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Home range of greater and lesser rhea in Argentina: relevance to conservation

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Abstract. In this work we report results of radiotracking studies on the movements and home range sizes of two near-threatened species, the greater rhea (*Rhea americana*) and the lesser rhea (*Pterocnemia pennata pennata*) in relation to different land use regimes. We radiomonitored greater and lesser rheas for 3 years in their respective habitats: the Pampas and the Patagonia regions. We chose two study areas in each habitat with similar agricultural activities and different hunting control. We did not find significant differences in movements and home range size between study areas of each species. This suggests that disturbance caused by human presence in the areas did not affect rhea spacing behaviors. Moreover, lesser rheas showed larger home range and movements than greater rheas, showing that the home range size is not an immutable property of body mass, and that abundance and distribution of food appears to be the main factor that influences the movements and home range size of these birds.

Introduction

The concept of home range has been defined as the area within which an animal traverses to meet normal daily needs (Mohr 1947 in Rodrigues and Monteiro-Filho 2000). Knowledge of home range has received increasing attention in the last years because of its importance to conservation and management (Caro 1998; Pasinelli et al. 2001). However, in Argentina there is little information about the home range of most species, especially birds.

Greater rhea (*Rhea americana*) and lesser rhea (*Pterocnemia pennata pennata*) are two ratite species native to South America. Greater rhea's range includes grassy plains and open bush areas. In Argentina, this species has adapted to agricultural landscapes where food resources are particularly abundant (Bellis et al. 2004). In agroecosystems rheas consume mostly alfalfa and wild dicots, showing no preference for grasses (Martella et al. 1996). Lesser rhea is an endemic subspecies of shrub steppes and semideserts of Argentine Patagonia and southern Chile (Del Hoyo et al. 1992). In Patagonia, rhea shows a constant diet year-round, which consists of shrubs ($\sim 70\%$) and to a lesser extent herbaceous and gramineous species (Bonino et al. 1986; Camezzana 1987). Regarding habitat use, both rhea species show preference for areas where abundant forage and safety from predators are combined, counterbalancing food profitability with the corresponding cost of vigilance (Martella et al. 1995; Codenotti and Alvarez 2000; Bellis et al. 2001, 2003).

Free ranging populations of these birds have declined drastically due to human activities; consequently they were included in Appendices II and I of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), respectively. The main causes of these reductions are habitat loss, egg gathering, and predation (Bucher and Nores 1988; Martella et al. 1995, 1996; Bellis et al. 1999; Funes et al. 2000; Navarro and Martella 2002). Adult rheas have only two known predators: felids (*Puma concolor* and *Felis colocolo*) and humans, who in the last decades have become the main rhea predator, hunting them for their meat and feathers or for sport purposes (Martella et al. 1995; Novaro 1995; Reboreda and Fernández 1997; Novaro et al. 2000; Navarro and Martella 2002). Moreover, illegal hunting is a significant problem for wild species throughout Latin America since hunting regulations are largely ignored in all the region (Silva and Strahl 1991).

Previous studies about rhea reintroduction showed the feasibility of supplementation of wild rhea populations through release of individuals reared in captivity (Bellis et al. 1999). However, no attention has been paid to the spatial requirements of these birds so far. In this work we report the first results of studies on spacing behavior of greater and lesser rheas by means of radio-tracking techniques. Specifically, we have focused on two aims: to gain information regarding home range size and movements of these birds, and to verify if human presence in each study area affects the spacing behavior of rheas.

Materials and methods

Study areas

Greater rheas

Fieldwork was conducted in two ranches of the Pampas region: El Refugio (33°44′47″ S, 64°57′49″ W) and Las Dos Hermanas (33°39′18″ S, 62°33′39″ W), from August 1998 to December 2000. El Refugio is a 1350-ha ranch devoted to cattle raising and crops. It had 931 ha with sunflower (*Heliantus annus*) crops and 418 ha with pastures composed mainly of alfalfa (*Medicago sativa*), *Eragrostis* sp., *Agropyron* sp., brome grasses (*Bromus* sp.) and *Stipa* sp. The rhea population comprised 30 individuals (1 individual/45 ha) and the main herbivores inhabiting the area were cattle, horses and hares (*Lepus* sp). Hunting was banned but no effective control was exerted. Las Dos Hermanas ranch had an area of 3776 ha with different kinds of habitats: 1330 ha of pastures: alfalfa (*Medicago sativa*), *Festuca* sp., brome grasses, clover (*Melilotus* sp); 746 ha of crops: sunflower, corn (*Zea mays*), wheat (*Triticum aestivum*), and soybean (*Glycine max*); and 1700 ha devoted to wildlife conservation. Vegetation in this area included grasslands (*Stipa* sp., *Spartina densiflora, Distichis spicataa, Cyperus* sp., *Juncus* sp., and *Eleocharis* sp.); shrubs (*Cyclolepys genistoides, Artlipex undulata,* and *Schinus fasculatus*); salt flats (*Heterostachys ritteriana* and *Salicornia virginiana*) and saline marshes (*Paspalum vaginatum* and *Eleocharis palustris*) (Cantero et al. 1994). In addition to 300 greater rheas (1 individual/13 ha), the principal herbivores inhabiting the area were cattle, horses, sheep and hares. Hunting was prohibited and the area was invigilated by a ranger. In both ranches cattle was stocked at densities of 1 individual per 0.5–2 ha.

Lesser rheas

Field research was conducted from October 1998 to July 2000 in two areas of the Argentine Patagonia: Loma Blanca (40°31′59″ S, 68°38′29″ W) and El Remiendo ranches (40°7′57″ S, 69°12′51″ W). Both areas were located in an ecotone, where typical elements of the Monte and Patagonic steppe coexisted. This ecotone was included in the physionomic-floristic district (DFF) of medium to low shrub steppes. The species present were *Prosopis denudans, Schinus polygamus, Prosopidastrum globosum, Nassauvia glomerulosa, Acantholippia seriphioides, Mulinun spinosum, Grindelia chiloensis, Stipa humilis,* and *S. speciosa* var. *speciosa* (Somlo 1997; León et al. 1998; Paruelo et al. 1998). Loma Blanca is a 29,000-ha ranch without free pass roads; wildlife was protected and sheep carrying capacity was controlled (1 sheep/4 ha). Hunting was banned and control was exerted by the owner (A. Garrido, personal communication). Lesser rhea population comprised 2300 birds (1 individual/12 ha), and the other wild herbivorous species living in the area were guanacos (*Lama guanicoe*), hares (*Lepus* sp.) and upland geese (*Chlöephaga* sp.). El Remiendo ranch had an area of 6500 ha, with free pass roads; sheep was stocked at densities of 2–3 individuals/4 ha, wildlife was not protected nor was hunting forbidden. In this ranch, besides the lesser rhea population (157 individuals, 1/41 ha), the only natural herbivore was the hare, since the wild population of guanacos disappeared some years ago (J. Taux, personal communication).

In all the study areas, plots were equally available to lesser and greater rheas, because they could easily cross the six-wire fences delimiting the plots.

Methodology

Nineteen greater rheas and seven lesser rheas produced by artificial incubation (*sensu* Navarro et al. 1998) and reared in captivity were released into the field, following The World Conservation Union guidelines for re-introduction (IUCN 1998). Each bird was marked with colored leg bands. Ten greater rheas and seven lesser rheas were also equipped with transmitters on CB-4 expansion, break-away collars (Telonics, Mesa, Arizona, USA). The released rheas were young individuals (10 months of age) whose sex was not determined.

In the Pampas region, greater rheas were released in pasture paddocks following soft and hard release protocols (Kleiman and Beck 1994). (1) 'soft' protocol released rheas: 12 individuals were kept for 5 months in corrals to become familiar with the area before being released in Las Dos Hermanas ranch (October 1998); and (2) 'hard' protocol released rheas: seven birds were transported in wood boxes from the breeding site and released on the same day, without any familiarization period with the release area. Of these, five rheas were released in Las Dos Hermanas ranch (three in February 2000 and two in July 2000) and two in El Refugio ranch (October 1998).

In Patagonia, lesser rheas were released in the ecotone monte-steppe, following the same procedures as with greater rheas. Five birds were kept at the study area (three in Loma Blanca ranch and two in El Remiendo ranch) for 7 months before being released in October 1998, and two lesser rheas were transported and released on the same day (July 2000) in Loma Blanca ranch. In all cases, lesser and greater rheas were fed with concentrate food and alfalfa until they were released.

We collected data for 3 years (1998–2000) from August to December. Each bird was radio-located, by triangulation or by direct observation, during 3–4 days per week each month, using a Telonics hand-held antenna and a portable Telonics TR4 receiver (168–172 MHz). Greater rheas were successively located 5–9 times/day at $\geq$1-h intervals and lesser rheas were located 3–6 times/day, at least 30-min apart. These intervals were chosen to minimize dependency between successive locations, because this amount of time was enough for a bird to move from one place to other places (White and Garrot 1990). Individual home range sizes were calculated by 95% minimum convex polygon (95 MCP) using the geographic information system CAMRIS (Ford 1998). Furthermore, we determined the maximum linear distance traveled as that from the releasing site to the farthest location.

Statistical analysis

Data were log-transformed and normality and variance homogeneity were tested using Saphiro Wilks and Levene tests, respectively (Zar 1984). Differences in home range size and maximum distance traveled between study areas and rhea species were tested simultaneously using two-way nested ANOVA (Zar 1984).

Results and discussion

In El Refugio ranch, greater rheas swiftly abandoned the area where they were released, and in a few hours they were feeding in alfalfa paddocks, together with nine wild greater rheas present in this area. Maximum distance traveled was 1.8 km, and the average home range size was 1.8 km^2 ± 0.38 [S.E.] (Table 1). Two months after release, the signal of radiomarked rheas was lost, although a broad area of 2000 ha was inspected. Hence, we supposed that

Table 1. Home range size defined by the minimum convex polygon (MCP) method, and distance traveled from the release sites by greater and lesser rheas in the Pampas region and in the ecotone Monte-Steppe of Patagonia, Argentina, from 1998 to 2000.

	Study area	Individuals	MCP (km^2)	Maximum distance (km)
Greater rheas (Pampas region)	El Refugio	c3	2.15	1.77
		c8	1.39	1.58
	Las Dos Hermanas	c1	4.5	5.44
		c4	4.14	7.78
		cr	2.81	2.05
		ca	2.82	1.52
		c4a	2.24	0.63
		c6	2.35	1.31
		c34	0.93	0.3
		c49	1.17	0.45
Lesser rheas (Ecotone Monte-Steppe)	El Remiendo	c0	37.78	17.4
		c7	5.65	16.3
	Loma Blanca	c2	11.68	4.35
		c5	9.54	31.7
		c9	7.48	5.74
		c57	49.39	12.7
		c19	45.7	11.4

greater rheas were killed and taken by poachers who are very common in the area (P. Bocco, personal communication). In Las Dos Hermanas ranch, greater rheas stayed for 5 months in the alfalfa paddocks where they were released. Later, the rheas moved to other paddocks with pastures, joining groups of 8–30 wild adults and juveniles. The maximum distance traveled by rheas was 7.8 km and their average home range size was 2.6 $km^2 \pm 0.45$ (Table 1). In this ranch, only two out of eight released greater rheas were killed by poachers.

In the ecotone monte-steppe, lesser rheas moved constantly, and sometimes were found feeding together with groups of 2–15 wild lesser rheas. In El Remiendo ranch, the maximum distance traveled was 17.4 km and the average home range size was 21.7 $km^2 \pm 16.08$, whereas in Loma Blanca ranch lesser rheas traveled a maximum distance of 31.7 km and the average home range size was 24.8 $km^2 \pm 9.34$ (Table 1). In both rhea species, birds spacing behavior did not differ between study areas, either in home range size ($F = 0.52$; $P = 0.61$) or in maximum distance recorded ($F = 0.20$; $P = 0.82$).

The similarity found in home range size of rheas from the different study areas apparently would be related to food preferences of these species. The smaller home range of greater rheas was likely the result of their permanence in pasture paddocks cultivated mostly with alfalfa. This plant, as well as other wild dicots, constitutes the preferred food item in the greater rhea diet

(Martella et al. 1996), because of its high protein and fiber content, and its year-round availability (Medina 1999). Thus, greater rheas do not need to travel large distances to meet their food requirements. Accordingly, in agricultural landscapes, greater rheas showed preference for pastures which provide sufficient forage and good visibility for avoiding predation (Codenotti and Alvarez 2000; Bellis et al. 2004). Although alfalfa is a food item shared by cattle and rheas, there is no competence for this resource because greater rheas consume alfalfa in higher proportions during winter, when this plant is too short to be available to domestic livestock (Martella et al. 1996).

Likewise, lesser rhea home range size did not differ between study areas, possibly because both areas had the same floristic composition and consequently food supply (Somlo et al. 1997). A larger home range for lesser rheas was the result of the low food availability in the arid environments of Patagonia. There was practically no competence for food resources among lesser rheas and the other herbivore species (hares, upland geese, guanacos and sheep), because of the low diet overlap ($\sim$30%) between them, together with the low density of wild rhea population (Bonino et al. 1986; Camezzana 1987).

Human presence due to agricultural activities (sowing, plowing, harvesting, livestock movements, sheepshearing, etc.) in each of the study areas does not appear to influence the spacing behavior of lesser and greater rheas. However, the loss of all individuals released in the El Refugio ranch, together with the low population density (30 rheas, compared to the wild population of Las Dos Hermanas ranch – 300 birds), emphasize the negative effect of hunting on the wild population of greater rhea, mainly in areas where hunting was not controlled. In the monte-patagonic steppe ecotone we did not find any influence of pouching on released lesser rheas. Nonetheless, poachers were occasionally observed in both areas (A. Garrido and J. Taux, personal communication). As in the case of greater rhea, in areas without hunting control, the abundance of the wild lesser rhea population was remarkably smaller (157 individuals) than in areas where hunting was banned (2300 birds). The serious damage that poaching has caused on wild populations of rhea species has been stated in previous studies (Cajal 1988; Del Hoyo et al. 1992; Demaría 1994; Martella et al. 1996; Bellis et al. 1999; Funes et al. 2000; Navarro and Martella 2000; Novaro et al. 2000), showing that this activity affects their populations directly and negatively. Therefore, it is imperative to take into account that target areas for rhea conservation should include not only suitable habitats but also strict poaching control.

On the other hand, lesser rheas traveled farther ($F = 14.36$, $P = 0.003$) and had a larger home range than greater rheas ($F = 15.81$, $P = 0.002$). These variations may be due to differences in food supply between the areas occupied by the rheas. The arid regions of Patagonia have a very low food availability as a result of water constraint and the rigorous weather conditions which reduce the aboveground net primary production (Camezzana 1987; León et al. 1998; Paruelo et al. 1998). In this scenario, although lesser rhea is well adapted to this environment through a generalist diet that allows it to optimize the energetic and feeding yield (Bonino et al.1986; Camezzana 1987), it needs to travel long distances to feed. Hence, lesser rhea home range size will be larger than that of the greater rhea in the agroecosystems, where food resources are plentiful.

Our results suggest that the abundance and distribution of suitable food are the main causes of variations in the home range size of these ratites. This idea was recently supported by Micolini's results (unpublished observation), who studied the home range of greater rheas released in natural grasslands. In this study, home range size was significantly larger than for rheas of the agroecosystem (11 $km^2 \pm 3.98$ [S.E.]; $F = 11.87$, $P < 0.001$; Tukey test $P < 0.05$) but did not show differences with the lesser rhea home range size ($P > 0.05$). These variations in greater rheas home range would be due to low wild dicots availability in the grassland. Greater rheas are very selective in their feeding and as grasslands are constituted mostly by gramineous species, these birds would be forced to enlarge the home range (with respect to greater rheas of the agroecosystem) to obtain suitable food.

This inverse relationship between the home range and food supply was stated by Harestad and Bunell (1979) and verified in different taxa: ostriches *Strutio camelus* (Williams et al. 1993; Milton et al. 1994), deer *Ozotoceros bezoarticus* (Rodrigues and Montheiro-Filho 2000), houbara bustards *Chlamydotis macqueenii* (Combreau et al. 2000), lesser spotted woodpecker *Dendrocopus minor* (Wiktander et al. 2001), and mountain lions *Puma concolor* (Grignone et al. 2002), among others. Thus, although theory showed that across a large range of body sizes, these are positively related to the home range area (Mc Nab's 1963; in Relyea et al. 2000; Schoener 1968; Jenkins 1981; Mace and Harvey 1983), within a species where the body size is limited, factors such as food availability and distribution, foraging strategies and habitat productivity could combine to determine the spacing behavior of an individual.

Finally, from a conservation point of view, this work addresses three relevant issues to the management of greater and lesser rheas, which should be considered when designing protected areas for rhea species: (1) the home range size of rheas is not an unalterable property of their body size, so it could be actively managed by modifying habitat quality (food supply); (2) rural areas have a potential to contribute to maintain viable populations of rheas, and (3) a strict hunting control must be exerted to optimize efforts to preserve populations of wild rheas, mainly greater rheas.

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