

# CHAPTER 12

## PAMPAS DEER *Ozotoceros bezoarticus* (Linnaeus 1758)

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### GENERIC SYNONYMY

*Ozotoceros* Ameghino, 1891:243. Type species *Blastocerus campestris* Gray, 1850:237 (not *Cervus campestris* Cuvier)= *Cervus bezoarticus* Linnaeus, 1758:67.

*Ozotoceros* Palmer, 1904: 492 Lapsus for *Ozotoceros* Ameghino.

*Ozelaphus* Knottnerus-Meyer, 1907:98. Type species *Blastocerus campestris* Gray, 1850:237 by designation.

### SPECIES SYNONYMY

*Ozotoceros bezoarticus* Linnaeus, 1758:67. Type locality South America restricted to Pernambuco Brazil by Thomas, 1911:151.

*Cervus cuguapara* Kerr, 1792:303. Renaming as *Cervus bezoarticus*.

*Cervus leucogaster* Goldfuss, 1817:1127. Type locality Paraguay restricted to Asunción by Cabrera 1943:31.

*Cervus azarae* Wiegmann, 1833:954. Type locality Paraguay.

*Cervus comosus* Wagner, 1844:368. Type locality probably Pernambuco Brazil.

*Cervus pampaes* Bravard, 1857:10. Type locality Paraná-Argentina (a fossil).

*Blastocerus sylvestris* Gray, 1873:427. Type locality Brazil.

*Blastocerus bezoarticus* L. 1758 (Pocock, 1933; Asdell, 1946)

*Blastoceros bezoarticus* L. 1758 (Langguth and Jackson, 1980; Frädrieh, 1981a, 1981b; Spotorno et al., 1987)

*Odocoileus bezoarticus* L. 1758 (Langguth and Anderson, 1980).

### COMMON NAMES

*Spanish:* Argentina: *Venado de las pampas*, *ciervo de las pampas*; Argentina, Bolivia, Paraguay, Uruguay: *Venado*, *venadito*; Argentina, Bolivia, Paraguay: *venadillo*, *gama* (often used to designate females); Uruguay: *Venado de campo*.

*Portuguese:* Brasil: *Veado*, *veado-branco*, *veado-campeiro*, *veado-galheiro*.

*Indigenous:* *Gwazú-tí* (Guaraní) northern Argentina, southern Brazil and Paraguay (Dennler 1939); *Guasu ti* Paraguay, *Yoam-shezée* (Puelche) Argentina (Cabrera and Yepes 1960).

*English:* *Pampas deer*

### SUBSPECIES

*O. b. bezoarticus* Linnaeus 1758, in the Cerrado ranging from eastern and central Brazil, south of the Amazon river between the plateau of Mato Grosso and the upper San Francisco river.

*O. b. celer* Cabrera 1943, inhabiting the entire Argentinean pampas from the Atlantic coast to Sub Andean foothills and southward to the Rio Negro basin.

*O. b. leucogaster* Goldfuss 1817, located in the seasonally flooded grasslands of southwestern Brazil in southern Mato Grosso, southeastern Bolivia, Paraguay and in the Chaco savannas in northern Argentina (northern Santiago del Estero, Santa Fe, Formosa and Corrientes).

*O. b. arerunguaensis* González et al. 2002. Type locality.- Uruguay; northwestern Salto Department, Arerunguá, El Tapado, 31°41'51"S, 56°43'31"W.

*O. b. uruguayensis* González et al. 2002. Type locality.- Uruguay, grasslands of eastern Rocha Department, Sierra de Los Ajos, 33°50'01"S; 54°01'34"W.

### MORPHOLOGICAL DESCRIPTION

The Pampas deer is a medium sized cervid that weights from 20 to 40 kg and shows a wide variation in body size both among individuals and between populations (Table 1). The coat color varies geographically according to subspecies from pale red-brown (*O. b. bezoarticus*) the northern subspecies, through tawny brown (*O. b. leucogaster*) to bay in the southern subspecies (*O. b. celer*) and different tones of bay from light fawn brown to tawny, bay, and dark cinnamon bay in *O. b. arerunguaensis* and *uruguayensis* (Cabrera 1943; González et al. 2002; Ridgway 1912). Fawns are spotted until three months of age. Afterwards they change to the juvenile coat similar to that of adults, though a bit more reddish (Figure 1). The face at the frontal part has a dark brown to black rhomboid (*O. b. leucogaster* and *arerunguaensis*). Whitish or cream-colored areas occur as tarsal tufts, as well as around each eye, inside the ears, the lips, throat, chest underparts, front and inner sides of the thighs, inner parts of the buttocks and underside of the tail (Cabrera 1943). Females have a small white spot located on each side of the forehead, in the same area where the antler pedicels are located in the males. White individuals have been reported (Rodrigues et al. 1999; Whitehead 1972).

Only males have antlers, typically with three characteristic tines (Figure 2), although it is not uncommon to see individuals with a larger number of tines.

The Pampas deer has well developed preorbital scent glands with a characteristic strong smell reminiscent to garlic or onion. In fact, the name “Yoam-shezée” given to this species by the Puelches, means “smelly or stinking deer” (Cabrera and Yepes 1960). Other glands present are the vestibular nasal and metatarsal. Metatarsal glands may or may not be present (Jackson 1987). They were not detected by Miller (1930) or Langguth and Jackson (1980), but were detected by Hershkovitz (1958) and Bianchini and Delupi (1979).



**Figure 1** - Pampas deer male from Pantanal, Brazil (Courtesy, M.D. Christofolletti).

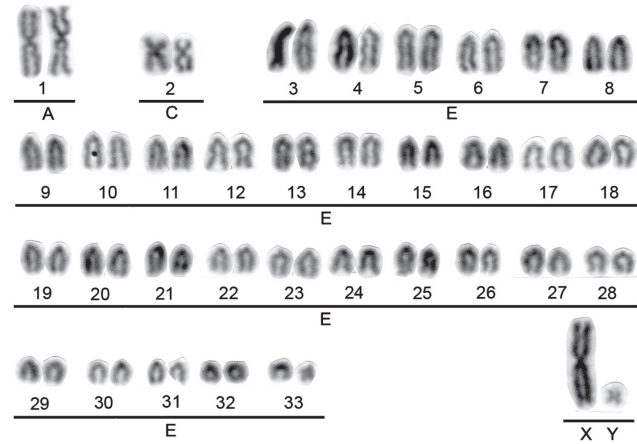


**Figure 2** - Pampas deer doe from Emas National Park, Brazil (Courtesy, R.J.G. Pereira).

### CYTOGENETIC DESCRIPTION

The diploid number of 68 chromosomes, with two metacentric autosomes and the remaining being acrocentric chromosomes (NF= 74; Figure 3). The X

chromosome is the largest of the karyotype and metacentric, while the Y is the smallest and also metacentric. Cytogenetic studies on Pampas deer found no geographic variation in chromosome number or morphology (Bogenberger et al. 1987; Duarte 1996; Duarte and Giannoni 1995; González 1997; González et al. 1992; Neitzel 1987; Spotorno et al. 1987). Only in the Ag-NORs banding pattern were reported differences among one Uruguayan animal studied by Spotorno et al. (1987) and the sample analyzed by Duarte and Giannoni (1995). In addition a slight difference in the C banding pattern of the X chromosome was found among the individuals studied.



**Figure 3** - Pampas deer male standard karyotype formulae  $2n=68$ ; NF= 74 (Courtesy J.M.B. Duarte).

### MOLECULAR GENETICS

DNA sequences from the mitochondrial control region (DNA mt) were examined in 54 individuals from six localities with the objective of analyzing the effect of habitat fragmentation on gene flow and genetic variation, and to uncover genetic units for conservation (González et al. 1998). The Pampas deer control region showed high polymorphism reflecting large historic population sizes of millions of individuals in contrast with the low numbers observed today. Five conservation genetic units were determined coincident with the five subspecies: Emas (*O. b. bezoarticus*), Pantanal (*O. b. leucogaster*), El Tapado (*O. b. arerunguaensis*), Los Ajos (*O. b. uruguayensis*) and Bahía Samborombón-San Luis (*O. b. celer*).

The levels of genetic diversity found in the species suggest that historic population sizes were several orders of magnitude larger than current population sizes and that, recently, populations have decreased dramatically, thus providing a strong mandate for conservation efforts (Gonzalez et al. 1998).

### DISTRIBUTION

#### Historical

The Pampas deer was a widespread species occupying a range of open habitats, including grasslands, pampas and the Brazilian savanna known as the Cerrado, in eastern South America from 5° to 41° South (Cabrera 1943; González et al. 2002; Jackson 1987; Merino et al. 1997; Weber and González 2003; Figure 4). However

**Table 1** - Biometry of Pampas deer subspecies.

Measure	Population	Subspecies	Male	Female
Weight (Kg)	Emas <sup>a</sup>	<i>O. b. bezoarticus</i>	31.68 ± 6.19 (8)	28.38 ± 2.64 (9)
	Pantanal <sup>a</sup>	<i>O. b. leucogaster</i>	32.42 ± 4.50 (7)	26.42 ± 2.22 (7)
	Los Ajos <sup>b</sup>	<i>O. b. uruguayensis</i>	31.5 ± 4.72 (4)	25.57 ± 2.14 (7)
	El Tapado <sup>c</sup>	<i>O. b. arerunguaensis</i>	23.62 ± 2.04 (5)	21.50 ± 4.94 (2)
	Bahía Samborombón <sup>d</sup>	<i>O. b. celer</i>	33.92 ± 2.63 (6)	28.92 ± 2.69 (6)
Shoulder height (cm)	Emas <sup>a</sup>	<i>O. b. bezoarticus</i>	68.56 ± 3.70 (8)	65.27 ± 2.42 (9)
	Pantanal <sup>a</sup>	<i>O. b. leucogaster</i>	70.07 ± 2.76 (7)	69.07 ± 1.13 (7)
	Los Ajos <sup>b</sup>	<i>O. b. uruguayensis</i>	65.20 ± 1.92 (5)	61.90 ± 1.14 (5)
	El Tapado <sup>c</sup>	<i>O. b. arerunguaensis</i>	65.80 ± 4.20 (5)	65.50 ± 3.96 (3)
	Bahía Samborombón <sup>d</sup>	<i>O. b. celer</i>	69.02 ± 4.9 (5)	66.00 ± 2.8 (6)
Ear length (cm)	Emas <sup>a</sup>	<i>O. b. bezoarticus</i>	13.68 ± 0.70 (8)	13.00 ± 0.79 (9)
	Pantanal <sup>a</sup>	<i>O. b. leucogaster</i>	13.14 ± 0.62 (7)	12.57 ± 0.73 (7)
	Los Ajos <sup>b</sup>	<i>O. b. uruguayensis</i>	11.33 ± 0.40 (6)	10.64 ± 0.55 (7)
	El Tapado <sup>c</sup>	<i>O. b. arerunguaensis</i>	12.50 ± 1.72 (3)	11.03 (1)
	Bahía Samborombón <sup>d</sup>	<i>O. b. celer</i>	11.82 ± 0.39 (5)	11.78 ± 0.42 (6)
Tail length (cm)	Emas <sup>a</sup>	<i>O. b. bezoarticus</i>	13.68 ± 1.41 (8)	14.05 ± 1.18 (9)
	Pantanal <sup>a</sup>	<i>O. b. leucogaster</i>	13.50 ± 0.50 (7)	13.64 ± 2.23 (7)
	Los Ajos <sup>b</sup>	<i>O. b. uruguayensis</i>	11.58 ± 1.56 (6)	12.07 ± 1.59 (7)
	El Tapado <sup>c</sup>	<i>O. b. arerunguaensis</i>	10.76 ± 2.65 (3)	11.00 (1)
	Bahía Samborombón <sup>d</sup>	<i>O. b. celer</i>	10.12 ± 2.1 (5)	9.42 ± 1.5 (6)

References: The mean measurements and standard deviations obtained (in brackets the number of individuals measured) from five populations and subspecies taken from: <sup>a</sup>Márquez et al. 2001; <sup>b</sup>González and Duarte 2002; <sup>c</sup>Cosse et al. 1998; <sup>d</sup>Beade et al. 2000 and Vila 2006.

the species was recently found at 0° latitude in south Marajó island at Pará State-Brazil (Silva-Junior et al. 2005). It is unknown if this population is native to the island or introduced. Further research is necessary to resolve this question.

Naturalists, voyagers and historians reported that until the late 1800s this species was widespread and very abundant (Cabrera 1943; Canal Feijoo 1979; Darwin 1860; Franco 1968; Hudson 1947; Jackson et al. 1980; Jackson and Langguth 1987; Kraglievich 1932; Marelli 1942 and 1944; Sáenz 1967). These references indicate that it was not only common but also subject to hunting for their meat and hides as well as to obtain the “bezoar” or calcareous stones, with supposed medicinal properties, that were found in the stomachs of the deer and give the name to the species. Local indigenous populations also hunted this species for their subsistence, and its remains have been found in pre-Colombian sites (Madrid et al. 1985). Furthermore, the “gauchos”, would go after the deer for “sport” and to try their skill in the use of the “boleadoras”.

Towards the beginning of the 20th century a decrease in populations started to be noticed. The main causes being the reduction and modification of pampas deer habitats, the introduction of both domestic and wild ungulates, as well as their diseases, and over-hunting

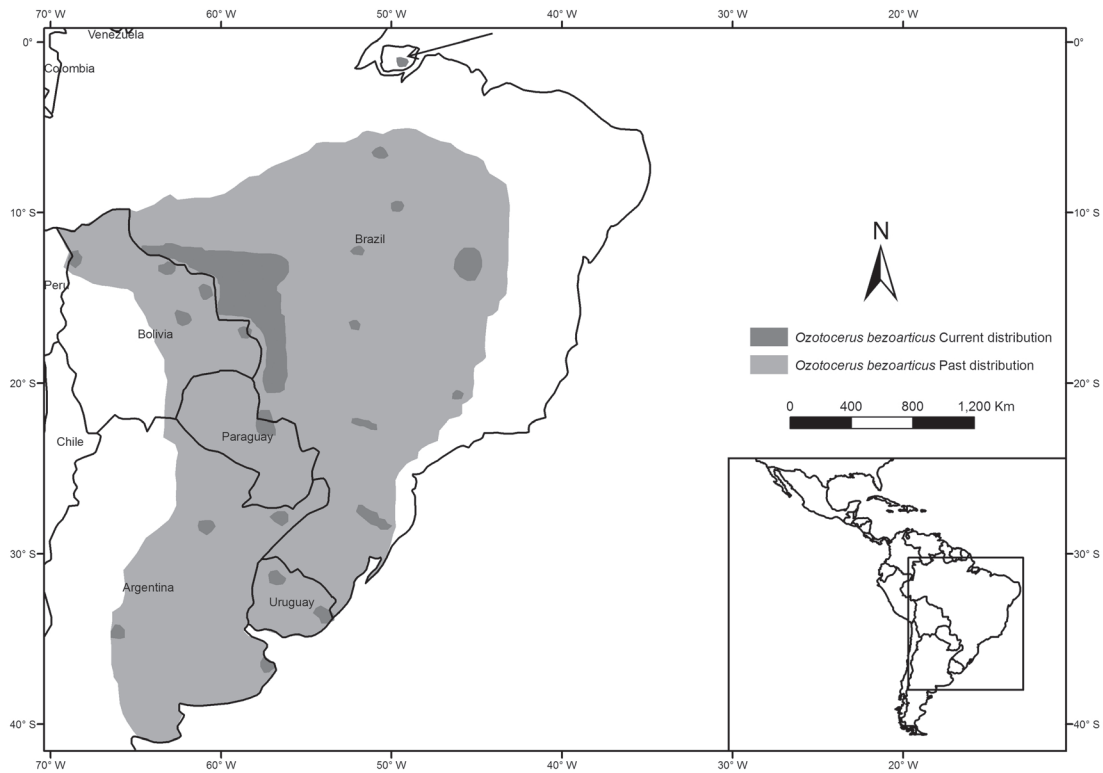
(Giménez Dixon 1987). Habitat fragmentation has dramatically reduced their range to less than 1% of that present in 1900, producing small and highly isolated populations (González et al. 1994; 1998; Jackson and Langguth 1987; Pinder 1994; see Table 2).

## KNOWN POPULATIONS

### Argentinean populations

In Argentina, Cabrera (1943) reported two subspecies: *O. b. celer* in the pampas region and *O. b. leucogaster* in the Chaco and mesopotamian region. At present, only four isolated populations remain in Buenos Aires (Bahía Samborombón), Corrientes, Santa Fe and San Luis provinces (Dellafiore et al. 2001; González 1999; Jackson and Langguth 1987; Merino et al. 1993; Pautasso and Peña 2002).

*Bahía Samborombón population:* The coast of the Samborombón Bay is a narrow strip of salt-marsh extending 120 km. along the western shore of the Rio de la Plata estuary. This area represents one of the few remaining natural ecosystems in the Buenos Aires province. This zone, sculptured by daily and periodic tidal flooding, comprises a mosaic of meandering creeks, drainage canals, lagoons and coastal marshes. This area has low agricultural value and is mainly used for extensive cattle breeding.



**Figure 4** - Pampas deer geographic range and main populations. The South Marajó island at Pará State-Brazil is shown with an arrow.

**San Luis population:** This population is located in south-central San Luis Province (General Pedernera Department) (Jackson 1978). This area belongs to a phytogeographic region with grassland and patches of “chañar” (*Geoffroea decorticans*), which in the recent past encompassed 20,000 Km<sup>2</sup> (Anderson et al. 1970). Pampas deer population now inhabits an area of 500 Km<sup>2</sup>; but it is mainly concentrated over 1450 Km<sup>2</sup> (Dellafiore 1997; Dellafiore and Maccera 2001; Dellafiore et al. 2001; Demaria et al. 2003).

A significant change in the habitat is occurring as the native species of the natural grasslands of the province are being replaced by non-native grassland species with higher value as forage for cattle. Furthermore two provincial routes cross the area, one from north to south and the other one from east to west. Though the effect of poaching has never been evaluated, it is probable that it is higher due to the easy access via the provincial routes and absence of police control in the area.

**Corrientes population:** This population of *O. b. leucogaster* is located between Esteros del Iberá and the Aguapey river in the northeast of Corrientes Province, covering 1200 Km<sup>2</sup> of flooded grasslands and non-flooded “lomadas” (Ituzaingo Department, Merino and Beccaceci 1999; Parera and Moreno 2000). Main threats for this population are human activities including cattle ranching, forestry and rice crops.

**Santa Fe population.** In the “Bajos Submeridionales” area a small population inhabits in an area of 23,000 ha. (Vera Department). This isolated population is distributed on grasslands of *Spartina argentinensis* (Pautasso et al. 2002). Cattle ranching are the most important activity in this region.

### Bolivian populations

Small populations of Pampas deer may still be extant in the National Park Noel Kempff Mercado (Santa Cruz Department), in southwestern Bolivia (Anderson 1985; 1993; Tarifa 1993). Pampas deer occurs further west in Beni or up to northern La Paz. However, it is restricted to relatively small patches of suitable habitat and may have become locally extinct in some of them.

### Brazilian populations

The historic distribution of Pampas deer in Brazil is known from reports of expeditions by pioneering naturalist and specimens collected for museums (Goeldi 1902; Miranda Ribeiro 1919). Due to the large size of the country it is difficult to determine the exact range of Pampas deer.

In central Brazil, *O. b. bezoarticus* inhabits the northeastern portion of the cerrado ecosystem in a number of national parks, reserves and indigenous areas. Pinder (1994) estimated that in these protected areas there are 450,000 km<sup>2</sup> of habitat available that could potentially sustain a total of 10,600 Pampas deer.

The Pantanal region holds another subspecies of Pampas deer (*O. b. leucogaster*) (Cabrera 1943). For this region Pinder (1994) estimated an available area of 125,116 km<sup>2</sup> that could potentially support 20,000 to 40,000 individuals. A small population whit less than 100 individuals was rediscovered in the South of the country, in Paraná State (Braga 1997, 2004; Braga et al. 2005). Another two populations were also discovered recently in Santa Catarina and Rio Grande do Sul States, but their population sizes were not evaluated yet (Braga 2009; Mazzolli and Benedet 2009).

**Table 2** - Pampas deer populations habitat and ecological data.

Country	Population	Subspecies	Habitat	Population Size and density	Antler Cycle Velvet-Hard
Argentina	Bahía Samborombóm 35°30' S; 56°45' W	<i>O. b. celer</i>	Pampas grassland	N= 251 to 445 <sup>a</sup>	Jun-O / N-Jul <sup>b</sup>
	San Luis 34°22' S; 65°44' W	<i>O. b. celer</i>	Pampas grassland	N= 500 - 1,200 <sup>c</sup>	Sep-Nov / Dec-Jul <sup>b</sup>
	Corrientes 28°08' S, 56° 33' W	<i>O. b. leucogaster</i>	Chaco Savanna	N= 170 - 220 <sup>d</sup>	
	Santa Fé 28° 47' S, 60° 38' W	<i>O. b. leucogaster</i>	Mesopotania grasslands	N= 25-50 <sup>e</sup>	
Brazil	Emas 18°15' S 52° 53' W	<i>O. b. bezoarticus</i>	Cerrado	N= 1,000 - 1,200 <sup>f</sup> D= 0.001 / km <sup>2</sup>	A-S / O-M <sup>g,n</sup>
	Cabeça de Veado, DF 15° 51' S , 47° 49' W	<i>O. b. bezoarticus</i>	Cerrado	N= 100 - 130 <sup>h</sup> D= 0.0001 / km <sup>2</sup>	
	Rio Negro State Park	<i>O. b. leucogaster</i>		N=245 <sup>i</sup> D=2.45 / km <sup>2</sup>	Jul-S / O-Jun
	Paraná 25° 34' S; 49° 49' W			N=72 <sup>j</sup> D=0.0031 / km <sup>2</sup>	M-Ag / S-A
Uruguay	Tapado 31° 36' S, 56° 43' W	<i>O. b. arerunguaensis</i>	grassland	N=1,000 <sup>k</sup> D=16 / km <sup>2</sup>	Ag-N / D-Jul
	Los Ajos 33° 50' S; 54° 01' W	<i>O. b. uruguayensis</i>	grassland	N=300-350 <sup>m</sup> D=17.5 / km <sup>2</sup>	Jul-N / D-Jun

References: In the table is detailed the country and populations, including name, geographic location, subspecies, habitat, population size (N), density (D) and the antler cycle.<sup>a</sup> Vila and Beade 1997; Beade et al. 2003; Vila 2006; <sup>b</sup>Jackson 1986; Jackson and Langguth 1987; <sup>c</sup> Dellafiore et al. 2003; <sup>d</sup> Merino and Beccaceci, 1999; <sup>e</sup> Parera and Moreno 2000; <sup>f</sup> Pautasso and Peña 2002; <sup>g</sup> Rodrigues and Monteiro-Filho 2000; <sup>h</sup> Rodrigues 1996; <sup>i</sup> Leeuwenberg and Lara Resende 1994; <sup>j</sup> Tomas 1995; Tomas et al. 2001; <sup>k</sup> Braga 1997; 2004; <sup>l</sup> González et al. 2002; <sup>m</sup> Moore 2001, <sup>n</sup> Cosse and González 2002, <sup>o</sup> Pereira et al. 2005.

### Paraguayan populations

The species is on the verge of extinction in Paraguay, if not already extinct. The Pampas deer formerly occurred in Cerrado savannas and natural grasslands in the eastern part of the country (Azara 1802). A population of *O. b. leucogaster* may survive in the extensive Cerrado savannas of northern Concepción Department, an area largely comprised by private ranches (“estancias”), though it includes the San Luis National Park. However, the species has become increasingly rare in this area, and few observations have been reported after 1995. Local reports also suggest that a population may survive in San Pedro Department, in the Cerrado of Laguna Blanca, though this has yet to be confirmed.

Although there are no ex situ populations known in Paraguay, the captive stock of the Berlin Zoo was founded by two Pampas deer from Paraguay (Frädrich 1987).

### Uruguayan populations

In the past, Pampas deer was one of the most common ungulates of the Uruguayan grasslands. Eighty percent of Uruguayan territory is composed of open

grassland habitat suitable for this species. Nowadays extant populations are isolated in private ranches: “El Tapado” in the northwest of the country (Salto Department) and “Los Ajos” in the southeast (Rocha Department) (González 1993; González 1996; González et al. 2002).

*El Tapado population:* Apart from scattered tree plantations, eucalyptus windbreaks or riverside trees the area is treeless and the land is largely devoted to extensive sheep and cattle ranching. Landowners fulfill an essential role in conservation through cattle-deer management, not allowing hunting in their lands and controlling poaching, to the extent of their means. Yet there are no incentives for landowners to maintain wildlife that are as powerful as the economic gains obtained from farming and livestock ranching. The variation in Pampas deer density depends on the stocking rate of cattle and especially sheep. The higher deer densities were observed on sheep-free management areas and the lowest values where cattle and sheep were present (Sturm 2001).

*Los Ajos population:* The main population of Los Ajos population is found in a ranch located in the “Bañados

del Este” Biosphere Reserve MAB/UNESCO. The species is presently expanding to neighboring ranches that are willing to protect them.

The principal activities are based on livestock (cattle and sheep) and crops, mainly rice and soy. The highest deer densities were observed on areas with natural grassland and on rye grass pastures that were established for livestock. However, the areas with rice, and soy crops, or sheep are less used by Pampas deer (Cosse et al. in press; González and Duarte 2003).

### EX SITU POPULATION

Pampas deer captive breeding began in the last century at Berlin Zoo which held the most important Neotropical deer collection in Europe. In the 1980s a pair of Pampas deer were the founders of the San Diego Zoo herd (Frädrieh 1987). Currently these captive populations are extinct in spite of zookeepers efforts. In South America the Pampas deer captive breeding began in Argentina with a traslocation from Samborombon Bay to La Corona ranch (Gimenez Dixon 1987). Twenty-one deer formed the founding stock in 1969 and increased to 43 by 1972. After this initial “success” the herd was affected, and reduced, by cattle-borne diseases (hoof-and mouth and clostridiosis). Additionally inadequate management and lack of funding hindered efforts. The numbers of deer in the herd slowly diminished and by 1997 ceased to exist (Merino in litt).

The largest captive stock with around 95 individuals *O. b. arerunguaensis* is found in Uruguay. Seventy two percent of them are located in the Piriapolis Zoo and the remaining deer are in Salto (11%), Flores (12%), Durazno (3%), Parque Lecocq (2%) and Rocha (1%). In spite of being the largest captive population, there is no metapopulation management, nor has any studbook been kept since the 1980’s (Frädrieh 1987). “La Esmeralda” breeding center, located in Santa Fe Province, Argentina, has a small population founded in 1986 with a couple from the Piriapolis Zoo (Descendents of this couple have been translocated to other zoos in Argentina (La Plata and Florencio Varela).

As several Zoos in Argentina and Uruguay have Pampas deer of the same subspecies, a metapopulation approach should be implemented and each stock should be managed as a unique subpopulation. With this approach interbreeding of individuals from different subspecies would also be avoided.

In Brazil Sao Paulo and Sorocaba zoos had Pampas deer in the eighty’s, since the last decade they do not have any Pampas deer in captivity.

### HABITAT

The Pampas deer was a widespread species occupying a wide range of open habitats, including grasslands, pampas in Argentina and the Brazilian savanna known as the Cerrado (Cabrera 1943; González et al. 2002; Jackson 1987; Merino et al. 1997; Weber and González 2003; Figure 1). Also the species use in South of Brazil and Uruguay crop lands (Weber and González 2003).

### SPATIAL USE AND HOME RANGE

The populations of Pampas deer that have been studied have shown a wide variation in size of the home range (Table 3). The observed variation was correlated with sex, seasonality, breeding season, resource availability and rangeland management.

### FEEDING ECOLOGY

Their nutritional requirements vary according to sex, age and life cycle events such as antler growth, rut, lactation and pregnancy. The diet was described in populations from Argentina (Jackson and Giulietti 1988; Merino 2003), Uruguay (Cosse et al. in press) and Brazil (Pinder 1997; Rodrigues and Monteiro-Filho 1999). The Argentinean Pampas deer consume mainly grass (Jackson and Giulietti 1988; Merino 2003). The species was considered by Jackson and Giulietti (1988) as selective feeders in San Luis, depending heavily on green forage throughout the year, and were best described as “concentrate selectors” by these authors. Merino (2003) classified the Pampas deer from “Campos Tuyú” Wildlife Reserve (Buenos Aires Province) as a mixed grass feeder with a mixed diet and a preference for grass.

The same pattern was observed on Uruguayan Los Ajos population (Cosse et al. in press). On the other hand, in Brazilian populations, Rodrigues (1996) detected Pampas deer selecting forbs, instead of the more abundant grasses in the the Brazilian Cerrado. Finally, Pinder (1997) observed that Pampas deer in the Pantanal did not show preference for grasses nor forbs selecting new growth despite the food category.

These different feeding strategies in the populations may be explained by the phytogeographical variation in the distribution of Pampas deer. The Uruguayan and

**Table 3** - Pampas deer home range discriminated by gender.

Population	Male home range (Km <sup>2</sup> )	Female home range (Km <sup>2</sup> )	Reference
Brazilian Cerrado	11.8-175	8.3-168	Rodrigues and Monteiro-Filho (1996)
Brazilian Cerrado	9.9	5.9	Leeuwenberg et al. (1997)
Bahía Samborombóm	14.22	5.32	Vila (2006); Vila et al. (2008)
Los Ajos	3.75	4.74	González (2004)
El Tapado	0.249-0.39	0.181-0.519	Moore (2001)

Argentinean grasslands have a predominance of temperate grasses; this kind of grass and dicotyledons are three-carbon compound (C3), very different from the tropical C4 plants (rough grasses dominant in the Cerrado), which tends to exhibit high dry weight accumulations that are often of low nutritive value (Van Soest 1982). Furthermore, the phenological succession of vegetation in the Pantanal is marked by three main seasons: rain, flood and dry seasons (Pinder 1997).

Considering the overall scenario, the Pampas deer is characterized by an opportunistic foraging strategy such as that of intermediate or mixed feeders. Hofmann (1989) described this group with a marked degree of forage selectivity, and a mixed diet but avoiding fiber as long and as much as possible, accepting a broad range of items including grasses, browse, leaves, flowers, depending the phenological characteristics of the different habitats in which they occur throughout the range of the species.

### REPRODUCTIVE BIOLOGY

Females are polyestric with oestrus cycles of approximately 21 days (Duarte and Garcia 1995; González Sierra 1985). Pregnancy is about seven months and birth season varies according to the location (Merino et al. 1997). In some populations from Argentina and Uruguay, Jackson and Langguth (1987) observed births throughout the year with a higher incidence from September to November (spring and summer). Redford (1987) however quotes that the majority of births observed in Central Brazil happen from August to November, while Rodrigues (1996) observed the amount of births to be directly linked to food availability, when females and young deer have a high energy demand during the last month of pregnancy and first month of lactation. Furthermore, a study in the Emas population that measured and correlated fecal testosterone concentrations showed a peak in December–January (summer), March (early autumn) and in August–September (winter–spring), with minimal values from April–July (Pereira et al. 2005). The authors found significant correlations between fecal testosterone and reproductive behavior. The reproductive behavior had two peaks, the first in December–January, characterized by predominately anogenital sniffing, flehmen, urine sniffing, chasing and mounting behavior, and the second peak in July–September (behavior primarily related to scent-gland marking).

In the early period of pregnancy females keep on with their normal activities. Between the fourth and fifth months a swollen belly is noticeable and from that moment on the females go through long periods of rest (Deutsch and Puglia 1988). When the month prior to birth approaches, females tend to separate from the group, preparing the “bed” in a discreet location, remaining isolated for several days subsequent to the young deer’s birth (Moore 2001). In that particular period females are vulnerable to predators (Braga 2004). The fawns are kept in safety, feeding at frequent intervals. The protection of the young is done through a strategy of misleading the predator. When danger approaches the young remains lied down, hiding in the vegetation, while the female places

herself opposite to the spot where the young is lying, looking sporadically at it (Rodrigues 1997). Weaning occurs around the fourth month of age when the female can once again go into estrus (Deutsch and Puglia 1988).

Information from ear-tagged animals indicates that females can reach reproductive maturity at 16 months of age. After a seven-eight month gestation, the first fawn would come when they are at least two years old (Moore 2001).

The evaluation of reproductive condition on captured females in Los Ajos population showed high reproductive success levels with 87.5% pregnant or lactating females between 18 months and five-years old. This information indicates that the reproductive maturity would be reached at 11 months in this population (González and Duarte 2003).

In Uruguay, fawns are generally born in spring (between October and December). This seasonality is clearer in El Tapado population (González 1997; Jackson and Langguth 1987; Sturm 2001); than in Los Ajos population, where newborn fawns have been seen all year round including midwinter (Cosse 2002; González 1997).

It is interesting to note that Frädriich (1981a, 1981b), Jackson and Langguth (1987), and others have mentioned that a characteristic of Pampas deer is the absence of twins (which usually are very common in other cervids)

### ANTLER CYCLE

The antler cycle has been described in Brazilian, Argentinean and Uruguayan populations (González et al. 1994; Jackson 1987, Merino et al. 1997). The antler cycle is a crucial biological event in males. According to Bubenik and Bubenik (1987) androgens are one of the most important hormones involved in development and mineralization of antlers, while photoperiod is the most important environmental factor influencing its seasonal characteristics, through the secretion of melatonin from the pineal gland. Also, after verifying elevated levels during antler mineralization, Suttie et al. (1995) suggested that cortisol secretion may play a role in antler growth of red deer.

However the role of photoperiod on the reproductive biology and antler cycles in many species of deer that live in tropical and subtropical regions, with comparatively minor annual changes, is not clear. Yet it is widely accepted that reproductive activity in tropical deer may be more influenced by local climatic factors such as annual rainfall patterns rather than being dependent on the photoperiod (Pereira et al. 2005).

In the Pampas deer antler casting and re-growth occurred under low testosterone concentrations, whereas velvet shedding was associated with high concentrations of testosterone (Pereira et al. 2005). Furthermore the antler cycle observed in stags with antlers in velvet showed higher concentrations of fecal glucocorticoids than males with hard antlers or after casting (Pereira et al. 2006).

However, research done in the Pantanal and Emas National Park, on individuals submitted to electroejaculation showed that some animals, which had hard antlers in September, did not produce semen; while one

individual, with antlers in velvet, produced good quality semen in July (Duarte and Garcia 1997).

As in most cervids, the first pair of antlers is a simple “spike”, the second has (normally) two tines and it is with the third pair that the typical three points in the fully grown adult deer

The Pampas deer’s three-pointed antlers, has one tine close to the base and the other two resulting from a bifurcation of the main axis (see Figure 1; Duarte 1996). Antlers are in velvet for a period that varies 30 to 45 days, after which the velvet dries out and is shed, giving way to the hard antler (Merino et al. 1997). The antler cycle in Pampas deer is related with the geographical locations (see Table 2).

## BEHAVIOR

Group behavior seems to be correlated to several factors such as season, reproductive condition, age, sex, and food availability. The social structure seems to be complex. A typical group size varies from 5 to 17 individuals from both sexes with adults and juveniles (González and Cosse 2000; Moore 2001; Sturm 2001). In agricultural areas such as Los Ajos larger feeding groups were recorded around 80 animals in 1 km<sup>2</sup> of rye grass (González 1997). However, social organization in Bahía Samborombon is characterized by single individuals and pairs (Giménez-Dixon 1991; Vila and Beade 1997). Reported sex ratio was 1:1.5 and the mean group size  $1.9 \pm 1.2$  (Vila 2006). In winter, Pampas deer groups tend to increase in size in this population.

In the Brazilian Cerrado, even when resources are abundant Pampas deer live in small groups, joining and dispersing continuously as the individuals roam freely among different groups (Rodrigues 1999; Rodrigues and Monteiro-Filho 1996). The predominance of small groups could be related to social instability, linked to a low population density (Netto et al. 2000). The daily movements of the Pampas deer in the Brazilian cerrado varied from 0.7 and 3.4 km in a day (Leeuwenberg et al. 1997).

Another important parameter that may be connected to the level of glucocorticoid secretion in Pampas deer is male grouping. A study performed in Emas showed that groups with three or more males exhibited higher concentrations of fecal glucocorticoid levels than those from groups with one male (Pereira et al. 2006). Nevertheless, no significant differences were found in fecal testosterone concentrations among males from groups of varying sizes, contradicting the belief that the increase of male grouping in free-ranging Pampas deer may be influenced by low concentrations of testosterone. However in this species, food distribution and availability appear to be more important elements associated with grouping patterns, since larger aggregations were found on common feeding grounds such as burnt patches (Pereira et al. 2006).

During mating period antlered males establish their territory scratching their front hoofs and antlers on the ground or shrubs; sometimes defecating over the spot. Frequently dominant males urinate over other younger males demarcations. Disputes between males are ritualized through encounters where males lock each other’s antlers,

pushing one another until the opponent’s head touches the ground (Pereira et al. 2006). The frequency of vigilance postures in individual males are related to the reproductive cycle. Specifically with the annual casting of the antlers (Braga 2003). Among young males (about five to six months of age) an increase in the frequency of vigilance postures was observed, thus suggesting the beginning of the process in which the young become independent, separating from the care of their mothers (Braga 2003).

When females go into estrus, the dominant males start following them, taking a distance from the group for mating. Aggression between females is ritualized by standing on their hind legs, making circular movements with their front hoofs in what could somewhat resemble boxing (Braga 2003). The behavior activities comparison of the maintenance of vigilance and the social interactions among adult and young males and female individuals, showed also significant differences (Braga 2003).

## Inter-specific relations

The commensalistic relationships between Pampas deer and greater rheas (*Rhea americana*) was recorded in Goiás and in the Uruguayan populations (Gimenez Dixon 1987; González and Cosse 2000; Rodrigues and Monteiro-Filho 1996). This was also observed between Pampas deer and buff-necked ibises (*Theristicus caudatus*) in Paraná and El Tapado (Braga and Moura-Britto 1998, González in litt).

Their main natural predators are the jaguar (*Panthera onca*) and the puma (*Puma concolor*). However, the pampas fox (*Pseudalopex gymnocercus*), the ocelot (*Leopardus pardalis*) and feral pigs (*Sus scrofa*) could be responsible for killing fawns and weak animals (Jackson and Langguth 1987). Pérez Carusi et al. (2009) provide evidence of the potential existence of negative interactions between Pampas deer and feral pigs. A negative correlation was found between the densities of these two species and they distributions were not mutually independent (Pérez Carusi et al. 2009). Records of Pampas deer killed by maned wolf (*Chrysocyon brachyurus*) were obtained in the Emas National Park (Bestelmeyer and Westbrook, 1998) where also the anaconda (*Eunectes murinus*) is also a potential predator (Pereira 2002; Rodrigues 1996). Dog predation was reported by Vila (2006) in Samborombón Bay.

## CONSERVATION STATUS

The global IUCN Red List assessment of the species (*Ozotoceros bezoarticus*) is Near Threatened (NT) (IUCN 2008). Yet it is considered to be threatened in Argentina, Bolivia, Paraguay and Uruguay with fewer than 2,500 individuals. This is reflected by the Red List categories (op.cit.) of the subspecies: *O. b. celer*, -Argentina-: Endangered [EN B1ab(iii)]; *O. b. arerunguaensis* -Uruguay- [CR B1ab(iii)]; *O. b. uruguayensis* -Uruguay- [CR B1ab(iii)]; *O. b. bezoarticus* -Brazil- (DD); *O. b. leucogaster* - Argentina, Bolivia, Brazil; Paraguay- Near Threatened (NT) (IUCN 2008).

In the Argentinean Red List the species is considered endangered (Díaz and Ojeda 2000). A recent workshop

of “threatened fauna” held in Paraguay has also catalogued *O. b. leucogaster* as “Endangered” (Cartes in litt). Pampas deer was assessed as vulnerable in the Bolivian Red Data Book (Rumiz 2002; Tarifa 1996).

As mentioned earlier Pampas deer was a common and abundant species, occupying a wide range. Yet, in the late 1800s and early 1900s the populations were decimated and its habitat fragmented. The main causes of Pampas deer decline were the reduction and modification of its habitats, the introduction of domestic livestock, wild ungulates (from Europe and Asia) and their diseases; and over-hunting. An additional, and relatively recent threat, is the “control efforts” of ranchers who believe that the deer compete with livestock.

Due to the fragmentation of the remaining habitat the small and isolated populations face other threats. According to Pautasso and Peña (2002) floods affect the Santa Fe population, isolating individuals into small “islands”, making it easier to capture or kill them. In Paraná State, Brazil, another cause of mortality, outside of the Conservation Units, is the juvenile and fawn mortality during the crop harvest (Braga 2004). Some authors quote that wire fences are a factor of mortality (Beade et al. 2000). Other researchers suggest that electric and barbed-wire fences are not limiting factors for the Pampas deer; however they could present some risks in specific situations such as when under stress and escaping from predators (Braga 2004; González and Duarte 2003). Dellafiore et al. (2001) suggests that the subdivision of land plots is inversely proportional to the population size.

Furthermore, Pereira et al (2006) has recorded higher levels of cortisol and stress in the groups of Pampas deer that inhabit outside Emas National Park than the tagged individuals inside the Park.

Breeding of cattle and sheep is also signaled as one of the negative factors for the species, due to competition for food and habitat, or transmission of diseases (Cosse et al. in press; Giménez Dixon 1987; González 1997; Jackson et al. 1980). The presence of dogs related with the cattle activities and, even more, of feral dogs that attack the deer is a serious threat (Beade et al. 2000; González 1997; Jackson et al. 1980).

In Argentina, the need to plan conservation actions was mentioned by several authors, such as: Mac Donagh (1940); Marelli, (1942); Cabrera (1943) and Sáenz (1967). Yet it was not until 1968, that any real interest in pampas deer conservation was taken as a result of oil exploration being undertaken in the Bay of Samborombón. In the years 1968-69, the “Operativo Venado” (Operation Pampas Deer) was carried out. Its purpose was to capture deer to establish a captive breeding facility. This was based on the idea that the only effective conservation measure that would ensure the survival of the deer, would be to “rescue” (i.e. capture) as many individuals as possible and their translocation to suitable lands with appropriate ecological conditions to reproduce the species in semi-captive conditions. It should be noted that, based on aerial surveys, Bianchini and Luna Pérez (1972) estimated that the population was of 78 individuals in 1968 and 40 in

1969. The captured animals were taken to a 37 ha. enclosure in the Estancia La Corona (Buenos Aires Province), (Bianchini and Luna Pérez 1972; Giménez Dixon 1987; Menéndez et al. 1968). Thus, initial work gave emphasis to captive breeding.

In 1975, contact between the Province of Buenos Aires, WWF, IUCN-The World Conservation Union, Fundación Vida Silvestre Argentina, and other institutions, paved the way to the development of “Project 1303 WWF/IUCN”. This project provided financial resources and additional expertise. In addition to the herd in La Corona, conservation actions were also oriented towards the known wild populations, and natural habitats, in Argentina (Bahia Samborombón, Punta Médanos, San Luis). Project 1303 ended in 1979 and conservation activities were continued by local bodies (Giménez Dixon 1986, 1987, 1991).

The entire Bahia Samborombón area has been a protected area since the 1970s. The area currently includes two provincial reserves (Bahia Samborombón and Rincón de Ajó) and one private reserve (Campos del Tuyú); all of which were created with the purpose of providing refuge and protection to Pampas deer. The entire Bay was included in the **List of Wetlands of International Importance of the Ramsar Convention** and was declared as Wildlife Refuge in 1997. Currently Campos del Tuyú reserve was donated to the federal government to convert it to a National Park (Vilá, in litt).

A Pampas deer PHVA workshop was conducted in Uruguay in 1993 and conservation recommendations were listed for the main populations in Uruguay (González et al. 1994). Several conservation deer workshops were facilitated by Deer Specialist Group to plan management and conservation strategies for this species. These have been followed up by diverse research and conservation activities in the region.

Pampas deer is legally protected throughout its range. The species is listed in “Appendix I” of the CITES Convention (CITES 2007). In 1984 the Province of Buenos Aires declared the species a “Natural Monument” in Argentina (Gimenez Dixon 1991). The provinces of Corrientes, and San Luis did likewise in the 1990s. Uruguay also declared it Natural Monument in 1985 (decree 12/9/85).

In spite of all these efforts, the majority of populations remain in fragile condition. Recommended conservation actions include further population surveys, ecological research, strengthening of existing management of protected areas, creation of new protected areas, establishment of a collaborative captive breeding program, and enlisting the co-operation of local landowners in maintaining this species (Wemmer 1998). Some measures must be implemented to develop privately owned protected areas in order to preserve these last populations. These measures should include fiscal incentives to stimulate private conservation action (González et al. 1998, 2002).

Population numbers might increase if protected from poaching in areas where natural habitats remain and if some grazing land, as a buffer, could be designated for dual use by deer and livestock. The Pampas deer maintain

high levels of genetic diversity and has the potential to recover and expand if habitat is available (González et al. 1998).

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