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Changes in wild ungulate populations in Aragon, Spain between 2001 and 2010

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Abstract

To update the information on the distributions of wild ungulates in Aragon, Spain, populations were surveyed based on questionnaires sent to rangers of the Government of Aragon. The data were analyzed in two five-year periods: 2001-2005 and 2006-2010. Our analysis was based on the 242 and 278 questionnaires, corresponding approximately with 80-90% answers that were analyzed in 2006 and 2011, respectively. The survey documented the presence/absence of up to eight wild ungulate species within a UTM 10x10 km grid on maps that were specific to the counties in which the rangers worked. In 2006-2010, wild boar *Sus scrofa* was the most widely distributed species as it occurred in all of the grid blocks. Roe deer *Capreolus capreolus* were documented in 89% of the grid blocks, Iberian wild goat *Capra pyrenaica* in 37%, red deer *Cervus elaphus* in 31%, Pyrenean chamois *Rupicapra p. pyrenaica* in 10%, feral goat *Capra hircus* in 8%, fallow deer *Dama dama* in 3%, and mouflon *Ovis aries* in 0.3%. The Pyrenees had the highest and the Middle Ebro Valley had the lowest diversity of ungulates. In the Iberian System, diversity was intermediate. Overall, the distribution of ungulates increased 21% between the two periods. Feral goat populations expanded the most (111%), although Iberian wild goat (61%), roe deer (50%), and red deer (4%) also expanded. The range of wild boar populations remained stable, but the ranges of chamois and fallow deer populations were reduced 6%. By 2010, typically, in most block grids three or more species of wild ungulates coexist. We recommend that ungulate populations in Aragon be surveyed at least every five years.
Key words: re-wilding, sympatry, enclosures, rangers.

Resumen

Con el fin de actualizar la distribución de los ungulados silvestres en Aragón, se realizaron encuestas a los Agentes de Protección de la Naturaleza del Gobierno de Aragón en dos periodos: 2001-2005 y 2006-2010. Se recibieron un total de 242 y 278 respectivamente, correspondientes a un 80-90% de respuestas y que se analizaron en 2006 y 2011 respectivamente. Las encuestas documentaron la presencia/ausencia de hasta ocho especies de ungulados silvestres en cuadrículas UTM 10 x 10 km. En 2006-10, el jabalí *Sus scrofa* es la especie con una mayor distribución, ocupando la totalidad de las cuadrículas. El corzo *Capreolus capreolus* ocupó el 89% de las cuadrículas, la cabra montés *Capra pyrenaica* el 37%, el ciervo *Cervus elaphus* el 31%, el sarrio *Rupicapra p. pyrenaica* el 10%, la cabra doméstica asilvestrada *Capra hircus* el 8%, el gamo *Dama dama* el 3% y el muflón *Ovis aries* el 0,3%. Las zonas con mayor riqueza de ungulados se encuentran en el Pirineo, y los de menor con el Valle Medio del Ebro, siendo el Sistema Ibérico el que tiene una riqueza intermedia. En conjunto los ungulados han aumentado en un 21% su distribución entre los dos periodos, siendo el de mayor crecimiento la cabra doméstica asilvestrada (111%), seguido de la cabra montés (61%), corzo (50%) y ciervo (4%). La distribución del jabalí se ha mantenido y la del sarrio y el gamo han disminuido un 6%. Hoy en día la coexistencia de tres o más especies de ungulados silvestres representan el patrón general. Con el fin de monitorizar el conocimiento sobre la distribución de estas especies, algunas en pleno proceso expansivo, se recomienda repetir la encuesta al menos cada cinco años.
Palabras clave: asilvestramiento, simpatría, cercados, Agentes de Protección de la Naturaleza.

Introduction

In recent decades, the ranges of wild ungulates have expanded significantly in Europe (Apollonio *et al.* 2010). In some regions of Spain, some populations of wild ungulates expanded between the mid of the 19th C. and the mid-20th C (Madoz 1856, Sáenz de Buruaga, 1987, Gortázar *et al.* 2000), as well as in recent decades (Pérez *et al.* 2002). Expanding ungulate populations have led to increases in crop damages (Herrero et al. 2006), automobile accidents (Lagos *et al.* 2012), the human consumption of game, the prey availability to endangered large carnivores (Blanco *et al.* 2011), disease transmission (Armenteros *et al.* 2013), and changes in the composition and abundance of plant species in natural and seminatural ecosystems (Wilson 2004, Bueno *et al.* 2012) because of their diet, which has affected other species (Apollonio *et al.* 2010, Barrios-García & Ballari 2012). In Aragon, Spain, the government budget for compensating farmers for damages caused by wild ungulates (primarily, red deer *Cervus elaphus* and roe deer *Capreolus capreolus*), was 180,000 € in 2008 and 90,000 € in 2009, as well as the ones due to car crashes, which in 2009 were 500,000 € (Marco *et al.* 2011).

Those factors, among others, such as the need to establish hunting quotas for some species, and the obligation to assess the health of populations (Arnal & Fernández de Luco 2013a), provide the rationale for updating the information on the distributions of wild ungulates in Aragon. The objective of this study was to update the information on the distribution of wild ungulates in Aragon by comparing two five-year periods, 2001-2005 (Osuna *et al.* 2006-08) and 2006-2010.

Materials and methods

The study area was the region of Aragon, Spain, a 47,669 km^2 area that, in 2010, had 1, 347,095 inhabitants (according to the INE, Spanish Statistical Office). More than half of the human population lives in the city of Saragossa; thus, large areas have population densities <10 inhabitants km^{-2} (Sampietro 2000).

The area has a Mediterranean continental climate, with cold winters and hot, dry summers. It is defined by as having two mountain areas: the Pyrenees and the Iberian System, and the Middle Ebro Valley (López *et al.* 2007) (Fig. 1).

There are bag limits for red deer, roe deer, Iberian wild goat, and Pyrenean chamois, but not for wild boar, mouflon, or fallow deer. Feral goats are not huntable, but can be culled to prevent damages to crops. Mouflon and fallow deer are considered introduced species. In 2006 and 2011, questionnaires were sent to the rangers that requested information about the presence of wild ungulates in the county in which they worked. The questionnaires included the objectives and methods of the survey, and included the county maps for each species. The maps contained topographical features including relief, rivers, main roads, and urban areas, which were overlain by a 10 x 10 UTM grid. On each map, the rangers recorded the wild ungulate species that were occurred within the area represented by each of the grid blocks in one of two five-year periods (2001-2005 or 2006-2010). Wrong inquiries were rejected and we asked for rectification following the compilation rules. The

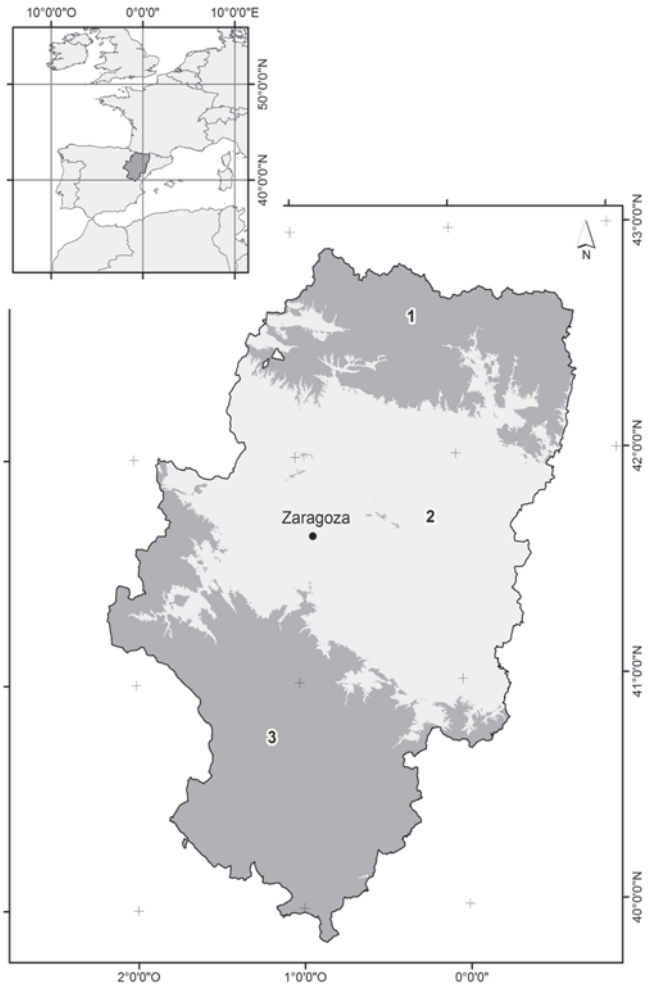

Figure 1. Map of Aragon, Spain, and its location within Western Europe. 1: Pyrenees; 2: Middle Ebro Valley; 3: Iberian System.

information that was considered dubious was sent again to the author and contrasted with him via phone calls. Information from the questionnaires entered into a Geographical Information System (GIS, ArcMap Version 9.3). In 2001-2005 and 2006-2010, respectively, data were recorded for 577 and 578 grid blocks. In the 2006-2010 period, wild ungulates within enclosures were excluded from the survey, which involved mouflon in three blocks and Iberian wild goat and fallow deer in two blocks.

Results

In 2006 and 2011, 242 and 278 questionnaires were returned, corresponding approximately with 80-90% answers, and wild ungulates were documented in 1,335 and 1,608 of the grid blocks. Eight species of wild ungulates lived freely in the area (Table 1). Based on the presence/absence of wild ungulates in grid blocks, between 2005 and 2010, the distribution of wild ungulates increased 21%, overall, and feral goats exhibited the greatest increase (111%), including expansion into some new areas in the Iberian System. The distribution of Iberian wild goat increased 61%, roe deer increased 50%, and red deer increased 4%. In both periods, wild boar was present throughout the study area. Between 2005 and 2010, the number of grid blocks in which Pyrenean chamois and fallow deer were present decreased by 6% and the number in which mouflon were present decreased by 61%.

Table 2 reflects overlapping of species distribution and Figure 2 the distribution of each species in the two five-year periods as well as the number of species per square during the second five-year period. Wild ungulate species richness was highest in the Pyrenees, intermediate in the Iberian System, and lowest in the Middle Ebro Valley. Between the two periods, the proportion of grid blocks in which one or two species occurred decreased and the proportion in which three to eight species were present increased (Table 3).

Discussion

Typically, species' distribution maps present heterogeneous information (Palomo *et al.* 2007), because they are based on a variety of sources, or sound information on the period they reflect is absent, which makes them difficult to interpret and limit their value. In species that exhibit significant range variations exacerbate the problem. In our study, the information gathered was based on two identical, questionnaire-based surveys done with the same procedures (expert inquiry). This fast, inexpensive approach provides facilitates the collection of high-quality standardized data (Jones *et al.* 2008).

Table 1. The number (and %) of 10 x 10-km grid blocks in which wild ungulate species occurred in Aragon, Spain, in the 2001-2005 (Osuna *et al.* 2006-2008) and 2006-2010.

	Presence in grid block (% of blocks)	
Species	2001-2005 period	2006-2010 period
Wild boar	578 *100*	577 *100*
Red deer	174 *30.1*	181 *31.3*
Fallow deer	20 *3.5*	19 *3.3*
Roe deer	343 *59.3*	513 *88.9*
Pyrenean chamos	60 10.4	57 9.8
Iberian wild goat	134 *23.2*	215 *37.3*
Feral goat	21 *3.6*	44 *7.6*
Mouflon	5 *0.9*	2 *0.35*
Total	1,335 *28.8*	1,608 *34.8*

Table 2. Overlap (%) of the grid blocks in which wild ungulate species were present in Aragon, Spain, in 2006-2010 (normal font) and 2001-2005 (in cursive, Osuna et al. 2006-2008).

	Wild boar	Red deer	Roe deer	Fallow deer	Pyrenean chamois	Iberian wild goat	Feral goat	Mouflon
Wild boar	-	31	89	3	10	37	8	0,3
		30	59	3	10	23	4	1
Red deer	100	-	87	9	12	20	10	1
	100		80	11	17	13	5	3
Roe deer	100	31	-	4	11	40	9	0.4
	100	41		6	15	25	6	1
Fallow deer	100	89	100	-	5	47	16	5
	100	95	95		0	25	10	20
Pyrenean chamois	100	39	100	2	-	4	25	2
	100	48	85	0		10	15	0
Iberian wild goat	100	17	95	4	1	-	7	1
	100	17	*63*	4	4		4	2
Feral goat	100	43	100	7	32	36	-	5
	100	43	100	10	43	24		10
Mouflon	100	100	100	50	50	100	100	-
	100	100	100	80	0	60	40	

Today in Aragon, sympatry among wild ungulate species is common, however, in the mid-19th C., they occupied marginal, fragmented habitats in the mountains (Gortázar *et al*. 2000). Wild boar has been present throughout Aragon since at least the end of the 20th Century (Gortázar *et al*. 2000), and the range has remained stable. Pyrenean chamois have continued to occupy the entire Pyrenees, which is the extent of its potential distribution. As of 2010, the red deer population was distributed throughout the Iberian System. In the Eastern Middle Ebro Valley, red deer exists as a relict, autochthonous population that has been supplemented by releases from southern Iberia and has expanded in the last 30 years. In addition, the population in southwestern Aragon originated from reintroductions from central and southern Iberia, plus the arrival of animals from neighboring regions. The red deer population in the Pyrenees has two origins: reintroductions from Southern Iberia if a recognized geographical region and Central Europe (on the French Slope of the Pyrenees, see Marco *et al.* 2011). In Aragon, the range of roe deer populations has increased significantly (Acevedo *et al*. 2005), and there was no evidence of reintroductions since at least the end of the XX Century. In our study, roe deer were not detected in some grid blocks, probably because population densities were low.

Table 3. Proportion (%) of 10 x 10-km grid blocks in which wild ungulate species coexisted in Aragon, Spain.

Number of coexisting species	2001-2006 (%)	2006-2010 (%)	Change (%)
1	26	5.7	-78
2	33.6	29	-13.7
3	28.9	50	73
4	9.7	12	23.7
5	1.5	2.2	46.7
6-8	0.5	0.7	40

The Iberian wild goat was present throughout the Iberian System, but the population in the Middle Ebro Valley was scattered. The population in the Pyrenees is derived from escapes from an enclosure (Herrero *et al*. 2013a). In the Pyrenees, the feral goat population is derived from the abandonment of domestic herds which began in the 1960s, and has its range in the Pyrenees and the Iberian System. Probably, the Pyrenean population could be the largest in continental Europe (Herrero *et al.* 2013b). The populations of mouflon and fallow deer in Aragon are derived from escapes from enclosures, and the latter has increased because of emigration from neighboring areas to the south. The absence of hunting bag limits probably limit the range and potential for expansion of those species. Finally, Pyrenean chamois remained stable, in spite of an important keratoconjunctivitis outbreak (Arnal *et al*. 2013).

Some of the wild ungulate species in Aragon appear to be expanding their range and we recommend that presence/absence surveys be repeated at least every five years.

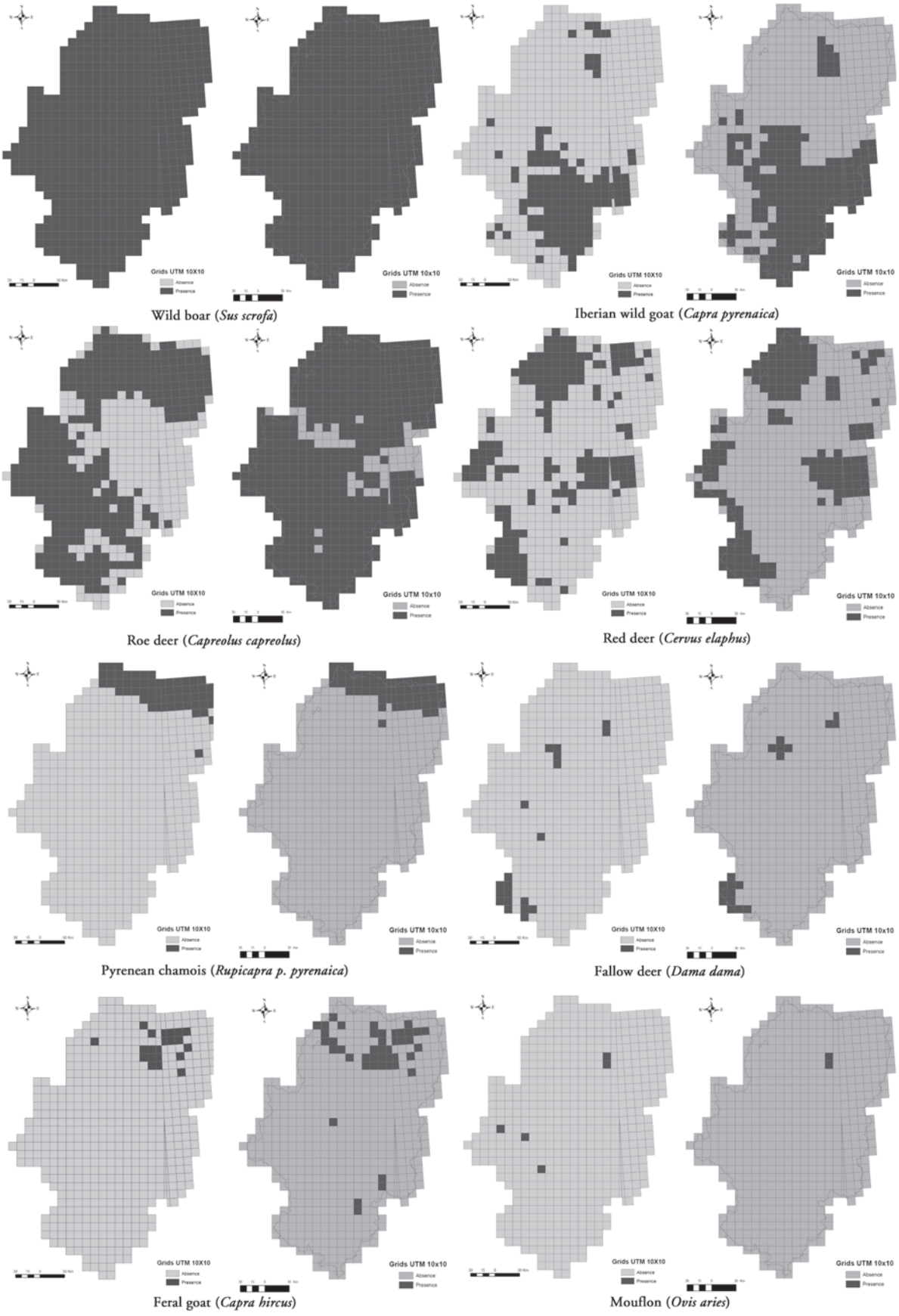

Figure 2. Distribution and species richness of wild ungulates in Aragon, Spain in 2001-2005 (left map based on Osuna *et al*. 2006-08) and 2006-2010.

Figure 2. (continuation)**.**

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