina del Cono Sur de Sudamérica. *Darwiniana, Nueva Serie*. 10(2):537–574. https://doi.org/10.14522/darwiniana.2022.102.1043

Bonacic C, Leichtle J, Ohrens O. 2015. *El puma del altiplano de Tarapacá*. Santiago, Chile: Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile.

Castillo D, Arbeláez P, Arias H, Ramírez H. 2020. Food habits of the cougar *Puma concolor* (Carnivora: Felidae) in the central Andes of the Colombian coffee region. *Papéis Avulsos de Zoologia*. 60:e20206023. https://doi.org/10.11606/1807-0205/2020.60.23

Castro R, Verdugo C. 2014. Análisis de la tendencia histórica de vegetación azonal hídrica sector Quebrada de Villalobos: Altiplano Región de Atacama. Santiago, Chile: Servicio Agrícola y Ganadero (SAG).

Chame M. 2003. Terrestrial mammal feces: A morphometric summary and description. *Memórias do Instituto Oswaldo Cruz*. 98(1):71–94. https://doi.org/10.1590/S0074-02762003000100011

Chávez R, Meseguer O, Olea M, Calderón M, Yager K, Meneses R, Prieto M. 2023. Andean peatlands at risk? Spatiotemporal patterns of extreme NDVI anomalies, water extraction, and drought severity in a large-scale mining area of Atacama, northern Chile. *International Journal of Applied Earth Observation and Geoinformation*. 116:103138. https://doi.org/10.1016/j.jag.2022.103138

Chehébar C, Martín S. 1989. Guía para el reconocimiento microscópico de los pelos de los mamíferos de la Patagonia. *Acta Vertebrata*. 16:241–291.

De Lucca E. 2010. Presencia del puma (*Puma concolor*) y conflicto con el hombre en las pampas argentinas. *Nótulas Faunísticas (2da serie)*. 48:1–17.

De Oliveira T, Pereira J. 2014. Intraguild predation and interspecific killing as structuring forces of carnivoran communities in South America. *Journal of Mammalian Evolution*. 21(4):427–436. https://doi.org/10.1007/s10914-013-9251-4

Duclos M, Silva C, Silva E, Jaksic F. 2024. *Cráneos y pelos: guía de identificación de mamíferos chilenos*. Santiago, Chile: CAPES UC.

Elbroch L, Wittmer H. 2013. The effects of puma prey selection and specialization on less abundant prey in Patagonia. *Journal of Mammalogy*. 94(2):259–268. https://doi.org/10.1644/12-MAMM-A-041.1

Faúndez A. 2015. Caracterización florística de las formaciones de vegetación de la Región de Tarapacá [Memoria de título]. Santiago, Chile: Facultad de Ciencias Agronómicas, Universidad de Chile.

Fernández F, Ballejo F, Moreira G, Tonni E, De Santis L. 2011. Roedores cricétidos de la Provincia de Mendoza: guía cráneodentaria orientada para su aplicación en estudios zooarqueológicos. Buenos Aires, Argentina: Sociedad Argentina de Antropología.

Fernández C, Baldi R. 2014. Hábitos alimentarios del puma (*Puma concolor*) e incidencia de la depredación en la mortandad de guanacos (*Lama guanicoe*) en el noreste de la Patagonia. *Mastozoología Neotropical*. 21(2):331–338.

Geisa M, Dottori N, Cosa M. 2018. Dieta de guanaco (*Lama guanicoe*) en el Chaco Árido de Córdoba, Argentina. *Mastozoología Neotropical*. 25(1):59–80. https://doi.org/10.31687/saremMN.18.25.1.0.07

Guerisoli M, Luengos E, Caruso N, Giordano A, Lucherini M. 2021. Puma–livestock conflicts in the Americas: A review of the evidence. *Mammal Review*. 51(2):228–246. https://doi.org/10.1111/mam.12227

Henríquez G. 2013. Caracterización de humedales altoandinos para una gestión sustentable de las actividades productivas del sector norte del país: condición ambiental y vulnerabilidad de humedales muestra. XV Región Arica y Parinacota. Santiago, Chile: Centro de Documentación de Recursos Naturales.

Instituto Nacional de Estadísticas (INE). 2022. VIII Censo nacional agropecuario y forestal. Resultados finales del VIII Censo Nacional Agropecuario y Forestal (CAF 2021). Santiago, Chile: INE.

Izquierdo A, Aragón M, Navarro C, Casagranda M. 2018. La puna argentina: naturaleza y cultura. En: Grau HR, editor. *Humedales de la puna: principales proveedores de servicios ecosistémicos de la región*. Tucumán, Argentina: Fundación Miguel Lillo; p. 96–111.

Jury P. 2016. Caracterización de las interacciones entre la ganadería camélida doméstica y depredadores silvestres en la provincia de Parinacota, Región de Arica y Parinacota [Memoria de título]. Santiago, Chile: Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile.

Kalb D, Bowman J, DeYoung R. 2018. Dietary resource use and competition between white-tailed deer and introduced sika deer. *Wildlife Research*. 45(5):457–472. https://doi.org/10.1071/WR17166

Leichtle J. 2013. Oferta de presas, dieta y densidad de puma (*Puma concolor*) en el altiplano de la región de Tarapacá, Chile [Tesis de Magíster]. Santiago, Chile: Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile.

Logan K, Sweanor L. 2024. Cougar (*Puma concolor*). En: Wild carnivores of New Mexico. Albuquerque, USA: University of New Mexico Press.

Márquez R, Goldstein I. 2014. Manual para el reconocimiento y evaluación de eventos de depredación de ganado por carnívoros silvestres. Bogotá, Colombia: Wildlife Conservation Society.

Miller J, Schmitz O. 2019. Landscape of fear and human-predator coexistence: Applying spatial predator-prey interaction theory to understand and reduce carnivore-livestock conflict. *Biological Conservation*. 236:464–473. https://doi.org/10.1016/j.biocon.2019.05.021

Muñoz A, Simonetti J. 2013. Diet of guanaco in sheep-free rangeland in Tierra del Fuego, Chile. *Ciencia e Investigación Agraria*. 40:185–191. https://doi.org/10.4067/S0718-16202013000100016

Núñez E, Araya P, Salinas J. 1988. Plan de manejo Parque Nacional Volcán Isluga. Arica, Chile: Corporación Nacional Forestal.

Osorio C, Muñoz A, Guarda N, Bonacic C, Kelly M. 2020. Exotic prey facilitate coexistence between pumas and culpeo foxes in the Andes of central Chile. *Diversity*. 12(12):3171. https://doi.org/10.3390/d12120317

Pacheco L, Lucero A, Villca M. 2004. Dieta del puma (*Puma concolor*) en el Parque Nacional Sajama, Bolivia y su conflicto con la ganadería. *Ecología en Bolivia*. 39:75–83.

Palmeira F, Trinca C, Haddad C. 2015. Livestock predation by puma (*Puma concolor*) in the highlands of a southeastern Brazilian Atlantic Forest. *Environmental Management*. 56:903–915. https://doi.org/10.1007/s00267-015-0553-6

Pessino M, Sarasola J, Wander C, Besoky N. 2001. Respuesta a largo plazo del puma (*Puma concolor*) a una declinación poblacional de la vizcacha (*Lagostomus maximus*) en el desierto del Monte, Argentina. *Ecología Austral*. 11(2):61–67.

Rau J, Jiménez J. 2002. Diet of puma (*Puma concolor*, Carnivora: Felidae) in coastal and Andean ranges of southern Chile. *Studies on Neotropical Fauna and Environment*. 37(3):201–205. https://doi.org/10.1076/snfe.37.3.201.8569

Reise D. 1973. Clave para la determinación de los cráneos de marsupiales y roedores chilenos. *Gayana: Zoologica*. 27:3–20.

Turin C. 2019. Perceptions of rangeland degradation and its causes in the Peruvian Altiplano dry puna [Tesis de Doctorado]. Columbia, USA: University of Missouri-Columbia.

Villalobos Aguirre R. 2008. Hábitos predatorios del puma (*Puma concolor*) y su impacto en la ganadería de la provincia de Parinacota, Región de Arica y Parinacota, Chile [Tesis de pregrado]. Santiago, Chile: Facultad de Ciencias Veterinarias y Pecuarias, Universidad de Chile.

Valladares P, Spotorno A, Cortés M, Zuleta C. 2018. *Chinchilla chinchilla* (Rodentia: Chinchillidae). *Mammalian Species*. 50(960):51–58. https://doi.org/10.1093/mspecies/sey007