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Short Communication

Effect of cattle breeding on habitat use of Pampas deer *Ozotoceros bezoarticus celer* in semiarid grasslands of San Luis, Argentina

M.L. Merino [a,*], M.B. Semeñiuk [b], J.E. Fa [c]

[a] *Sección Mastozoología, División Zoología Vertebrados, Museo de La Plata, Universidad Nacional de La Plata, CICPBA (Comisión de Investigaciones Científicas de la Provincia de Buenos Aires), Paseo el Bosque (B1900FWA), La Plata, Buenos Aires, Argentina*
[b] *Sección Mastozoología, División Zoología Vertebrados, Museo de La Plata, Universidad Nacional de La Plata, CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas), Paseo el Bosque (B1900FWA), La Plata, Buenos Aires, Argentina*
[c] *Durrell Wildlife Conservation Trust, Les Augrés Manor, Trinity, Jersey, JE3 5BP, UK*

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ABSTRACT

The largest population of the Argentinean Pampas deer *Ozotoceros bezoarticus celer* is found in the semiarid grasslands of the San Luis province. Despite relatively high deer numbers in the region, there has been concern that expansion of farming practices could displace the species. Since the 1990's, cattle breeding has intensified especially as a result of the replacement of natural grassland with South African digit grass (*Digitaria eriantha*) and African lovegrass (*Eragrostis curvula*). In this study, we studied how deer in "El Centenario" ranch used available habitat types, especially to assess whether it preferentially used natural over exotic pastures. We employed 8 fixed line transects to record deer numbers and habitat use during the dry season, early rainy and late rainy seasons. We estimated a mean population size of 731 ± 121 individuals, a density of 1.95 ± 0.25 deer/km^2. Our results also showed that deer did not appear to select natural pastures over exotic ones, though *D. eriantha* grasslands with cattle were used less during the late rainy season. Grazed pastures with *D. eriantha* without cattle were used significantly more during all time periods. Our results therefore suggest that Pampas deer are not shifted by exotic pastures but we caution that it is important to manage these habitats sustainably (e.g. cattle load adjusted to grassland nutritional supply, rotational crops with parcel rest period), to ensure the conservation of the species within agricultural areas.

1. Introduction

The Argentinean Pampas deer (*Ozotoceros bezoarticus celer* Cabrera (1943)) is a cervid subspecies endemic to Argentina, now threatened with extinction (Diaz and Ojeda, 2000). Its geographic range has declined drastically to less than one percent of its historic range as a result of agricultural expansion (Demaría et al., 2003). Currently, it is found in two separate localities; one population in the western arid Pampean region, south-central San Luis Province (Dellafiore et al., 2003), and another in the coastal fringes of Samborombón Bay (Merino et al., 1997) (Fig. 1A). Because of its small population size (<300 individuals) the conservation status of the Samborombón Bay population is highly compromised (González and Merino, 2008; Vila, 2006). The San Luis population, however, estimated at around 700 individuals (Dellafiore et al., 2003) and therefore may have a better future if adequate conservation measures are taken.

Despite the reported high numbers of San Luis Pampas deer, there has been concern that the expansion of farming practices in the region could displace the species. Farming in the areas occupied by the deer has been dominated by extensive year-round Hereford and Aberdeen Angus cattle breeding (Aguilera and Panigatti, 2003), characterized by very low stocking rates, use of natural pastures in large (<10,000 Ha) paddocks often with a single watering station (Anderson et al., 1978; Frasinelli et al., 2003). Since the 1990's, cattle breeding has intensified in the area as a result of further subdivision of land plots, more and better distributed watering stations, the replacement of natural grassland with South African megathermal perennial species such as digit grass (*Digitaria eriantha*) and African lovegrass (*Eragrostis curvula*), as well as implementation of plot-based rotational grazing (Aguilera and Panigatti, 2003). These changes have also been favored by increases in precipitation (Berton and Echeverria, 1999).

* Corresponding author. Sección Mastozoología, División Zoología Vertebrados, Museo de La Plata, Universidad Nacional de La Plata, Paseo el Bosque (B1900FWA), La Plata, Buenos Aires, Argentina. Tel.: +54 221 4257744/9161x146; fax: +54 221 4257527.
E-mail address: mlmerino@fcnym.unlp.edu.ar (M.L. Merino).

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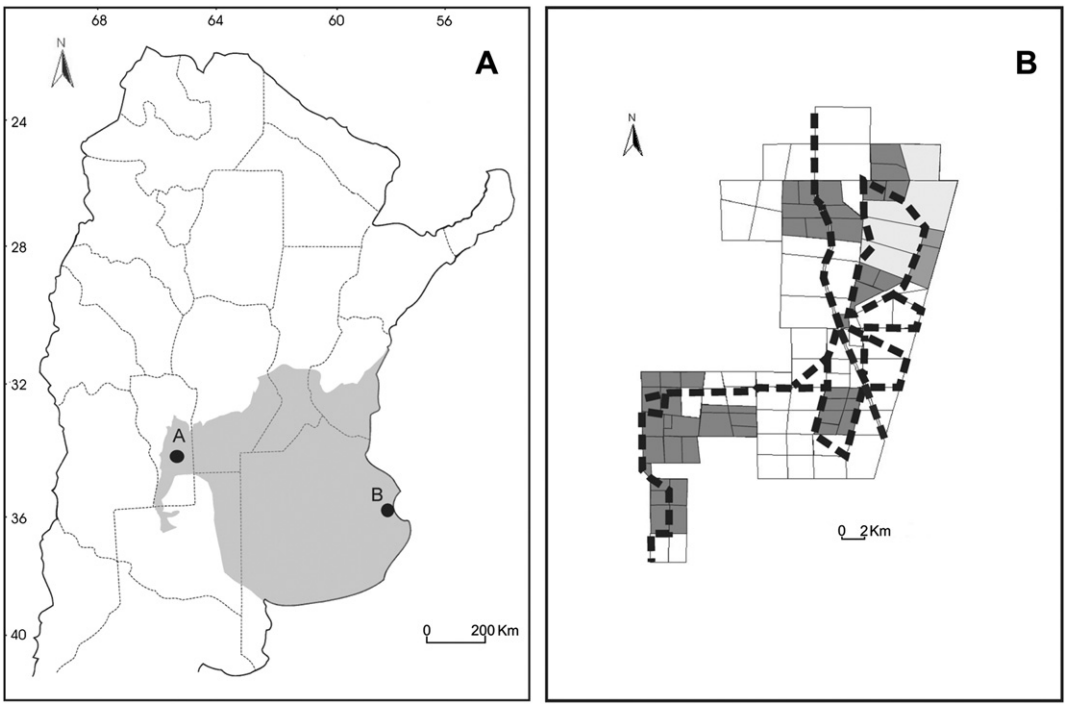

Fig. 1. (A). Current population cores of *Ozotoceros bezoarticus celer* in pampas grassland. A: semiarid grassland in San Luis province; B: coast of Samborombón Bay (Buenos Aires province). Gray area: pampas grassland region. (B) Ranch "El Centenario" (San Luis, Argentina). Dotted line: fixed-line transects. Grassland types: gray: natural grassland; dark gray: *Eragrostis curvula;* white: *Digitaria eriantha*.

The consequence of these agricultural changes on deer behavior and numbers is unknown. Collado and Dellafiore (2002) suggested that the widespread introduction of exotic pastures could force deer to seek refuge in remaining patches of less disturbed natural grasslands. And more categorically, Demaría et al. (2003) proposed that intensification of land use could precipitate deer extinction. In this paper, the goal was to evaluate the effects of intensification of cattle breeding on population size and habitat use by Pampas deer, through testing whether Pampas deer favor ungrazed grasslands and native species as suggested by previous authors, or whether they are able to coexist alongside new agricultural practices.

2. Materials and methods

2.1. Study area

The Pampas deer population in San Luis inhabits semiarid Pampean grasslands, a graminaceous steppe with small *chañar* (*Geoffroea decorticants)* patches (Anderson et al., 1970). Mean annual precipitation is 510 mm, about 80% of which falls between October and April, with low water availability during winter (Berton and Echeverria, 1999). The mean annual temperature is 17 °C, with a strong continental effect (43 °C in summer and 15 °C in winter) (Anderson, 1979). The seasonality of the rains and temperatures causes marked fluctuations in forage availability.

We studied the Pampas deer at "Rancho El Centenario" (34° 10′2.57″S, 65°50′26.82″W) (hereafter referred to as REC). This cattle ranch contains the largest Pampas deer nucleus of the San Luis population (Dellafiore et al., 2003). REC covers 380 km^2 subdivided into 27 paddocks with one watering station each. Cattle stocking rates here have increased from 0.067 cows/Ha in 1990, to 0.2 cows/Ha in 2006, largely as a result of the introduction of exotic pastures and changes in cattle rearing practices. During our study, only 18% of the ranch was natural grasslands (a severe drop from the 90% in 1992); the remaining grasslands occupied by *D. eriantha* (58%) and *E. curvula* (24%) (Molina, pers. com.) (Fig. 1B). These exotic pastures can be grazed throughout the year, especially in winter as dry standing paddocks (Veneciano et al., 2003). Together with native species such as *Sorgastrum pellitum* (a summer forage species) exotic pastures made up 90% of the total biomass, in two growth peaks. The highest peak occurred in spring (September–December) with the second in autumn (March–June); plant growth decreases markedly during the summer (December–March) and reaches almost null values in winter (June–September) (the critical period for herbivores) (Carrillo, 2005).

2.2. Deer density and population size

Between April 2006 and March 2007 ($n = 12$ censuses) we counted Pampas deer along 8 fixed-line transects (159 km per census) from a moving vehicle. All deer sighted within a 400 m-wide land segment on each side of each transect were included in the surveys. Censuses were carried out from 2 h after sunrise to 1 h before sunset. All animals seen were geo-referenced and perpendicular distances calculated from the animal to the line transect using a range-finder. Deer group composition was recorded according to three age-sex classes: adult males and females (≥two years) and young (individuals conspicuously smaller than adults) (Netto et al., 2000).

Overall population size and density (mean ± standard deviation) of the deer in the study area were estimated with DISTANCE 5.0 software (Thomas et al., 2006), using the most likely detection probability function model, and truncation selected using the Akaike Information Criterion (AIC) (Burnham and Anderson, 2002). Differences between censuses of observed individuals were evaluated using a *G*-test (Sokal and Rohlf, 1995).

2.3. Habitat use

Due to the clear differentiation between rainy and dry periods we evaluated use of pastures by Pampas deer during three main

time periods: dry season (June–September) when the winter species grow among the dry dead standing tussocks of the summer forage species, early rainy season (October–January) with the regrowth of the summer forage species (almost exclusive formation of leaf tissue), and late rainy season (February–May) when the summer forage species bloom and fructify (Fig. 2). For each period, we built a contingency table including three cattle management variables evaluated during censuses: 1) dominant pasture in the paddock, 2) presence of cattle (animals observed within a 500 m radius from the deer group), and 3) vegetation grazed by cattle (recorded forage consumption within a month or less before the survey). Habitat use was then defined as the number of Pampas deer observations relative to each of the studied variables (Garshelis, 2000).

We tested for significant selection of the different habitats by means of a log-likelihood *G*-test for each contingency table. The expected frequency for each habitat was estimated according to availability of each variable within the study area, and the total number of deer observed during each period of the year (Manly et al., 1993; Sokal and Rohlf, 1995). We tested whether particular variables deviated strongly from their expected values by examining the standardized residual of each cell in the contingency table. A negative residual value indicated that the observed frequency was lower than expected, while a positive one indicated the opposite; this difference was significant ($p < 0.05$) if the absolute value was >2 (Agresti, 2002; Sheskin, 2004).

3. Results

3.1. Deer density and population size

Mean individual density was 1.95 ± 0.25 deer/km^2 (%CV 21.98 ± 2.7). These data were obtained with a half-normal detection function, and a right truncation of the largest 5% according to AIC.

An average of 128.1 ± 22.3 deer was observed per census, with significant differences between periods ($G_{0.05,\ 11\ df}$ 26.4, $p < 0.05$). However, censuses undertaken during the calving period (October–December) did not differ significantly ($G_{0.05,\ 8\ df}$ 8.8, $p = 0.45$), because in these months the pregnant females and those with fawns, display cryptic behavior (Jackson, 1985). No significant differences were found in the number of young individuals estimated between censuses ($G_{0.05,\ 11\ df}$ 7.5, $p = 0.37$); these were observed next to adult females in 97% of sightings. The estimated mean population size during the study was 731 ± 121 individuals; coefficient of variation (%CV) = 21.40% ± 2.9.

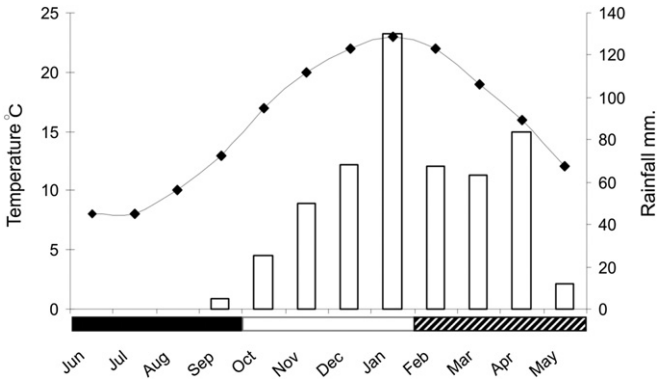

Fig. 2. Relationship between rainfall and average T° at the ranch "El Centenario" (San Luis, Argentina) (Period, 1995–2007). Different period, black: dry season, white: early rainy season, oblique stripes: late rainy season.

3.2. Habitat use

Significant differences were found between observed and expected frequencies when cattle management variables were compared ($G_{0.05,\ 11\ df}$: 83.3 ± 31, $p < 0.05$). These results suggest non-random habitat use.

During the late rainy season, Pampas deer showed significant use of non-grazed pastures including natural grassland and *Digitaria* (Fig. 3A). Non-grazed pastures with *Eragrostis* were less utilized throughout the year. During the dry season (Fig. 3B) and early rainy season (Fig. 3C), non-grazed *Digitaria* pastures were

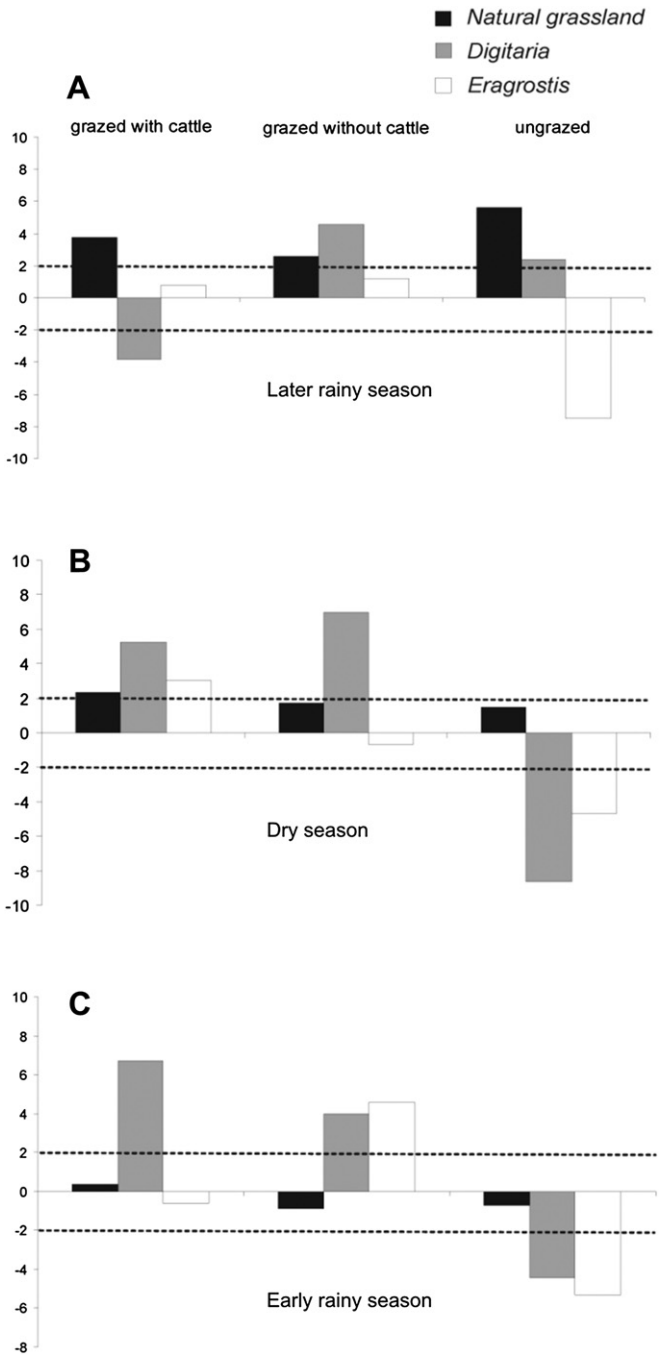

Fig. 3. Residual values from Pearson analysis of number of Pampas deer individuals observed during different periods with respect to pasture use conditions (2006/2007) at the ranch "El Centenario" (San Luis, Argentina). The dotted line indicates significance level.

under-used. On the other hand, grazed *Digitaria* with no cattle presence, were used more than expected during the three periods considered.

The presence of cattle did not negatively affect the presence of Pampas deer, except during the late rainy season, when the *Digitaria* pastures with cattle presence were used significantly less (Fig. 3A). During this period, Pampas deer positively selected natural grassland with cattle presence, whereas in the dry season they selected all pastures, and in the early rainy season only *Digitaria*.

4. Discussion

The Argentinean Pampas deer is an emblematic ungulate, whose populations have declined drastically since the expansion of farming activities in the Pampean region. This situation is complicated because this population is near the southern boundaries of the historical distributional range of the species (Jackson and Langguth, 1987). Until the late 1980's, traditional use of land in the semiarid grasslands of San Luis consisted of extensive cattle breeding using native pastures. This system has been gradually replaced by the use of exotic pastures and greater technification. Both alien pasture species introduced in the area of study, *D. eriantha* and *E. curvula*, also are used as forage grass in their native ranges (Fernandez et al., 1991; Meissner, 1997).

Some authors have suggested a direct correlation between the decline in deer population and agricultural expansion, even resulting in their extinction (Dellafiore et al., 2003; Demaría et al., 2003).

The population estimate of more than 700 individuals does not differ significantly from the population size estimated by Dellafiore et al. (2003), which in fact was calculated before natural pastures were replaced. That the deer population size did not decrease after the introduction of exotic pastures would indicate that this replacement did not adversely affect the Pampas deer population. In addition, these results suggest there is good population viability, given that a third of the individuals that were recruited during the study and half of the observed females were accompanied by juveniles that survived perinatal mortality (Jarnemo, 2004).

Although this study found non-random habitat use by the Pampas deer, our results do not support the hypothesis that the deer would prefer little-disturbed natural grasslands, as previously proposed by Dellafiore et al. (2003). Under the traditional system of continuous cattle grazing, winter and summer species with high foraging quality that grew in the vicinity of the less abundant watering stations were actually overgrazed (Deregibus et al., 1995). The replacement of this system by rotational grazing, with an increase in number of watering stations (and greater division of the land), results in higher cattle loads during shorter periods, allowing pasture regrowth and avoiding overgrazing of the more palatable species (Aguilera, 2003).

Given the lower frequency of natural fires, cattle are probably acting as a modulating agent for the grassland, thus allowing constant regrowth of the foraging species that are widely consumed by the deer. This situation is particularly intense during the critical dry season, when the nourishment of Pampas deer is based on winter species (Jackson and Giulietti, 1988); thus, the regrowth of the latter is favored by cattle consumption of the dead plant material leftover from the summer species (Frasinelli, 1997).

Cattle are a typical "bulk and roughage feeder" sensu Hofmann (1989), characterized by their low selectivity and highly efficient cellulose digestion, and are consequently better adapted to consumption of foods with high proportion of low digestible fibers, such as dry standing material from grasses. In contrast, Pampas deer is a concentrate selector sensu Hofmann (1989), with a diet restricted to green and highly nutritive parts of plants (Merino, 2003). Therefore, cattle grazing would favor the deer, because cattle feed on the dry standing portion of grasses, favoring their regrowth and the increase of green parts that constitute the main part of Pampas deer diet (Merino, 2003). Consequently, the deer tend to select areas that have previously been grazed by cattle. Thus, deer and cattle utilize the same grass species, but they consume different parts at different times.

The occurrence of cattle seems not to affect the presence of Pampas deer, in agreement with previous observations (Jackson, 1985). The only situation in this study in which negative interaction was detected in *Digitaria* lots during the late rainy season (Fig. 3A); possibly due to the intensification of cattle movements brought about by the end of the cattle breeding cycle. On the other hand, the Pampas deer have been observed to use the stubble from some produce crops and winter "cover crops" as feeding patches during winter (Merino et al., 2009). However, the deer was observed to use areas adjacent to these patches, where the good conditions of the pasture allowed its use as a refuge in threatening situations. Currently, in Argentina the largest population of Pampas deer inhabits an area where the use of the land has increased in the last decade. It is fundamental to consider such activities for any future management of these areas for their conservation.

Although the early and late rainy seasons may not be critical periods for the Pampas deer with respect to the food availability (Jackson and Giulietti, 1988), we observed selection of grazing areas. This could happen because cattle grazing favors the appearance of tender shoots in the summer forage species and prevents their blooming and fructification (Carrillo, 2005).

Our work has shown that improved farming activities appear to be beneficial or at least for the survival of this population, because these seem to increase the availability of better-quality patches in the deer's habitat. These results suggest that intensification of cattle breeding does not affect the abundance of the Pampas deer population in the semiarid grassland of San Luis, contrary to the previous suggestions, although it has a direct effect on their habitat use.

Consequently, the fact that the Pampas deer can maintain populations within productive areas managed with a sustainable approach to grasslands use (cattle load adjusted to the nutritional supply, rotational crops with a period of parcel rest, and adequate distribution of watering stations), opens an important avenue for the conservation of the species that may complement the creation of protected areas in the region.

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