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# MONITORING AND MANAGEMENT OF PYRENEAN CHAMOIS IN ARAGON

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## INTRODUCTION

In 1966, a number of Game Reserves (GR) were established in Spain, and the four in the Aragonian Pyrenees were established with the objective of recovering and conserving the population of Pyrenean chamois *Rupicapra p. pyrenaica*, which began the management of the subspecies in the region. Another GR was established in 1995 (Figure 1). In 2011, 3.6% of the country's surface was GR (Pita et al. 2011). In the Aragonian Pyrenees, the GR were delimited and had a permanent staff of rangers and technicians, which ensured the design and implementation of management practices and provided important direct and indirect economic benefits to local mountain communities (Domínguez & París 2011) by allowing the sustainable harvest of this resource through game hunting.

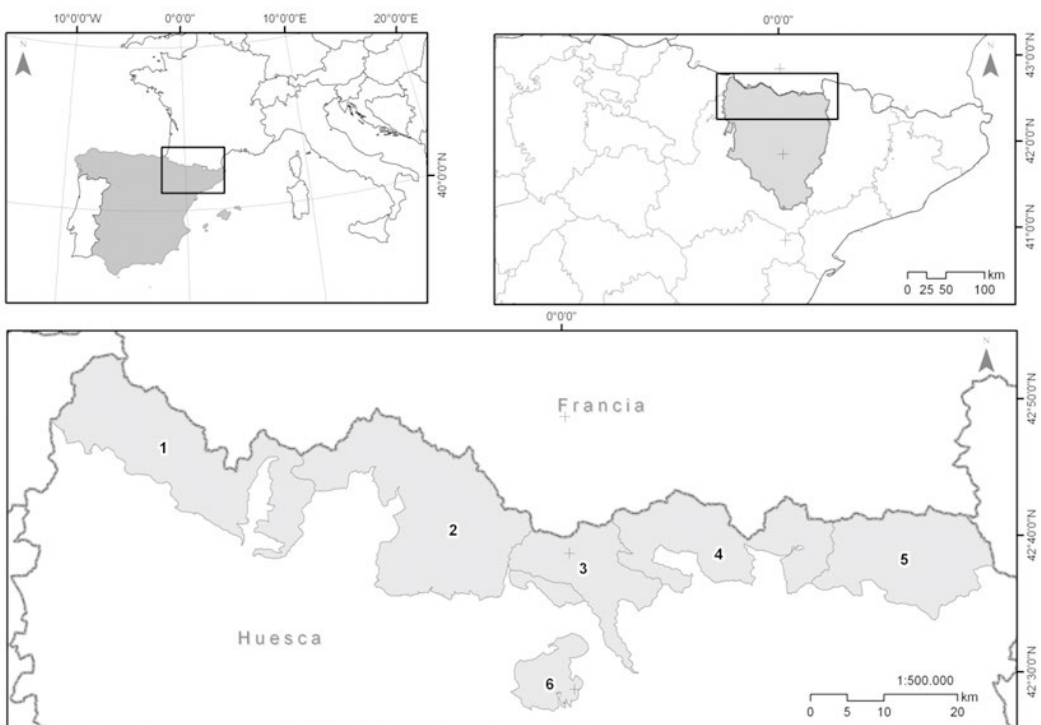
The establishment of Ordesa and Monte Perdido National Park (ONP) in 1918 and, particularly, its expansion in 1982 (15,608 ha) allowed the designation of a Protected Area, which had harboured an important non-hunted population of Pyrenean chamois. ONP and the GR form a continuous, 142,174-ha area under public management, from Navarre to Catalonia, and north to the French border (Figure 1).

Since 1995, the management of GR and Pyrenean chamois has been reviewed annually, with new policies and guidelines. Some of the guidelines were modified as new information became available and new management practices were developed. The most important guidelines are as follows:

- population distribution assessed every five years (González et al. 2013, Figure 2);
- design and implementation of a plan for monitoring the demographics of the subspecies throughout its range, regardless of the administrative status (hunnable or non-hunnable) of the land;
- hunting quotas set based on population surveys in the GR and on local hunting grounds;
- development of health and biometric monitoring of wild ungulates in the Game Reserves and ONP (Arnal et al. 2013 a);
- development of an annual economic assessment of GR (Domínguez & París 2011);
- promotion of citizen participation in the management of GR by including citizens on administrative boards, and the participation of hunters in field monitoring;
- material support (e.g., binoculars, spotting scopes) and courses for rangers involved in the monitoring
- annual reports on the activities and surveys of the GR;
- organization of meetings on Pyrenean chamois (2003 and 2004), Cantabrian and Pyrenean chamois (Alarcón et al. 2011), Iberian Ungulates (García-González & Herrero 2011), and the IUCN Third World Conference on Mountain Ungulates (García-González et al. 2002);
- publication of a booklet on Pyrenean chamois for hunters (Herrero et al. 2002) and a book on the status, management, and research on Pyrenean chamois in the Pyrenees (Herrero et al. 2013a);
- annual subsidies for the municipalities of ONP and GR.

This contribution presents the results of the demographic monitoring and management of Pyrenean chamois in Aragon, and describes the management decisions made for this subspecies in the GR of Aragon, which is part of a large, long-term monitoring program for wild ungulates in the region (Marco et al. 2011).

The study area included an almost continuous mountain range that has peaks higher than 2000 m on all of the mountain massifs. About 100 regional rangers do the fieldwork, throughout the distribution area of chamois (200 000 ha). Within the area are one National Park, three Nature Parks, five GR, 56 local hunting grounds, and one Biosphere Reserve. Over 90% of the area falls within the Natura 2000 network. For more information on the study area, see Arnal et al. (2013 a). Roe deer *Capreolus capreolus* (Herrero et al. 2013 b), wild boar *Sus scrofa* (Herrero 2003), and red deer *Cervus elaphus* are the other wild ungulates present and, in summer, > 75 000 sheep graze within the area. For management purposes, the area was divided into hunting grounds and one non-huntable area, the ONP. The most important results of game management have been the harmonization of hunting and the conservation of huntable species, economic benefits to municipalities, and access to hunting at reasonable prices. In 2014, the GR had 30 rangers and one technician, which was sufficient for the technical management of the area, its vigilance and monitoring of huntable species (Pyrenean chamois, wild boar *Sus scrofa*, roe deer *Capreolus capreolus*, red deer *Cervus elaphus*), apart from other objectives, such as public use management and endangered species monitoring and protection (bearded vulture *Gypaetus barbatus*, rock ptarmigan *Lagopus mutus*, capercaillie *Tetrao urogallus*). Most of the area of the GR is communal land that belongs to the local municipalities.



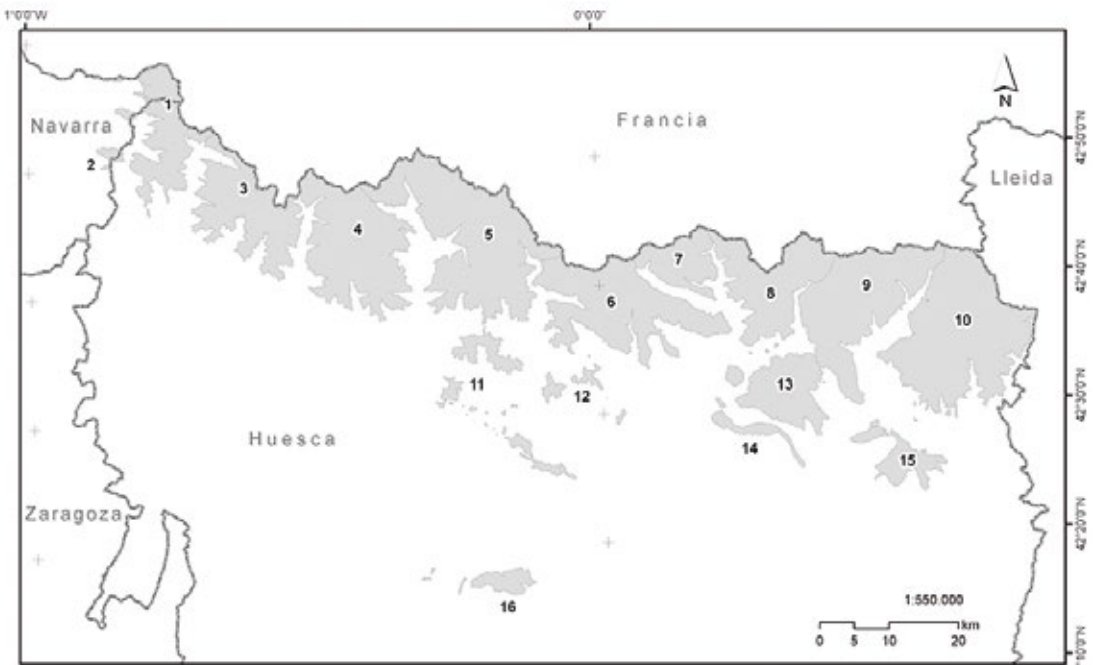
**Figure 1.** Chamois Game Reserves in Aragon. 1 Los Valles; 2 Viñamala; 4 Los Circos; 5 Benasque; 6 Solana de Burgasé (1995) and Ordesa National Park (3) in the Aragonian Pyrenees (Herrero et al. 2013 a).



**Figure 2.** Distribution of Pyrenean chamois in Aragon (2007-2011). Areas higher than 1600 m are indicated in dark grey, and the presence of the species within 10 x 10 km UTM.

## DEMOGRAPHIC MONITORING

From 1982 to 1995, block counts were used to estimate the size of Pyrenean chamois populations in some areas of the Aragon Pyrenees (Herrero et al. 2013 a). ONP started its own monitoring program in 1987. In 1997, the block counts incorporated natural management units (Figure 3), the mountain massifs, including the hunting grounds managed by local hunters, the GR managed by the region, and ONP managed by the state, until 2006, when it became the responsibility of the regional government. By 2000, monitoring was evenly distributed throughout the area. Originally, small massifs were surveyed annually and large ones every five years, respectively. In the latest itineraries that covered > 50% of the estimated minimum number of chamois were conducted annually, extrapolating results. Since 2008, all of the massifs have been included in the itineraries, and an annual report provides information on the abundance, structure, and trends in each of the subpopulations (Prada et al. 2013). To improve health (Arnal et al. 2013 b) and demographic monitoring, in 2006, we began a bimonthly inquiry of the rangers of the GR and ONP for information on ungulate mortality.



**Figure 3.** Management units for Pyrenean chamois in the Aragonian Pyrenees. 1 Larra-Peña Forca; 2 Ezcaurri; 3 Bixaurín; 4 Anayet; 5 Biñamala; 6 Monte Perdido; 7 Liena; 8 Punta Suelsa; 9 Posets; 10 Maladeta; 11 Oturia; 12 Sueiro; 13 Cotiella; 14 Sierra Ferrera; 15 Turbón; 16 Guara (Herrero et al. 2013 a).

Block counts (itineraries) were conducted from early June to early July, after the parturition period, which occurs in the first half of May (Garin & Herrero 1996). In that period, the counts of adult females, kids, and yearlings are unbiased; however, the itineraries underestimate the number of adult males. For that reason, another survey is performed during the rut, from late October until mid-November, to count adult males, which provides a better estimate of the adult population sex ratio. Chamois populations in two massifs in the Pre-Pyrenees are also surveyed in April; when chamois start to graze open pastures within mainly forested land.

Simultaneous, above-the-timberline complete surveys (Berduco et al. 1982) are the most common method for counting chamois in open areas that provide good visibility in the Alps, Apennines, Cantabrian Mountains, Pyrenees, and other European mountain ranges. Mainly, that method is used because it is economical and simple for data collection, analysis and estimating the minimum number of animals, and it is accurate if visibility is good and the population density is not exceptionally high. It involves counting animals during itineraries within sectors that reflect natural management units (mountain massifs), simultaneously, which prevents animals from being counted more than once. Underestimates can be important (Houssin et al. 1994) or unimportant (Herrero et al. 2011). The natural management units have been defined as the area above 1600 m a.s.l., a height above which most chamois live most of the year in the study area, which avoids comparisons based on artificial administrative units. In addition, distance sampling has been used for forest itineraries in one massif that had a high-density population (Buckland et al. 2001), which has been used with chamois previously (García-González et al. 1992, Garin & Herrero 1997).

## ORGANIZATION OF THE FIELD WORK

Itineraries (~ 230), designed by the rangers, covered all open areas above 1600 m, and each of the massifs was divided into sectors, which were surveyed on a single day (1-3 days for the entire massif). Most of the itineraries were performed by pairs of rangers or by us, although hunters and volunteers that had good knowledge of the species and the area contributed to the effort. All were equipped with binoculars, spotting scopes, transmitters, data sheets, and ad hoc maps. The age and sex (adult males, adult females, yearlings, and kids) of the individuals within groups of chamois were recorded and their locations plotted on maps.

## MONITORING RESULTS

In 2013, the estimated minimum number of Pyrenean chamois was 10.935, which included two massifs that are shared with the neighbouring region of Navarre (Herrero et al. 2010). At that time, the total area occupied by the species in Aragon was ~200.000 ha (González et al. 2014). Between 2000 and 2007, the average annual increase of the population was 3%. Between 2007 and 2008, a keratoconjunctivitis outbreak reduced the population by 20% and, between 2008 and 2009, the population was reduced an additional 7%. Thus, the average annual reduction was 14%. Between 2009 and 2010, the population increased 10%, and it was stable in 2011, at a size that matched that of the population in 2000 (Arnal et al. 2013a). In 2011, a pestivirus outbreak began in the eastern massifs and, subsequently, the chamois population decreased 7% (2011-2012) and 18% (2012-2013) (Arnal et al. 2013 b).

Between 2000 and 2013, population density was 6-8 chamois km<sup>-2</sup>. Productivity was 62-76% (2000-2012), but was 57% in 2013. Between 2000 and 2007, and between 2008 and 2013, the adult sex ratio was about 60% and 70% males, respectively, because keratoconjunctivitis led to more mortality among adult females than among adult males (Arnal et al. 2013 b). Based on the number of chamois found dead, mortality was average in 2006, 2009, and 2010; however, in 2007-2008, mortality was increased because of keratoconjunctivitis and, in 2011-2013, because of pestivirus (Prada et al. 2013).

## MANAGEMENT

In Spain, regional governments have the responsibility for the management and conservation of biodiversity, which includes defining which species are huntable. The Pyrenean chamois is huntable in Aragon, but still-hunting is the only legal type of hunting. The hunting period is divided into spring, from the first Sunday in April to the first of July, when only adult males may be hunted, and autumn, from the second Sunday in September until the second Sunday in December, when adult females and adult males may be hunted. Approximately 50.000 hunting licenses have been issued in the region.

Population structure, trends, and estimates of the minimum size of the Pyrenean chamois population are the basis for the annual hunting quota (~ 5%). The quota is split among the hunting grounds, and adult males and females are hunted (proportion 1:1). The distribution of the quota among types of hunters within the GR is presented in Table 1.



Type of hunter	Adult male chamois	Adult female chamois
Landowners (municipalities)	40	0
Locals	15	50
Regional	25	30
EU	20	20
Total (%)	100	100

**Table 1.** Distribution (%) of the hunting quotas for Pyrenean chamois in the GR of Aragon.

Harvested animals have to be tagged. The following criteria are used to set the hunting quota for each hunting ground:

- population structure and trends;
- amount of area above 1600 m;
- proportion of the Pyrenean chamois population observed during block counts;
- any natural management unit that includes an area above 1600 m and a population > 250 animals can have a hunting quota, even if animals were not observed during block counts, because Pyrenean chamois are not present in municipal hunting grounds in some months. Those grounds must contribute to the conservation of the population just as do the others, throughout the year.

## INCOME FROM GR TO LOCAL MUNICIPALITIES

Based on the mission mandate of the law that created the GR, the affected municipalities and landowners receive money from the regional administration in the following ways:

- complementary income, derived from the value of the trophy after it has been harvested;
- the auction of 40% of the total GR quota, divided proportionally based on the amount of and owned by each landowner. In 2014 the price for an adult male is 2000-3000 €;
- a subsidy for the lands that were incorporated into the GR, with an understanding that the budgets of the municipalities usually are modest;
- indirect benefits derived from the presence of non-resident hunters in the tourism low season.

The annual cost of monitoring the chamois population, including the work done by rangers, technicians, and consultants is about 45.500 € (Escudero et al. 2009).

## CITIZEN PARTICIPATION IN THE MANAGEMENT OF GR

Citizen participation is channelled through the administrative boards, one for each GR. The interest groups represented include municipalities, landowners, farmers, local and regional hunters, environmentalists, hunting experts, and the regional administration.

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