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SPACE USE BY WILD GREATER RHEA (*RHEA AMERICANA*) IN A RELICT GRASSLAND OF CENTRAL ARGENTINA DURING THE NON-BREEDING SEASON

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ABSTRACT.— To determine movement patterns and home range of wild Greater Rhea (*Rhea americana*), two subadult males were radio-tracked during the non-breeding season in a relict grassland of San Luis Province, Argentina. The average home range was 452.8 ha, the average daily distance travelled was 1.08 km/day, and the maximum distance from the capture/release site was 13.66 km. Rheas showed differences in habitat types used throughout the day. Grasslands were more frequently used early in the morning and late in the afternoon, whereas cultivated pastures (*Medicago sativa*) were used at noon. Although data is considered preliminary due to the small sample size, the importance of this study is here emphasized because it provides the first records of the spatial ecology of wild individuals for this species.

KEY WORDS: *conservation, grassland, radio-telemetry,* Rhea americana.

RESUMEN. USO DEL ESPACIO POR ÑANDÚES (*RHEA AMERICANA*) SILVESTRES EN UN RELICTO DE PASTIZAL DEL CENTRO DE ARGENTINA DURANTE LA ESTACIÓN NO REPRODUCTIVA.— Para determinar los patrones de movimiento y el área de acción de ñandúes (*Rhea americana*) silvestres, se capturaron dos machos subadultos durante la temporada no reproductiva en un relicto de pastizal en la provincia de San Luis, Argentina. Cada individuo fue monitoreado por radio telemetría. El área de acción promedio estimada fue de 452.8 ha, la distancia promedio recorrida de 1.08 km/día y la máxima distancia atravesada desde el sitio de captura de 13.66 km. Los ñandúes usaron diferencialmente el hábitat a lo largo del día. Los pastizales fueron más utilizados por la mañana y por la tarde y las pasturas cultivadas (*Medicago sativa*) al mediodía. Si bien los resultados de este estudio son preliminares debido al pequeño tamaño de muestra, representan el primer registro de la ecología espacial de individuos silvestres de esta especie.

PALABRAS CLAVE: *conservación, pastizales, radio telemetría,* Rhea americana.

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The Greater Rhea (*Rhea americana*) is one of the most conspicuous native birds of South America; in Argentina it is typically associated with the Pampas grassland, one of the most human-modified ecosystems in the country (Demaría et al. 2008). During the last 150 years the Pampas ecosystem has been severely transformed by agriculture and cattle breeding, showing a continuous advance of the agricultural frontier from the humid east to the semiarid west (Viglizzo et al. 2001). The Greater Rhea has been affected by this habitat modification which, along with indiscriminate hunting and egg and chick harvesting, has caused the decline of their wild populations to the point of local extinction (Navarro and Martella 2008). Therefore, because Greater Rhea is considered a Near Threatened species (IUCN 2013), there is an urgent need to develop management plans for ensuring its long-term conservation.

Effective conservation and management of any species requires information on habitat preferences, movement patterns, space use, and home range (Kapfer et al. 2010), all of which reflect key behavioural and ecological aspects of an animal species (Nathan et al. 2008). However, these aspects have been studied only in captive-bred Greater Rhea individuals that were released into the wild (Bellis et al. 2004a, 2004b, Navarro and Martella 2008). Studies on the spatial ecology of wild individuals will contribute with information to explore if there are behavioural

differences between wild and captive-bred rheas and fine tune management strategies accordingly, because the captive-bred individuals are usually used to reinforce wild threatened populations. Hence, the present study is the first one to provide information on space use, home range, and movement patterns of wild Greater Rhea in a natural grassland environment, where populations still exhibit a healthy condition (Giordano et al. 2008).

METHODS

The study was conducted in two adjacent ranches situated on the western border of the Pampas Region in San Luis Province, Argentina (Fig. 1a): El Águila (34°25'S, 65°22'W; 7900 ha) and La Colina (34°22'S, 65°21'W; 4600 ha). This region still exhibits a good conservation status (Demaría et al. 2008). The study area is characterized by sandy soils and rolling hills with fixed and moving dunes (Anderson et al. 1970). The average annual rainfall is approximately 450 mm, concentrated between October and April. Vegetation is mostly composed of native grasses (*Sorghastrum pellitum*, *Elyonurus muticus*, *Bothriochloa springfieldii*, *Chloris retusa*, *Schizachyrium plumigerum*, *Eragrostis lugens*, *Sporobolus subinclusus*, *Aristida spegazzini*, *Poa ligularis*, and *Poa lanuginosa*), with small tree patches of *Geoffroea decorticans*, *Prosopis caldenia*, and *Prosopis alpataco* (Anderson et al. 1970, Anderson 1973). Exotic grass species, such as *Eragrostis curvula* and *Digitaria eriantha*, were introduced to increase livestock carrying capacity on ranches. Because the land is mostly used for cattle grazing, the study area was covered mostly with grasslands and forest patches (75%), *Medicago sativa* (13%), and only 10% of crops (*Zea mays* and *Helianthus annuus*) (Bazzano, pers. obs.). Although all uses of wild Greater Rhea are legally banned throughout the country, hunting and egg-harvesting of this species are common practices in the region, including the study area.

The present study was conducted during the non-breeding season, the time of the year when Greater Rhea is commonly grouped in flocks of up to 70 individuals (Bazzano 2010) and is most easily detected and shows the lowest tendency to escape (Martella and Navarro 1992). In autumn 2006, 12 nocturnal 5-h surveys were conducted to capture wild individuals, covering the entire study area. After being detected, individuals were captured following the procedure described by Martella and Navarro (1992): the birds were blinded with a spotlight and then immobilized with "boleadoras" that were thrown towards their legs by two expert rural workers. Captured rheas were equipped with a CB-4 Telonics radio-transmitter mounted on an expansion/breakaway collar and a differently coloured Velcro leg-band (for visual identification). Overall, handling of individuals lasted less than 5 min, and none of them was injured. Two subadult rheas of about 10 months of age were captured (identified as individual #1 and individual #2). Both were genetically determined to be males; sex determination was performed by a molecular method (Rossi Fraire and Martella 2006) at the Cátedra de Genética de Poblaciones, Universidad Nacional de Córdoba.

Captured rheas were immediately released and monitored for 21 consecutive days in autumn (between April and May) and 16 consecutive days in winter (between July and August) by radio-telemetry, using a hand-held antenna and a TR4 portable receiver (168–172 MHz) (Telonics, Mesa, Arizona, USA). Location of individuals was confirmed by direct observation and recorded with a GPS. This procedure was performed 2–4 times a day, at ≥2.5-h intervals, from the earliest daylight hours to sunset, following the criteria of Bellis et al. (2004b) who suggested that this interval is enough to minimize dependency between successive locations. In addition, the habitat —grassland, pasture or shrubland (open patches of *Prosopis caldenia* and *Geoffroea decorticans*)— where individuals were observed was recorded and classified according to three periods throughout the day: morning (08:30–11:00 h), noon (11:05–15:15 h) and afternoon (15:20–19:30 h). To compare habitat use among different times of the day, a Chi-square Test was applied. For this analysis, data of the periods morning and afternoon were pooled because there were no differences between them ($\chi^2 = 1.35$, df = 2, $P = 0.509$). Likewise, data of habitat use of the two individuals for both autumn ($\chi^2 = 5.56$, df = 2, $P = 0.062$) and winter ($\chi^2 = 0.17$, df = 1, $P = 0.682$) were pooled.

Home ranges were estimated using the Minimum Convex Polygon (95%) to allow compari-

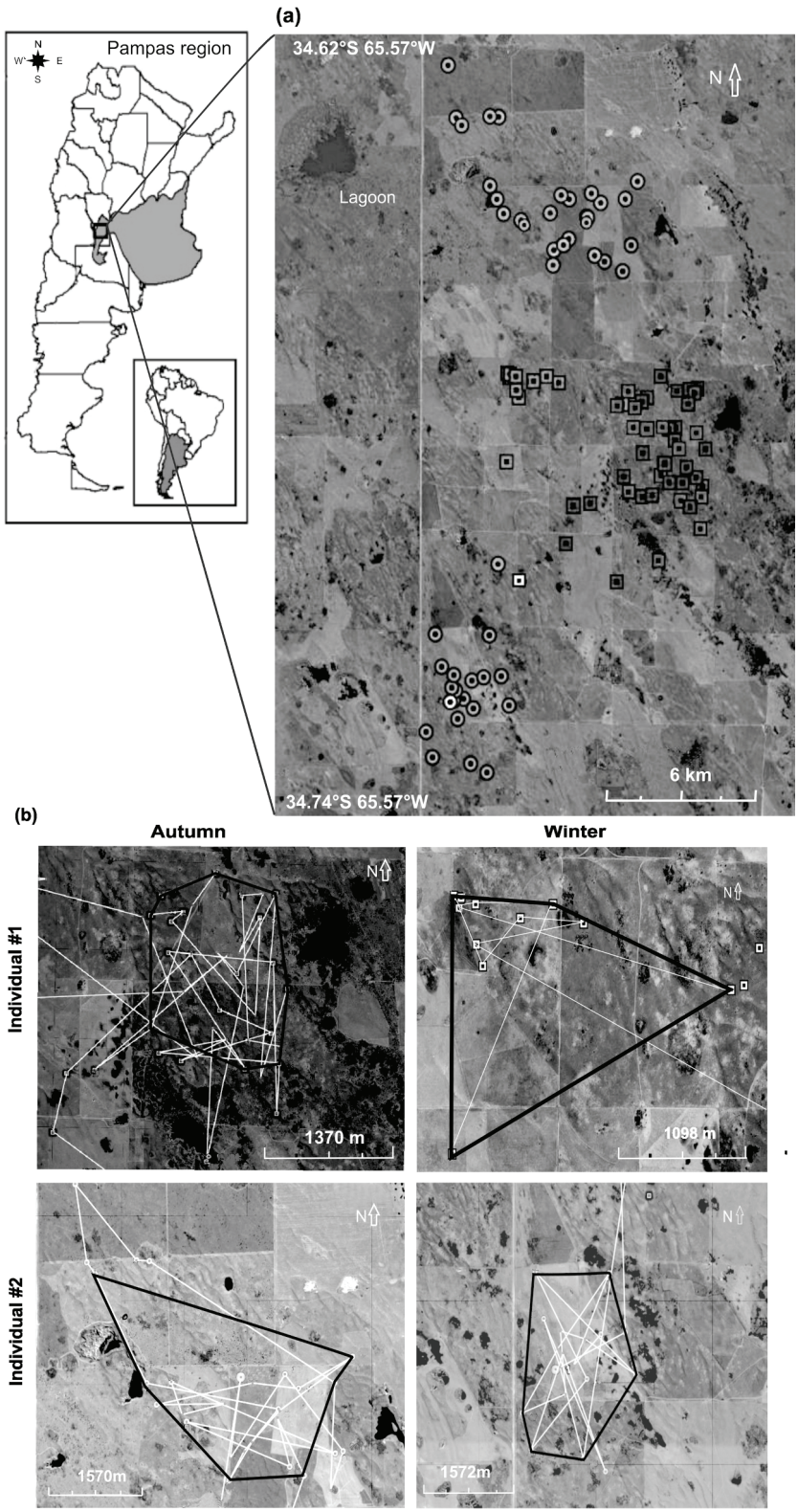

Figure 1. Monitoring of wild subadult males of Greater Rhea (*Rhea americana*) by radio-telemetry in grasslands of central Argentina during the non-breeding season. (a) Squares correspond to individual #1 and circles to individual #2. Capture/release sites for individuals #1 and #2 are indicated with a white square and circle, respectively. (b) Home range (black lines) and movements (white lines) of individuals #1 (above) and #2 (below) during autumn (left) and winter (right).

son with previous studies on Greater Rhea (Bellis et al. 2004b, Bazzano 2010). The data obtained during the first five days after capture were discarded to avoid overestimation of home ranges due to the possible capture-induced behavioural alteration of individuals (Morellet et al. 2009). The Home Range Extension of ArcView 3.2 software (Rodgers and Carr 1998) was employed to estimate home range, distance between consecutive points and total distance travelled in a given period. Mean values are presented with their associated standard error.

Results and Discussion

This study reports the first records of the home range and movements of wild Greater Rhea. Nevertheless, because sample size was small and monitoring was conducted only during the non-breeding season, the results should be taken with caution. The fact that only males were monitored in this study is another limiting factor; however, a previous work involving captive-bred rheas did not find significant differences in home range between males and females in the same season and for the same habitat type (Bazzano 2010).

Despite the effort devoted to locate and capture rheas, the capture rate was lower (1 individual/30 h) than that reported by Martella and Navarro (1992) (1 ind/h). Although these authors worked in a nearby area in which vegetation, land use and density (5 ind/km^2; Martella, unpublished data) were similar to those of the present study area (4.08 ± 0.36 ind/km^2; Bazzano 2010), in the work situation reported by Martella and Navarro (1992) poaching was non-existent because of the effective control and access restrictions imposed by the ranch owner. Thus, the low capture rate observed may be a consequence of a strong hunting pressure on the species in the study area. According to this hypothesis, as a general pattern, the observed individuals were constantly vigilant during the daylight hours, keeping a distance of at least 500 m to the observer.

During the radio-tracking phase of this study, 57 locations were recorded for individual #1 and 49 for individual #2 (Fig. 1a). After release, both rheas moved away from the capture/release site (individual #1: 2 km, individual #2: 10.12 km), remained alone during the first two days, and then joined different groups of variable size (2–50) over time.

During autumn, individual #1 spent all day in a grassland area with open forest patches of *Prosopis caldenia* and *Geoffroea decorticans*. By contrast, daily movements of individual #2 showed greater variation, alternatively visiting sites with pastures of *Medicago sativa* and *Secale cereale* at noon, and natural grasslands during the early morning and afternoon. During the winter period, individual #1 remained in the same area as in autumn, whereas individual #2 returned to the capture/release site. However, during winter both males exhibited the same daily pattern, occupying *Medicago sativa* fields during the day and moving to natural grassland areas in the afternoon.

Rheas showed differences in habitat types used between morning and afternoon vs. noon ($\chi^2 = 6.517$, df = 2, $P = 0.038$; Fig. 2). Early in the morning and late in the afternoon, the birds were more frequently observed in natural grasslands, suggesting that they used this habitat type as roosting and shelter sites. Indeed, these are open areas with few obstacles, which would facilitate vigilance and a rapid running away tactic to escape from predators. By contrast, the use of cultivated pastures by rheas, especially of *Medicago sativa*, which is Greater Rhea's preferred food item (Martella et al. 1996), increased at about noon.

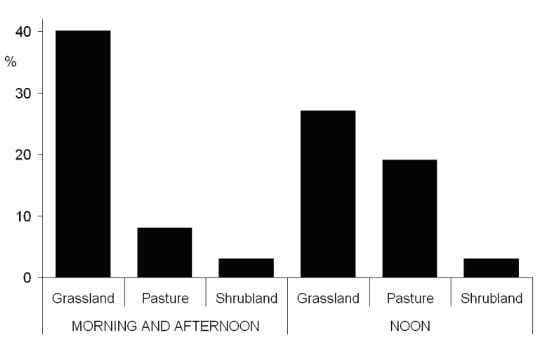

Figure 2. Percentage of radio-locations of two wild subadult males of Greater Rhea (*Rhea americana*) in three habitats in grasslands of central Argentina at different times of the day during the non-breeding season.

Finally, rheas used the shrubland in low proportion and indistinctly throughout the day. These results agree with previous studies on habitat use by this species, which reported that wild and captive rheas use both the grassland and the pastures (*Medicago sativa*) with preference for the latter (Bellis et al. 2004a) and only use the shrubland as a shelter site (Bazzano et al. 2002).

Mean home range of the wild rheas was 452.8 ± 86.3 ha. In autumn, the home range of individual #1 was 325.6 ha, which was smaller than that of individual #2 (705.9 ha) (Fig. 1b). In winter, differences in home range sizes were reduced (individual #1: 365.2 ha, individual #2: 414.5 ha; Fig. 1b). These values are within the range reported for captive-bred Greater Rhea males (745 ± 367 ha) and females (549 ± 216 ha) released into a similar grassland (San Luis Province) during the non-breeding season (Bazzano 2010). Likewise, the mean distance traversed throughout the day (assuming straight-line movements between consecutive locations) by wild rheas (1.08 ± 0.08 km) and captive-bred subadult rheas (1.41 ± 0.40 km; Bazzano 2010) were similar. Maximum distance travelled by wild rheas from the capture/release site was 13.66 km (individual #2).

In November 2006 (three months after the end of monitoring) the collars of the rheas were found in good condition in a *Medicago sativa* field of an adjacent ranch. The birds either might have lost the collars by accident or might have been hunted and the collars left *in situ*. Although extensive searches of these individuals were made afterwards, trying to identify them by the presence of the Velcro leg-band, they were not located.

Despite the sampling limitations of the present study, from a conservation standpoint, results obtained in wild rheas in terms of habitat use, home range and mean distance traversed are consistent with those reported for captive-bred individuals of both sexes, which suggests a promising future for translocation of individuals as a management strategy for the restoration of populations of this threatened species. However, as most of the wild populations persist in private lands, the success of this type of strategies requires controlling illegal hunting and promoting land use types that can combine the presence of grasslands and pastures.

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