# A survey of a pampas deer, *Ozotoceros bezoarticus leucogaster* (Arctiodactyla, Cervidae), population in the Pantanal wetland, Brazil, using the distance sampling technique

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## Abstract
*A survey of a pampas deer,* Ozotoceros bezoarticus leucogaster *(Arctiodactyla, Cervidae), population in the Pantanal wetland, Brazil, using the distance sampling technique.*— The pampas deer is an endangered South American species which occurs in open grasslands and savannas. This aim of this survey was to evaluate the use of the distance sampling technique to estimate densities of the species in the Pantanal wetland, as well as to analyze the applicability of the method for a monitoring program. The surveys were conducted on roads from vehicles and also on foot along 26 parallel transects in November 1999 and 2000 at Campo Dora ranch, south-central Pantanal, Brazil. Deer densities were estimated using the program DISTANCE, and the program MONITOR was used to run a power analysis to estimate the probability of detection of a decline in the population. The deer density estimated from vehicles, with data from both years, was 9.81±3.8 individual/km$^2$, and 5.53±0.68 individuals/km$^2$ from transects sampled on foot. The power analysis of these data revealed a monitoring program would require at least two surveys per year over seven years to obtain a 90% chance of detecting a 5% decline in the population. Our results also indicate surveys from roads are not recommended for pampas deer counts as the animals appear to keep a relatively safe distance from cars.

Key words: Pampas deer, *Ozotoceros*, Distance sampling technique, Pantanal wetland, Population survey.

## Resumen
*Estudio de una población de venados de la Pampa* Ozotoceros bezoartcus leuogaster *(Artiodactyla, Cervidae) en el Pantanal, Brasil, mediante la técnica del muestreo a distancia.*— El venado de la Pampa es una especie sudamericana en peligro de extinción que se encuentra en praderas abiertas y sabanas. El objetivo de este trabajo es evaluar el uso de la técnica de muestreo a distancia para estimar densidades de esta especie en el Pantanal, así como analizar la aplicabilidad de este método a un programa de monitoreo. Los estudios se realizaron desde caminos, con vehículos y a pie, a través de 26 transectos paralelos en noviembre de 1999 y 2000, en la hacienda Campo Dora, Pantanal, Brasil. Las densidades de venados se estimaron con el programa DISTANCE, empleándose el programa MONITOR para efectuar un análisis de poder estimativo para la detección de un descenso en la población de venados. La densidad de venados estimada desde los vehículos fue de 9.81±3.8 individuos/km$^2$, mientras la obtenida desde transectos realizados a pie fue de 5.53±0.68 individuos/km$^2$. Ambas densidades incluyen datos de los dos años de estudio. El análisis potencial de estos datos señala que un programa de monitoreo precisaría como mínimo de dos muestreos por año, durante siete años, para obtener una probabilidad del 90% de detectar un descenso del 5% en la población. Los resultados de este estudio indican asimismo que las observaciones efectuadas desde caminos no son recomendables para el recuento de venados de la Pampa, ya que se observó que éstos tienden a mantener una distancia de seguridad respecto a los coches.

Palabras clave: Venados de la Pampa, *Ozotoceros*, Técnica de muestreo a distancia, Pantanal, Estudio de población.

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## Introduction

The pampas deer (*Ozotoceros bezoarticus* L., 1758) is a species characteristic of open habitats in South America, with historic distribution ranging from central Argentina to mid–western and northeastern Brazil, eastern Bolivia, Paraguay and Uruguay (CABRERA, 1943; CARVALHO, 1973; JUNGIUS, 1976; JACKSON & GIULIETTI, 1988; JACKSON & LANGGUTH, 1987; TOMÁS, 1995). The species is included in the International Union for Conservation of Nature (IUCN) Red Data Book as a lower risk, near–threatened species (WEMMER, 1998); it is also considered endangered by the United States Department of Interior–USDI, is in the Appendix I of Convention International Trade Endangered Species–CITES (CITES, 1995), and is listed as endangered in Brazil (FONSECA et al., 1994). Population declines in this species have been attributed to habitat destruction related to agricultural expansion, poaching, and diseases transmitted by cattle (MERINO et al., 1997). Although surveys and monitoring programs have been recommended in conservation action plans for the species (CBSG, 1993; WEMMER, 1998), little has been published on population size estimates for this species in Brazil (e.g., LEEUWENBERG & LARA RESENDE, 1994; RODRIGUES, 1996; MOURÃO et al., 2000). The largest population is known to occur in the Pantanal wetland, and is estimated at 60,000 individuals (MOURÃO et al., 2000).

MOURÃO et al. (2000) called for long–term monitoring of pampas deer populations in the Pantanal by means of ground surveys, but we know of no concerted effort to evaluate the appropriate techniques to accomplish this goal. Distance sampling techniques offer potential for a monitoring program because the assumptions are relatively robust and the protocols can be quickly taught to survey staff (ANDERSON et al., 2001). This survey aims to evaluate the use of the distance sampling technique (BURNHAM et al., 1980) to estimate densities of pampas deer through transects sampled on foot and/or from a vehicle, as well as to analyze the applicability of the method and sampling protocol for a monitoring program of this species.

## Material and methods

The survey was conducted in an area of 8,400 ha of the Campo Dora ranch (40,000 ha) located 90 km from Corumbá, Mato Grosso do Sul State, Brazil, in the south–central Pantanal wetland. The average annual rainfall is 1,182 mm and the average temperature varies from 31.6°C to 20.2°C (SORIANO, 1999). The Pantanal vegetation consists of a mosaic of several forested and open habitats that vary in topography and flooding regime (PRANCE & SCHALLER, 1982). The open habitat is flooded from January to June, with a draining period from July to August. Lower areas may retain water until October, and some permanent ponds are scattered throughout the study area. During the flooding period the grassland is substituted by a massive formation of aquatic macrophytes, which is gradually replaced by grasses as the water recedes. The principal economic activity in the study area is cattle ranching.

Pampas deer were simultaneously counted from vehicles in three different, non–intercepting transects (roads) on November, 1999, and in the same month of 2000, between 7.30 and 11.00 a.m., at a speed of 20 km/h. In each car, one observer standing in the back of the vehicle recorded the presence of deer clusters on both sides of the road. For each sighting, the vehicle stopped and the perpendicular distance to the road was measured by counting steps, which were then converted into meters. The conversion factor had been previously established for each observer. The number of individuals was recorded in each cluster as observed from the vehicle without optical instruments, as well as the actual number of deer per cluster, which included any additional individual observed afterwards during the perpendicular distance estimation and/or with binoculars.

Deer were also counted on foot from 12 parallel east–west oriented transects in November, 1999, and 14 transects in 2000, between 7.30 and 11.00 a.m. In 1999, fifteen observers, divided into six groups of two or three people, surveyed the transects starting from a road (with approximately north–south orientation) that traversed the Campo Dora ranch. In the 2000 survey, seven groups of at least 2 observers sampled the south–north and east–west oriented transects The transects were separated by 2 km, with lengths varying from 3 to 11 km. Because pampas deer do not use forested habitats (MERINO et al., 1997), we excluded the interception with forest patches from the total length of each transect. Deer clusters were recorded using the same protocol defined in the survey from vehicles.

Deer cluster densities were estimated using the program DISTANCE (LAAKE et al., 1993; BUCKLAND et al., 1993) by selecting the model that best fit the data (BURNHAM et al., 1980). The data were analyzed separately for each year. The histograms of observation distributions were examined visually and truncated as necessary. To determine average cluster sizes and calculate densities, truncation was based on the definition of the effectively sampled area given by the program DISTANCE to avoid any bias of cluster size being related to the sighting distance. DISTANCE produces a variance estimate that has 3 components: the first is the proportion due to the observer's ability to detect animals along the transect; the second due to the variability between transect lines; and the third due to variance in group size observed.

The program MONITOR (GIBBS, 1995) was used to run a power analysis with the data obtained from the transects surveyed on foot in 1999. To perform this analysis we need to know the number of observations expected along each transect and their variance. The number of deer/km of transect for each of the 12 transects surveyed were used in order to estimate number of observations and calculate variance. Simulations were made with a one–tailed test, and the amount of effort needed to establish a 90% probability of detecting a population decline was estimated as to avoid error type II. In these simulations we varied: 1. The number of transects per year; 2. The number of times the sampling would be repeated per year; 3. The number of years of monitoring necessary to detect decline.

## Results

A total of 58.7 km of transects were surveyed by vehicle in 1999, and 29.5 in 2000. Twenty–seven deer clusters were detected, with a total of 58 individuals in the first year, and 31 clusters (79 individuals) in 2000. The pooled data obtained by vehicle displayed in figure 1B demonstrate that few deer were observed close to the road, contrasting with the data obtained from the surveys made on foot (fig. 1A). One critical assumption with the distance techniques is that the further the distance from the survey line, the lower the count (BURNHAM et al., 1980; BUCKLAND et al., 1993; LAAKE et al., 1993). In order to meet this assumption we had to truncate observations up to 100 m from the road, thus reducing the analysis to 58 clusters. The model which best fitted our data was a half normal adjustment. The density estimate was 3.63±1.31 clusters/km$^2$ with an average cluster size of 2.38±0.28 deer/cluster. The deer density was estimated to be 9.81±3.8 deer/km$^2$. For the vehicular survey, the probability of detection accounted for 43.9% of the variance, the encounter rate 38.7%, and the cluster size 17.4%. The population size was estimated as 824±318.68 pampas deer.

A total of 77.6 km of transects was surveyed on foot in 1999. Seventy–eight deer clusters were recorded in 1999. Unlike the vehicle survey, examination of the data indicated no truncation along the survey line was necessary. A half normal model was found to best fit our data, and effective sampled width was 163.65±14.75 m. Cluster density was estimated as 3.07±0.59 clusters/km$^2$ and the average cluster size as 2.23±0.18 individuals. The deer density for our study area was estimated to be 6.85±1.43 individuals/km$^2$ and the population size was estimated as 575±120.16 pampas deer for the Campo Dora ranch. The encounter rate (differences between transect lines) accounted for 67.3% of observed variance, leaving 18.6% for detection along the transect line and 14.1% for cluster size.

A total of 106.51 km of transects was surveyed on foot in 2000. Ninety–eight deer clusters were recorded in 2000. A half normal model was found to best fit our data, and effective sampled width was 175.96±14.02 m. Cluster density was estimated as 2.61±0.32 clusters/km$^2$ and the average cluster size as 1.91±0.13 individuals. The deer density for our study area was estimated to be 4.99±0.70 individuals/km$^2$ and the population size was estimated as 419±59.84 pampas deer for the Campo Dora ranch. The encounter rate accounted for 45.8% of the variance, with 32.2% of the variance due to detection probability and 22.0% to cluster size.

A total of 186 deer clusters was recorded during the two sampling periods. The sighting of clusters was rare 500 m beyond the transects (fig. 1A), with a positive correlation between the log of cluster size and perpendicular distance from the transect ($r = 0.037$, $t = 2.65$, Df = 184, $P = 0.009$). The data at this distance was therefore truncated. Analysis of the pooled data from 1999 and 2000 indicated that the best model fit was a half normal key (fig. 2), and the effective sampled width was 181.12±10.76 m. The estimated cluster density was 2.68±0.30 clusters/km$^2$, and the average cluster size was 2.06±0.10 individuals. The deer density for our study area was estimated to be 5.53±0.68 individuals/km$^2$ and the population size was estimated as 465±57.11 pampas deer. The encounter rate accounted for 59.8% of the variance, leaving 23.4% for detection probability and 16.8% for cluster size.

Our power analysis of the 1999 data revealed that to obtain a 90% chance of detecting a 5% annual decline in the studied population, at least two surveys per year for 7 years would be necessary. On the other hand, it would take at least 10 years with one survey per year to obtain a 90% chance of detecting the same annual decline. In a shorter time period, three surveys per year would be necessary for 5 years to detect a 7% decline (table 1).

## Discussion

Reviewed survey information revealed few studies of pampas deer whose survey protocols offered viable data for comparison. RODRIGUES (1996) found 1.97±1.38 deer/group and 0.1 deer/km$^2$ for Emas National Park, applying the distance sampling technique to analyze counts obtained from a vehicle using roads as transects. LEEUWENBERG & LARA RESENDE (1994) found 1.26 (SD = 0.65) deer/km$^2$ in night counts using strip transects 100 m wide, in the environmental protection area of Gama–Cabeça de Veado, near Brasilia. In northern Argentina, MERINO & BECCACECI (1999) counted pampas deer from an airplane defining a strip of 300 m in each side, and found an average group size of 1.75±0.78 deer/group, and a density of 0.39±0.35 deer/km$^2$. The authors also surveyed deer from roads using a strip of 300 m on each

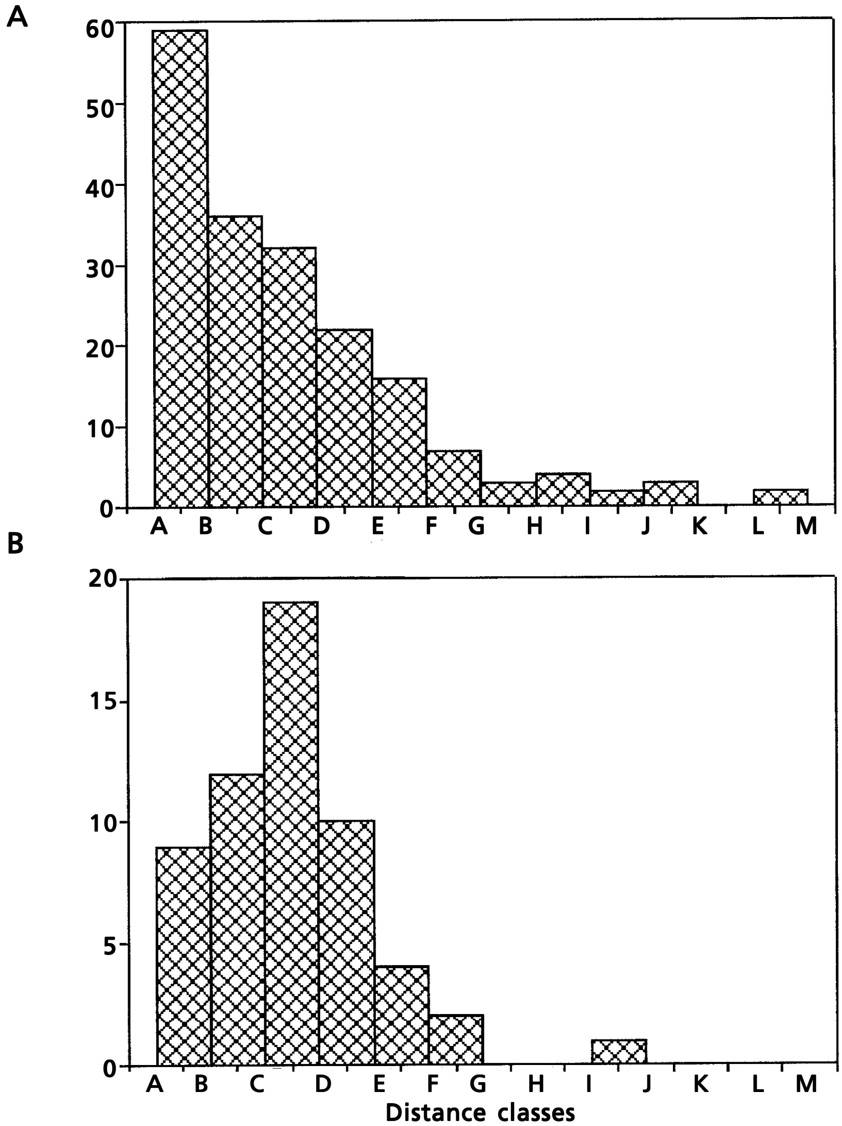


Fig. 1. Distribution of observed clusters of pampas deer (*Ozotoceros bezoarticus*) at different distances from the transect lines surveyed on foot (A) and from a vehicle (B), at Campo Dora ranch, Pantanal, Brazil. Distance classes: A. 0–49; B. 50–99; C. 100–149; D. 150–199; E. 200–249; F. 250–299; G. 250–299; H. 300–349; I. 350–399; J. 400–449; K. 450–499; L. 500–549; M. 550–599.

*Fig. 1. Distribucion de los grupos observados del venado de la Pampa (*Ozotoceros bezoarticus*) en diferentes distancias de la transección realizada a pie (A) y en vehiculo (B), en la Hacienda Campo Dora, Pantanal, Brasil. (Para las clases de distancias, ver arriba.)*

side of the vehicle at 40 km/h, but the estimates were not reported. For the Pantanal, MOURÃO et al. (2000) found an overall density of 0.25 groups/km$^2$ for the entire floodplain and an average group size of 1.67±0.85 deer, using aerial survey techniques. In areas of slightly higher elevation in the Central Pantanal, MOURÃO et al. (2000) found a density of 0.57 groups/km$^2$.

The survey results presented in this study produced the highest population density reported to date for this species, with 2.68±0.30 clusters/km$^2$, and an average cluster size of 2.06±0.10 individuals. This result is due in part to our survey of only grasslands and not the intervening forest, which is included in any aerial survey. Campa Dora is also high quality pampas deer habitat and probably represents one of the highest density limits for pampas deer within the Pantanal (pers. obs.). MOURÃO et al. (2000) indicate that the relatively small deer is difficult to monitor from aerial surveys.

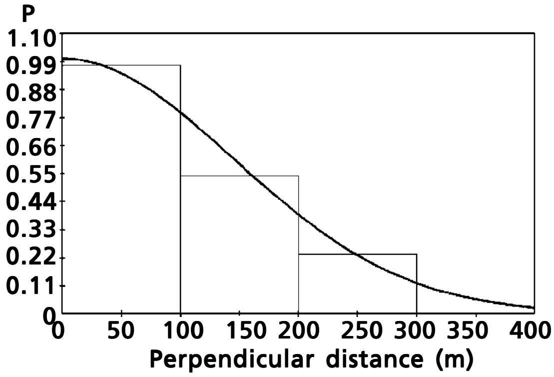


Fig. 2. Distribution of observed pampas deer (*Ozotoceros bezoarticus*) clusters at different distances from the transect line surveyed on foot, pooled from 1999 and 2000, at Campo Dora ranch, Pantanal, Brazil; and the fitted curve of detection probabilities (P).

*Fig. 2. Distribución de grupos de venados de la Pampa (*Ozotoceros bezoarticus*) a diferentes distancias de la transección realizada a pie, datos de 1999 y 2000 agrupados, en la Hacienda Campo Dora, Pantanal, Brasil; y la curva ajustada de las probabilidades de detección (P).*

Table 1. Probabilities of detecting declines in the pampas deer (*Ozotoceros bezoarticus*) population from Campo Dora ranch, Pantanal, Mato Grosso do Sul, Brazil, using distance sampling technique in transects conducted on foot: Pd. Percent decline; N. Number of surveys per year.

*Tabla 1. Probabilidad de detección del descenso en la población de venados de la Pampa (*Ozotoceros bezoarticus*) en la Hacienda Campo Dora, Pantanal, Mato Grosso do Sul, Brasil, usando la técnica del muestreo a distancia en transectos a pie: Pd. Descenso del porcentaje; N. Número de observaciones por año.*

| | | N | | | |
|---|---|---|---|---|---|
| Period | Pd | 1 | 2 | 3 | 4 |
| 5 years | 1 | 0.15 | 0.18 | 0.21 | 0.23 |
| | 3 | 0.3 | 0.4 | 0.52 | 0.6 |
| | 5 | 0.49 | 0.68 | 0.78 | 0.86 |
| | 7 | 0.64 | 0.86 | 0.95 | 0.97 |
| | 9 | 0.75 | 0.93 | 0.98 | 1 |
| 7 years | 1 | 0.25 | 0.25 | 0.31 | 0.37 |
| | 3 | 0.48 | 0.69 | 0.8 | 0.87 |
| | 5 | 0.74 | 0.92 | 0.97 | 1 |
| | 7 | 0.91 | 0.99 | 1 | 1 |
| | 9 | 0.97 | 0.99 | 1 | 1 |
| 10 years | 1 | 0.3 | 0.44 | 0.5 | 0.6 |
| | 3 | 0.78 | 0.95 | 0.99 | 1 |
| | 5 | 0.97 | 1 | 1 | 1 |
| | 7 | 0.99 | 1 | 1 | 1 |
| | 9 | 1 | 1 | 1 | 1 |

Ground surveys are more labor intensive, but may supplement a more broad–scale aerial survey.

The present study is the first to make direct comparisons between vehicle and foot surveys for this species and indicate that surveys from roads should be avoided. This recommendation makes no distinction between the survey being made from a vehicle or walking, because the large variance about the estimate along roads produced no viable monitoring schedule in a power analysis. Roads in the Pantanal tend to be constructed in higher areas, avoiding obstacles, channels and marshy areas. This may influence the location of the deer clusters in relation to the roads in such a way that no representative sampling of the population would be obtained. Additionally, it is possible that pampas deer tend to keep a relatively safe distance from roads, as a means of avoiding the movements of cars, even if this movement is not intense in the Pantanal.

The results of the power analysis indicate that an adequate monitoring program, using the distance sampling technique, to detect population declines is feasible. As with previous surveys using distance techniques (Anderson et al., 2001), teams of students and volunteers were utilized to complete the survey. The comparable results between the 2 survey years, despite using different teams of students, indicate that the protocols can be sufficiently basic for use by non–professionals or people with litle experience. For large areas, such as the Pantanal, we suggest several areas such as Campo Dora, should be established and distributed throughout the region, covering a gradient of habitat types used by pampas deer. Each of these sampling areas could be monitored after a power analysis to establish a suitable local survey program. As recommended by Mourão et al. (2000), ground surveys may be a necessity to accurately monitor trends in pampas deer abundance in the Pantanal. By utilizing teams of students and volunteers within select ranches the present study indicates it is feasible to monitor population trends using standard distance sampling techniques.

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## References

ANDERSON, D. R., BURNHAM, K. P., LUBOW, B. C., THOMAS, L., CORN, P. S., MEDICA, P. A. & MARLOW, R. W., 2001. Field trials of line transect methods applied to estimation of desert tortoise abundance. *Journal of Wildlife Management,* 65: 583–597.

BUCKLAND, S. T., ANDERSON, D. R., BURNHAM, K. P. & LAAKE, J. L., 1993. *Distance Sampling. Estimating Abundance of Biological Populations.* Chapman & Hall, London.

BURNHAM, K. P., ANDERSON, D. R. & LAAKE, J. L., 1980. Estimation of Density from Line Transect Sampling of Biological Populations. *Wildlife Monographs,* 72: 1–202.

CABRERA, A., 1943. Sobre la sistemática del venado y su variación individual y geográfica. *Rev. Mus. La Plata,* 3: 5–41.

CARVALHO, C. T., 1973. O veado mateiro, situação e distribuição. *Bol. Tec. do I. F. São Paulo,* 7: 9–22.

CBSG, 1993. Population and Habitat Viability Assessment for the Pampas Deer *Ozotoceros bezoarticus*. IUCN/SSC Captive Breeding Specialist Group, Gland.

CITES, 1995. *Appendix I. Convention International of Trade Endangered Species*, Gland, Switzerland.

FONSECA, G. A. B., RYLANDS, A. B., COSTA, C. M. R., MACHADO, R. B. & LEITE, Y. L. R., 1994. *Livro Vermelho dos Mamíferos Brasileiros Ameaçados de Extinção*. Fundação Biodiversitas, Belo Horizonte.

GIBBS, J. P., 1995. *Monitor Users Manual*. Yale University, New Haven, Connecticut.

JACKSON, J. E. & GIULIETTI, J. D., 1988. The food of pampas deer *Ozotoceros bezoarticus celer* in relation to its conservation in a relict natural grassland in Argentina. *Biological Conservation,* 45: 1–10.

JACKSON, J. E. & LANGGUTH, A., 1987. Ecology and status of the pampas deer in the Argentinian Pampas and Uruguay. In: *Biology and Management of Cervidae:* 402–409 (C. M. Wemmer, Ed.). Smithsonian Institution Press, Washington, DC.

JUNGIUS, H., 1976. Status and distribution of threatened deer species in South America. In: *World wildlife Yearbook 1975–76:* 203–217. World Wildlife Fund, Morges, Switzerland.

LAAKE, J. L., BUCKLAND, S. T., ANDERSON, D. R. & BURNHAM, K. P., 1993. *Distance User's Guide V 2.0.* Colorado Cooperative Fish & Wildlife Research Unit., Colorado State University, Fort Collins, CO.

LEEUWENBERG, F. & LARA RESENDE, S., 1994. Ecologia de cervídeos na Reserva Ecológica do IBGE–DF: manejo e densidade de populações. *Cad. Geoc.*, 11: 89–95.

MERINO, M. L. & BECCACECI, M. D., 1999. *Ozotoceros bezoarticus* (Artiodactyla, Cervidae) en Corrientes, Argentina: distribución, población y conservación. *Iheringia, Ser. Zool.*, 87: 87–92.

MERINO, M. L., GONZALES, S., LEEWENBERG, F., RODRIGUES, F. H. G., PINDER, L. & TOMÁS, W. M., 1997. Veado–campeiro (*Ozotoceros bezoarticus*). In: *Biologia e Conservação de Cervídeos Sulamericanos: Blastocerus*, *Ozotoceros* e *Mazama:* 42–58 (J. M. Barbanti Duarte, Ed.). FAPESP/FUNEP/UNESP, Jaboticabal, SP.

MOURÃO, G. M., COUTINHO, M., MAURO, R., CAMPOS, Z., TOMÁS, W. M. & MAGNUSSON, W., 2000. Aerial Surveys of Caiman, Marsh Deer and Pampas Deer in the Pantanal Wetland of Brazil. *Biological Conservation,* 92: 175–183.

PRANCE, G. T. & SCHALLER, G. B., 1982. Preliminary Study of Some Vegetation Types of the Pantanal, Mato Grosso, Brazil. *Brittonia,* 34: 228–251.

RATTER, J. A., POTT, A., CUNHA, C. N. DA & HARIDASAN, M., 1988. Observations on Wood Vegetation Types in the Pantanal and at Corumbá, Brazil. *Notes RGB Edinb.*, 45: 503–525.

RODRIGUES, F. H. G., 1996. História Natural e Biologia Comportamental do Veado–campeiro (*Ozotoceros bezoarticus*) em cerrado do Brasil Central. Ph. D. Thesis, Univ. Estadual de Campinas.

SORIANO, B. M. A., 1999. Caracterização climática da sub–região da Nhecolândia, Pantanal, MS. *Anais do II Simpósio sobre Recursos Naturais e Socio–econômicos do Pantanal*, EMBRAPA–Pantanal, Corumbá, MS.

TOMÁS, W. M., 1995. Seasonality of the antler cycle of Pampas deer (*Ozotoceros bezoarticus leucogaster*) from Pantanal wetland, Brazil. *Studies on Neotropical Fauna and Environment,* 30: 221–227.

WEMMER, C. (Ed.), 1998. *Deer. Status Survey and Conservation Action Plan*. IUCN/SSC Deer Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.