

**TERRITORIALITY AND HOME RANGE OF THE RED-LEGGED SERIEMA (*CARIAMA CRISTATA*)**Daniele Cipriano de Souza<sup>1</sup> · Lucas Donizetti Vieira<sup>1</sup> · André Luis da Silva Castro<sup>2</sup>

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**Abstract** · Little is known about the ecology and biology of the Red-legged Seriema (*Cariama cristata*), a large territorial South American bird. This study aimed to describe aspects of the home range and territoriality of *C. cristata* in an anthropized region of the Cerrado in the western central Brazil. Based on georeferenced observations, the Minimum Convex Polygon 100% (MCP) and Kernel density (95% and 50%) methods were used to construct home-range maps for five family groups of *C. cristata*. The mean ( $\pm$  SD) home-range sizes were estimated as  $24.34 \pm 13.31$  ha (100% MCP),  $20.13 \pm 6.69$  ha (fixed Kernel 95%) and  $18.98 \pm 7.64$  ha (fixed Kernel 50%). There was little overlap among the home ranges of the different groups. Territorial defense observed included duetting vocalizations and agonistic encounters. We conclude that the home ranges of *C. cristata* have little overlap, and that the entire home range is treated as a territory and defended against intruders.

**Resumo · Territorialidade e área de vida de Seriemas (*Cariama cristata*)**

Pouco é conhecido sobre a biologia e ecologia da Seriema (*Cariama cristata*), uma ave territorial da América do Sul e de grande porte. O presente estudo descreve aspectos da área de vida e territorialidade de *C. cristata* em uma região antropizada de Cerrado no Centro-Oeste do Brasil. Baseado em observações georreferenciadas, os métodos do Mínimo Polígono Convexo (100% MPC) e Densidade de Kernel (95% e 50%) foram utilizados para construir os mapas de área de vida de cinco grupos familiares de *C. cristata*. O tamanho médio ( $\pm$  desvio padrão) das áreas de vida foram estimados em  $24,34 \pm 13,31$  ha (100% MPC),  $20,13 \pm 6,69$  ha (Kernel 95%) e  $18,98 \pm 7,64$  ha (Kernel 50%). Houve pouca sobreposição das áreas de vida dos diferentes grupos. As defesas territoriais observadas incluíram vocalizações em dueto e encontros agonísticos. Concluímos que a área de vida de *C. cristata* tem pouca sobreposição e que toda a área de vida é defendida como território contra intrusos.

**Key words:** Behavior · Brazil · Cariamidae · Cerrado · Conservation · Territory

**INTRODUCTION**

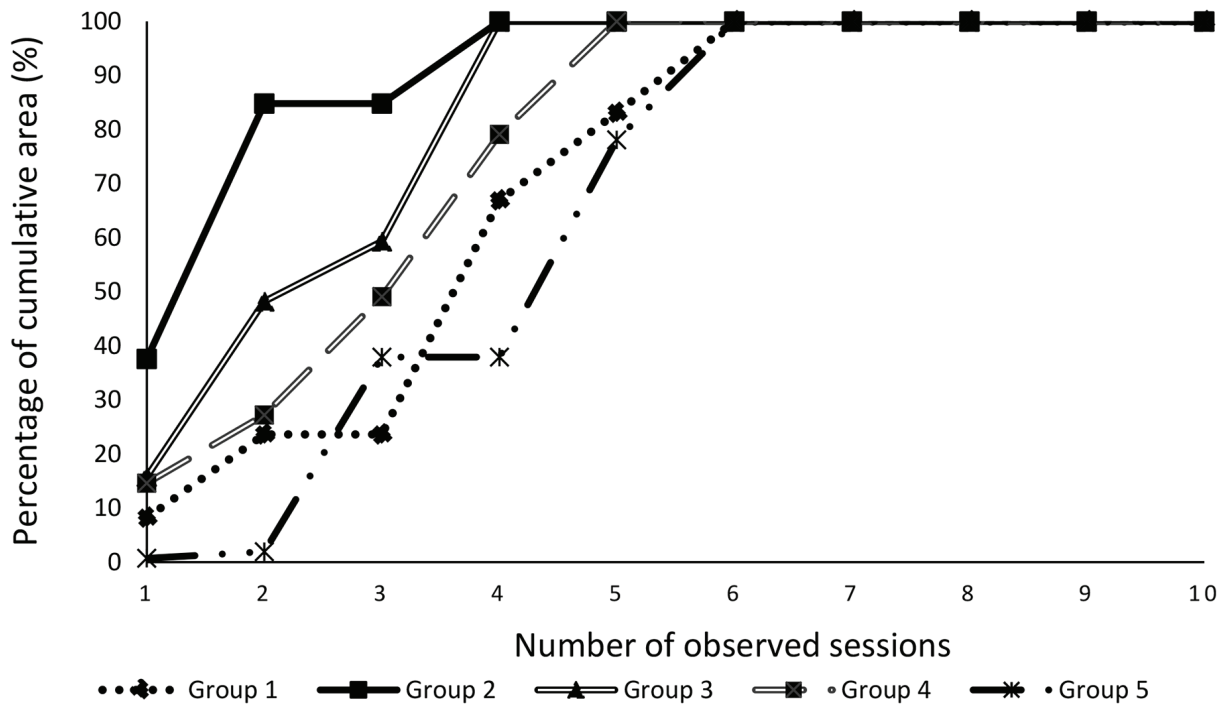
Territoriality is common in birds and necessary for the defense of food and reproductive resources (Davies 1978). Territorial behaviors often define an area of occupation that is defended from intruders: the territory or home range. Home range and territory size fundamentally affect ecological processes, such as the distribution and abundance of organisms and population parameters, respectively (Schoepf et al. 2015), habitat selection, and predator-prey dynamics (Börger et al. 2008).

The Crested or Red-legged Seriema (*Cariama cristata*) is a large, territorial species of South American bird that is widely distributed from Argentina and Bolivia to northeastern Brazil (Sick 1997). *C. cristata* can be found as solitary individuals or in family groups consisting of a mated pair and up to two offspring (Redford & Peters 1986, Silva et al. 2016). Its loud vocalizations are used for territorial defense (Redford & Peters 1986). *Cariama cristata* reaches 90 cm height, weighs approximately 1.5 kg, and has limited sexual dimorphism (Sick 1997). This species is omnivorous, feeding on grains, fruits, insects, and snakes (Almeida 1994, Redford & Peters 1986).

Previous studies have focused on habitat use and distribution (Brooks 2014), basic aspects of biology and behavior (Redford & Peters 1986, Brooks 2014, Silva et al. 2016), vocalizations (Redford & Peters 1986), and

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**Figure 1.** Sampling effort curve plotting number of observation sessions per group against the cumulative percentage of area for five groups of the Red-legged Seriema (*Cariama cristata*), using the Minimum Convex Polygon method. Data collected in western central Brazil (Urutaí, Goiás State), from October 2013 to June 2014.

reproduction (Almeida 1994). However, other ecological aspects of *C. cristata*, such as territoriality and home range, which are necessary for population studies, management, and conservation, are unknown. Thus, this study aims to quantify home-range size and describe patterns of territoriality of *C. cristata* groups in the Cerrado of central-western Brazil.

## METHODS

The study was conducted on a 245 ha site (17°28'51.78"S, 48°12'36.14"W – 17°30'40.45"S, 48°12'28.99"W) belonging to the Instituto Federal Goiano - Urutaí Campus and located within the Cerrado biome of central-western Brazil (southeast Goiás state). The study site is rural and characterized by a mosaic of land-use types including several types of native Cerrado vegetation (Riparian Forest, Gallery Forest, and Semi-Deciduous Forest in various successional stages) and anthropic areas used for grazing, agriculture and built-up areas belonging to the school. The study area presents predominance of plateaus and a topography between 685 to 988 m a.s.l.. The climate is tropical humid with a rainy and a dry season, the annual rainfall and temperature average 1402 mm and 23.4°C, respectively.

Data were collected between October 2013 and June 2014 (spanning the period of egg incubation to offspring care after leaving the nest). Animals within transects were found and observed through binoculars (Sumax, 10x50 mm) from 10 to 50 m away (Medeiros & Marini 2007). The location of individuals

was determined by GPS and recorded every 10 minutes or after movement. The animals remained in open areas, which facilitated observation and georeferencing.

Data were obtained from 50 sessions (ten sessions/group), totaling 88 hours of direct animal observation and averaging 1.76 hours/daily session. Observations were carried out between 07:30 and 17:00 h by two pre-trained researchers. The entire study area was sampled and all groups of *C. cristata* were observed.

Five groups of *C. cristata* (13 subjects) were observed. An individual from each group was captured and tagged with a colored band. This allowed the groups to be identified given that the animals within a given group always remained together. Capture and banding occurred after obtaining permission from the Brazilian Institute of Environment and Renewable Natural Resources (Case No. 40187-1/2013) and the Ethics Committee on Animal Use (CEUA) of the Federal Institute Goiano (Case No. 26/2013). The animals were captured using dip nets and mist nets and manually restrained, including covering the bird's eyes to reduce stress (Pachaly & Brito 2000). The entire process of restraining, banding, and releasing an individual lasted  $\leq 3$  min.

The geographic locations of individuals in each group were plotted in ArcGIS-ESRI (version 10.1) and group home ranges were determined using the Minimum Convex Polygon (MCP) method, and fixed kernel density. MCP reflects the most parsimonious simplification of the home range using the extreme

**Table 1.** Home-range size of five Red-legged Seriema (*Cariama cristata*) groups in the West Central Brazil (Urutaí, Goiás State), estimated by Minimum Convex Polygon 100% (MCP) and Kernel density (95% and 50%) methods.

Group	Home-range size (ha)		
	100% MCP	Kernel 95%	Kernel 50%
1	38.39	30.12	30.28
2	15.81	19.23	18.75
3	5.64	11.65	9.72
4	29.96	21.26	21.05
5	31.89	18.07	15.02
Mean	24.34	20.07	18.96
Standard deviation	13.31	6.67	7.64

location points of the samples (Laver & Kelly 2008, Powell & Mitchell 2012). Fixed kernel density uses the geographic locations of animals to estimate the likelihood of an individual being within a given area. Least squares cross-validation was used to smooth the fixed-kernel density parameters, with 95% contours used to show the most extreme limits (Worton 1989, Laver & Kelly 2008) and 50% contours to demonstrate more central areas (Powell 2000).

Behavioral observations related to *C. cristata* territoriality (Silva et al. 2016) were georeferenced and recorded on field worksheets. Occurrences of territorial defense were also registered and georeferenced.

## RESULTS AND DISCUSSION

Five groups of *C. cristata* were observed that consisted of mated pairs (groups 2 and 3) or pairs with offspring (groups 1, 4 and 5, one offspring per pair). The birds inhabited fragments of Cerrado, pastures, and built-up areas. During the observation period, estimates of home ranges increased and plateaued from the 4th to the 6th observation (MCP, Figure 1), indicating that the observation efforts were sufficient (Domingues & Rodrigues 2007).

The mean sizes of the home range ( $\pm$ SD) of *C. cristata* groups were  $24.34 \pm 13.31$  ha for MCP (100%),  $20.07 \pm 6.67$  ha for the 95% Kernel method, and  $18.96 \pm 7.64$  ha for the 50% Kernel method (Table 1). Combining these methods provides a better understanding of home-range size and boundaries by MCP (Ribeiro et al. 2002, Domingues & Rodrigues 2007, Bellis et al. 2004, Kanegae 2013) and usage within that area by Kernel analysis (Freitas & Rodrigues 2012, Costa & Rodrigues 2013, Schoepf et al. 2015).

The areas of highest density, estimated by 50% Kernel method and illustrated in Figure 2, show usage patterns that varied greatly among groups. The nests of groups 2 and 5 were in high density regions on the periphery of the home range, indicating more frequent presence close to the nests.

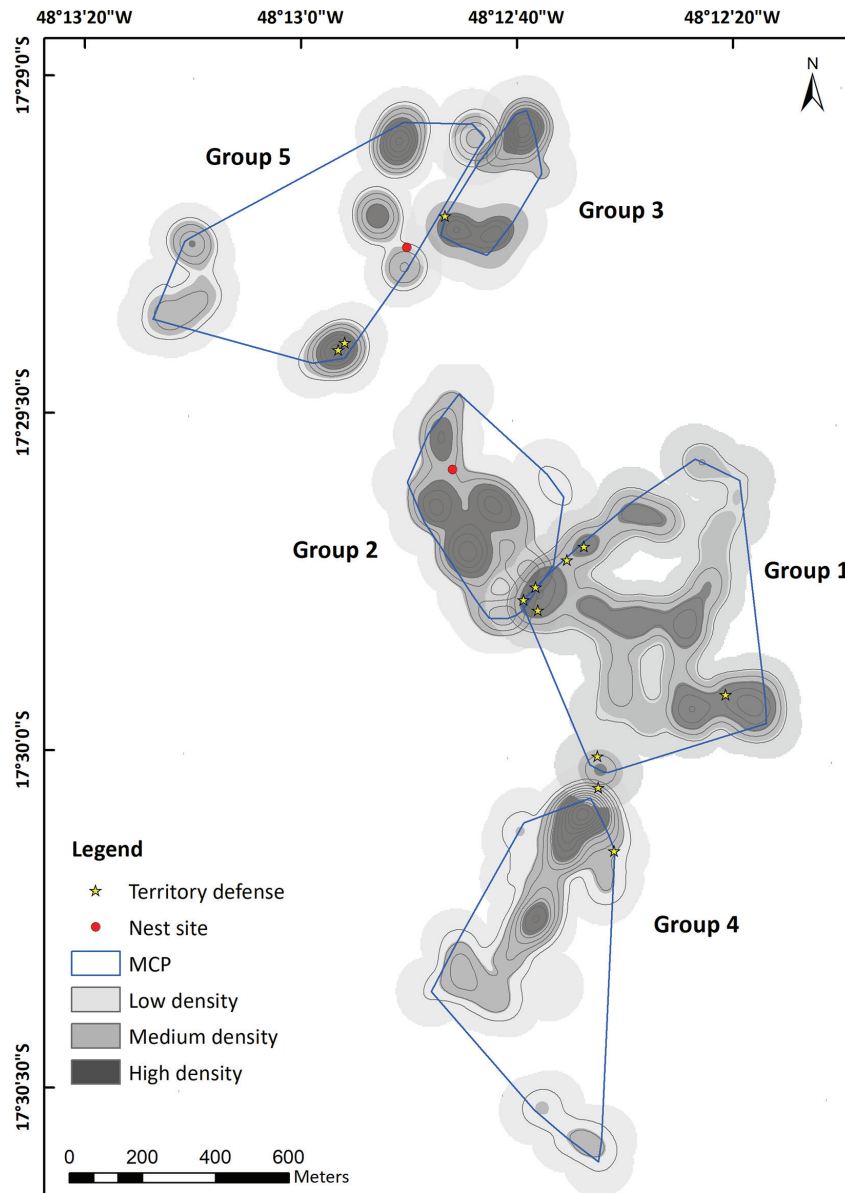
The great variation in home-range size of these *C. cristata* groups may have been due to several factors (Kelt & Van Vuren 1999, Santangeli et al. 2012, Bellis et al. 2004, Schoepf et al. 2015). Some studies have shown that in areas with high food availability, home ranges may be smaller because individuals need not travel as far for food (Bellis et al. 2004, Ribeiro et al. 2002). Body mass and density may also influence home-range size (Kanegae 2013, Schoepf et al. 2015). However, probable explanations for the large difference in the home-range sizes of the groups are the presence of offspring and the need for food, since the groups with offspring (1, 4, and 5) showed larger home-range size than groups composed only of mated pairs (2 and 3), as discussed by Schoener (1968) and Mcloughlin & Ferguson (2016).

Figure 2 shows that the home ranges of the groups were mostly separate, with minimal overlap observed only between groups 1 and 2. The groups occupied a total area of 121.29 ha (49.67% of the study area), with a density of 0.11 individuals/ha or 0.04 groups/ha.

Twelve occurrences of territorial defense were observed (yellow asterisks, Figure 2), characterized by duetting vocalizations (made by a mated pair), which are described as full vocalizations by Silva et al. (2016). Territorial defense occurred between neighbors and involved agonistic confrontation between individuals that were characterized initially by full vocalization duetting followed by short runs and flights toward intruders, interspersed with claw and beak attacks (Silva et al. 2016).

The presence of complete duetting vocalizations and physical confrontations confirms territorial behavior of *C. cristata* found in previous studies (Redford & Peters 1986, Almeida 1994, Silva et al. 2016). Hinde (1956) described vocalizations and other behaviors designed to prevent another individual from entering the territory. The limited overlap among home ranges and the territorial defense indicate that the territory of a *C. cristata* group encompasses the entire home range, as defined by Odum & Kuenzler (1955). The only cases of intraspecific agonistic confrontation we observed took place at the border of the home range between two groups. Silva et al. (2016) studied *C. cristata* within the same region and noted that individuals attacked reflections of themselves in metal troughs, providing further evidence of the territorial behavior of this species. The territory of *C. cristata* can be therefore classified as "type A" (Hinde 1956), which is defined as a large area within which all activities take place (foraging, nest building, courting and copulation).

However, our data collection period spanned from parental care of the nestlings (mated pair and offspring) to parental care outside of the nest and was limited to a single life-cycle of the species. It is important to note that the territory size of birds may vary with the time of year (Niedzielski & Bowman 2016). Since the sampled period did not complete one year,



**Figure 2.** Home-range maps of the five Red-legged Seriema (*Cariama cristata*) groups in the West Central Brazil (Urutaí, Goiás State), from October 2013 to June 2014. The blue lines delimit home ranges, estimated by Minimum Convex Polygon method (MCP), yellow asterisks indicate territorial defense sites and red dots show nests. Kernel density (95%) is represented by gray shading, where dark, medium, and light gray represent high, medium, and low density, respectively.

it is possible to have variations related to home-range size and territoriality of *C. cristata* not observed in the present study.

The areas used by *C. cristata* groups were heterogeneous and included spaces occupied by livestock (with little human presence) and fully built-up areas with intense human traffic, indicating that human activity does not prevent occupation by this species. The occurrence of *C. cristata* in urban and rural areas has been reported in other studies (Alexandrino et al. 2013, Silva et al. 2016) and reinforces the need for increased conservation efforts in these environments (Pautasso et al. 2011). We concluded that the home ranges of *C. cristata* groups overlap very little, and that these groups use their entire home range as ter-

ritory, which they defend through vocalizations and agonistic behaviors.

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