SHORT COMMUNICATION: Estimating abundance, survival and age structure of the Alberes cattle using recapture techniques

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Fina, M., Casellas, J. and Piedrafita, J. 2011. **SHORT COMMUNICATION: Estimating abundance, survival and age structure of the Alberes cattle using recapture techniques**. Can. J. Anim. Sci. **91**: 343–347. The Alberes breed is an endangered bovine breed with an unknown population size. In this study, we estimated a total of 447.9 (435.5 to 456.6) individuals using capture-recapture methods. Overall survival and recapture estimates were 0.85 ± 0.01 and 0.94 ± 0.01, respectively, leading to an average longevity of 5.64 yr and with the highest death rate concentrated in the first 3 yr of life (38.94%). For breeding cows, the average length of the productive life was 8.35 yr. The current population of this local breed is too small to prevent future losses of genetic variability, and a conservation program is essential to ensure the long-term viability of the breed.

Key words: Endangered population, capture-recapture, survival, population size, Alberes breed

Fina, M., Casellas, J. et Piedrafita, J. 2011. **BRÉVE COMMUNICATION: Estimation de l'abondance, de la survie et de la pyramide d'âge des bovins Albères par les techniques de recapture**. Can. J. Anim. Sci. **91**: 343–347. La race Albères est une race bovine menacée d'extinction dont on ignore la population. Dans le cadre de cette étude, les auteurs l'ont estimée à 447,9 (de 435,5 à 456,6) sujets, par des techniques de capture et de recapture. Dans l'ensemble, les taux de survie et de recapture estimatifs s'établissent respectivement à $0,85 \pm 0,01$ et à $0,94 \pm 0,01$, ce qui donne une longévité moyenne de 5,64 ans, le taux de mortalité le plus élevé survenant au cours des trois premières années de la vie (38,94 %). La vie productive des vaches en âge de procréer dure en moyenne 8,35 ans. Le nombre de sujets de cette race locale recensés est trop faible pour empêcher une réduction de la variabilité génétique à l'avenir. Il est essentiel d'amorcer un programme de conservation si l'on veut garantir la viabilité de la race à longue échéance.

Mots clés: Population menacée, capture-recapture, survie, taille de la population, race Albères

There are a number of situations, especially those involving wild animals or large study areas, in which a complete enumeration of the population is impossible, and sampling methods become essential (Huggins et al. 2003). It is a common problem in studies of natural populations where some individuals remain undetected during sampling events, as occurs in the Alberes bovine population. These animals live under semi-feral conditions in the Alberes massif (north-eastern Spain), being roughly grouped during the winter into three main herds called *Freixe*, *Castanyers* and *Roig*. Alberes cattle are an autochthonous and endangered breed and there is no reliable census of their population, which is assumed to be fewer than 500 individuals (Casellas et al. 2004; Fina et al. 2008). It is essential to determine the current population of Alberes cattle in order to establish an appropriate conservation program for the breed. The aim of this research was to undertake a reliable census and establish some population dynamics parameters for the Alberes breed.

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Once a year, herds are restrained within small enclosures to worm animals and wean male calves. At this time, the animals are registered and new individuals are ear-tagged and identified by electronic boluses (Caja et al. 1999). This was the source of capture-recapture data for our study. A total of 907 Alberes individuals were registered in six capture-recapture events from 2001 to 2007 (December 2001, November 2002, December 2003, January 2005, March 2006 and March 2007). At the beginning of the study, we had no information about the animals. When an Alberes individual was captured for the first time, a brief description was recorded on a technical document: official ear-tag and electronic bolus number, sex, herd, morphologic description and age. Age was approximated by trained staff on the basis of teeth weakening (Aparicio 1960) and number of rings in the horns (Caughley 1977). We took the average of both estimates as an approximation of the age of the individual. Our study focused on capture-recapture data from females because of the small number of available males in the Alberes population, with 51.9% of Alberes-type cows and 48.1% of crossbred cows.

Our analyses were performed using the MARK package (White and Burnham 1999) following a

Cormack-Jolly-Seber model, which is the standard methodology to calculate survivability, recapture probabilities and population size in open populations. Explanatory variables included in our study were: cow age with nine levels (<3, 3, 4, 5, 6, 7, 8, 9 and >9 yr), herd of origin with three levels (*Freixe*, *Castanyers* and *Roig*) and year of capture-recapture with five levels (note that year effects were characterized as the time interval between two successive recapture events). The same structure of systematic effects was assumed for survival (s_i) and recapture (r_i) parameters. In a preliminary analysis, the effect of coat color with two levels (Alberes morphotype or crossbred animals) was tested, although it was excluded from the final model because of the lack of statistical relevance according to Akaike's information criterion (Akaike 1973).

Following Tarrés et al. (2004) and once survival parameters were obtained through the Cormack-Jolly-Seber model, the observed survival probability at time t was calculated as:

$$S(t) = \prod_{l=0}^{t} s_l$$

where s_l was the survival probability estimated for each age l ($t = 16$ was the oldest age of a registered animal in the Alberes population). Death probability at time t was calculated as:

$$1 - \prod_{l=0}^{t} S(t)$$

In addition, the average longevity (AL) in the Alberes population was calculated as:

$$AL = \sum_{l=0}^{t} \prod_{j=0}^{t} S_j$$

The turnover rate was $1/AL$ and represented the percentage of animals that must be replaced each year in order to maintain the population size. We assumed that productive life began when the cows were 3-yr-old, and the average length of productive life (AP) became:

$$AP = \sum_{l=3}^{t} \prod_{j=3}^{t} S_j$$

with $1/AP$ being the annual replacement rate for adult cows (i.e., the number of 3-yr-old heifers which must be introduced to the herd in a particular year to preserve herd size in terms of adult females). See Rendel and Robertson (1950) for a detailed description of all these survival-related parameters.

The Alberes population showed a recapture probability of 0.94 ± 0.01. According to the results reported by Loison and Langvatn (2002), other populations of mountain ungulates have similar recapture rates. The Pyrenean chamois (*Rupicapra pyrenaica*) had a recapture probability of 0.99 and ibex (*Capra ibex*) had a recapture probability of 0.89 (Loison and Langvatn 2002). Similarly, Catchpole et al. (2000) reported a recapture estimate of 0.93 in Soay sheep. In general, recapture parameters did not show significant differences across systematic effect, with the exceptions of the lower probability ($P < 0.05$) for the last recapture event of this study ($r_{2007} = 0.83 \pm 0.01$) and the differences between herds ($P < 0.05$), being higher in the *Roig* herd (0.97) than in *Castanyers* (0.91) and *Freixe* (0.94) herds. This could be explained by the conjunction of the small size of the *Roig* herd and the supplementary feed that is provided under adverse climatic conditions.

Overall survival probability between two successive recapture events was 0.85 ± 0.01 (Table 1). Survival probability varied among years, being greater in the first and last years (0.93 and 0.98, respectively) than in intermediate years (0.88, 0.77 and 0.85). Survival estimates also varied among herds, the *Freixe* herd revealing the best performances. There were significant differences in survival probability between some age classes (i.e., 0.87 for 5-yr-old animals and 0.78 for animals older than 10 yr; $P < 0.05$). The differences between adult ages in survival estimates could be related to differences in physiological condition [Henson (1992), Coulson (1997) i.e., infectious diseases or physical circumstances], climate conditions or available resources (Fowler 1987).

Table 1. Regression coefficients (β) and survival (*S*) and recapture (*r*) estimates with their standard errors (SE)

	Survival		Recapture	
Variable	β_s	$S \pm$SE	β_r	r $\pm$SE
Population				
μ^z	1.73	0.85 ± 0.01	2.72	0.94 ± 0.01
Age (yr)				
<3	−0.01	0.85*a* ± 0.01	−0.55	0.90*a* ± 0.02
3	0.19	0.87*a* ± 0.03	−0.08	0.93*b* ± 0.03
4	−0.50	0.78*b* ± 0.04	−0.14	0.93*b* ± 0.03
5	0.18	0.87*a* ± 0.02	0.64	0.97*b* ± 0.01
6	0.82	0.93*c* ± 0.02	0.05	0.94*b* ± 0.02
7	−0.16	0.83*a,b* ± 0.03	0.22	0.95*b* ± 0.02
8	0.04	0.86*a* ± 0.03	0.51	0.96*b* ± 0.02
9	0.64	0.92*c* ± 0.03	0.60	0.97*b* ± 0.02
>9	−0.47	0.78*b* ± 0.03	1.98	0.99*b* ± 0.01
Herds				
Freixe	0.18	0.87*a* ± 0.01	0.09	0.94*a* ± 0.01
Castanyers	−0.13	0.83*b* ± 0.02	−0.46	0.91*b* ± 0.02
Roig	−0.41	0.79*c* ± 0.02	0.70	0.97*c* ± 0.01
Year				
2001–2002	0.81	0.93*a* ± 0.02	−0.05	0.94*a* ± 0.01
2002–2003	0.28	0.88*b* ± 0.02	−0.24	0.92*a* ± 0.02
2003–2004/2005	−0.53	0.77*c* ± 0.02	0.37	0.96*a* ± 0.01
2004/2005–2005/2006	0.00	0.85*b* ± 0.02	−0.15	0.93*a* ± 0.02
2005/2006–2006/2007	2.04	0.98*d* ± 0.02	−1.16	0.83*b* ± 0.01

[z] μ, overall mean.
a–d Within a column, estimates with the same letters are not significantly different.

Older animals must be more susceptible and not recover the body condition lost during an adverse climatological period. In some herbivore species, such as the bighorn sheep [*Ovis canadensis* (Portier et al. 1998)], alpine ibex [*Capra ibex* (Jacobson et al. 2004)], roe deer [*Capreolus capreolus* (Gaillard et al. 1997)] and chamois (also called isard, *Rupicapra pyrenaica*), a high density of animals increased competition for resources (Crawley 1983), impairing the survivability of weaker individuals by increasing infections (Crawley 1992) and the incidence of parasitic diseases (Wandeler et al. 1974). In general, adults were relatively impervious to density and weather effects, while juveniles (and possibly senescent individuals) were highly susceptible to both (Gaillard et al. 2000; Coulson et al. 2001). Typically, in most species of large herbivores, 10-yr-old and older animals are considered to be in the senescent stage (Gaillard et al. 2000) and are more sensitive to environmental variation. Our survival estimate for 10-yr-old and older cows (i.e., 0.78) fitted with previous results reported by Festa-Bianchet et al. (2003; 0.82) and Gaillard et al. 2000; 0.83).

The predicted survival function is shown in Fig. 1. This survival function becomes the starting point to characterize several demographic parameters with huge relevance for further conservation programs. Estimated average longevity for Alberes cattle was 5.64 yr, this population suffering a huge mortality rate during the first 3 yr of life (38.94%). Nevertheless, the cows that overcame these first years and joined the breeding stock of the Alberes breed expanded their average productive lifespan up to 8.35 yr. This length of productive life was similar to the estimate reported in the *Bruna dels Pirineus* population (~9 yr; Tarrés et al. 2004), another Catalonian autochthonous beef cattle breed. Other authors reported similar estimates of length of productive life in beef breeds (Buxadé, 1997; Díaz el al. 2002). When focusing on the different Alberes herds, the average length of productive in the *Freixe* herd was 8.98 yr, higher than those of *Castanyers* (7.90 yr) and *Roig* (7.03 yr) herds. These differences among herds must mainly be due to feeding management. The easier access by road to the *Freixe* herd allowed the animals' feed to be supplemented the whole winter, whereas the *Castanyers* and *Roig* herds could become inaccessible for several weeks each winter. The turnover rate (including young, adult and old individuals) and replacement rate (adult and old cows only) were 17.74 and 11.98% in the Alberes population.

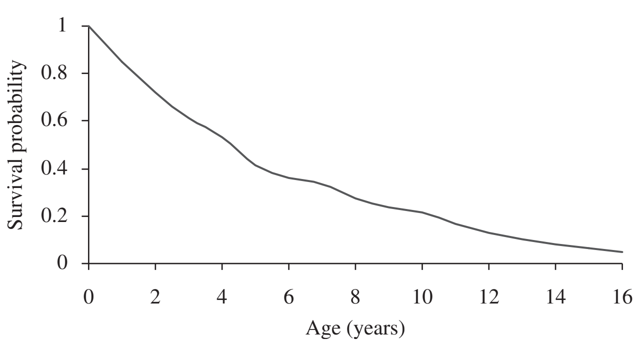

Fig. 1. Estimated survival function of females of the Alberes population.

The large difference between longevity and productive life was mainly due to the high mortality rate reported for young individuals up to 3 yr of age (38.94%). Compared with wild bovine species, our mortality rate was slightly higher than the 26% reported in wild banteng calves (*Bos javanicus*; Choquenot 1993). According to Gaillard et al. (2000), survival in juveniles is generally dependent on maternal care and, therefore, maternal attributes, such as age, reproductive experience, dominance status, previous reproductive status and the size of female kin groups, can have strong effects on juvenile survival. Other factors, such as weather during gestation, can affect juvenile survival because a long duration of adverse climatic conditions could impair maternal nutrition and future maternal care of offspring. Indeed, both milk production and colostrum quality must be reduced by maternal under-nutrition, the latter impairing the transfer of the passive immunity to newborns (Sams et al. 1996).

There were 370 registered females in the Alberes population in 2007 (Table 2). MARK-recapture analyses estimated an overall census of 447.9 (435.5 to 456.6) individuals. Predicted age structure revealed

Table 2. Predicted population size across herds and ages of the Alberes population

	Global	*Freixe*	*Castanyers*	*Roig*
Recapture	0.83	0.84	0.75	0.91
Observed[z] (N)	370	234	88	48
Predicted (N)				
Overall	447.78	279.01	117.20	53.04
<1	72.95	40.47	20.85	11.47
1	61.89	35.21	17.33	9.04
2	52.50	30.63	14.39	7.12
3	44.54	26.65	11.96	5.61
4	38.85	23.74	10.25	4.60
5	30.09	19.10	7.70	3.20
6	26.22	17.00	6.59	2.62
7	24.32	15.96	6.05	2.34
8	20.15	13.60	4.89	1.78
9	17.22	11.91	4.10	1.42
10	15.76	11.05	3.71	1.25
11	12.29	8.94	2.81	0.87
12	9.59	7.23	2.12	0.61
13	7.48	5.85	1.61	0.43
14	5.83	4.74	1.22	0.30
15	4.55	3.83	0.92	0.21
16	3.55	3.10	0.70	0.15

[z]Observed = number of female animals (*N*) registered in the last recapture event (year 2007).

many more young and youthful animals than adults, which is linked to the difficulty of survival through the first years or life. Furthermore, this small census evidenced the critical status of the Alberes cattle breed in terms of genetic conservation (Oldenbroek 1999). The census of the Alberes cattle shows that the population is smaller than is needed to prevent continuous loss of genetic variation by inbreeding (Bodo 1989). Therefore, it is important to establish a control program that allows us to work towards improving the management of this population, by increasing survival rates and decreasing mortality during the first 3 yr of life. To avoid an overabundance of animals that could not be supported by the forests and pastures of the Alberes Mountains, it is necessary to use these techniques to determine the number of animals. Overcrowding could cause further problems, such as ground degradation, deficiency in nutritional resources and the loss of vegetal diversity. Finally, it is important to take into account the natural habitat management of the Alberes population, which is focused on the maintenance and restoration of the Alberes massif.

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