Home range of pampas deer in a human–dominated agro–ecosystem

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Abstract

Home range of pampas deer in a human–dominated agro–ecosystem. The subspecies of pampas deer *Ozotocerus bezoarticus uruguayensis* is an endemic and endangered cervid from southeast Uruguay. However, knowledge regarding its home range requirements in agroecosystems is scarce. Our aim was to survey ten radio–collared pampas deer for two years to monitor their movements. The mean home–range size was 5.54 ± 3.18 km^2. The core area size for all individuals monitored was 0.87 km^2, which concurs with grazing crops for beef cattle. The population showed philopatric behavior and no significant differences were detected in the total area of occupation in respect to sex and season.

Key words: *Ozotoceros bezoarticus uruguayensis*, Neotropical deer, Spatial ecology, Habitat selection, Conservation, Uruguay

Resumen

El área de distribución del venado de campo en un ecosistema agrícola dominado por los seres humanos. La subespecie de venado de campo *Ozotocerus bezoarticus uruguayensis* es un cérvido endémico del sureste de Uruguay que se encuentra en peligro de extinción. A pesar de ello, se tienen pocos conocimientos sobre sus necesidades respecto del área de distribución en ecosistemas agrícolas. El objetivo de este trabajo fue rastrear los movimientos de 10 venados de campo marcados con collares transmisores por un período de dos años. La superficie media del área de distribución fue de 5,54 ± 3,18 km^2. La superficie del área central para todos los individuos estudiados fue de 0,87 km^2 y coincidió con parcelas de cultivo para el pastoreo de vacuno de carne. Esta población mostró un comportamiento filopátrico y no se detectaron diferencias significativas en la superficie total de ocupación en función del sexo o la estación.

Palabras clave: *Ozotoceros bezoarticus uruguayensis*, Venado neotropical, Ecología espacial, Selección de hábitat, Conservación, Uruguay

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Introduction

Pampas deer, *Ozotoceros bezoarticus*, is a medium–size ungulate native to the open grassland habitats of South America from 1ºS to 41ºS (Cabrera et al., 1940; Jackson and Langguth, 1987; González et al., 2010; Rocha et al., 2019). Their natural habitat (Pampas, Cerrado, and grasslands of Argentina, Uruguay, Paraguay, Bolivia, and Brazil) has diminished drastically over the last two centuries, mainly due to modifications related to agricultural activities (Fonseca et al., 1999; González et al., 2010). The pampas deer has been cataloged by the Uruguayan government as a threatened species, and declared a living Uruguayan Natural Monument (Ministerial Decree 12/985). Nevertheless, management guidelines have not yet been established, and actions have not been taken to ensure the effective conservation of populations on private land (González et al., 2010). The subspecies *O. b. uruguayensis* (González et al., 2002) occurs at Sierra de Los Ajos, in the Rocha Department (southeast Uruguay) and is one of the most endangered subspecies; there is only one population, and th is consists of fewer than 350 individuals. The breeding season starts in September and continues through December. In 2002 this population occupied around 25 km^2 on private ranches where various agricultural activities were conducted (Jackson et al., 1980; Cosse et al., 2009). In the same year, on some ranches in the Rocha Department, an outbreak of *Brucella abortus* was reported in livestock. In October 2002 the Ministerial Uruguayan Animal Sanitary Authority (MGAP) requested we perform a pampas deer capture to assess the role of pampas deer as a reservoir of *B. abortus*. This assessment provided the opportunity to radio–tag animals in order to evaluate this population's spatial patterns of use in an agro–ecosystem (González and Duarte, 2003).

Few studies have been conducted to determine the home range and habitat selection for Brazilian, Argentinian, and Uruguayan Pampas deer populations (Leeuwenberg et al., 1997; Pinder, 1997; Rodrigues and Monteiro–Filho, 2000; Moore, 2001; Lacerda, 2008; Vila et al., 2008). Understanding the ecological processes that determine the home range and patterns of use of space is crucial to develop and implement management and conservation plans (Gordon et al., 2004; Börger et al., 2006, 2008; Wingfield, 2009).

Our aim was to monitor the ten tagged pampas deer for two years to assess their home range size in an agro–ecosystem. This is the first report of the home range with radio–collared animals on Uruguayan populations.

Material and methods

Study area

The study area of the Los Ajos population is mainly located within an 80 km^2 ranch (33º 50' 01" S; 54º 01' 34" W) located in the Bañados del Este Biosphere Reserve in the southeastern Uruguayan department of Rocha. The landscape is characterized by low, rolling hills; the soils are predominantly gley. Altitudes range from –5 to 100 m a.s.l., the annual average rainfall is 1000 mm, and the average annual temperature is 16ºC (Herzig, 1994). The pampas deer population size was estimated as 117 individuals, occupying an area of 25 km², the highest density recorded for the species with 11 animals/km² (Cosse and González, 2013). The main ranch activities at the study site are livestock (cattle and sheep ranching), rice crops for human consumption, and ryegrass for pasture of the livestock. Pampas deer and domestic animals in the area share grazing land. Cattle are fenced in various paddocks and managed by the ranchers. Rotation is performed in accordance with forage requirements. The pampas deer can move freely from one paddock to another by crossing under the bottom strand of wire.

Methods

In October 2002 pampas deer from the Los Ajos population were captured by ranch staff on horseback using fixed nets .The animals were herded under supervision of the Uruguayan animal health authorities (Duarte et al., 2010). The veterinarian staff restrained the deer immediately after capture and the animals were administered intravenous ketamine (150 mg) and xylazine (30 mg) (Pinho et al., 2010). All captured animals were tagged with Allflex ear tags and blood samples were taken to perform serological tests and genetic analysis. Ten animals were fitted with radio collars (Wildlife Material Inc., 150–151 Mhz; González and Duarte, 2003).

As the captured specimens were adults, this study does not take juvenile deer dispersal patterns into account. Radio–tagged animals were located monthly from December 2002 to February 2005.

Monitoring was carried out during the day, with two recording periods (7:30–13:30 h and 13:31–19:30 h). The geographic locations were obtained by triangulation using a hand–held four–element Yagi RA–2AK antenna and a TR–4 Telonics portable receiver. Three azimuth readings per fix were obtained with a compass. To minimize error due to the animals' movements, the time between each recording was established at a maximum of 25 minutes. Each animal was located incorporating only the azimuths that differed from each other on 60–120º (White and Garrott, 1990). Whenever possible, location was verified by binoculars or telescope. These occasional sightings of radio–collared animals were geo–referenced using a Garmin eTrex H GPS (Olathe, KS, USA) and included in the analysis. In these cases we recorded the reproductive state and group composition.

Data points concerning the animals' location were obtained using the computer program LOCATE II (Nams, 2000). We rejected triangulation fixes with an error ellipse exceeding 0.5 km^2 (Atwood et al., 2004). The locations were then loaded into an Arcview Gis 3.3 (ESRI, Redlands, CA, USA) project. The Animal Movement Analyst Extension 2.0 (Hooge and

Table 1. Radio–tracked Pampas deer in this study: EAY, estimated age in years at capture; RS, reproductive status at capture; RTTM, radio–tracked time in months; Fixes, number of fixes; GS, group size; and home ranges (km^2) of pampas deer calculated using minimum convex polygon (MCP) and fixed Kernel estimators; DO, direct observation.

Tabla 1. Datos de individuos monitoreados en este estudio: EAY, edad estimada, en años, al momento de la captura; RS, estado reproductivo de las hembras al momento de la captura; RTTM, tiempo de monitoreo en meses; Fixes, número de registros; GS, tamaño de grupo; y áreas de distribución (km^2) calculado utilizando los estimadores de mínimopolígono convexo (MCP) y Kernel; DO, observación directa.

Ind.	Sex	Sex	EAY	RS	Mass (kg)	RTTM	Fixes	MCP	Kernel 95%
SG124	♂	Male	3	–	35	5	5	1.27	5.28
SG125	♂		4	–	25	DO 2004	–	–	–
SG126	♂	Male	4	–	35	20	29	7.97	9.28
SG129	♂	Male	No data	–	31	21	30	4.19	4.39
SG130	♂	Male	3	–	no data	5	–	–	–
SG127	♀	Female	4	Pregnant	25	18	15	6.26	8.68
SG131	♀	Female	3	Pregnant	27	21	35	5.04	4.5
SG132	♀	Female	2	–	29	21	37	5.66	3.3
SG133	♀	Female	3	Lactating	25	21	25	6.62	5.5
SG137	♀	Female	18 m.	Pregnant	22	5	–	–	–
Male mean					31.5			4.5	6.3
Female mean					25.6			5.9	5.5

Eichenlaub, 2000) was used to estimate home range following the minimum convex polygon (Mohr, 1947) and Kernel density with 95 % of locations (Worton, 1989). We used Student's *t*–tests (Zar, 1999) to evaluate any significant differences between sexes and seasons regarding home–range size (Atwood et al., 2004; Shibuya et al., 2018).

Interactions between radio–collared animals were analyzed following the measure of static territorial interaction (*S*) (White and Garrott, 1990). This value represents the proportion of $animal_i$'s home range overlapped by $animal_j$'s home range. We also estimated the mean overlap area (R_{ij}), which represents the size of the area of overlapping among deer *i* and *j* (Chaverri et al., 2007). In all cases, the home ranges included in each analysis were generated from locations taken at the same time (n = 6 from 2003; n = 5 from 2004). We did not test for statistical significance of home range overlap because of the low number of locations. To determine whether the radio–collared pampas deer interact in space, a complete linkage clustering method (Romesburg, 2004) was performed (StatSoft Inc., 2004) using Euclidian distance with the matrix data from the value of overlap between each deer pair. Additionally, we estimated the pampas deer densities in the paddocks where radio–collared animals were located following Cosse and González (2013).

Results

Sixteen adult deer were captured (8 males: 8 females); two deer (12.5 %) died in the capture procedure. Ten deer, 5 females and 5 males, were radio–tagged. Only one radio collar (deer identification number SG125) did not receive the VHS signal. However, the animal was seen on one occasion, and recognized by the ear tag number. We were able to determine that the radio–collar antenna was broken and not transmitting. Three deer were monitored until they died at less than six months and it was not possible to determine the cause of death in any of the three. Six individuals (two males and four females) were monitored for 18–21 months (table 1), during which time we obtained 184 locations. The estimated locations obtained with Locate II were confirmed by direct observation in 26 % of cases. The mean home range per individual was estimated as 5.54 ± 3.18 km^2. The activity area and the core area sizes obtained for all the individuals monitored in this study were 16.83 km^2 and 0.87 km^2, respectively (fig. 1). The activity range area remained unchanged for the two consecutive years (MPC: 12.9 km^2 and 13.5 km^2).

The core area concurs with the capture zone and is part of the paddocks in which grazing crops were grown for beef cattle breeding. No statistically significant differences were detected with the Student's

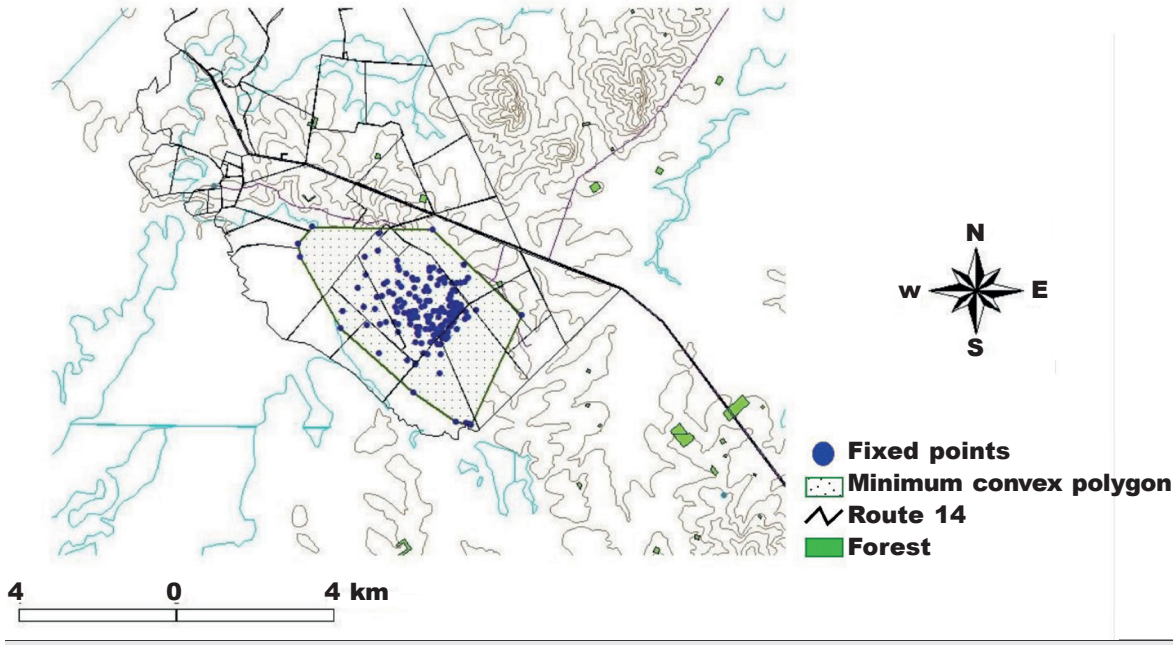

Fig. 1. Monitored area showing details of the specimens' location points and the total area of occupation, obtained over the 26 months of monitoring. The fine black lines represent the paddocks with different forage types. The brown lines show level curves and blue lines represent water courses.

Fig. 1. Mapa del área estudiada donde se señala la localización de los individuos y la superficie total de ocupación en los 26 meses de rastreo. La línea negra continua delgada representa las parcelas con diferentes tipos de forraje. Las líneas marrones muestran las curvas de nivel y las líneas azules representan los cursos de agua.

t–test in the total area of occupation after discriminating by sex and season, including spring, which is the breeding season.

The pairwise percent overlap of home ranges showed an average value equal to 36.5 %. However, the overlap in home ranges of females was greater than that between mixed and male pairs (fig. 2). The results of cluster analysis of the overlapping matrix associations of radio–collared individuals (R*ij*) were consistent for the two years of the study (fig. 3). Both males evaluated were spatially highly associated with two females who, in turn, presented an association in the use of the environment (SG129♂ with SG131♀ and SG132♀ / SG126♂ with SG127♀ and SG133♀; see fig. 3).

Discussion

The home range sizes obtained in this study are in concordance with those observed for other pampas deer populations in Uruguay, Argentina, and Brazil, in which average values recorded ranged from 0.35 to 7.9 km^2 (Leeuwenberg et al., 1997; Moore, 2001; Lacerda, 2008; Vila et al., 2008). These home range sizes and the low level of movement displayed by the individuals suggest the species has a philopatric behavior. However, in a one–year radio–tracking study of six deer in an EMAS population (Cerrado biome, Rodrigues and Monteiro–Filho (2000) reported greater home ranges for the species, with a mean value of 82.3 km^2 (min: 48; max: 146.8 km^2). Based on the theory of optimal foraging (MacArthur and Pianka, 1966) tthey suggested that the animals at the Emas National Park limit their movements in the dry season (when forage is scarce) and stay in forage patches because it is energetically expensive to move to distant patches, but during the wet season, they move long distances so as to reach the areas with optimal forage, reaching the most distant home ranges described for pampas deer to date.

The species has been described as selective feeders or concentrate selectors (Jackson and Giulietti, 1988; Pinder, 1997; Rodrigues and Monteiro–Filho, 1999; Merino, 2003; Cosse et al., 2009). Pampas deer can also be considered mixed feeders, switchingbetween grazing and browsing throughout the year, mostly due to changes in environmental conditions. Pampas deer from Argentine and Uruguay occupy a wide variety of open grassland habitats in which temperate grasses are in general significantly more digestible than tropical grasses (from Cerrado and Pantanal in Brazil) (Demment and Van Soest, 1985; Pinder, 1997), and potentially more palatable.

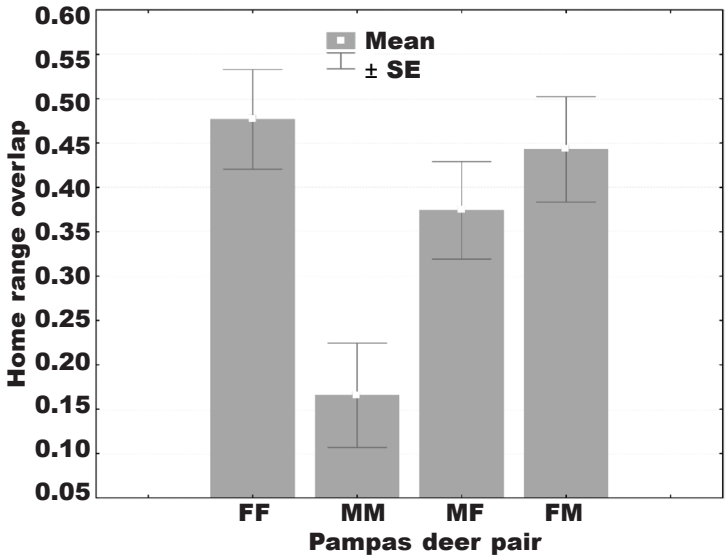

Fig. 2. Home range overlap (mean and standard deviation) between pampas deer of the same sex and different sex: F, females; M, males.

Fig. 2. Solapamiento en el área de distribución (media y desviación estándar) entre venados de campo del mismo sexo y de diferente sexo: F, hembras; M, machos.

However, in the Pantanal, the pampas deer can find high quality forage on a local scale throughout the different seasons following the pulse of the floods (Lacerda, 2008). In contrast, in the Cerrado, where the scrub landscape is dominated by C4 rough grasses of reduced digestibility, the pampas deer may respond with a larger home range (Pinder, 1997; Lacerda, 2008).

The home ranges observed at Los Ajos population are in concordance with the opportunistic feeding behavior described by Cosse et al. (2009), where the pampas deer occupy a cattle–raising paddock with high nutritional temperate forage such as ryegrass (*Lolium* sp.). This population showed the highest densities of pampas deer (Cosse and González, 2013) in these large capacity paddocks. Chaverri et

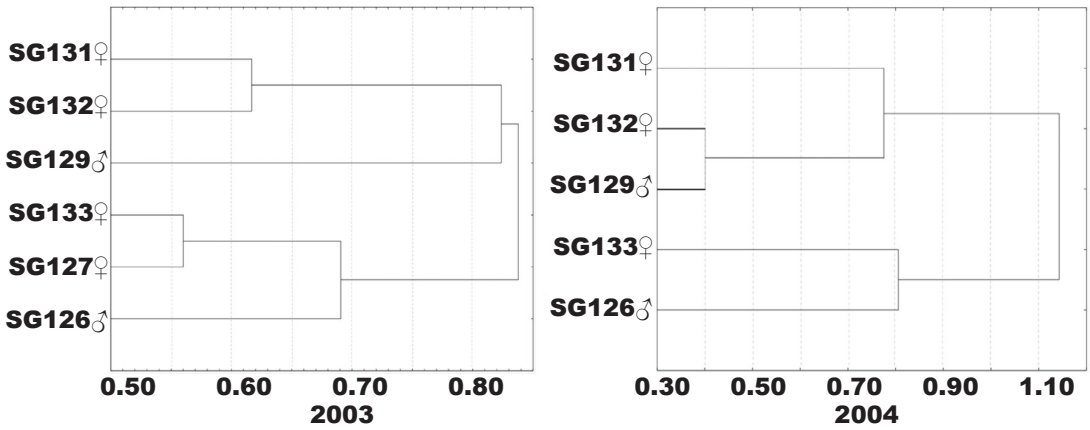

Fig. 3. Cluster analysis results on the mean overlap matrix (S) for pampas deer pairs. Associations in the use of the environment were consistent over the two years (2003–2004) of monitoring.

Fig. 3. Resultados del análisis de conglomerados realizado a partir de la matriz del valor medio de solapamiento (S) para los pares de venados de campo. Las asociaciones en el uso del ambiente son las mismas en los dos años (2003 y 2004) de rastreo.

al. (2007) suggest that an extraordinary supply of resources favors high population density and this is a predominant force behind high social interaction, as observed in on the Los Ajos population. The nutritional quality of the Uruguayan temperate grassland allows the coexistence of pampas deer population and cattle ranching.

The individuals analyzed from the Los Ajos pampas deer population showed no statistically significant differences between home range size, sex, or season. These results are consistent with several other studies of pampas deer populations (Leeuwenberg et al., 1997; Rodrigues and Monteiro–Filho, 2000; Moore, 2001; Lacerda, 2008) and could be related to the gregarious behavior, with a group composition that includes both adult males and females, and the favorable nutritional conditions of the temperate grassland where pampas deer populations are mainly located.

At Los Ajos, we observed a mean value of overlap of 36.5%, which is considerably lower than that for the Emas (around 80%) and Samborombón (50%) populations (Rodrigues and Monteiro–Filho, 2000; Vila et al., 2008). However, when we analyzed the value of the mean overlapping area (R_{ij}) each year separately, we found a permanent spatial association between the individuals. In turn, if the population has a stable group structure, we can expect to find different levels of overlap between individuals of the population, as observed at Los Ajos. Furthermore, the combined and independent effects of demography and social affinities could determine the overlapping in home range.

Conservation implications

As our findings show the pampas deer has a philopatric behavior, it is important to promote specific conservation policies to assure the long term viability of the remaining pampas deer populations in Uruguay. While biodiversity offsets are increasingly being used by governments and companies, an International Union for Conservation of Nature (IUCN) study found current efforts to mitigate impacts were proving insufficient to reduce the decline in biodiversity (Bull and Strange, 2018).

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