



## A low altitude forest dwelling Pyrenean chamois population increases the potential habitat of this subspecies

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### Abstract

**Aim of study:** To demonstrate if a population of Pyrenean chamois *Rupicapra p. pyrenaica* can live at low altitudes all year long. This could enlarge dramatically its potential habitat.

**Area of study:** A hunting ground in Sobrarbe County, Pyrenees, Spain, in 2022.

**Materials and methods:** We interviewed local hunters to find out when the presence of the subspecies in the area dates back. We performed block counts from April to December in the target area for calculating the size of the population.

**Main results:** There was a presence of at least 15 years of the subspecies living at 600 m asl. The population was at least 18 animals, reproduces, and shows a normal demographic structure of kids, yearlings, adult females, and adult males.

**Research highlights:** Low-altitude chamois populations living in forests could be a result of important ecological changes in high mountain pastures producing migrations to newly suitable areas as low-altitude forests. The potential habitat of the subspecies should be broadened.

**Additional key words:** global warming; expansion; potential habitat; wild ungulates; *Rupicapra p. pyrenaica*.

**Citation:** Herrero, J; García-Serrano, A; Félez, C; Herrero, F; Machuca, A; Ponz, B; Sancho, S (2023). A low altitude forest dwelling Pyrenean chamois population increases the potential habitat of this subspecies. Forest Systems, Volume 32, Issue 3, eSC03. <https://doi.org/10.5424/fs/2023323-20521>

**Received:** 06 Jun 2023. **Accepted:** 24 Aug 2023.

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**Funding:** This research is part of the long-term monitoring of wild ungulates in Aragon, Spain, supported by its Regional Government.

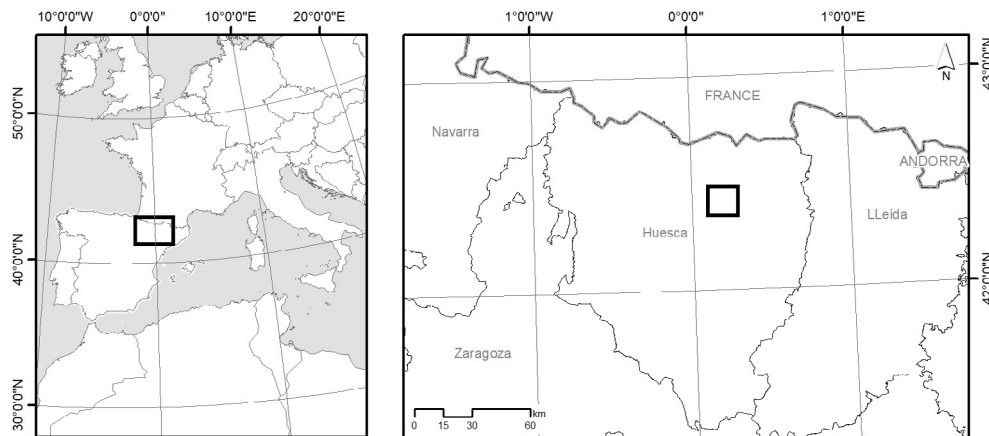
**Competing interests:** The authors have declared that no competing interests exist.

### Introduction

Wild ungulates have experienced an extraordinary increase in number and expansion in occupancy in Europe (Apollonio et al., 2010) and in the Pyrenees (Gortázar et al., 2000; González et al., 2013) in the last decades. Southern chamois *Rupicapra pyrenaica* is one of these species. This mountain ungulate is widespread, abundant, and increasing. It is adapted to high elevations and cold climates (Corlatti et al., 2022), occupying altitudes between 1,000 and 2,800 m asl. It is endemic to Southern Europe and has three subspecies: *Rupicapra pyrenaica parva*, living in the Cantabrian Mountains, *Rupicapra pyrenaica*

*ornata*, in the Apennines and *Rupicapra p. pyrenaica* in the Pyrenees (Herrero et al., 2020). In 2002 the population of Pyrenean chamois was estimated at around 53,000 animals, comprising one single metapopulation (Herrero et al., 2004). Even if there are no complete figures of its historical distribution in the whole Pyrenees, in the mid-19th century it was marginal. Since the mid-20th century, the population experienced an extraordinary expansion and today occupies the whole mountain chain (Gortázar et al., 2000).

This endemic Pyrenean subspecies is found in alpine meadows, rocky areas, forested valleys, and lower slopes in mountainous regions. Pyrenean chamois is a mixed grazer or intermediate feeder (García-González &



**Figure 1.** Localization of study area in Southern Pyrenees, Spain.

Cuartas, 1996) adapted to high mountain environments with pastures, scrubs, and forests. The subspecies has occupied its potential habitat in the mountain range and has been subjected to sporadic outbreaks which produced important mortality (Arnal et al., 2013; Corlatti et al., 2022). It generally stays above 1,800 m in alpine meadows during the warmer months of the year (Corlatti et al., 2022). Some populations have started to inhabit forests permanently (Herrero et al., 1996), even if their ecology is poorly known. Expansion continues nowadays on the border of the distribution of the subspecies, creating new subpopulations (Antón et al., 2019) and showing sporadic presence in marginal areas (Sampere et al., 2023).

It is considered of Least Concern under IUCN criteria, listed in Appendix III of the Bern Convention and Annex V of the EU Habitat Directive (Herrero et al., 2020) and suitable to be hunted in the whole Pyrenees except for the Navarre region, Spain. Nowadays it is a relevant primary consumer, important huntable trophy and a touristic attraction. Reintroductions have been frequent in the French part of the Pyrenees (Corlatti et al., 2022).

In February 2022 we received the testimony of two local hunters on the presence of Pyrenean chamois living for a long period (since 2007, 15 years) in a forest area of Southcentral Pyrenees (Fig. 1). They were asking the Regional Government for a chamois quota for their hunting ground. As there was no previous information on this issue, we decided to undertake a one-year monitoring system to increase the knowledge of this particular situation. In this short communication, we would like to describe the demographic characteristics of the subpopulation and comment on the possibilities that this new situation creates.

## Material and methods

We performed block counts (Berduco et al., 1986, Herrero et al., 2011) of the area where Pyrenean chamois was supposed to dwell once in April (before parturition),

June (after parturition), September and November (rut) during 2022. Four operators walked in the area after sunrise following a planned route using binoculars, spotting scopes, mobile phones and cameras, for a period of around 4 h. When Pyrenean chamois individuals were sighted, animals were registered in a sheet. Double counts were avoided gathering together information at the end of each survey, considering sex, age, localization, and timing. Occasional sightings were also recorded.

## Study area

The area has strong slopes of loam substrate. Forest tree cover is composed mainly by *Pinus halepensis*, but other species such *Quercus × cerrroides*, *Pinus nigra* or *Pinus sylvestris* are locally common. *Medicago sativa* pastures are present too. Total surface surveyed was around 1,000 ha. Other ungulates in the area were domestic sheep *Ovis aries*, wild boar *Sus scrofa*, and roe deer *Capreolus capreolus*. Wild boar is usually hunted in battues and roe deer in still hunts. No interference with chamois occurred during battues due to the proper behavior of hunting dogs. The entire study area is under Natura 2000 Network protection because of its Aleppo pine autochthonous forests, among other values (Code ES2410055).

The source of this subpopulation of chamois could be the nearby Sierra Ferrera (2,295 m), with a population of around 150 chamois, stable since 2000 (García-Serrano & Herrero, 2022).

## Results and discussion

Table 1 shows the results of the survey (Fig. 2). There were sighted at least 18 chamois during the whole study period. Movements from the neighboring Sierra Ferrera could not be discarded. The subpopulational stock is very low compared to other Pyrenean subpopulation (Herrero

**Table 1.** Sightings of Pyrenean chamois in the study area during 2022.

Date	Source	Males	Females	Kids	Yearlings	Adults	Indet.	Total
February	Hunters			2		15		17
March	Casual						7	7
April	Count	5	2	2				9
June	Casual							4
July	Count		4	2	5			11
August	Count						10-12	10-12
September	Count		3		7*		4	14
November	Count		5	3	1			
Estimate		5	5	3	5			18

\*: some were probably kids.

et al., 2004), but the population structure is comparable to other forest populations (Garin & Herrero, 1997). Even habitat use and grouping are comparable to other forest-dwelling populations of the species (Herrero et al., 1996, 2002). The occupied area is around 2 km<sup>2</sup> and the density is 9 chamois km<sup>-2</sup>, moving in an altitudinal range of 600-650 m asl.

Even if this altitudinal and habitat pattern can be considered as an exception, Pyrenean chamois could inhabit forests with strong slopes below 700 m permanently. This would mean a significant increase in its distribution range surpassing the current consideration of the species as an exclusively high mountain dweller. In any case, steep slopes are a fundamental requirement for the reproduction of chamois since females need vertical areas to give birth and have their young protected from terrestrial predators when they cannot flee (Pérez-Barbería & Nores, 1994).

It has to be considered that global warming (Lovari et al., 2020), encroachment (García-Ruíz et al., 2021) and forest increase (Lasanta & Vicente-Serrano, 2007) are reducing chamois habitat and quality. The occupation of these low elevation areas can represent an alternative to their traditional habitat. This preliminary work is the first document that shows a Pyrenean chamois population living all year long for a long period under 1000 m of altitude. Additional work is needed for corroborating this potential trend and studying the variables involved in this process.

## Authors' contributions

**Conceptualization:** J. Herrero

**Data curation:** J. Herrero, A. García-Serrano

**Formal analysis:** J. Herrero, A. García-Serrano

**Funding acquisition:** A. García-Serrano

**Investigation:** J. Herrero, Carlos Féliz, Fernando Herrero, A. Machuca, B. Ponz, S. Sancho

**Methodology:** J. Herrero, Carlos Féliz, Fernando Herrero, A. Machuca, B. Ponz, S. Sancho



**Figure 2.** Above: adult female and kid in the loam. Below: group of chamois in the loam surrounded by Aleppo pine; from left to right: kid, yearling, adult female and adult female.

**Project administration:** A. García-Serrano

**Resources:** A. García-Serrano

**Software:** A. García-Serrano

**Supervision:** J. Herrero, A. García-Serrano

**Validation:** J. Herrero, A. García-Serrano

**Visualization:** J. Herrero, A. García-Serrano

**Writing – original draft:** J. Herrero

**Writing – review & editing:** J. Herrero, A. García-Serrano

## References

- Antón A, Clemente M, Foulché K, Artazkotch R, García-Serrano A, Herrero J, 2019. International coordinated monitoring of Pyrenean chamois in its westernmost edge. *Caprinae News* 2019: 4.
- Apollonio M, Anderson R, Putman R, 2010. European ungulates and their management in the 21st century. Cambridge University Press, UK. 618 pp.
- Arnal MC, Herrero J, de la Fe C, Revilla M, Prada C, Martínez-Durán M, et al., 2013. Dynamics of an infectious keratoconjunctivitis outbreak by *Mycoplasma conjunctivae* on Pyrenean chamois *Rupicapra p. pyrenaica*. *PLoS One* 8: e61887. <https://doi.org/10.1371/journal.pone.0061887>
- Berduco C, Besson C, Garde moniteurs du PNP, 1986. Dynamique des populations d'isards du Parc National des Pyrénées. *Acta Biologica Montana* 1: 153-175.
- Corlatti L, Herrero J, Ferretti F, Anderwald P, García-González R, Hammer S, et al., 2022. Chamois *Rupicapra* spp. In: *Handbook of European Mammals*; Hackländer K & Zacos FE (eds.). Springer Verlag, Berlin.
- García-González R, Cuartas P, 1996. Trophic utilization of a montane/subalpine forest by chamois (*Rupicapra pyrenaica*) in the Central Pyrenees. For *Ecol Manage* 88(1-2): 15-23. [https://doi.org/10.1016/S0378-1127\(96\)03805-4](https://doi.org/10.1016/S0378-1127(96)03805-4)
- García-Ruiz JM, Arnáez J, Sanjuán Y, López-Moreno JJ, Nadal-Romero E, Beguería S, 2021. Landscape changes and land degradation in the subalpine belt of the Central Spanish Pyrenees. *J Arid Environ* 186: 104396. <https://doi.org/10.1016/j.jaridenv.2020.104396>
- García-Serrano A, Herrero J, 2022. Pyrenean chamois monitoring in Aragon. Internal report of the Regional Government of Aragon [in Spanish].
- Garin I, Herrero J, 1997. Distribution, abundance and demographic parameters of the Pyrenean chamois (*Rupicapra p. pyrenaica*) in Navarre, Western Pyrenees. *Mammalia* 61(1): 55-63. <https://doi.org/10.1515/mamm.1997.61.1.55>
- González J, Herrero J, Prada C, Marco J, 2013. Changes in wild ungulates populations in Aragon, Spain between 2001 and 2010. *Galemys* 25: 51-57. <https://doi.org/10.7325/Galemys.2013.A05>
- Gortázar C, Herrero J, Villafuerte R, Marco J, 2000. Historical examination of the status of large mammals in Aragon, Spain. *Mammalia* 64(4): 411-422. <https://doi.org/10.1515/mamm.2000.64.4.411>
- Herrero J, Garin I, García-Serrano A, García-González R, 1996. Habitat use in a *Rupicapra pyrenaica pyrenaica* population. For *Ecol Manage* 88: 25-29. [https://doi.org/10.1016/S0378-1127\(96\)03806-6](https://doi.org/10.1016/S0378-1127(96)03806-6)
- Herrero J, Garin I, García-Serrano A, García-González R, Aldezabal A, 2002. Grouping patterns in a forest dwelling population of Pyrenean chamois. *Pirineos* 157: 89-101. <https://doi.org/10.3989/pirineos.2002.v157.64>
- Herrero J, Escudero E, Fernández de Luco D, García-González R, 2004. El sarrio pirenaico *Rupicapra p. pyrenaica*: biología, patología y gestión. Publicaciones del Consejo de Protección de la Naturaleza de Aragón, Serie Investigación, 309 pp. [In Spanish and French with English abstracts].
- Herrero J, García-Serrano A, Prada C, Fernández-Arberas O, 2011. Using block counts and distance sampling to estimate populations of chamois. *Pirineos* 166: 123-133. <https://doi.org/10.3989/pirineos.2011.166006>
- Herrero J, Lovari S, Nores C, Toïgo C, 2020. *Rupicapra pyrenaica*. The IUCN Red List of Threatened Species 2020.
- Lasanta T, Vicente-Serrano SM, 2007. Cambios en la cubierta vegetal en el Pirineo aragonés en los últimos 50 años. *Pirineos* 162: 125-154. <https://doi.org/10.3989/pirineos.2007.v162.16>
- Lovari S, Franceschi S, Chiatante G, Fattorini L, Fattorini N, Ferretti F, 2020. Climatic changes and the fate of mountain herbivores. *Climatic Change* 162: 2319-2337. <https://doi.org/10.1007/s10584-020-02801-7>
- Pérez-Barbería FJ, Nores C, 1994. Seasonal variation in group size of Cantabrian chamois in relation to escape terrain and food. *Acta Theriologica* 39(3): 295-305. <https://doi.org/10.4098/AT.arch.94-33>
- Sampere FX, García-Martí C, López-Martín TM, Ruíz-Olmo J, López-Olvera JR, Lavín S, et al., 2023. Presencia de sarrio *Rupicapra p. pyrenaica* en el macizo de Montserrat (NE España). *Galemys* 35: 1-4. <https://doi.org/10.7325/Galemys.2023.N1>