

# Proposal to list the Peruvian tuco-tuco (*Ctenomys peruanus*, Ctenomyidae, Rodentia) as a critically endangered species

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**Abstract.** Medina CE, Medina YK, Bocardo EF. 2024. Proposal to list the Peruvian tuco-tuco (*Ctenomys peruanus*, Ctenomyidae, Rodentia) as a critically endangered species. *Biodiversitas* 25: 5005-5011. The Peruvian tuco-tuco, *Ctenomys peruanus* Sanborn and Pearson 1947, is a subterranean rodent endemic to High Andes of southern Peru. This rodent is historically known by four record localities dating back to the 1950s, and a fifth locality in 2011, all based on specimens housed in natural history museums, is now facing a critical situation. Recent surveys in 17 localities in Arequipa, Moquegua, Tacna, and Puno regions revealed the local extinction of *C. peruanus* at previously recorded sites while identifying two new localities; however, currently, the species only lives in one locality (Callacami, Puno). This remaining population of fewer than 50 mature individuals is under intense hunting pressure for human consumption and traditional medicinal practices, and it is experiencing a continuous loss of the extension and quality of its habitat due to overgrazing and agricultural expansion. Our research is the first effort to fill a 72-year gap with no field data for *C. peruanus*. Therefore, we propose to categorize *C. peruanus* as a Critically Endangered species (CR) according to the criteria established by the International Union for Conservation of Nature's Red List of Threatened Species. The authorities and academic community are urged to join efforts to curb the aforementioned anthropogenic threats and devise and implement management and conservation plans for *C. peruanus* in Peru.

**Keywords:** Conservation, endemic, extinction, human-wildlife conflict, remanent population

## INTRODUCTION

Some studies indicate that anthropogenic activities are the first cause of mammalian extinctions, particularly in the Americas and Australia, due to human colonization in these regions (Andermann et al. 2020). For this reason, some species of fauna, rare or endemic, are currently at risk of extinction, which means that they are quickly included in lists of globally threatened species (Dunnum et al. 2016; Zeballos and Vivar 2016a; Zeballos and Vivar 2016b; Teta and D'Elía 2019). For instance, the saola *Pseudoryx nghetinhensis* Dung, Giao, Chinh, Tuoc, Arctander and MacKinnon 1993 (Dung et al. 1993), a species endemic to the Annamite Mountains range of Vietnam and Lao People's Democratic Republic (Lao PDR), which was described in 1993 and currently listed as a Critically Endangered species (Phommachanh et al. 2020). Another example is the Annamite striped rabbit *Nesolagus timminsi* Averianov, Abramov and Tikhonov 2000 a species that occur at low and medium altitudes in the northern and central Annamite Mountains along Vietnam and Lao PDR border, which was described in 2000, currently listed as Endangered species (Tilker et al. 2020).

South American subterranean rodents, tuco-tuco, mainly belong to the genus *Ctenomys* (Rodentia, Ctenomyidae, tuco-tuco), a monotypic and highly diverse genus of rodents with at least 68 recognized species (Brook et al. 2024; Contreras et al. 2024). *Ctenomys* rodents generate a great concern because 78% of its species are threatened, 47 have little or no overlap in their spatial distribution with protected natural areas, and 33 have been reported from three or

fewer localities, highlighting the need for their conservation (Caraballo et al. 2023).

The diversity of Peruvian mammals is currently estimated to be at 590 species (Jefferson et al. 2015; Pacheco et al. 2021; Medina et al. 2023; Pacheco and Ruelas 2023; Voss et al. 2024; Pacheco et al. 2024) and 92 of these are included in the list of threatened wildlife species legally protected by the Peruvian State (MINAGRI 2014). Notably, all species of the genus *Ctenomys* that inhabit Peru are classified as threatened species under the Peruvian law: the White-toothed tuco-tuco, *Ctenomys leucodon* Waterhouse 1848 is categorized as Critically Threatened (CR); the Peruvian tuco-tuco, *Ctenomys peruanus* Sanborn and Pearson 1947 is Endangered (EN); and the highland tuco-tuco, *Ctenomys opimus* Wagner 1848 is Vulnerable (VU). MINAGRI (2014) considers that the main threat to *Ctenomys* from Peru is the probability of environmental changes (e.g., climatic changes or environmental modification by urbanization and agricultural development) occurring in their range that would lead to a decline or local extinction of small populations.

International Union for Conservation of Nature's Red List of Threatened Species (IUCN) listed *C. leucodon*, *C. opimus*, and *C. peruanus* as Least Concern species, considering that their populations are stable and there appear to be no major threats to these species (Dunnum et al. 2016; Zeballos and Vivar 2016a; Zeballos and Vivar 2016b). Likewise, they state that *C. leucodon* is sometimes used for traditional medicinal purposes (Zeballos and Vivar 2016b), and *C. peruanus* had been locally threatened at some sites through persecution as a pest of grazing land.

However, the authors need to be made aware of the degree of threat posed by measures (Zeballos and Vivar 2016a).

The information available about the natural history of *Ctenomys* in Peru dates to 1952 (Sanborn and Pearson 1947; Pearson 1951; Pearson 1959); since then, more needs to be made to understand its diversity, ecology, and conservation status as a whole. Therefore, to address this knowledge gap, we carried out field surveys in the Andes from southern Peru in 2023 and 2024, with the purpose of updating the distribution maps of *Ctenomys* species that occur in Peru. Here, we document the current distribution and conservation status of *C. peruanus*, a species that is, unfortunately, reducing its limited geographic range in southern Peru.

## MATERIALS AND METHODS

### Study area

The research was carried out in the Andean Puna from southern Peru during October and November 2023 and May 2024. That puna is dry and characterized by shrubs, dwarf shrubs, tussock grasses, annual herbs, and ferns. It is being affected by grazing, predominantly *Vicugna pacos* Linnaeus 1758 and *Lama glama* Linnaeus 1758 (Duchicela et al. 2024).

Seventeen localities were visited to search for *C. peruanus* populations in the Arequipa, Moquegua, Tacna y Puno regions, which were selected based on an extensive bibliographic review of the geographical distribution of *Ctenomys* spp. from Peru (Sanborn and Pearson 1947; Pearson 1951; Pearson 1959; Bidau 2015; Freitas 2016) and data on specimens deposited in the Museo de Historia

Natural de la Universidad Nacional de San Agustín de Arequipa, Peru (MUSA) (Figure 1).

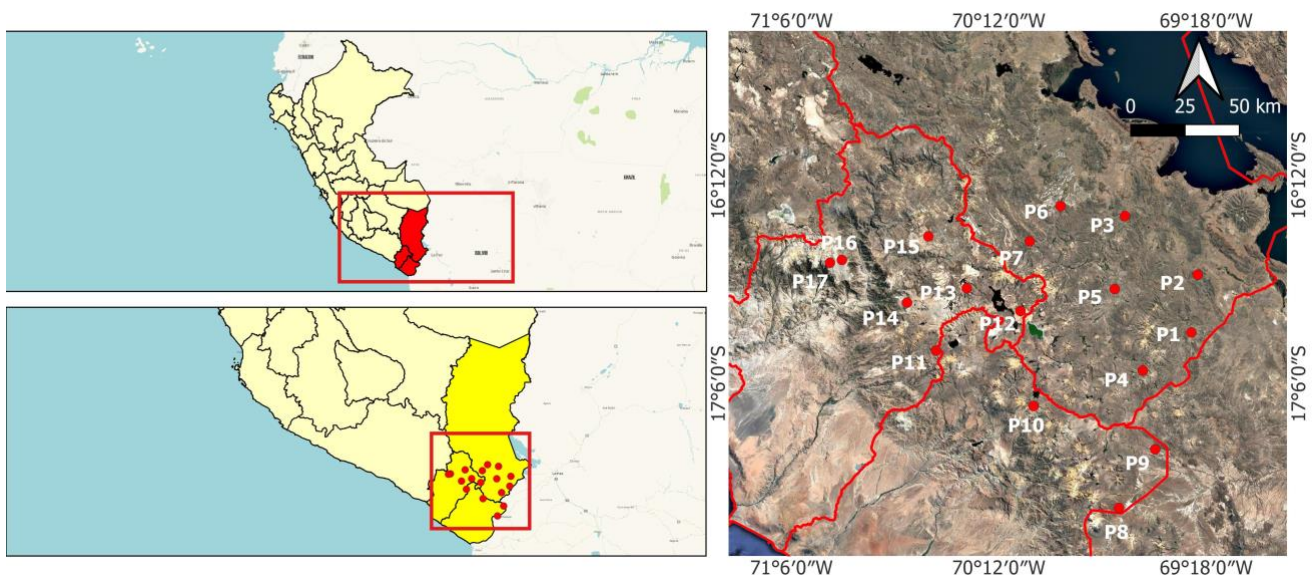
### Data collection

The field sampling was carried out in a radius of 15 km around each locality named in the literature and museum vouchers. Preferably, this was in areas of sparse vegetation with loose sandy, gravelly, and clayey soils between 3,700 and 5,000 meters above sea level (m.a.s.l.) (Sanborn and Pearson 1947; Pearson 1951; Pearson 1959).

We used 40 live traps by locality, 20 jaw spreads covered with silicone tubes, and 20 tubes and those were placed at the entrance of burrows that showed recent activity by *Ctenomys* spp. (O'Brien et al. 2020). The traps were activated for five hours per locality and checked every 20 minutes. The specimen captured was measured, weighed, sexed, and photographed for taxonomic identification following the morphological characters and taxonomic key reported by Sanborn and Pearson (1947), Pearson (1951), Pearson (1959), Bidau (2015), and Freitas (2016).

Line transects were used to assess the abundance of *C. peruanus* by counting the number of individuals observed and/or heard (Crum et al. 2021). Pearson (1959) noted that *C. peruanus* is the only species of *Ctenomys* from Peru that vocalizes conspicuously. The sound is reminiscent of liquid poured from a glass bottle.

In addition, we conducted unstructured interviews with local residents to obtain information on potential areas with Peruvian tuco-tuco presence and documented the potential threats for the species in each locality visited (Young et al. 2018).



**Figure 1.** Location of sampling sites of *Ctenomys* spp. from southern Peru: P1, Pizacoma (16°52'40"S, 69°21'51"W); P2, Huacullani (16°37'40"S, 69°20'15"W); P3, Sorapa (16°22'25"S, 69°39'8"W); P4, Chontacollo (17°02'29"S, 69°34'27"W); P5, Mazocruz (16°41'22"S, 69°41'52"W); P6, Ampaturi (16°19'53"S, 69°55'55"W); P7, Aguas Calientes (16°29'04"S, 70°03'57"W); P8, Laguna Blanca (17°38'04"S, 69°40'42"W); P9, Tripartito (17°22'56"S, 69°31'16"W); P10, Vilacota (17°11'44"S, 70°02'55"W); P11, Asana (16°57'21"S, 70°28'21"W); P12, Pasto Grande (16°47'05"S, 70°06'18"W); P13, Achacala (16°41'08"S, 70°20'21"W); P14, Volcan Ticsani (16°44'53"S, 70°35'53"W); P15, Chancolle (16°27'42"S, 70°30'20"W); P16, Volcan Huaynaputina (16°33'49"S, 70°52'51"W); and P17, Omate (16°34'33"S, 70°55'57"W)

### Data analysis

The coordinates of *C. peruanus* records and interview data were used as input parameters to assess this species' extinction risk following the criteria established by the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (Betts et al. 2020).

The evaluation considered the following criteria: population size reduction, geographic distribution assessed using the extent of occurrence (EOO) and/or area of occupancy (AOO) with the help of the GeoCAT tool (Cazalis et al. 2022), small population size and its decline, very small or restricted population, and quantitative analysis of extinction risk.

## RESULTS AND DISCUSSION

### Records of *Ctenomys peruanus*

Our literature review was able to identify four historical record localities for *Ctenomys peruanus* and a fifth locality based on museum vouchers deposited in 2011 (Table 1). Two additional localities were found in our fieldwork. Moreover, we confirmed that *C. peruanus* only lives in one locality: Callacami, El Collao, Puno (Figure 2). Currently, there are less than 50 mature individuals of *C. peruanus* inhabiting an elevation of 4,075 m.a.s.l. in clayey soils of flat lands in the high-Andean puna habitat. Likewise, this remnant population grazing area shared with cows, sheep, and domesticated camelids.

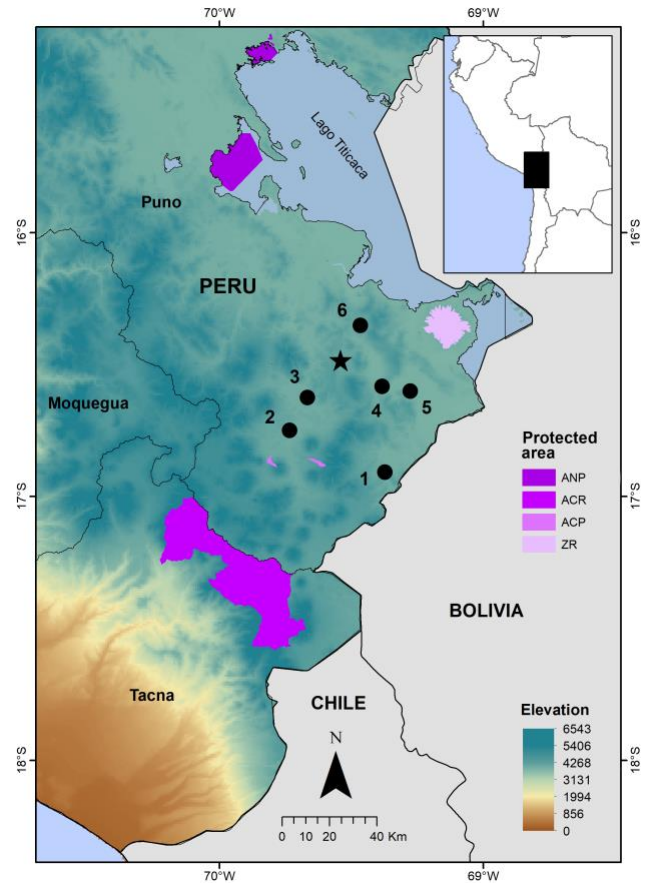
One specimen of *C. peruanus* was captured in Callacami, an adult female with the following external measurements: total length 285 mm, body length 200 mm, tail 85 mm, hindfoot 38 mm, ear 9 mm, and weight 280 g. The specimen displays the following diagnostic characteristics: back, sides, and belly colored creamy buff, heavily lined in black to give an overall brown tone; nose, lips, ears, and surrounding fur dark brown; hindfeet brown above; forefeet the same color as body; and tail tawny. In general, the specimen was quite similar to those described as *C. peruanus* by Sanborn and Pearson (1947), Pearson (1951), Pearson (1959), Bidau (2015), and Freitas (2016). Figure 3 provides the first photographic documentation of the *C. peruanus* species.

### Conservation status of *C. peruanus*

We interviewed 59 residents of the record localities of *C. peruanus*. They referred to the species' disappearance in six localities between 3 and 20 years ago (Table 1) but could not identify a possible cause. However, Challacollo, Pampa de Queullacota, Callacami, and Pasiri residents expressed their disapproval of *C. peruanus* because it damages crops and grass used for their livestock. Sometimes, they took drastic measures to remove it, such as plowing the field with a tractor.

According to Callacami residents, *C. peruanus* was once abundant and intensely sought after for meat or traditional medicinal purposes, with individuals being sold for between \$5-24 for each live specimen (Figure 4). Moreover, they mentioned the capture of many individuals of *C. peruanus* years ago because these animals were once

abundant in several areas from Callacami. This finding was confirmed as we found several abandoned galleries in the landscape of Callacami.



**Figure 2.** Distribution map of *Ctenomys peruanus* in Peru. Circles denote the historical records (see Table 1) and star the last population living in Peru. Protected areas are Reserva Nacional del Titicaca (ANP), Área de Conservación Regional Vilacota Maure (ACR), Áreas de Conservación Taypipiña and Checca (ACP), and Reserva Paisajística Cerro Khapia (ZR)

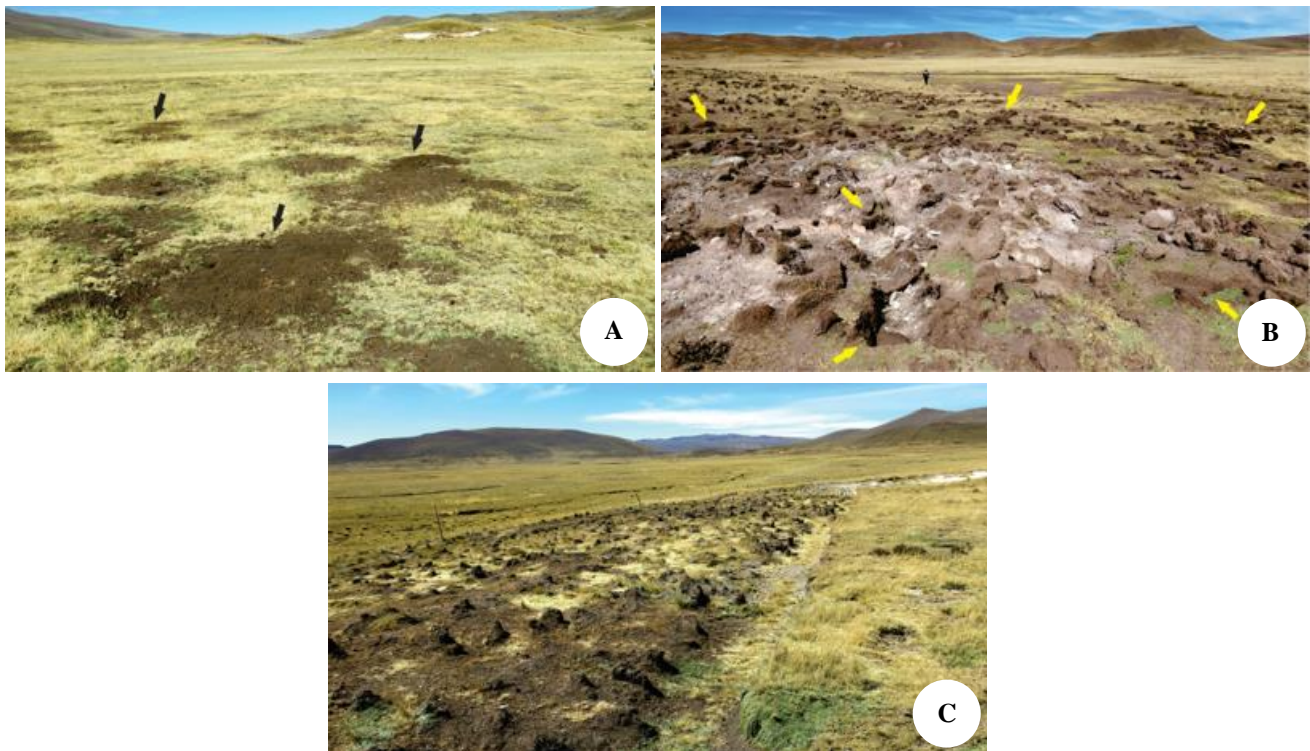


**Figure 3.** Individual of *Ctenomys peruanus* captured in Callacami, Puno, Peru (Photo by C.E. Medina)



**Table 1.** Record localities of *Ctenomys peruanus* in the state of Puno, Peru

ID	Province	Locality	Latitude	Longitude	Altitude	Reference	Interviews	Status	Threats
1	Chucuito	Pisacoma (Type locality)	16°54'28"S	69°22'21"W	3,940	Sanborn and Pearson (1947)	8	Locally extinct since 15 years ago	Overgrazing agricultural expansión
2	El Collao	Mazacruz	16°45'0"S	69°43'59"W	3,960	Sanborn and Pearson (1947)	6	Locally extinct since 20 years ago	Overgrazing agricultural expansión
3	El Collao	Pampa de Queullacota, Conduriri	16°37'32"S	69°40'0"W	4,000	Pearson (1959)	7	Locally extinct since 5 years ago	Overgrazing agricultural expansión
4	Chucuito	Hacienda Pichupichuni, Río Callacame,	16°34'59"S	69°22'59"W	3,885	Pearson (1959)	5	Locally extinct since 10 years ago	Agricultural expansión
5	Chucuito	Challacollo	16°36'1"S	69°16'38"W	3,860	MUSA 12402, MUSA 12428, MUSA 12429, collected in 2011	15	Locally extinct since 10 years ago	Agricultural expansión
6	Chucuito	Pasiri	16°21'7"S	69°27'57"W	4,083	Present study	6	Locally extinct since 3 years ago	Hunting, overgrazing, Agricultural expansión
7	El Collao	Callacami	16°29'4"S	69°32'24"W	4,075	Present study	12	Living and declining	Hunting, overgrazing, agricultural expansión



**Figure 4.** Habitat of *Ctenomys peruanus* in Callacami, Puno, Peru. A. View of the high-Andean puna with large areas flattened, where the Peruvian tuco tuco currently inhabits; the black arrows indicate the burrow entrances, with clayey pellet mounds nearby, created by *C. peruanus* under relatively good conservation conditions; B. Burrows destroyed by hunting activities; the yellow arrows indicate excavations up to 45 cm deep to capture the animals; C. Burrows destroyed by plowing the field with a tractor

The main threats to *C. peruanus* are hunting, overgrazing, and agricultural expansion, which destroys the burrow galleries where the animals live. It should be noted that none of the localities are within any Natural Protected Areas and that there are no current or proposed conservation measures for the species.

According to our results, *C. peruanus* can be categorized as a Critically Endangered species by the following IUCN Red List Criteria: (i) Distribution geographic. Population with an extent of occurrence (EOO) under 100 km<sup>2</sup>; one location; continuing decline observed of the EOO and number of mature individuals; and extreme fluctuations of EOO, number of locations, and number of mature individuals (Criteria: B1 ab[i,v]c[iv]); (ii) Small population size and decline. Number of mature individuals under 250; continuing decline observed and extreme fluctuations in the number of mature individuals (Criteria: C2a[i]b); (iii) Very small or restricted population and the number of mature individuals under 50 (Criteria: D).

## Discussion

One of the reasons we conducted this research was the lack of current field data for the species of the genus *Ctenomys* in Peru. In fact, there are some recent publications presenting information on the Peruvian populations of *C. leucodon*, *C. opimus*, and *C. peruanus* (Bidau 2015; Freitas 2016; Zeballos and Vivar 2016a; Zeballos and Vivar 2016b; Dunnum et al. 2016; Caraballo et al. 2023). However, these authors simply transmitted or used the same field data obtained by Colin C. Sanborn and Oliver P. Pearson in southern Peru from 1941 and 1952 (Sanborn and Pearson 1947; Pearson 1959). Therefore, our research is the first effort to fill a 72-year gap without field data for *C. peruanus*, an endemic species from southern Peru.

Pearson (1959) did the most complete study on the natural history of Peruvian tuco-tuco *C. peruanus*. This author documented that *C. peruanus* inhabits areas adjacent to the highland tuco-tuco *C. opimus*. However, we did not record both species together in any locality during the present study. Moreover, Pearson (1959) mentioned that *C. peruanus* is active during the day, sitting motionless with its head at the entrance of its burrows and feeding on the ground a meter or more from its burrow entrance. However, this behavior was not observed in Callacami Village (Puno), possibly as a result of hunting pressure in the area or the competition with domesticated livestock (alpaca, llama, and sheep).

Several vertebrates (mammals, birds, reptiles, and amphibians) use abandoned burrow systems created by the subterranean rodents of the genus *Ctenomys* (Bidau 2015; Freitas 2016). Pearson (1959) highlights the close relationship between *C. peruanus* and common yellow-toothed Cavy *Galea musteloides* Meyen 1833. The latter species take over burrows immediately after Peruvian tuco-tuco is removed. This situation was observed with concern in Callacami (Puno) because a large number of *G. musteloides* (~100 individuals) were counted in the destroyed galleries, suggesting the subsequent displacement of *C. peruanus*. On the other hand, Pearson (1959) estimated a density of 42 individuals of *C. peruanus* per hectare in Huacullani.

However, our preliminary notes on *C. peruanus* from Callacami suggest that the density would be much lower than 42 individuals.

The altitudinal distribution range of *C. peruanus* was from 3,860 to 4,083 m.a.s.l. (Sanborn and Pearson 1947; Pearson 1959), while nowadays, it occurs at 4,075 m.a.s.l. (Table 1). This rodent inhabited the open shrub-steppe in clay or sandy soils, close to wetlands (bofedales) or rivers (Pearson 1951), and has been found within areas with domesticated camelid livestock (Pearson 1959). This scenario is quite similar to the habitat where currently inhabited by *C. peruanus*, in clayey soils of flat lands in the high-Andean puna habitat and within one graze area of cows, sheep, and domesticated camelids.

Pearson (1959) suggested that *C. peruanus* was social, living in colonies, a behavior that contrasts with other species of *Ctenomys*, except *C. opimus* and *C. sociabilis* Pearson and Christie 1985. However, studies of the home range and space use of *C. peruanus* are needed to clarify that hypothesis. Indeed, only seven of 68 *Ctenomys* species have data about the average size of their home range. These are: *Ctenomys australis* Rusconi 1934, *Ctenomys haigi* Thomas 1917, *Ctenomys minutus* Nehring 1887, *C. opimus*, *Ctenomys rionegrensis* Langguth and Abella 1970, *C. sociabilis*, *Ctenomys talarum* Thomas 1898, and *Ctenomys* sp. (Estevan et al. 2016; Kubiak et al. 2017a; O'Brien et al. 2020; Amaya et al. 2021; Amaya et al. 2022; Lacey et al. 2022; Lacey et al. 2024).

Regarding the conservation status of *C. peruanus*, MINAGRI (2014) places it as Endangered (EN) because the species could suffer changes in the availability of its habitat due to current and ongoing climate change. While Zeballos and Vivar (2016a) listed the species as Least Concern (LC) because it apparently does not face major threats, it is somewhat adaptable, and it is unlikely to be declining fast enough to qualify for listing in a more threatened category. In contrast, Caraballo et al. (2023) carried out a re-evaluation of the extinction risk of the genus *Ctenomys*. They categorized *C. peruanus* as Vulnerable (VU) based on information on its geographical distribution. Nevertheless, the data presented here reinforce the idea that *C. peruanus* should be categorized as Critically Endangered (CR) due to the reduction in its distribution and the decrease in its population size. Other latent threats to the species are climate change due to the projected decrease in rainfall for the region of Puno between 2035 and 2065 (Lazo-Cancino et al. 2020; Zeballos and Lavado-Casimiro 2022) or the low mobility of the species and emerging barriers (e.g., roads, dam channels) that could affect its dispersal ability (Navarro et al. 2024).

Regarding potential conservation measures for *C. peruanus*, it would be necessary to approach the local human population to raise awareness and reduce hunting and habitat modification. Long-term, it would be necessary to generate a management and conservation plan for the species, so that the same local human communities protect the species and will be able to trap the species sustainably in the future. It would also be necessary to create a Protected Area to conserve the biological and cultural diversity of southern Puno, which is threatened by agricultural

expansion and artisanal mining (Caraballo et al. 2023; Revollo-Cadima and Salazar-Bravo 2024).

Future studies on *Ctenomys peruanus* are recommended to search more populations and to document aspects like home range, population demographics, reproductive patterns, diet, parasitology, activity patterns, and social behavior (Kubiak et al. 2017b; Garcías et al. 2018; Caraballo et al. 2020). Such updated information on the species' natural history would be most beneficial in supporting the goals of devising and implementing effective management and conservation plans to facilitate the recovery of this species (Gardner et al. 2021).

In conclusion, the present study shows the serious conservation issues faced by *C. peruanus* after 72 years without field data for the species. Our data reflect the need to update the conservation status of *C. peruanus* to one Critically Endangered species (CR). Likewise, it is imperative to design and implementation of management and conservation plans for this species with the support of government agencies, conservation organizations, and the local population.

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